SCIENCE EDUCATION IN THE BORDERLANDS: AN EXAMINATION OF SCIENCE CLASSROOMS IN TEXAS HIGH SCHOOLS IDENTIFIED AS SUCCESSFUL AND DIVERSE

A Dissertation

by

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ABSTRACT

Science literacy is a civil right and a critical part of becoming a participatory citizen in democracy. However, almost thirty years after *Science for All Americans* was released, scientific literacy is still not accessible to all. Unfortunately, science in schools is a place where students must transgress complicated cultural borders, even more so for students in highly diverse schools. Overall, science education is not inclusive, which becomes obvious in the disproportionate numbers of historically underrepresented individuals entering the science career pipeline. In this dissertation, my overall goal was to investigate the classroom learning environments of science teachers in traditional high schools identified as highly successful and highly diverse (HSHD) to uncover practices and patterns associated with high levels of success.

In Study 1, I provided a demographic overview of the HSHD schools, using an algorithm to identify highly successful schools in terms of science achievement and college and career readiness. Through my examination of state databases, I found that only 1.8% (n=24) of the 1,308 traditional high schools satisfied the criteria for recognition as both highly successful and highly diverse. This percentage occurred in Texas, a border "Mega-State" currently serving a student population over 50% Hispanic.

In Study 2, I looked into the classrooms of three schools identified as HSHD to focus on three to four science teachers within each school (n=10), individuals most responsible for the successful preparation of learners for career and college readiness.

As a result of this study, I developed a grounded theory explaining the process of science teachers' committing to science teaching at HSHD schools.

Finally, in Study 3, I used the *How People Learn Framework* to focus on observable practices and patterns of nine of these teachers in their classrooms to uncover unique strategies enhancing their students' learning. Classroom observation and analysis of teachers' interviews revealed that a strong sense of community pervaded among the teachers' practices. Each study tightened my lenses to examine aspects of the state, schools, and teachers of highly important yet often overlooked school ecologies associated with success in high school science achievement and college and career readiness.

DEDICATION

I dedicate this dissertation to my parents, to the professors who believed in me when I didn't believe in myself (Dr. Stuessy, Dr. Carter, Dr. Bozeman, and Dr. Larke), and to all the science teachers who volunteered their precious time to this research and others who continually fight for quality/equitable science education on the frontlines every day. There will never be enough words in this world for me to describe my gratitude. Therefore, to all of you I simply say - thank you.

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TABLE OF CONTENTS

Page

Page

LIST OF FIGURES

FIGURE | Page

FIGURE Page

LIST OF TABLES

TABLE Page

INTRODUCTION

Borderland is a place among multiple spaces: "a vague and undetermined place created by emotional residue of an unnatural boundary" (Anzaldúa, 2007, p. 25). *Science Education in the Borderland*s is a story about science teachers. Specifically, how science teachers in a border state (Texas) are currently preparing underrepresented students in the field of science. In *Science Education in the Borderlands*, I examined multiple border and borderland spaces. Geographical border spaces I examined included: Texas as a border state, Texas as a Mega-State with education research implications outside of its borders, and schools on the border being of urban and suburban boundaries. The borderland spaces I examined included: students in the borderlands of multiple spaces, and teachers' attempt to teach within and navigate these various borderlands.

Current education researchers and education policy makers have increasingly focused on the issue of underrepresented students' participation in science education. For example, in the report, *Successful Science, Technology, Engineering, and Math (STEM) K-12 Education*, researchers discussed the need "to increase the participation of groups that are underrepresented in the sciences, especially Blacks, Hispanics, and low-income students" (National Research Council [NRC], 2011a, p. 4). Efforts put forth by education policy makers, such as *Race to the Top* (2009), addressed the need for preparing more students from underrepresented groups to pursue advanced studies and careers in science (e.g., see Priority 2, p. 4). Additionally, committee members from national reports have cited the critical economic need for underrepresented populations to pursue careers in science fields (Committee on Science, Engineering, and Public Policy, 2012; National Academies of Sciences [NAS], 2011; NRC, 2012). Information regarding students entering STEM careers has come to be known as the STEM pipeline.

The rhetoric surrounding the pathways for underrepresented students to enter the STEM pipeline focuses mostly on the economic nature of the problem. However, much is at stake. If we do not educate all students to be scientifically literate, then disparities in social justice are created for underrepresented learners in the STEM fields. Authors of the *Next Generation of Science Standards* (Next Generation of Science Standards [NGSS], 2013) stated, “never before has our world been so complex and science knowledge so critical to making sense of it all” (p. 1). The humanistic need to understand science as a critical piece to make sense of the world more closely aligns with my position. Being scientifically literate allows students the opportunity to question their worlds and participate in evidenced-based problem solving. Science education researchers have stated:

> Without scientific knowledge we are wholly dependent on others as “experts”. With scientific knowledge we are empowered to become participants rather than merely observers. Science, in this sense…is a resource for becoming a critical and engaged citizen in a democracy. (Michaels, Shouse, & Schweingruber, 2008, p. 2)

Empowerment through opportunities to learn science and science literacy is a civil right (Tate, 2001). The processes learned through science education become a critical part of navigating and adapting to the quickly changing world. Carter, Larke, Singleton-Taylor, and Santos (2003), support this notion and stated that students of color are missing out on gaining “knowledge and a sense of empowerment that could provide untold benefits to their lives” (p. 5).

Whether it is economics or human need, one thing is certain: underrepresented groups are often provided less opportunities to participate in science education (Tate, Jones, Thorne-Wallington, & Hogrebe, 2012). The increasing political and education rhetoric focused on increasing underrepresented students’ participation in science derives from the fact that the student population in the United Stated is becoming more diverse, but “achievement gaps” in science have continued to persist (NGSS, 2013). Ensuring that students are provided equitable opportunities in science means researchers need to focus research and policy efforts on the K-12 STEM pipeline, particularly on schooling and how teachers choose to open the door of opportunity to science (NAS, 2011). However, examining and building on current science teaching practices is often top down. Cuban (2013) noted this top down phenomena and stated, “plans for restructuring science curricula have consistently come from the top of the policy making pyramid…it has been uncommon that curricular changes in science education have either begun with or spread from teachers” (p. 20). The primary goal for my dissertation research was to observe/interview science teachers at schools identitfied as Highly Successful and Highly Diverse (HSHD). Then from these teachers’ voices, practices, and experiences, share best practices to encourage curricular changes in science education.

I argue there is a need to build from sites of resilience where science teachers are successfully preparing diverse students in science and preparing diverse students for college, instead of focusing on the "achievement gap" and implementing some type of science education reform from the top down. Heath and Heath (2010) posited that change will happen when you look at the "bright spots," suggesting researchers should examine the successes within a specific context or micro-specific level of the system. Other researchers are also in agreement of a critical examination of the successes taking place in education and specifically in content areas such as science (Boykin & Noguera, 2011; NRC, 2011a, b).

Researchers from the National Center for Education Statistics (NCES) mentioned the importance of examining Mega-States, states that educate large numbers of the nation's students. In the report released by the NCES (2013), Texas was listed as one of the five Mega-States (i.e., California, Florida, New York, and Illinois.) Combined, the Mega-States educate close to 19 million (one-third) of the 49.5 million students in public schools. They are "at the forefront of the demographic shifts in our nation" (p. 2). The NCES (2013), noted that evaluating the Mega-States is critical:

> As policymakers and educators look at the nation's changing demographics and explore ways to close achievement gaps, the educational progress of children in these stated is of interest far beyond their state borders. (NCES, 2013, p.1)

With this perspective, as well as the need to create equitable science opportunities for all learners, the need to increase underrepresented populations participation in science and the need to examine "bright spots," I decided to zoom into a “bright-spot.” There is research within a Mega-State, Texas, focused on the “bright spot” of successful teaching and learning for diverse students in secondary science education. This “bright spot” research emerged from the Policy Research Initiative in Science Education (PRISE), National Science Foundation (NSF) Grant number 0455679 (Stuessy, McNamara, & Scott, 2005-2012).

The Texas-based PRISE research was an initiative aimed at examining the state of high school science education in Texas. PRISE researchers studied the interactions of complex school ecologies supporting the science teacher professional continuum. Concerned about the alarming attrition rates of science teachers, the researchers described school contexts and built models based on their understanding of science teacher recruitment, induction, professional development, and retention. As a follow up to the initial PRISE results and findings the researchers decided to continue their research through a no-cost extension to specifically examine schools identified as Highly Successful and Highly Diverse (HSHD). During this extension, survey results and interview findings from science teachers allowed Blocker (2013), in his dissertation work, to build a model of *Systematic Equity Pedagogy in Science Education*.

The previous PRISE researchers provided models of various aspects of science program ecologies in Texas based on extensive survey and interview self-report data from principals, science program leaders, and science teachers. Additionally, the previous PRISE researchers used the Student Aggregate Science Score (SASS) to identify HSHD schools to complete more specific and context based research within the school ecologies. However, I remained skeptical of the reliability of teacher self-report data regarding teachers' classroom practices at HSHD schools and the conclusions drawn from the analysis of these self-report practices. The PRISE researchers were not able to collect or explore data from observations of secondary science teachers in Texas high schools identified as HSHD. Therefore, I decided to focus on classroom observations of science teachers in identified HSHD schools for my dissertation research.

The state-of-the-state report for Texas high schools generated by previous PRISE researchers was not enough, in regard to HSHD schools. Blocker (2013) developed an equity pedagogy framework based on the self-report data. Additionally, PRISE researchers uncovered information about science teacher recruitment, induction, professional development, and retention practices in a representative sample of all high schools across Texas, including HSHD schools. However, evidence was still needed from teacher observations to extend the PRISE research to the next stage of the school ecologies research: the micro-level of science classrooms. Texas is a main player in in the world of education policy and reform. The purpose of my study was to extend the data collected by the PRISE research team to include an intensive examination of classroom practices associated with a small yet important sample of unique high schools in Texas.

Problem Statement

An analysis of public use data from the Academic Excellence Indicator System (AEIS) within the Texas Education Agency (TEA) regarding the 2011-2012 demographic characteristics of Texas public high schools revealed 24 (1.8 %) high schools (out of a total of 1,308) satisfy the HSHD requirements originally established by the PRISE project. This sample of high schools is based on demographic characteristics originally determined by PRISE to identify HSHD high schools. These schools provided the researchers a test bed from which to uncover classroom practices associated with HSHD high schools.

Previous PRISE researchers examined practices at HSHD schools based on self-report interview and survey data. Additionally, PRISE researchers focused on data collected at levels of school and science program, not data at the level of the science classroom. The PRISE researchers were unable to answer questions about what was actually going on in the science classrooms within schools identified as HSHD. I questioned whether I would find assimilationist pedagogy that emphasized memorization drills or if I would find a well-balanced effectively designed learning environment.

Limited studies exist in which researchers focused on successful secondary science learning for diverse learners. Furthermore, even fewer studies exist in which researchers focused on classroom observations using the *How People Learn (HPL)* framework (Bransford, Brown, & Cocking, 2000) as a lens for classroom based research on effective learning environments. While there is a tradition of scholarly work examining successful schools for underrepresented students, this genre has limited studies examining secondary teachers and science education. In Ladson-Billings' forward for *Start Where You Are But Don't Stay There*, a text examining successful teachers of diverse students written by urban education researcher, Richard Milner (2010), she stated that secondary teachers are a "group that has been under studied in this research genre" (p. ix). The *Successful STEM Education: A Workshop Summary* created by the National Research Council (NRC, 2011b) further supports this statement. Researchers noted, "although all too much is known about why schools may not succeed, it is far less clear what makes STEM education effective" (p. ix). Science education has often been dismissed from the success literature specifically in regard to diverse learners. In the forward for *Deep Knowledge: Learning to Teach Science for Understanding and Equity*, Douglas Larkin (2013), Ladson-Billings stated that "Larkin's text is an important contribution to a field that has long avoided issues of diversity, difference, and multiculturalism" (p. x). Limited literature exists regarding successful secondary science teaching practices for diverse learners; even fewer researchers have focused on the *HPL* framework as a lens for classroom observation and teaching improvements. Therefore, I chose the *HPL* framework (Bransford et al., 2000) as the overarching theoretical lens for my research in secondary science classrooms.

Theoretical Framework

The National Research Council (NRC) compiled decades of research in the learning sciences, to develop the *HPL* framework as part of their report titled *How People Learn: Brain, Mind, Experience, and School* (Bransford et al., 2000). The elegant, yet simple, *HPL* framework for the design of effective learning environments resulted from a convergence of research from cognitive psychology, social psychology, neuroscience, developmental research, anthropology, evaluation of learning environments, and research based on the "wisdom of practice" (Bransford et al., 2000, p. 7). The framework integrates research from the learning sciences to create a model identifying and connecting Learner-, Knowledge-, Assessment-, and Community-centered components (see Figure 1.1) to provide design specifications and models of practices for teachers in creating effective science classroom teaching and learning environments.

The *HPL* framework is essential for understanding the historical progression of current science education standards. Policy statements and national documents (e.g., *How Students Learn Science*, National Academies Press, 2005; *Taking Science to School,* Duschl et al., 2007; *A Framework for K-12 Science Education,* NRC, 2012) stated that show how the *HPL* framework substantially laid the foundation for the *Next Generation of Science Standards* (NGSS, 2013). Advancing almost a decade forward from the development of *HPL* (Bransford et al., 2000), there was the emergence of NGSS, but reflection backwards to what led up to *HPL* is equally as important.

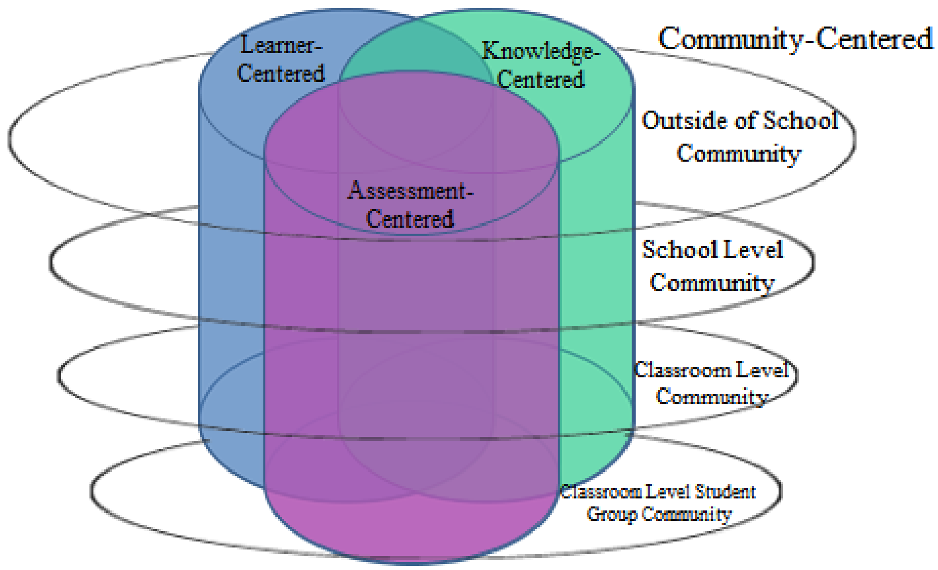

Figure 1.1. A visual of the community adapted *How People Learn* framework. Adapted from Bransford, Brown, and Cocking (2000).

The *HPL* framework had many uses over the past fifteen years. For example, HPL was used to train pre-service teachers at Stanford; and as an organizing framework for technology-based learning modules at Vanderbilt (Bransford, Derry, Berliner, Hammerness, & Beckett, 2005). In a recent *HPL* webcast meeting Marrett (National Academies, 2015a) stated, "there are teachers who have copies of the report in their limited libraries, there are policy makers who turn to *HPL* and as we will review a bit later there are people in the worlds of policy making who are paying a lot of attention to *HPL*." *HPL* has been fundemental to the field of learning sciences and education since its publication. Currently, the National Academies has put together a committee to create an updated edition of the *HPL* report set to release in 2018 (National Academies, 2015b).

Sujeet Bhatt, the study director for the updated *HPL* report, *How People Learn 2:The Science and Practice of Learning (HPL2)*, dicussed the populatrity of the original *HPL* report as well as the excitement building for *HPL 2* in her recent introductory address at a committee meeting on August 3, 2015. During the webcast meeting, Bhatt (National Academies, 2015c) stated the original *HPL* report "was the tenth most downloaded report for July 2015. So 15 years after the report was written *HPL* is still in the top ten. That tells you what an impact this report has and the excitement that has built for our subsequent report." In addition to being the tenth most downloaded report, HPL is overall the third most downloaded report from the National Academies. Over 80,000 downloads and 156,000 hard copies of the report have been sold, making it the sixth highest selling report from the National Academies. Clearly *HPL* is an important and meaningful framework. However, *HPL* is rarely used a lens for research on effective learning environments. As researchers and committee members at the National Academies move *HPL* into the next generation of learning sciences, teachers and policy makers will be paying attention to the pivotal research that will be addressed in the new report. However, before embracing *HPL2* we must truly understand what teachers currently know and do in their classrooms in regard to the original *HPL* framework.

Purpose and Research Questions

The overall purpose of this research study was to use the *HPL* framework as a primary lens to identify the characteristics of science classroom learning environments occurring within the unique set of schools in Texas identified as highly successful and highly diverse (HSHD). This knowledge will be useful to a number of stakeholders, including state policy makers, high schools and science teachers serving highly diverse populations of students. The guiding research question for this study was: *How do science teachers in high schools identified as highly successful, highly diverse (HSHD) design and orchestrate the learning environments of their science classrooms?*

Significance

Through this research, I provide a deeper understanding of how science teachers design and orchestrate their science classroom learning environments in a group of schools identified as being successful in preparing historically underrepresented students in science and college readiness. This research is significant for informing science education decisions at the state level through education policy makers and through teacher education outlets such as Education Service Centers (ESC), the Conference for the Advancement of Science Teaching (CAST), and various universities or alternative certification programs preparing secondary science teachers. Additionally, my research will help inform science education decisions at the district level through administrators, at the school level through principals and science program leaders, and finally at the classroom level through science teachers.

Dissertation Format

For this dissertation, I used a three-study format to answer the guiding question. I opted for a three-study format, because it allowed me the space to explore in depth the nuances and complexity of the ecological layer identified as the science classroom. The science classroom does not stand alone; science classrooms are the micro-level within a school ecology in which proximal and distal processes operate and guide daily actions (Wilcox, 2013). From the national problem as described in the context of my literature matrix (Appendix A), to the state level demographics with regard to the Student Aggregate Science Score (SASS), and finally to the classroom level to understand science teachers' stories and how science teachers orchestrate their classroom learning environments, I explored various levels of the school ecology system in which science classrooms operate. In each study within this dissertation, I tell a brief story of the classroom level in the overall system affecting science education for diverse students.

Table 1.1 is a roadmap for the studies in my dissertation. In Table 1.1, I present the guiding question and the additional sub-questions for each study. In addition to the research questions in Table 1.1, I also include a snapshot of the data and analysis used in each study. My literature matrix contains almost 200 articles. I examined and categorized the articles in the literature matrix using the *HPL* framework (Bransford et al., 2000). This allowed me to frame the national problem space regarding underrepresented learners in science education. In Study One, I described the state of science education in Texas for underrepresented learners, with details about how I selected schools for the research study. In Study Two, I examined science teachers' experiences about coming to and remaining at the selected school sites. Finally, in Study Three, I completed a multiple-case, embedded-design study to describe classroom observations, the *HPL* characteristics and the complexity dimensions of the teachers' classroom orchestrations.

Table 1.1

A Description of Research Questions, Data Sources, and Type of Analysis for Each Study in the Dissertation

Study	Research question	Data source	Type of analysis
Study 1 Introductory Information on HSHD Schools - an explanation about the unique qualities of HSHD schools and their place in the high school landscape of Texas.	How do the demographics of Texas high schools correspond in terms of their size, EcoDis percent, ESL percent and Hispanic student population with an aggregate measure of success (i.e., an aggregate score of measures of science achievement and college readiness called SASS)? What are the demographics of Texas schools distinguished as both highly successful (HS) and highly diverse (HD)?	USEP and SASS Data, School size and school demographics	Descriptive analysis
Study 2 Why do science teachers go to and remain at high schools identified as HSHD?	What are their backgrounds in terms of their teacher preparation? What are their backgrounds in terms of why they decided to become science teachers? What are their backgrounds in terms of years of previous teaching, other schools where they have taught, familiarity with the school in which they are currently teaching?	Pre- and post- observation interview, Survey	Grounded Theory

Table 1.1 Continued

Study	Research question	Data source	Type of analysis
Study 3 How do science teachers from HSHD high schools employ recommended teaching practices in their science classrooms?	What elements of the *How People Learn* (*HPL*) framework are evident in the science classroom learning environments of highly successful, highly diverse (HSHD) high schools? How do these science teachers orchestrate the complexity dimensions of their science lessons? Across all cases observed, what patterns of *HPL* design and practice characterize the science classroom learning environments of HSHD schools?	Classroom observations recorded on MSCOPS, *HPL* codes of MSCOPS, Interviews, Survey, Field noted, Artifacts	Multiple-case embedded design case study
Concluding summary	What do we now know about science classrooms in schools identified as HSHD?	Studies 1-3	Connecting summary
Literature matrix (Appendix A)	What previous research and thought is available to explain the state of science education for underrepresented learners? What previous research and thought explores the *How People Learn* framework in diverse science classrooms?	Literature from urban and multicultural science education coded into *HPL* components	Literature matrix

Clarification of Terms

For the purpose of this dissertation, I divided the terms into three categories which include: demographic descriptors, instrumentation, and theoretical perspectives.

Demographic Descriptors

Achievement gap. In the text *Closing the Opportunity Gap: What American Must Do to Give Every Child an Even Chance* (Carter & Welner, 2013) the authors explain that the "achievement gap" is a discussion regarding the "differences in school results between groups based on measured outcomes such as test scores" (p. 2). This disparity in education among the scores/measures of students from different backgrounds is traditionally broken down by racial/ethnic demographics descriptors. The conversation regarding achievement gap/disparities among groups of students can be traced back to the 1960's (Noguera, 2003). With regard to the discussion of the "achievement gap," I side with Carter and Welner (2013): "thinking in terms of the achievement gap emphasizes the symptoms; thinking about unequal opportunity highlights the causes" (p. 3). Carter and Welner (2013) preferred to view the issue in terms of an "opportunity gap" to shift "our attention from outcomes to inputs" (p.3).

However, when dealing with state and national data sets, those in power (policy makers) use standardize assessment measures to compare across socially constructed demographic categories. Instead of recognizing an opportunity gap or a flaw in the way they measure success, they see an "achievement gap." They obsess with "achievement gap" terminology and rarely focus on opportunity gaps, thus perpetuating a cycle of deficit ideology. This is highlighted by Carter and Welner's (2013) statement:

> A narrow focus on the achievement gap predictably leads to policies grounded in high-stakes testing, which in turn leads to narrow thinking about groups of students, their teachers, and their schools. While these assessments attempt to determine where students are, they ignore how they may have gotten there and what alternative pathways might be available. (p.3)

In this dissertation, I used the term "achievement gap" within quotations, thus recognizing the term as one used by researchers and policy makers when discussing success measures. However, when I use the term I always position my frame within one that is focused on the opportunity gap. Thinking more deeply about the inputs in the system, within my dissertation, I built from an "achievement gap" discussion (Study One) to one where I focused on opportunities to learn science (Study Two and Study Three). I moved towards specifically focusing on "inputs" and "alternative pathways" that have caused some schools serving diverse learners to create opportunities to learn science. The goal of my research was to observe the opportunities, not the gap.

Hispanic. This is a politically and socially constructed umbrella term used by policy makers to describe the "race/ethnicity" of a very diverse group/subpopulation of people. The term, "Hispanic," is highly debated and critics tend to make a case for using the term Latin@ (Gimenez, 2014). Those who debate the term also recognize that Latin@ is also an umbrella/generic term and many state that researchers should take into account additional information such as national origin, nativity, and/or generation. Furthermore, "regional variations ought to be taken into account as well" because people "living in the Southwest identify themselves in a variety of ways (e.g., Hispano, Mexicano, Manito, Chicano, Raza, etc.)" (Gimenez, 2014, p. 94). However, Gimenez (2014) noted that those in favor of using the term Hispanic operate from a pragmatic perspective. He stated "pragmatically, because the statistics compiled by the federal government and government agencies use the Hispanic label, social scientists and policy makers should avoid using a different term" (Gimenez, 2014, p. 94). Therefore, for the purpose of this dissertation I used the term Hispanic. If there is a case where I am quoting or paraphrasing a researcher who uses the term Latin@ or Latino/a in their research instead of Hispanic, then I respected his/her positionality and used the term as they reference it in their research. The reason why I am spending time problematizing and discussing only this racial/ethnic categorical term is because in this dissertation I focused on schools that are predominately Hispanic (e.g., 50% or more students attending the school self-identified as Hispanic.)

Highly successful and highly diverse (HSHD). This term is used to describe the schools selected for this study. Highly Successful (HS) is based on the highest categorical value of SASS (see SASS definition under the instrumentation section). Highly Diverse (HD) is defined as a school that has more than 75% students of color. These two variables combined create HSHD. I identified twenty-four HSHD schools out of 1,308 traditional high schools in the state of Texas. Note, in this dissertation I stated schools in the study have been "identified as HS," because we used an algorithm based on educational policy makers' ideas of success measures. Therefore, I gave those in power the power to define what is successful. I will not claim the school "is HS," because the definition of success is often fluid and dependent on variables sometimes beyond statistical measure. See “achievement gap” to review my position on success measures.

Mega-States. According to NCES (2013), Mega-States are the five stated in the United States that educate “close to 40% of the nation’s public school students” (p. 1). These stated include California (6.3 million students), Texas (4.9 million students), New York (2.7 million students), Florida (2.6 million students) and Illinois (2 million students). Additionally, Mega-States are: (1) responsible for educating most of the nation’s English Language Learners, (2) have the largest increases in immigrant populations, (3) hold more than one-third of all families below the poverty line, and, in general, (4) mirror the significant change in the nation’s demographic population shift (NCES, 2013).

Race/ethnicity. The Texas Education Agency (TEA, 2012) uses the term “race/ethnicity,” combined when referring to socially constructed categorical umbrella terms to describe phenotypic/cultural characteristics such as African American, Asian/Pacific Islander, Hispanic, Native American, Two or more, and White. From a critical pedagogy perspective of Kozol (1991), Milner (2015), Landsman and Lewis (2011) and other scholars in the field of urban education, I believe that many of the inequities in schools are based on systemic/institutionalized racism. Pragmatically speaking, however, the categories are not necessarily representative of the intense diversity within the demographic populations they describe. The naming of categorical data is socially constructed based on those who have the most power. Recognizing this limitation, my hands are tied. For quantitative social science research purposes and to highlight the racial inequities in the education system I find it necessary to use such categorical terms. As an emerging scholar I followed the political convention set by the Texas Education Agency (2012) in their reports and I followed the most recent science education research on "achievement gaps" released by Quinn and Cooc (2015) in American Education Research Association's (AERA) *Educational Researcher*. Following these conventions, I used the term "race/ethnicity" to refer to the socially constructed demographic descriptors (i.e., African American, Asian/Pacific Islander, Native American, Hispanic, White…etc.). Additionally, in efforts to be more socially responsible with my language I used the term "underrepresented students" when I referred more broadly to the STEM pipeline status of students within a subset of the listed categorical terms (see *underrepresented students* and *STEM pipeline* in Clarification of Terms for more details).

School size. I used school size as a variable describing the range of numbers of students within a high school in Texas. For this study the school size variable is broken down into small, medium, and large, based on the Texas University Interscholastic League (UIL) conference cutoffs (UIL, 2015). Large schools are UIL 6A (2100 students and above) and UIL 5A (1060 – 2099 students) schools. Medium schools are UIL 4A (465 – 1059 students) and 3A (220 – 464 students) schools. Finally, small schools are 2A (105 – 219 students) and 1A (104 students and below).

STEM pipeline. This is a term used to describe the flow of students interested in STEM related fields from K-12 schools through college and into a career in a STEM field.

Texas Education Agency (TEA). The Texas Education Agency is the state agency that oversees primary and secondary public education in the state of Texas. It helps deliver education to more than 5 million students (Williams, 2014).

Underrepresented students. Within this dissertation, I used this term to specifically describe students whose categorical demographic group is traditionally underrepresented in the STEM career pipeline, specifically with regard to science. NRC (2011a) has focused research efforts on successful STEM schools serving "groups that are underrepresented in the sciences, especially Blacks, Hispanics, and low-income students" (p. 4). These are not the only groups underrepresented in the sciences. For example we could also include females as underrepresented in science. In this dissertation I am focusing on racial/ethnic diversity. Therefore, when I use the term, "underrepresented student," I referred to racial/ethnic underrepresentation.

Urban. According to the U.S. Census Bureau, urban is "all territory, population, and housing units located within urbanized areas" (U.S. Census Bureau, 2015). Urbanized areas are places containing "50,000 or more people" (U.S. Census Bureau, 2015).

Urban schools. These are schools located in urban areas. Urban schools often serve a high number of students from racially/ethnically diverse backgrounds, as well as a high number of students coming from a low socioeconomic status (Noguera, 2003).

Instrumentation

How People Learn (HPL). I used *HPL* as the primary theoretical lens for the entire dissertation. See *HPL* under the Theoretical section of the Clarification of Terms for further details. As this was the primary theoretical lens, I also used it as the tool for analyzing the classroom observations. Each segment (see M-SCOPS for definition of segment) of the classroom is coded using *HPL components and codes* (see description below).

HPL component. In this dissertation, when I referred to *HPL* component or *HPL* components I specifically referred to the four main parts of the HPL framework (see Figure 1.1). The *HPL* components are learner-centered, knowledge-centered, assessment-centered, and community-centered.

HPL code. I developed *HPL* codes for each of the four *HPL* components in order to clearly tell stories about HSHD science teachers' teaching practices with regard to the *HPL* framework. I used *HPL* coding variables for categorizing sources within the literature matrix and data from classroom observations. I chose codes and elaborations for the codes (in parentheses) a priori on the basis of prior theory to further delineate the component; for example, I included these codes for the Learner-centered component: *Recognize/Build on Cultural Knowledge, Respect Language Practices,* and *Diagnostic Teaching,* which come from respected authors' descriptions of leaner-centered practices (Bransford et al., 2000). I made no attempts to confound the *HPL* framework by developing a formal checklist with components, codes, and elaborations. My only intent was to accurately identify *HPL* components with clarity and uniformity, particularly as they applied to observations and literature related to classroom learning environments within HSHD schools.

Math and Science Classroom Observation Protocol System (M-SCOPS). The M-SCOPS was developed by Stuessy (2009) to specifically identify teachers' enactments of "instructional and representational scaffolding" (p. 1). The M-SCOPS allows a researcher to capture continuous data from the classroom. Each time a student changes activity, the researcher starts a new segment on the M-SCOPS scripting sheet. Each segment on the M-SCOPS scripting sheet is coded according to levels of complexity in the engagement of classroom discourse and levels of complexity in model-building as well as model-eliciting actions. *Teacher-centered*, *shared*, and *student-centered* levels are descriptors used to describe levels of complexity in the engagement of classroom discourse. *High*, *medium*, and *low* levels are descriptors used to describe levels of complexity in the model-building and model-eliciting actions.

Student aggregate science score (SASS). This is an algorithm created by Bozeman and Stuessy (2013) to measure science programs across the state of Texas.

SASS = [(1.5 * SSE – 0.5) + CEET + PEET + APDE + SR]

State-reported school data are used to quantify each of the variables in the equation. SSE is the school's 10th grade Science TAKS score. CEET is the percent of Students at/above criterion on SAT/ACT scores. PEET is the percent of students taking SAT/ACT. APDE is the percent of students in Advanced Placement/ Dual Enrollment and SR is the School Rating. SASS scores for all schools are further categorized into quartile ranks. When I referred to aggregate student data within this dissertation, I specifically referred to the combination of accountability variables shown in the SASS algorithm.

Texas poll for secondary science teachers (TPSST). This is a survey created by members of the PRISE research group (Stuessy and Bozeman, 2011) for secondary science teachers. The purpose of the survey was to access "science teachers' level of participation in professional activities and attitude about their work environment," with "several questions related to teacher use of equitable teaching and learning practices" (Blocker, 2013, pp. 66-67). I administered the survey, of 36 Likert type questions, online to the ten teacher participants in this research study. In previous research, the TPSST was administered to 138 high school science teachers in a hand written response format.

Theoretical Perspectives

Borderland vs border. Throughout the dissertation, I used *border* and *borderland*; however, it is important not to confuse these terms. According to Anzaldúa (2007): "A border is a dividing line, a narrow strip along a steep edge. A borderland is a vague and undetermined place created by the emotional residue of an unnatural boundary. It is in a constant state of transition" (p. 25). For the purpose of this dissertation, I used Anzaldúa's take on borders and borderlands. The schools selected for the study are on the border of an urban and suburban area; they are all located in a border state; and they exist on the border of wealth and poverty. However, the students and teachers in the schools deal with borderlands of culture and science identities. Furthermore, the implications from this research will reach beyond the borders of Texas itself (NCES, 2013), as this research was situated in a Mega-State.

Culturally responsive teaching/culturally relevant pedagogy. It is important that I distinguish between and justify the use of these two terms. According to Gay (2002), culturally responsive teaching (CRT) is "using cultural characteristics, experiences, and perspectives of ethnically diverse students as conduits for teaching them more effectively" (p. 106). In addition to CRT, I referenced Culturally Relevant Pedagogy (CRP), coined by Gloria Ladson-Billings (2006, 1995, 1994). Her work, *The Dreamkeepers: Successful Teaching for African American Students* (Ladson-Billings, 1994) was the first major piece of literature that introduced me to the world of CRP. *The Dreamkeepers* was my inspiration to examine successful teachers of diverse learners within the micro-specific space of secondary science classrooms in Texas. Ladson-Billings (1995) described *cultural relevance* to include three criteria: "an ability to develop students academically, a willingness to nurture and support cultural competence, and the development of a sociopolitical or critical consciousness" (Ladson-Billings, 1995, p. 483). The development of sociopolitical consciousness is a feature that stands out in CRP. Additionally, Ladson-Billings contributed to *HPL* through her service on the Committee on Developments in the Science of Learning. Overall, the culturally responsive/relevant lens is critically important for understanding each piece of the *HPL* framework within science classrooms for diverse learners. In this dissertation I used both CRT and CRP.

Critical pedagogy. A philosophy of education described by Paulo Freire, critical pedagogy is a "social process, a social product, and a social movement that is grounded in a philosophy of praxis and democratic forms of organization" (McLaren &

Jaramillo, 2010, p. 260). Critical pedagogy is a combination of educational ideas with critical theory. Giroux, Apple, bell hooks, Kincheloe, and McLaren are scholars contributing largely to the development and progression of critical pedagogy. Olivos and Quitana de Valladolid (2014) state critical pedagogy is a "powerful lens" used to "examine underlying assumptions within social institutions, which lead to asymmetrical power relations based on race, class, and gender, particularly in the field of education" (p. 180). Critical pedagogy is a lens that is deeply ingrained into the way I make sense of the world. Therefore, within this dissertation, I used critical pedagogy as an additional lens through which to filter my research as I translated it from experience, analyzed, discussed, and made my conclusions. For my overall research lens, I combined critical pedagogy within a pragmatic perspective.

How People Learn. The *How People Learn (HPL)* framework (Bransford et al., 2000) is the primary and guiding theoretical lens for my dissertation. This framework is described in the *Introduction* of this dissertation under the *How People Learn Framework*. Also, see Figure 1.1 for a visual representation of the *HPL* framework.

Pragmatic perspective. Urban education scholar, Noguera (2003), used "pragmatic optimism" as a guide to discuss urban schools in his book, *City Schools and the American Dream: Reclaiming the Promise of Public Education*. Building on Noguera's idea of pragmatic optimism I chose to explore science teaching in HSHD classrooms using a pragmatic perspective. According to Creswell (2007):

> Pragmatism is not committed to any one system of philosophy and reality. Pragmatists do not see the world as an absolute unity. Truth is what works at the

> time; it is not based in a strict dualism between the mind and a reality completely independent of the mind. Pragmatists agree that research always occurs in social, historical, political, and other contexts. Thus, for the mixed methods researcher, pragmatism opens the door to multiple methods, different worldviews, and different assumptions, as well as to different forms of data collection and analysis in the mixed methods study (p. 12).

Using mixed methods, observing in urban schools, and viewing the world through multiple perspectives I used the pragmatic perspective to deviate from "strict dualism." By viewing the world through a pragmatic perspective, combined with a critical pedagogy lens, I explored research as it occurs within "social, historical, and political context" as well as examine the "underlying assumptions within social institutions, which lead to asymmetrical power relations" in those different contexts (Creswell, 2007; Olivos & Quitana de Valladolid, 2014).

Star Teacher ideologies. Haberman completed extensive research on teachers in urban schools who either stayed or left the school. Haberman (2005) identifid the teachers who stayed in diverse urban schools as *Star Teachers*. He then studied their beliefs about teaching specifically in relation to their beliefs about: (1) the role of the school, (2) about problems that might arise in the school, and (3) about what causes students' success. Haberman termed these beliefs *Star Teacher Ideologies*. In this dissertation, I focused on urban schools identified as successful, and therefore used the lens of *Star Teacher Ideologies* to better understand why the teachers particiapting in the study stayed and taught science at their identified successful schools.

Conclusion

Through the guidelines, conditions, and terms established in this introduction, I provided the framework for the design of the three research studiess that follow. My intent in implementing these studies was to learn as much as possible from models of schools idenfitifed to have successful secondary science teaching and learning for diverse learners. In that regard, I refused to succumb to the deficit model of "acheivement gaps" and persistent failures of schools. I wanted to know how I could learn from good models about successful practices that address the needs of historically underrepresented children. Furthermore, I wanted to find a way to contribute to the service of teaching and learning for children deserving to be empowered through the best opportunities to learn science and pursue STEM-related careers. Ultimately, I wanted to create research that would further advance our knowledge to assure that science literacy is recognized as a civil right for all children. Thus, providing future students with equitable opportunities to learn science, which is infinitely beneficial in their lives.

In the early stages of thinking about this research, I understood logically there was little probability of being able to make sense about "best practices" from observing science classrooms in low-performing schools. Instead, I pragmatically examined science teachers and their classrooms in schools distinguished by high school scores on "success variables." My reasoning was that I could learn more about successful science teaching practices in schools serving exceptionally high numbers of underrepresented students that had a "track record" in achieving highest schores on state-mandated measures of school success. While I might have argued more rigorously about what it means to be “successful,” I used a pragmatic route to define “school success.” I followed the lead of a research group that had established an extensive research agenda on the state-of-the-state of science teaching in Texas high schools, selecting high-stakes variables identified by the state of Texas as “college and career readiness” indicators. I adopted the SASS algorithm for “school success” that incorporated science achievement scores, percentages of students at or above the criterion on college entrance examinations, percentages of students in advanced placement and/or dial enrollment courses. Highly succesful (HS) schools scored on the fourth quartile on SASS; and highly diverse (HD) schools served populations that were serving at least 75% students of color. The schools I selected were exceptional, because HSHD schools represented a little less than two percent of all of the traditional high schools in Texas.

The schools and classrooms I carefully selected provide the context for the studies in this dissertation. Within each of the studies, I provided a partial answer to the guiding question of my research: *How do science teachers in high schools identified as highly successful, highly diverse (HSHD) design and orchestrate the learning environments of their science classrooms?* In Study One, I detailed the selection strategies I employed to identify traditional Texas high schools successfully serving high numbers of underrepresented students. In Study Two, I analyzed teachers’ interviews to understand these science teachers’ experiences in relation to their initial decisions to become, and then to remain a science teacher at HSHD schools. Finally, in Study Three, I completed my research journey with an in-depth study of science teachers’ design and orchestration of their classroom learning environments, attempting to answer the call for context-based, observational, secondary science education research in schools serving high numbers of underrepresented students. In the final section of this dissertation, the *Concluding Summary*, I addressed the compelling question, "What is next?" in terms of making "science for all" a reality for all school children served in this nation; a nation dependent upon the decisions of a scientifically literate population to guide their democratic society into the future.

A DEMOGRAPHIC OVERVIEW OF SECONDARY SCIENCE EDUCATION IN TEXAS

"Science for all" has a long history in science education policy and research. Additionally, for three decades, Atwater (1986) has advocated the need for underrepresented students to receive equitable opportunities to learn science. As "science for all" became increasingly important in the last couple of decades, policy makers began adding "science for all" rhetoric to both national and state standards. Science curricular frameworks such as *Benchmarks for Science Literacy* from Project 2061 (American Association for the Advancement of Science [AAAS], 1989), the *National Science Education Standards* (NSES, 1996), and more recently the *Next Generation Science Standard*s (NGSS, 2013) have all incorporated "science for all" into their frameworks in attempts to increase equitable learning opportunities for students from underrepresented groups. However, researchers have consistently claimed that in the field of science there is "staggering underrepresentation" in the mention of diverse groups (Aguilar-Valdez, et al., 2013). Gross underrepresentation in the field of science and opportunities to learn science are intricately linked together (National Academies of Sciences [NAS] , 2011). As a researcher I was left to question, what happened to "science for all" and what is going on at the high school level in the STEM pipeline for underrepresented learners in Texas?

Why Focus on Texas?

Texas is a border state. It juxtaposes the space between nations (Anzaldúa, 2007). Additionally, Texas is a “Mega-State” with over 8,000 schools that serve more than 5 million students (National Center for Education Statistics [NCES], 2013). Additionally, Texas spends over $42 billion dollars on elementary and secondary education annually. Researchers at NCES have mentioned the importance of examining Mega-States, those states educating large numbers of K-12 students. In a 2013 report released by the NCES, Texas was listed as one of five Mega-States. Combined with California, Florida, New York, and Illinois, these Mega-States educate approximately 19 million, or one-third, of the 49.5 million K-12 students in public schools within the U.S. These Mega-States are also “at the forefront of the demographic shifts in our nation” (NCES, 2013, p.2). Part of the reason Texas is on the forefront of demographic shifts is due to the fact that it is a state that sits on the border between North and South America. The researchers noted that evaluating the Mega-States is critical:

> As policymakers and educators look at the nation’s changing demographics and explore ways to close achievement gaps, the educational progress of children in these stated is of interest far beyond their state borders. (NCES, 2013, p. 1)

Finally, textbook developers heavily rely on influences from Texas, because Texas is a guiding state in the nation for textbook selection. With the importance of focusing on Mega-States and the need to create equitable opportunities in science education for all students, I have decided to focus my research efforts on Texas schools. Therefore, the first step in this research study required me to determine the current state of science education for underrepresented learners in Texas and identify highly successful and highly diverse (HSHD) high schools.

Purpose and Research Questions

In this study, I have explained a sampling method to identify HSHD science programs, and I described introductory information on HSHD schools. Specifically, I described the unique qualities of HSHD schools and their place in the high school landscape of Texas. In addition to the identification and description of HSHD schools, I also answer the following questions: (1) How do the demographics of Texas high schools correspond in terms of their size, Economically Disadvantaged (EcoDis), English as a Second Language (ESL), and Hispanic student percentages served by an aggregate measure of success (i.e., an aggregate score of measures of science achievement and college readiness called SASS)? and (2) What are the demographics of Texas schools distinguished as both highly successful (HS) and highly diverse (HD)?

Theoretical Perspective

I have taken a pragmatic perspective to discuss two assumptions guiding the purpose for this study. A pragmatic perspective in education research uses prevalent logic in current policy environments to address specific needs or concerns for stakeholders in education (El-Hani & Mortimer, 2007). I used this perspective to address two needs for stakeholders in education: (1) describing school level characteristics with aggregated student level data and (2) sampling schools likely to provide evidence of successful diverse student learning in science. First, I used a pragmatic perspective to discuss policy based assumptions to aid me in describing school characteristics in the state of Texas. Then, from a pragmatic perspective, I employed purposive sampling to identify HSHD schools for teacher, and school level research.

Background

Assumptions about Aggregate Student Data

Many researchers begin with the assumption that aggregate student level data described school level characteristics (i.e., high aggregated student scores on standardized tests describe successful schools; Bozeman & Stuessy, 2013; Carnoy, Loeb, & Smith, 2003; Knapp & Feldman, 2012). The analysis of aggregated student test scores on standardized science exams has led many researchers in science education to conclude few diverse or urban schools exist in which students exhibit successful acquisition of science material (Bozeman & Stuessy, 2013; Calabrese-Barton & Berchini, 2013; Johnson, 2013). In this study, I was not interested in analyzing the difference among students within schools. Rather, I was interested in analyzing relationships between school level characteristics and student level data—namely, achievement, by first sampling schools serving student populations identified as majority students of color (Jacob, Goddard, & Kim, 2013). Aggregated student test scores used to describe school level characteristics is described by Knapp and Feldman (2012). The authors state several developments happened with a focus on "new accountability" in the current policy environment, "accountability systems paid more explicit attention and placed far greater emphasis on: demonstrated results, generally through the vehicle of student test scores… the units of accountability broadened to include the whole school"

(Knapp & Feldman, 2012, p. 668). School characteristics, such as success, are often described with aggregated student data. To describe schools' success, researchers often use measures of students' high school completion, college attendance, and performance on standardized tests; "these are the 'signals' that society values" (Carnoy et al., 2003, p. 149). Today, researchers described schools as "good" when the majority of their students perform well on these measures (Carnoy et al., 2003). Therefore, in efforts to be consistent with the literature, within this study I used aggregate student level data to identify a sample of schools in Texas that are highly successful and highly diverse.

Assumptions about Sampling

Two assumptions about sampling must be taken into account: (1) defining populations, and (2) sampling designs. Populations are composed of individuals possessing similar characteristics. As a result, populations are defined broadly so as to include all potential individuals. Populations, however, can occur within populations. For example, highly successful schools are a population of schools occurring within the population of all schools (see Figure 2.1). As stated earlier, many stakeholders contend few highly successful and highly diverse schools currently exist. The fact few of these schools exist led me to my second assumption regarding sampling designs: "sampling refers to this process of selecting a sample from a defined population with the intent that the sample accurately represents that population" (Gall, Gall, & Borg, 2007, p. 166).

Two types of sampling are germane to this study, random (i.e., probability) and purposive (i.e., non-probability). In random sampling, all cases have an equal or independent chance of selection (Gall et al., 2007). In doing so, researchers are most likely to generate conclusions inferable to all individuals within a population. However, the Policy Research Initiative in Science Education (PRISE) researchers failed to identify a single highly successful and highly diverse school in a random sample of in Texas high schools. Therefore, in follow up research on HSHD schools, the PRISE researchers chose purposive sampling methods to identify the few HSHD schools existing in the population of all high schools. Purposive sampling, unlike random sampling, does not provide an equal or independent chance of selection. In purposive sampling, researchers are more concerned with the richness of information from selected cases that may not even be identified within a random sample. This often happens when populations of interest have few members.

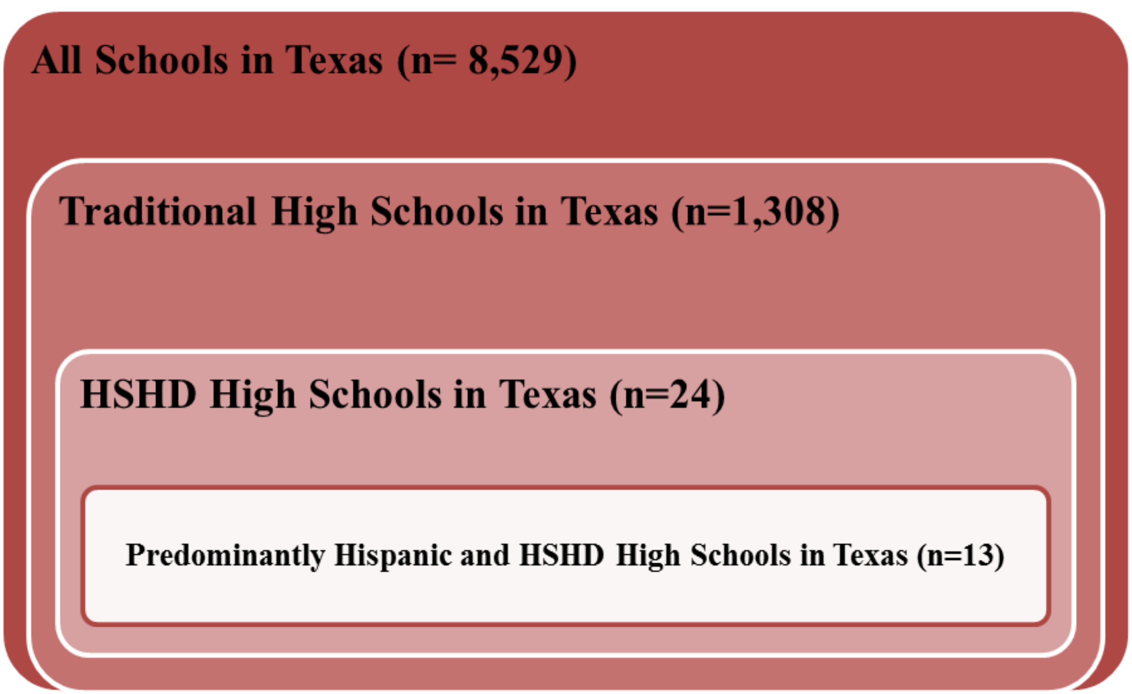

Figure 2.1. Populations within populations for the sample of interest in this study.

As mentioned, PRISE researchers found that random sampling did not identify highly successful and highly diverse schools within the population of all schools. Therefore, purposive sampling was chosen to: (a) set boundaries for case analyses, (b) identify deviant cases (i.e. successful and diverse schools), and (c) identify a sample within the deviant cases (Gall et al., 2007). The assumptions about aggregate student data led me to a purposive sampling design, which became the foundation for this research study.

Sampling successful schools for case study research is becoming a popular trend for policy makers in Texas. In 2014, Texas focused on "best practice" case study schools to meet the federal requirements for fulfilling a waiver request to *No Child Left Behind* (NCLB; TEA, 2014). TEA focused on "best practices" at eleven schools identified as successful for "disadvantaged students" (TEA, 2014). Specifically, TEA examined three high schools. The case studies were released in May 2015. The goal of these case studies was to share the identified best practices to help lower performing schools "in hopes of replicating that success" (TEA, 2014, para. 4). However, the case study schools were identified on the basis of reading and math scores. For this reason, there was still a need to specifically focus on schools identified as successful based on science programs, so that best practices for science achievement can be shared.

The importance of focusing on science practices and the STEM pipeline for Hispanic students has started to become a major collaborative research effort within Texas. For example, there is the Texas Hispanic STEM Research Alliance (part of the Regional Educational Laboratory Southwest), which has released a Texas Hispanic

STEM data inventory. This group is currently working on a literature review that focuses on key K-12 indicators for Hispanic students that have potential to impact post-secondary STEM outcomes (Texas Hispanic STEM Research Alliance, 2015), which is set to release in spring 2016.

Methods

Type of Research Design

In this quantitative study I used a non-experimental descriptive research design (Gall et al., 2007), which allowed me to identify and describe a sample of HSHD high schools across Texas. In identifying the schools, I used non-probability or purposive sampling (Gall et al., 2007).

Data Set

For the purpose of this analysis, I used the most recently released scores from the Texas Education Association (TEA); specifically, the Academic Excellence Indicator System (AEIS, 2012). The data in AEIS is approved by Texas A&M University Institutional Review Board (IRB) as a public use data set. I collected information from AEIS on the entire population of all schools (n=8,529) in the state of Texas. Then I used a system of limiting (if “a” then delete) terms to delete all schools except for traditional public high schools (see Appendix A for this process described in detail). After this process, the remaining population included 1,308 traditional public high schools in Texas. From this population, I sampled for highly successful and highly diverse schools. It is important to note that AEIS data was used instead of STAAR scores and more recent school accountability information. The data available in the TEA-AEIS has years of reliability and validity, whereas the more current school accountability system, which started in 2013, is still in the testing and revising phases.

Highly Successful and Highly Diverse Defined

Highly successful. As part of the NSF funded Policy Research in Science Education (PRISE) initiative, researchers developed a measure identified as the Student Aggregate Science Score (SASS). This measure is based on various indicators of science and college readiness from the Texas Education Agency (TEA) Academic Excellence Indicator System (AEIS). The algorithm for SASS (Bozeman & Stuessy, 2013) is below:

$$SASS = [(1.5 * SSE – 0.5) + CEET + PEET + APDE + SR]$$

SSE is the 10th grade Science TAKS score. CEET is the percent of Students at/above criterion on SAT/ACT scores. PEET is the percent of students taking SAT/ACT. APDE is the percent of students in Advanced Placement/ Dual Enrollment and SR is the School Rating. SASS scores for all schools are further categorized into quartile ranks.

Highly diverse. Highly diverse was defined using TEA data describing students' ethnicity. Specifically, I generated the Underrepresented Student Enrollment Proportion (USEP) from aggregated student ethnicity data by dividing the total number of students of color within a school by the total student population. Once I generated USEP values for schools, I generated categories using modified quartile ranks. First quartile schools are 0-35% USEP; second quartile, 36-50% USEP; third quartile, 51-

74% USEP; and fourth quartile, 75- 100% USEP. I used the first quartile range as 0-35% to follow the modified distinction used by TEA (Bozeman & Stuessy, 2013).

Additional Data

Additional data such as school size, socioeconomic status (SES), percent of English as a Second Language (ESL) students, and geographic location, were also collected from AEIS. I pulled this additional data to help me decide the school sample for future case study research and to describe the current demographic characteristics of the state with regard to SASS. Additionally, the state uses these additional variables to cluster schools into groups for achievement comparisons. All schools selected for the case study were HSHD for the most recent output (2011-2012 TEA AEIS) data set. With regard to SES, TEA specifically refers to a population of students from low SES backgrounds as “economically disadvantaged” (EcoDis). TEA classifies students as EcoDis based on free/reduced lunch (TEA, 2012). From this point forward, when I discuss SES I will specifically be focused on EcoDis percentages. See Table 2.1 for details regarding all the additional demographic data used in this study.

As seen in Table 2.1, all data for this study was transformed into ordinal data so that I could complete a crosstab analysis. I also considered schools that were consistently (meaning over the past 2 PRISE data sets) categorized as successful (3rd quartile SASS score) or highly successful (4th quartile SASS score) when I was selecting the HSHD school sites for the study. In Table 2.2, I have listed all the previous SASS and USEP categories for each of the identified HSHD schools. The consistently successful or highly successful school sites were determined based on a crosstab rerun of the previous PRISE data sets. For the crosstab rerun of the previous PRISE data sets, I limited the population using the traditional school selection criteria (see Appendix A) and computed SASS for 2006-2007 school year data and 2010-2011 school year data. I used the school size variable distinctions of small, medium, and large, based on the Texas University Interscholastic League (UIL) conference cutoffs (UIL, 2015). Large schools were UIL 6A (2100 students and above) and UIL 5A (1060 – 2099 students) schools. Medium schools were UIL 4A (465 – 1059 students) and 3A (220 – 464 students) schools. Finally, small schools were 2A (105 – 219 students) and 1A (104 students and below). For the SES and ESL data I used the natural breaks in the data to create quartiles.

Analysis

Frequency analyses were used to describe the population of traditional high schools and the sub-population of HSHD high schools in Texas. In describing traditional high schools in Texas, I used SASS and additional variables such as school size, EcoDis percent, ESL percent, and disaggregated USEP information (see Table 2.1). In describing HSHD schools in Texas, I had to first identify these schools by conducting cross tabulation with the quartile ranks for both the SASS and USEP variables (see Table 2.2). Next I used SASS, disaggregated USEP information, school size, SES, ESL, and geographic location to describe the HSHD schools.

Table 2.1

School Variables Used to Complete Analyses of HSHD Schools in Texas

Variable	Source	Level	Code (cutoffs)
SASS	Bozeman & Stuessy, 2010	Ordinal, 4 level	Lowest (score 0-10.99) Low (score 11.13.49) High (score 13.5- 15.99) Highest (score 16-23.5)
USEP	Texas Education Agency	Ordinal, 4 level	Lowest (0-34.99%) Low (35-49.99%) High (50%-74.99%) Highest (75-100%)
Size	University Inter-scholastic League	Ordinal, 3 level	Small (1A -2A) Medium (3A-4A) Large (5A-6A)
EcoDis % (SES)	Texas Education Agency	Ordinal, 4 level	Lowest (0-37.724 %) Low (37.725-51.049 %) High (51.050-67.699 %) Highest (67.7-100%)
ESL %	Texas Education Agency	Ordinal, 4 level	Lowest (0-.8%) Low (.801-2.09%) High (2.10-4.99%) Highest (5-38.3%)
Hispanic %	Texas Education Agency	Ordinal, 4 level	Lowest (0-24.99%) Low (25-49.99%) High (50-74.99%) Highest (75-100%)

Table 2.2

Texas HSHD School Success and Demographic Quartile Trends since the PRISE 1 Study

School	SASS Category 2006-2007	USEP Category 2006 - 2007	SASS Category 2010-2011	USEP Category 2010 - 2011
1	4	3	4	3
2	N/A	N/A	4	3
3	4	3	4	4
4	4	4	4	4
5	4	3	4	3
6	4	4	3	4
7	4	3	4	4
8	3	4	3	4
9	4	3	4	3
10	N/A	N/A	3	4
11	N/A	N/A	4	3
12	4	3	4	3
13	4	3	4	3
14	3	4	4	4
15	N/A	N/A	3	4
16	2	3	3	3
17	3	4	N/A	N/A
18	4	3	4	3
19	4	3	4	3

Table 2.2 Continued

School	SASS Category 2006-2007	USEP Category 2006 - 2007	SASS Category 2010-2011	USEP Category 2010 - 2011
20	N/A	N/A	3	4
21	N/A	N/A	N/A	N/A
22	4	3	4	4
23	3	4	3	3
24	3	4	4	4

Results

My first goal for this study was to identify possible HSHD schools for case study research. Based on the results from the cross tabulation (Table 2.3) I identified highly successful (SASS category 4) and highly diverse (USEP category 4) schools. Out of 1,308 traditional high schools in Texas, about 28 % of the schools were categorized as *highly diverse* (n = 360). However, of those 360 highly diverse schools only 1.8% of schools were identified as HSHD (n=24). This number is much smaller in comparison to schools that serve a predominately White student population. For example, there were 428 traditional high schools in Texas serving mostly (more than 65%) White students, and 10.6% of those schools were considered *highly successful* (n=140). Based on the results, it is clear to see too few highly diverse schools have outcomes indicating equitable opportunities to learn science. For example, 6.6 % of all highest USEP schools resided in the 4th quartile for SASS, while 32.7% of all lowest USEP schools resided within the 4th quartile. The comparison indicates that students in the lowest USEP schools were about five times more likely to score in the 4th quartile on SASS. Similar trends were apparent within the additional demographic data discussed in the next section.

Table 2.3

Distribution of Texas High Schools by Underrepresented Student Enrollment Proportion (USEP) and an Aggregate Measure of Science Achievement and College Readiness (SASS)

USEP	Total (%)	SASS Quartile	Number (%) within category	Percentage (%) of all schools (n=1,308)
Highest	360 (27.5)	4th	24 (6.6)	1.8
		3rd	71 (19.7)	5.4
		2nd	117 (32.4)	8.9
		1st	148 (41.1)	11.3
High	302 (23.0)	4th	85 (28.1)	6.5
		3rd	73 (24.2)	5.6
		2nd	71 (23.5)	5.4
		1st	73 (24.2)	5.6
Low	218 (16.6)	4th	83 (38.1)	6.3
		3rd	55 (25.2)	4.2
		2nd	43 (19.7)	3.3
		1st	37 (17.0)	2.8
Lowest	428 (32.6)	4th	140 (32.7)	10.6
		3rd	125 (29.2)	9.5
		2nd	99 (23.1)	7.5
		1st	64 (15.0)	4.9

Texas School Demographics

How do the demographics of Texas high schools correspond in terms of their size, EcoDis percent, ESL percent, and Hispanic student population percent with an aggregate measure of success? In Tables 2.4 through 2.7, I addressed this question. School size is the first additional variable I examined with regard to SASS. The majority of traditional high schools in Texas were medium schools (n= 503). The majority of large schools (n =468) were categorized as the highest level of SASS, whereas we see the opposite with small schools (see Table 2.4). Most small schools (less than 219 students) were categorized as the lowest level of SASS.

Table 2.4

Cross Distribution of Variables for Size by SASS Using 1,308 Traditional High Schools in Texas

	SASS level				
Size	Lowest	Low	High	Highest	Total
Large	84	112	101	171	468
Medium	117	131	153	102	503
Small	121	87	70	59	337
Total	322	330	324	332	1,308

In Table 2.5, I displayed the varying percent of students classified as EcoDis. The EcoDis percent was transformed into a quartile rank. Over half the schools in Texas (n = 683) were in the highest (more than 75%) or high (more than 50%) levels of classification for students identified as EcoDis. The majority of schools with the lowest percentages of students classified as EcoDis were in the highest SASS category (n = 105). There was an opposite trend for schools that had the highest percentages of students classified as EcoDis. These schools were in the lowest category of SASS (n = 121). In other words, 71% (n=484) of the schools had the highest or high levels of students classified as EcoDis were in the low or lowest levels of SASS. This trend means that schools with higher percentage (more than 50%) of students on free/reduced lunch were more likely to have a lower SASS score. This further perpetuates the "leak" in the STEM pipeline. Over 1/3 of Texas traditional high schools serving the most economically disadvantaged students had outcomes indicating poor preparation in science.

Unfortunately, when examining SASS categories for other variables such as ESL or Hispanic student percent, the trends were similar. The results I reported in Table 2.6, indicate the varying percent of students classified as ESL (transformed to quartiles) when crossed with SASS score. Over half the schools in Texas (n = 664) were in highest or high level classification of students that were identified as ESL. The majority of schools that had the lowest percentages of students classified as ESL were in the highest SASS category (n = 103). There is an opposite trend for schools that had the highest percentages of students classified as ESL. These schools were in the lowest category of SASS (n = 121). Over 50% (n=379) of schools that had the highest or high levels of students classified as ESL were in the low or lowest levels of SASS.

Table 2.5

Cross Distribution of Variables for EcoDis by SASS Using 1,308 Traditional High Schools in Texas

	SASS level				
EcoDis level	Lowest	Low	High	Highest	Total
Highest	121	65	39	3	228
High	145	153	108	49	455
Low	56	103	158	175	492
Lowest	0	9	19	105	133
Total	322	330	324	332	1,308

Finally, I examined disaggregated student percent by race/ethnicity, specifically focusing on Hispanic student population crossed with SASS score categories (see Table 8). Disparities continued to be present. Despite current demographics, which reflected that more than half of the school students in Texas were Hispanic (Williams, 2012; Williams, 2014), the majority (68% or n=895) of traditional high schools in Texas have less than a 50% Hispanic student population. This trend could be possible because the schools that were in the highest or high level of Hispanic student population were more likely (192 out of 413; 46%) to be large high schools serving over 1,060 students. As seen in Table 8, the trend in high schools that are in the high or highest levels of Hispanic student population (more than 50% students classified as Hispanic) were less likely to be categorized in the high or highest SASS category. For example, if the school was in the high or highest Hispanic student level, there was only a 8.8% chance (see Table 2.7) that it would also be in the highest SASS category. Whereas, if the school was in the low or lowest Hispanic student level (i.e, less than 50% Hispanic student population) then the school had a 33% chance to be in the highest SASS category.

Table 2.6

Cross Distribution of Variables for ESL by SASS Using 1,308 Traditional High Schools in Texas

	SASS level				
ESL level	Lowest	Low	High	Highest	Total
Highest	121	94	78	39	332
High	88	76	72	96	332
Low	45	73	82	94	294
Lowest	68	87	92	103	350
Total	322	330	324	332	1,308

Table 2.7

Cross Distribution of Variables for Hispanic Percent by SASS Using 1,308 Traditional High Schools in Texas

	SASS level				
Hispanic level	Lowest	Low	High	Highest	Total
Highest	87	68	43	6	204
High	69	57	53	30	209
Low	80	85	86	111	362
Lowest	86	120	142	185	533
Total	322	330	324	332	1,308

Overall, my examination of additional variable yielded persistent results: schools with higher percentages of students that are classified as ESL, EcoDis, or Hispanic were more likely to have lower SASS scores. In addition, an interesting finding from the additional data was the juxtaposition of SASS and school size. School size was a variable that is complex and deceiving. Based on the results, large schools were more likely to be identified as the highest SASS category. However, when I crossed large school size with USEP or EcoDis or both, a different story resulted (see Appendix B for layered cross tab tables). Almost half of the large high schools (217 out of 468; 46%) are classified in the highest USEP category (highly diverse). However, only 21 of those 217 large and highly diverse high schools were placed in the highest SASS category. Furthermore, out of the 468 large high schools, 106 were in the highest category of

EcoDis. Every one of those 106 high schools were in the highest USEP category; not a single one was in the highest SASS category. Therefore, students served by large, diverse high schools with the highest percentages of EcoDis students had zero probability of attending a school that was highly successful in preparing students for science or college readiness.

HSHD School Demographics

What are the demographics of Texas schools distinguished as both highly successful (HS) and highly diverse (HD)? Texas reports student demographic data for every school in the state. To answer this question, I focused on EcoDis percent, ESL percent, and race/ethnicity demographic characteristics of HSHD schools. Table 2.8 includes the demographic information for all 24 identified HSHD traditional high schools. Additionally, in Table 2.8, I listed the TEA district type for each school. The TEA district type provides information about school and location characteristics. There are a total of nine TEA district types. For detailed information about district types, see Appendix C. The average student enrollment for the 24 identified HSHD traditional high schools was about 2,250; therefore, these were classified as large schools (UIL classification would be a 6A school). The average race/ethnicity for the HSHD schools included 54% Hispanic, 18% African American, and 10% Asian, Pacific Islander, Native American, Two or More. The average EcoDis was 49 % for the 24 HSHD schools. Finally, the average ESL population at the HSHD schools was 4.5 %. While this ESL percent might seem low, it is important to keep in mind the ESL quartile cut offs and the range for the ESL percent. The range for ESL percent in the traditional high school was from 0-38.3%, and anything above 5% was considered to be in the highest quartile for ESL percentage.

There were 13 schools out of the 24 HSHD that predominately served a Hispanic student population. Only one (out of the 24 identified HSHD schools) served a predominately African American student population (School 14). Additionally, there was only one school (out of the 24 identified HSHD schools) where the Asian, Pacific Islander, Native American, and Two or More percent category was the highest underrepresented population (School 13). Finally, over 50% of the HSHD schools are classified as being in a major suburban district type. However, most of the schools in a major suburban district type were actually located in an urban Texas city that had several large districts. Therefore, TEA only considered the largest district in the city to be urban, whereas the other districts located in the area were suburban even though the district was in an urban city.

Table 2.8

Texas HSHD School Demographic Characteristics

School	Student enrollment count	EcoDis (%)	ESL (%)	Hispanic (%)	African American (%)	Asian, PI, NA, ToM* (%)	TEA district type
1	3,251	45.1	4.4	47.9	13.4	15.0	Major Suburban
2	3,149	55.7	3.8	50.7	18.9	6.8	Major Suburban
3	3,012	57.1	6.2	52.6	17.8	13.1	Major Suburban
4	2,999	38.7	5.8	77.6	1.8	3.2	Major Urban
5	2,975	46.5	4.3	36.3	32.0	8.2	Major Urban
6	2,790	47.1	1.5	71.0	8.0	5.3	Major Urban
7	2,774	41.9	5.7	76.2	1.6	3.7	Major Urban
8	2,751	52.2	11.5	95.7	0.3	1.5	Other Central City

Table 2.8 Continued

School	Student enrollment count	EcoDis (%)	ESL (%)	Hispanic (%)	African American (%)	Asian, PI, NA, ToM* (%)	TEA district type
9	2,661	56.6	3.5	54.3	15.7	9.0	Major Suburban
10	2,612	34.5	3.5	23.2	43.1	11.2	Major Suburban
11	2,520	46.4	2.1	65.4	7.3	6.1	Major Urban
12	2,519	45.9	4.0	63.2	5.5	8.3	Major Urban
13	2,397	35.6	4.4	28.9	15.1	35.6	Major Suburban
14	2,314	43.6	2.2	26.2	55.3	15.3	Major Suburban
15	2,307	49.5	5.6	46.7	25.8	8.0	Major Suburban
16	2,143	41.3	2.3	33.7	29.2	13.8	Major Suburban

Table 2.8 Continued

School	Student enrollment count	EcoDis (%)	ESL (%)	Hispanic (%)	African American (%)	Asian, PI, NA, ToM* (%)	TEA district type
17	2,109	69.3	6.8	74.5	4.9	5.7	Major Suburban
18	2,054	56.5	6.3	44.8	21.8	9.1	Major Suburban
19	1,998	22.7	1.6	14.9	39.3	23.0	Major Suburban
20	1,839	74.8	8.6	97.7	0.2	0.3	Other Central City Suburban
21	1,676	49.7	6.7	47.0	25.8	6.2	Other Central City
22	830	37.2	4.1	17.7	40.5	23.9	Major Suburban
23	368	44.3	1.1	75.3	1.9	2.7	Non-metro Stable
24	97	84.5	3.1	77.3	6.2	1.0	Rural

Selected HSHD Schools for Case Study Research

HSHD schools selected for case study research were large schools, serving at least 50% Hispanic student population, with at least 40% of students classified as EcoDis, and located in large urban cities. I selected schools serving predominately Hispanic student populations, because this population is the fastest growing population in the state of Texas, as well as the largest population of students currently in Texas schools (51.8 % of all Texas students are Hispanic; Williams, 2014). I used previous research from Friedlaender and Darling-Hammond's (2007) High Schools for Equity project to set the 40% cut off for EcoDis percent. These researchers used the 40% cut off for selecting high achieving schools; noting that high school students are typically under-enrolled in the free/reduced lunch program. Finally, I used large urban cities for the selection of schools, because these areas serve large number of students who traditionally come from underrepresented backgrounds.

Specifically related to location, the HSHD schools selected were located in four of the 20 largest cities in the nation, and were within the 100 largest districts in the nation. Revisiting the Mega-State distinction for Texas, these schools were located in large districts and cities educating huge number of students every year. As NCES (2013) noted, "the educational progress of children in these [Mega-] stated is of interest far beyond their state borders" (p. 1). In Figure 2.2, I displayed the approximate location of the HSHD high schools on a Texas map that shows district boundaries. The majority of the HSHD schools are in the Houston or Dallas area.

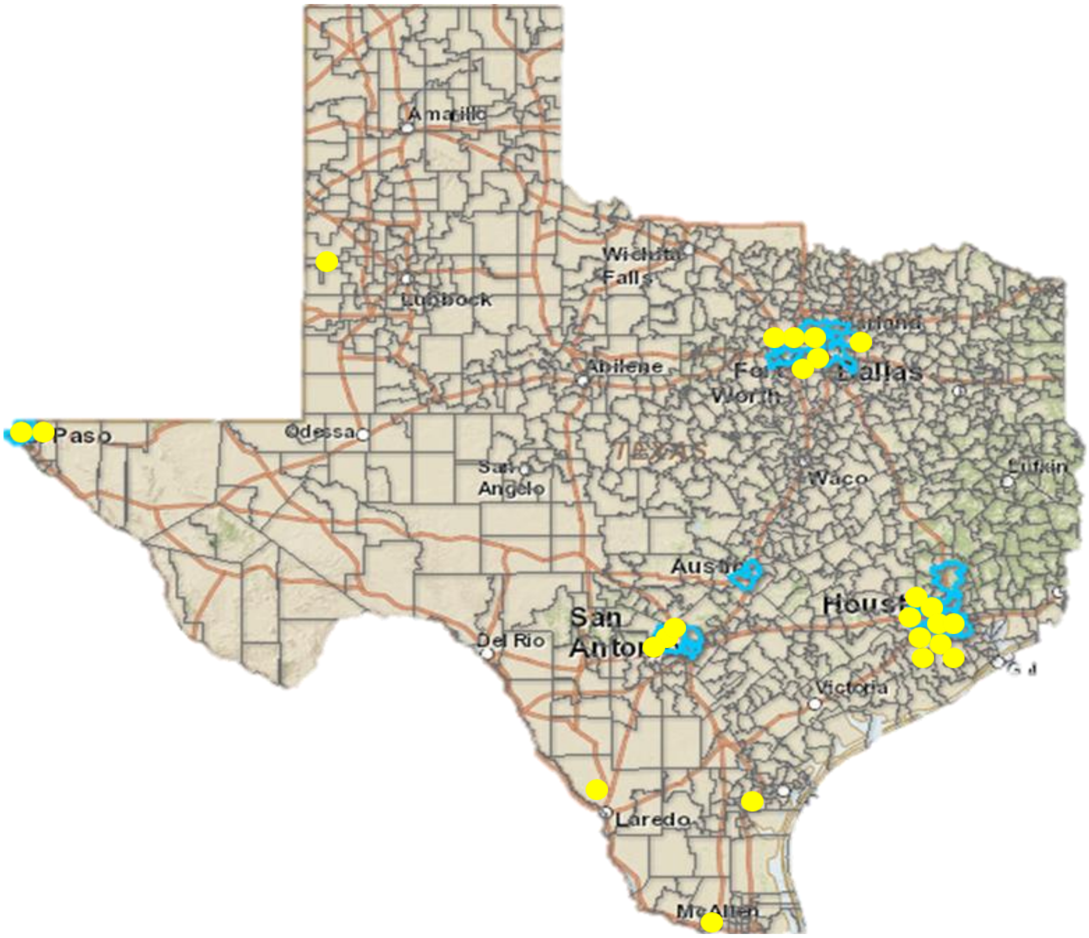

Figure 2.2. Geographic locations of identified HSHD high schools. The yellow dots represent the location of the 24 identified HSHD schools. The Texas school districts that were classified within the 100 largest districts in the United States are outlined in blue.

I selected schools 3, 6, 7, 9, and 12 to participate in the study (see Table 2.8). As previously mentioned, the schools I selected to participate were considered consistently successful and were in the 3rd or 4th quartile for success in previous PRISE years (see Table 2.2). While I originally selected five schools, only three of the districts approved research. Therefore, participating schools were schools 3, 6, and 7. I gave these HSHD schools pseudonyms for confidentiality reasons. School 3 is Bridge Rail Creek HS, School 6 is North Bend River HS, and School 7 is West Ridge Mount HS. The average demographic data for these three participating schools compared to the average state data is included in Table 2.9. It is important to note the state averaged data considers all K-12 students and the majority of the students in the state (49.08%) are in elementary school. This could explain why the average demographic data of the three selected high schools is slightly different than the state average.

Table 2.9

Comparison of Average Demographic Characteristics Among all HSHD Schools, Participating HSHD Schools, and Texas State Student Data

Population Averaged	EcoDis (%)	ESL (%)	Hispanic (%)	African American (%)	Asian, PI, NA, ToM* (%)
All-HSHD schools	49.0	4.5	54.1	17.9	9.8
Three participating HSHD schools	49.0	4.0	67.0	9.0	7.0
Texas State	60.2	17.5	51.8	12.7	6.1

Conclusion

Instead of asking what happened to "science for all" and continuing to describe the grim demographic characteristics of the leaky STEM pipeline, future research will need to examine spaces where "science for all" is taking place. If we, truly are to understand opportunities to learn science we must examine the "ripples of resistance" (Fine et al., 2014) or "bright spots" (Heath & Heath, 2010). These ripples of resistance/bright spots in Texas are the HSHD schools that stand out among the 1,308 traditional high schools in Texas. These ripples of resistance within the system will possibly provide a lens into effective secondary science teaching practices for underrepresented learners. Fine et al. (2014) noted:

> We must struggle, instead, as researchers, educators, and activist, to situate these movements of possibility within a wide ranging, vibrant educational human right movement in the country, before we sacrifice the next generation. (p. 316)

Science literacy through education is a human right. Through science education students are empowered to be critical and engaged citizens in the democracy (Michaels et al., 2008). As seen based on the results in this study, there are staggering deficiencies in opportunity to learn "science for all". As a result, science education becomes a civil rights issue (Tate, 2001). In *Science for All Americans* (AAAS, 1989) the authors support this ideology and state:

> Race, language, sex, or economic circumstances must no longer be permitted to be factors in determining who does and who does not receive a good education in science, mathematics, and technology. To neglect the science education of any

> (as has happened too often to girls and minority students) is to deprive them of a basic education, handicap them for life, and deprive the nation of talented workers and informed citizens—a loss the nation can ill afford. (AAAS, para. 14)

Now, 26 years after the publication of *Science for All Americans*, and the same problem is still being discussed. Therefore, as educators, researchers and policy makers move forward with agendas of "science for all" they must address the need to provide a substantive set of empirical literature regarding successful practices within the lens of designing effective learning environments (i.e., *How People Learn*; Bransford, Brown, & Cocking, 2000) for diverse learners in science education. This can only be accomplished through complex, rigorous, and purposive sampling criteria to select appropriate schools for case study research. Moving forward, the demographics of HSHD schools in Texas have implications to help future researchers understand the necessary rigor, complexity, and methods needed to purposively sample diverse and successful schools for case study research.

COMMITTING TO SCIENCE TEACHING: THE PROCESS OF BECOMING AND REMAINING A SCIENCE TEACHER IN URBAN HIGH SCHOOLS

Stakeholders continue to seek answers to questions about the underrepresentation of diverse students in science. Stuessy (2010) claimed, "highly qualified science teachers play a central role in educating the next generation of decision makers who will confront the challenges of living in a rapidly changing society driven by technological advancements" (p.1). Teachers are major players in defending against students dropping out of high school or becoming disinterested in STEM fields. This drop-out/disinterest, from students, is often referred to as the "leak" in the STEM pipeline (Tomas Rivera Policy Institute, 2008). Unfortunately, underrepresented students are the ones most impacted by the "leak" in the STEM career pipeline. Policy makers tend to link the leaky STEM pipeline for underrepresented students back to the "achievement gap" in K-12 STEM education (Committee on Science, Engineering, and Public Policy, 2012). Furthermore, Southerland, Gallard, and Callihan (2011), noted the "achievement gap" in science could be related to the fact that many science teachers do not "adapt how science is taught" for diverse learners (p. 2182). Texas follows the national trend regarding the leaking STEM pipeline for underrepresented learners, specifically in science. For example, in Texas, few schools exist that are identified as highly successful and highly diverse (HSHD) in preparing underrepresented students for science and college readiness (Bozeman & Stuessy, 2013).

With the concern regarding the leaky STEM pipeline, it becomes important to understand the process of how science teachers teach within HSHD schools, and why science teachers decide to teach within HSHD schools. In this study, I focused on why teachers decided to go to and remain at HSHD schools. Most science teachers have a degree in a STEM related-field, but choose to teach science at the high school level instead of going into a STEM related- career. Stuessy (2010) pointed out that, "currently, we know very little about the practices used by Texas high schools to find, attract, and hire qualified science teachers" (p.1). Based on previous results from the Policy Research Initiative in Science Education (PRISE) we know about recruitment, retention, induction, and professional development of teachers (Teacher Professional Continuum; TPC) in science programs at high schools across the state of Texas. The previous PRISE researchers focused on the TPC using teacher interviews and surveys, as well as principals' interviews and surveys to describe individual TPC stages at various types of high schools in Texas. Specifically, previous PRISE researchers zoomed in on a specific stage of the TPC (i.e., recruitment, induction, professional development, retention) and described the stage across various school contexts selected as a representative sample of 50 schools across Texas (McNamara & Bozeman 2007). Each stage was extensively researched using quantitative and mixed methods research.

As a follow up to previous PRISE research, in this study, I have zoomed out and examined the entire TPC (including pre-recruitment). However, I have also zoomed in and I focused my examination of the entire TPC within one unique school context (i.e, large, urban, successful and diverse high schools). Focusing on one specific school context is important because, based on previous PRISE research studies, Stuessy (2010) acknowledged:

> Our research results continue to support the idea that "one size does not fit all in Texas"…Policy makers should consider that policies and practices that have been found to be successful on one campus may not have the same results on another campus, due to distinctions in school level characteristics. (p.10)

Furthermore, much of the research regarding stages of the TPC for teachers in urban schools has been "conducted to investigate the rate of turnover among teachers in urban settings, but few researchers studied teachers who stayed and taught…" (Alhashem, 2012, p.84). Oakes, Franke, Quartz, and Rogers (2002) expressed retention is the most widely used measure for successful urban teaching and even though it is important, "the retention measure must be taken a step further:…To what extent do these teachers promote student success, the reform of their schools, and the health of their urban communities?" (p. 232). My goal within this study was to take the previous PRISE research "a step further."

While many researchers have examined recruitment and retention of science teachers, not many have focused on why secondary science teachers became interested in science or decided to join the profession. Nor are there many studies specifically focused on science teachers coming to and remaining at successful and diverse schools. Montoya (2015), in her recently released dissertation research, agreed with this statement:

> Although there is a significant body of literature concerning teacher retention in general, there is very little work done in this area of the country focusing on this demographic and the science teachers that serve this population in this area of South Texas (p.6).

Haberman (2005) completed extensive research on teachers in urban schools who stay and who quit or leave the schools. Haberman's research also focused on why star teachers go to diverse schools. Oakes et al. (2002) followed this line of research and argued a need to create research based stratgeties for attacting teachers to urban schools and more research "to better understand who considers becoming an urban school teacher and why" (p. 230). While this field of research is popular in urban education, literature is limited focusing specifically on science teachers in diverse high schools. Additionally, Oakes et al. (2002) explained: "We need to design and study the processes and structures that support urban teachers as they forge connections to schools, communities, and networks of teachers that sustain their commitment and hence keep them in urban schools" (p. 232). Understanding teachers' support and the community they develop inside and outside the school is important. This concept connects with the community-centered component of the *How People Learn* framework (Bransford et al., 2000). Overall, my goal was to understand science teachers' journeys to become and remain a science teacher at HSHD schools.

Stuessy (2011) compared demographic data for science teachers in three types of schools: highly successful, highly diverse (HSHD); highly successful, less diverse (HSLD); and less successful, highly diverse (LSHD). Her study provided information specific to the purposive sample of HSHD schools in comparison to baseline schools of HSLD and LSHD schools previously identified through random selection in the original PRISE sample. Table 3.1 summarizes the teacher demographics of retained teachers in these three types of schools.

Table 3.1

*Frequency of Retained Science Teachers across Three Schools Types**

	Teachers in HSHD Schools (n=161)		Teachers in LSHD Schools (n=87)		Teachers in HSLD Schools (n=62)	
Retention Status	Frequency	Valid %	Frequency	Valid %	Frequency	Valid %
Retained	123	75.9	60	69.0	60	80.6
Not Retained	39	24.1	27	31.0	12	19.4
Total	161	100.0	87	100.0	62	100.0

*Note: After Stuessy (2011), Final Report to the National Science Foundation

Stuessy's comparisons indicated higher retention rates of teachers in HSHD schools than the retention rates in teachers in LSHD schools, although retention rates in HSLD schools were highest among the three types. I found the differences in retention percentages between HSHD and LSHD schools to be noteworthy, particularly in the light of the history of previous researchers' claims (e.g., see Ingersoll & Perda, 2009; Knapp, 2003; Levy, Fields, & Jablonski, 2006; National Academy of Sciences, 2007; Schaffhauser, 2014) that teacher retention was the most important variable affecting student achievement in urban schools. Stuessy's final report also included comparisons regarding: gender distributions, with science teachers in LSHD schools less likely to be female; ethnicity distributions, which indicated more diversity in the science teachers in HSHD schools; and terminal degrees, which indicated teachers in highly successful schools, regardless of diversity distinction, were more likely to hold advances degrees than science teachers in less successful schools. In distribution of teachers by experience level, Stuessy's comparisons revealed all school types had similar percentages of highly experienced teachers, but teachers in highly successful schools had fewer novice teachers (i.e., those with three years of teaching or less) than those in the less successful schools. She concluded, "Overall, the population of teachers in HSHD schools as compared with their less successful, high-diversity counterparts can be characterized as more likely to be female, more diverse, more educated, and more experienced."

Purpose and Research Questions

In my attempt to understand science teachers' experiences as to why they go to and remain at diverse high schools, I felt it was important to understand why they decided to become science teachers, their beliefs about their roles as teachers, and the support they received as science teachers to teach diverse students. The purpose of this study was to have a better understanding of science teachers' experiences regarding the process of becoming and remaining teachers in HSHD schools that. The guiding question for this paper was, *Why do science teachers go to and remain at high schools identified as HSHD?* Subsequent questions helped me explore this guiding question more in depth. These additional questions included: (a)What are the teachers' backgrounds in terms of their teacher preparation?, (b) What are their backgrounds in terms of why they decided to become science teachers?, and (c) What are their backgrounds in terms of years of previous teaching, other schools where they have taught, and familiarity with the school in which they are currently teaching?

Research Design

Qualitative Research Strategy

For this study, I used grounded theory to examine and develop a "unified theoretical explanation" (Corbin & Strauss, 2007, p.107) about the process of science teachers becoming and remaining teachers at identified HSHD schools. Specifically, I explored the experiences of ten science teachers situated within these unique schools. Charmaz (2005) stated. "a social justice researcher can use grounded theory to anchor agendas for future action, practice, and policies in the analysis by making explicit connections between the theorized antecedents, current conditions, and consequences of major processes" (p. 512).

More specifically, I chose constructivist grounded theory as the qualitative methodology for this study. I used constructivist grounded theory because, "grounded theory conducted from a constructivist epistemological paradigm is particularly suited for examining processes, structure, and context…" (Charmaz, 2005, p. 210). In selecting constructivist grounded theory, I recognized the importance of methodological and philosophical alignment. Birks and Mills (2011) stated it is important to identify "your baseline position before you begin" a grounded theory study to help develop theoretical sensitivity (p.59). Additionally, Birks and Mills (2011) noted that one's position is key to methodological congruence in grounded theory. Therefore, before describing the detailed methods (i.e., participant selection, data collection, and data analysis), I discuss my positionality.

Positionality

Before becoming an urban science education researcher, I was a secondary science teacher for five years. I taught at a highly diverse school that was a discipline alternative education program (DAEP) in the Houston area. During this time and because of many of my previous life experiences I became a huge social justice advocate. While I was teaching I earned my masters' degree in urban education and presented research on culturally responsive teaching in science classrooms. My personal experiences as a science teacher in diverse settings drove me to want to learn more about how to help other science teachers orchestrate their diverse science classrooms. My role as the researcher in this study was to act as an interviewer within the selected school settings. I specifically interviewed high school biology teachers in schools identified as highly successful and highly diverse (HSHD). As the research instrument for this qualitative study, I completed daily reflections while I was in the field, created memos during the data collection/analysis phase, and debriefed with my mentor and research principal investigator (PI) after each field experience. See Appendix E for an extended positionality statement.

Data Collection Procedures

The selected participants for this study were biology teachers (and one science department chair who taught chemistry) at identified HSHD schools. The selection of the identified HSHD schools is described in detail, within this dissertation in the section titled, *A Demographic Overview of Secondary Science Education in Texas*. Once the schools were selected, the long process of research approval began.

This study fits Texas A&M University's Institutional Review Boards' (IRB) definition of human subject research. See Appendix F for IRB approval documents. I originally contacted IRB during the fall of 2013 to follow the necessary steps to seek approval for research at the identified HSHD school sites. After meeting with the IRB representative, I contacted schools for site authorization. As some of the school districts needed an approved IRB before they would consider site authorization, I met with IRB once again to confirm this process. Preceding this second meeting with IRB, I submitted an IRB application in January 2014 with the agreement that the site authorization would be added as I received the authorizations from the schools/school districts. The IRB was approved in March 2014. I contacted the schools again, went to the districts, and turned in the approved IRB with the district research application.

In total, I contacted five school districts. Two school districts declined participation in the study. Two issues arose with site authorization: (1) conflicts with state testing, and (2) my request to video record classroom observations. I revised the IRB protocol, and then contacted schools again in May and June of 2014. By June, one school agreed to participate in the research; I continued to contact the other schools, even revisiting schools that had previously denied the research. By fall 2014, three schools agreed to participate in the research study and signed site authorization letters. With these authorizations, I collected all data in September-October of 2014.

Once the school administrators signed site authorization agreeing to participate in the study, the schools or school districts made decisions about which teachers would participate in the research. This process was different for each school.

North Bend River High School was the first high school (and school district) to agree to participate in the study. At North Bend River High School (HS) the science department chair selected the participating teachers. Specifically, the district office received information about the study, contacted the district level secondary science coordinator, who then contacted the science department head at North Bend River HS. The science department head at the school decided to ask novice, mid-, and expert level biology teachers to participate in the study. I was given the name of the teachers and I began communicating with them via email. I was able to schedule an initial site visit with one teacher and that same day I was able to meet the other teachers, tour the school, and speak at length with the science department head. Also, during the initial site visit I was able to tell each teacher about the study, ask her/him if they would like to participate, and (if they said yet) have them sign the consent form. All of the teachers contacted by the science department chair agreed to be in the study. Interviews and observations were set with the teachers via email and I returned to the school within a few weeks.

West Ridge Mount HS was the second school (and school district) that agreed to be in the study. Once they agreed, I attempted to make contact via email with the assistant principal of the school. The assistant principal suggested I email the science department chair of the school. I did not hear from the science department chair via email so I decided to visit the school. The day I arrived in the city where the school was located, the science department chair emailed me and we were able to schedule a meeting. I met with the science department chair at the school and spoke with her about the study. Then we proceeded to tour the school, and while touring the school we asked biology teachers if they were interested in participating in the study. If the teachers said yes, then I set up a time during that day to explain the study to them, and have the teachers sign consent. Three teachers were interested in participating in the study and the department chair also said she was interested in participating in the study. As soon as the first teacher signed consent, she invited me to stay and observe her classroom and we set up the interviews for a later date. All of the other teachers scheduled me to collect data the following week (they all signed consent on a Friday; and data collection started on the following Monday). Since I stayed the weekend in this city I had the unique opportunity to attend a local science teacher conference with one of the biology teachers. This gave me additional perspective regarding the professional development and support opportunities available for the teachers at West Ridge Mount HS.

Finally, Bridge Rail Creek HS had a very different set of procedures for research. Like the other schools, the school district had to approve the study. However, one the district approved the study I was not able to contact the school or the teachers. The school district research coordinator contacted an administrator at the school. The administrator contacted the biology team leader, and the team leader selected teachers. The teachers were told about the study by the school administrator using all of my information; then the teachers signed consent. The research coordinator sent the signed consents back to me. Once I had received, the school gave me permission to contact the teachers to schedule data collection.

The ten participating teachers ranged in years of experience from two - 40 years. There were seven female teachers and three male teachers. The majority of the participating teachers were White. The average number of years the participating teachers had been teaching at their current school was about seven years. I gave each participating teacher a pseudonym to protect their identity. See Table 3.2 for demographic information about the ten participating teachers as well as their given pseudonyms. For detailed demographic information about the student population at the HSHD schools where the study participants teach science, refer to the section titled *A Demographic Overview of Secondary Science Education in Texas*, in this dissertation.

Data Sources

In grounded theory it is common to have multiple sources of data for triangulation to contribute to theoretical sensitivity (Birkes & Mills, 2011). In addition to the interviews that are traditional in grounded theory, I observed the teachers in their classrooms, and all of the teachers completed the *Texas Poll of Secondary Science Teachers* (TPSST). I used these additional data sources for triangulation purposes. Furthermore, as I collected the data, I also generated field notes, and memos; debriefed with the PI; and reviewed the observations and audio interviews for possible patterns.

Table 3.2

Pseudonyms and Demographic Data for Each of the Participating Teachers

School	Pseudonym	Gender	Race/ Ethnicity	Years of Teaching Experience	Years at the HSHD School
North Bend River HS	Kerri	F	W	12	7
	Elizabeth	F	W	2	2
	Michael	M	W	17	7
West Ridge Mount HS	Gabriela	F	H	30	9
	Kathy	F	W	12	7
	Danny	M	W	8	5
	Mariana	F	H	7	7
Bridge Rail Creek HS	Colleen	F	W	4	4
	Jason	M	W	40	13
	Kyra	F	AA	11	5

Note. F = Female, M = Male, W=White, H = Hispanic, AA = African American

With regard to the interviews, my original plan was to interview the teachers before and after the classroom observations. However, due to the very busy schedules of the participating teachers, I conducted the interviews whenever the teacher had available time. From the interviews, I wanted to hear about the teachers' experiences and stories regarding the process of why they became science teachers, the preparation they received, and their overall beliefs about teaching science. The semi-structured interview questions were based on literature from a socio-ecological perspective (Wilcox, 2013) and the *How People Learn (HPL)* framework (Bransford et al., 2000). A focus group of current science teachers and a small team of three researchers at a Texas science teachers' conference assisted me in developing the questions. Once the PI and I chose a final list of questions, I asked two science teachers from the original focus group to review the questions. The pre-observation interview protocol consisted of 12 questions which focused on the teacher's story, the school context, and the teacher's philosophy. The post-observation interview protocol consisted of 15 questions which focused on practices from the *HPL* framework. See Appendix G for the pre- and post-observation interview protocols.

I collected data from the ten participating teachers at HSHD schools. Each teacher completed two interviews and the TPSST survey; they also taught several days of classes, which I observed. The selected teachers decided the time and location of the interviews. However, all interviews took place at the authorized school site. I was the only researcher in the room asking the interview questions to individual teachers. I requested that the teachers set up individual interview times because I did not want other teachers to influence the interviewing teacher's responses. When given permission, I audio recorded the interviews using *QuickVoice* on my iPad. Most of the teachers (9 out of 10) allowed me to audio record the interviews on my iPad. For the teacher who did not allow audio recording I took noted and scripted as much as I could during the interview. In addition to using the iPad for audio recording, I also used the iPad to view and read the interview questions. I used the iPad so I could read the questions with minimal distraction from the audio recording application. I also kept a hard copy of the interview questions and a traditional audio recording device as backups in the case of technical issues with the iPad. There were no technical issues in any of the interviews.

Once the interviews were completed, they were downloaded to my computer and backed up on an external hard drive and in a password protected Dropbox folder. All transcribed interview files and written notes were coded to ensure participant anonymity and the transcriptions were stored in a secure file on my computer and a back-up hard drive.

Data Analysis Procedures

In grounded theory, analysis is closely linked with data collection. I was processed through what Creswell (2007) called a spiral of "moving in analytic circles" (p. 150). I moved through these "analytic circles" throughout data collection and data generation. During data collection I memoed, wrote field noted, and conceptualized the data through debriefings with the PI of the study. This process allowed me to "work at consciously developing [my] theoretical sensitivity during the research process" (Birks & Mills, 2011, p.59). After each field visit I met with the PI and discussed common findings, general environmental contexts, observed teaching strategies, and support structures. Through this process, patterns emerged. We were created visual/conceptual memos (most of the time on post-it noted or any random piece of paper laying around), which contributed to a wall of inspiration as I moved forward with the research (see Appendix H for a picture of the memo wall). Once I collected and transcribed the data, I continued to follow the appropriate methods for constructivist grounded theory according to Charmaz (2006).

I read through the text of the interviews and wrote memos. Then for the initial coding process I used line-by-line coding to identify *in vivo* codes that described the teachers' experiences (Charmaz, 2006; Glaser, 1992). After the initial coding I began collapsing codes and creating emerging categories through "focused coding" (Charmaz, 2006). I used constant comparison to continually spiral through the data to determine categories. I went back to the interviews from the first school with my developing perspective, "comparing data to data," and wrote memos about my reflections regarding the emerging categories while also ensuring I created meaningful focused codes (Charmaz, 2011, p. 60). During this stage I also began to examine the properties of the emerging categories as I "zoomed in and out of the data" to focus on a possible theoretical concept (Charmaz, 2006).

I had substantial discussions with the PI of the study regarding the possible emerging theoretical concept. This conversation led to the collapsing of two major categories with phases being developed as subcategories. This conversation was the beginning of the final phase of coding: theoretical coding (Charmaz, 2006). The theoretical coding process allowed me to "specify possible relationships" among the categories (Charmaz, 2006, p. 63). The memo from this process led my development of a draft of the visual framework describing the process of teachers' becoming and staying science teachers at HSHD schools.

During this process of theoretical coding, I visited the literature about science teacher recruitment and retention for the first time attempting to see if my theoretical codes would apply to previous research. My use of the literature as a form of theoretical sampling became an important step for me in realizing my codes were saturated. In addition to exploring the literature for previous research, I also reviewed the TPSST data as a form of theoretical sampling (i.e., looking at documents) to see if categories were appropriate. Additionally, during the theoretical coding phase, I avoided forcing my categories into the emerging theoretical codes, which required me to revisit the data again. During this time, I separated the ten teachers into the possible phases developed from the theoretical codes. I looked at the original *in vivo* codes to ensure the category and theoretical code I had applied was not just an application to "make it fit." I wanted to make sure I examined my biases and that the theoretical codes were relevant and embedded in the true experiences of the teachers.

Establishing Credibility

I used various methods to establish credibility within this study. First, I clarified my own bias as a researcher and as the instrument for this study through the examination of my positionality at the outset of the study (Creswell, 2007). Additionally, I used peer review and debriefing with the principle investigator of the study throughout the data collection and analysis phases. I used multiple sources of data to facilitate triangulation of my analyses such as interviews, a survey, observations, relevant literature. Finally, I used thick description within the research to ensure transferability (Creswell, 2007).

Findings

The teachers' coming to and staying at the identified HSHD schools are described as a two-phase process of committing to the profession. This process was the core ground theory described in this study: *The Process of Committing to Teaching*

Science at HSHD Schools. In each phase, teachers go through stages, phases, and levels of actions in the committing process. See Tables 3.3 and 3.4 to review details about the stages, phases, and levels of actions.

Table 3.3

Actions within the Early Stage of Committing to Teaching Science at HSHD Schools

Macro-Action	Meso-Actions	Micro-Actions
Becoming a science teacher at an HSHD school	Phase 1: Deciding to become a science teacher	Liking science based on early influences
		Being exposed to science or teaching
		Transitioning paths
		Training to become a science teacher
	Phase 2: Starting to teach	Deciding a location to teach
		Staying ahead/surviving
		Becoming comfortable
		Seeking learning opportunities
Remaining a science teacher at an HSHD school	Phase 3: Settling into teaching	Feeling comfortable with pedagogy/content
		Being confident in role as teacher/philosophy
		Beginning to contribute
	Phase 4: Remaining at the school	Appreciating type of support received
		Bonding with school, team, students
		Focusing on creating success
		Moving onto the advanced stage of committing to science teaching (see Table 3.4)

Table 3.4

Actions within the Advanced Stage of Committing to Teaching Science at HSHD Schools

Macro-Action	Meso-Actions
Remaining a science teacher at an HSHD School	Seeking new/innovative/challenging opportunities for learning/growth
	Incorporating new/innovative technology/ideas into classroom
	Mentoring teachers
	Providing professional development
	Reflecting on the old days/thoughts about role/philosophy

Committing to Science Teaching at HSHD Schools

In the early stages of developing the theory regarding the process of teachers coming to and remaining at HSHD schools, I noticed two core categories (or central phenomena) emerging. I noticed that within *Becoming a Teacher* (Table 3.3) there were a series of diverted paths or transformations. I also noticed for *Remaining a Teacher* the core category was support. However, after circling back in the data, having discussions with the PI, and reflecting on focused codes, I found that the core phenomenon in the entire process was an action of committing. Therefore, *committing to teaching at HSHD schools* became the central process (grounded theory). From the central process, I then focused on two stages of teachers committing through macro-, meso-, and micro-actions. See Tables 3.3 and 3.4 for the details about stages and actions. First is the *early stage of committing to science teaching* at HSHD schools. Within this early stage, teachers are going through the process of becoming a science teacher and going through the initial processes of remaining a science teacher. Once science teachers have decided to remain in the profession they move into the *advanced stage of committing to science teaching* in which they go the through the processes of either growing or staying the same within the teaching profession.

The Early Stage of Committing to Science Teaching at HSHD Schools

The *early stage of committing to science teaching* has two macro-actions: *becoming a science teacher* and *remaining a science teacher* at an HSHD school. Each macro-action has two meso-actions which are referred to as phases. Within *becoming a science teacher*, teachers go through *Phase 1: Deciding to become a teacher* and *Phase 2: Starting to teach*. Once teachers have progressed through these initials phases, then the next macro-action is *remaining a teacher* at an HSHD school. *Remaining a teacher* also has two phases; *Phase 3: Settling into teaching and Phase 4: Remaining at the school.*

As teachers progress through all four phases, there are certain micro-actions that drive their next steps in the process. However, the micro-actions are not the only thing driving the teachers. In addition, their beliefs and the supports they are receiving influence the decisions the teachers make in moving forward. The teachers' beliefs and the supports they receive are an infinitely continuous cycle always influencing the teacher's actions. These interactions are represented in Figure 3.2.

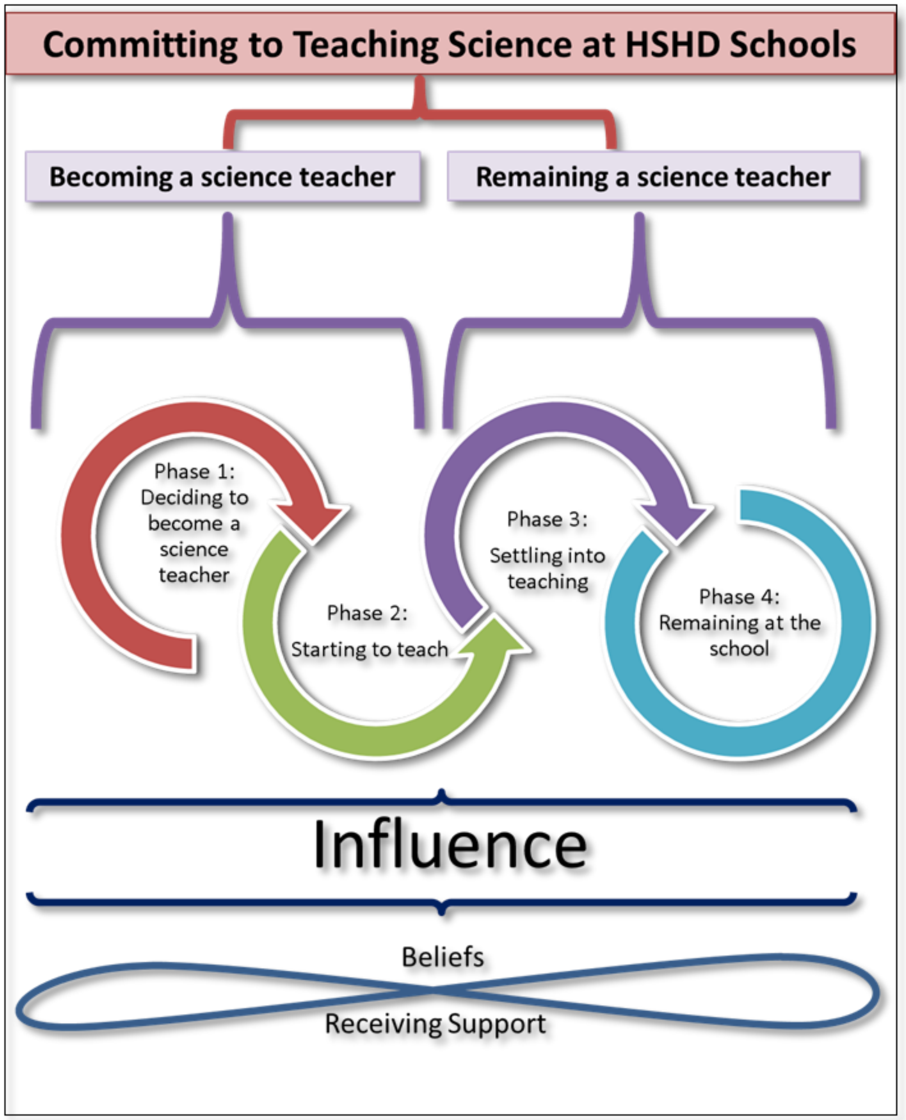

Figure 3.1. The process of committing to teach science at HSHD schools. The horizontal figure eight, below "influence," represents an infinitely ongoing process of beliefs and support influencing the entire process of committing to science teaching.

Becoming a science teacher at an HSHD school. *Becoming a science teacher* happens in two phases; *Phase 1: Deciding to become a teacher* and *Phase 2: Starting to Teach*. Looking back on PRISE, the researchers described recruitment, induction, retention, and professional development of teachers. The PRISE researchers used the Teacher Professional Continuum (TPC) as an encompassing frame to describe the areas listed. However, before teachers entered the TPC, they experienced processes that helped them decide to become teachers. This pre-recruitment phase, *Phase 1: Deciding to become a teacher*, is a meso-action in which the participating teachers reflect on and describe why they decided to become a science teacher in general. Then in *Phase 2: Starting to teach*, the teachers enter into the TPC through recruitment, and describe the process of them coming to the HSHD school. Additionally, they reflect on what they experienced when they first started teaching.

Phase 1: Deciding to become a science teacher. In this phase, participating teachers described the mirco-actions that drove them into teaching science as a career. Most of these micro-actions took place pre-recruitment (i.e., before entering into the TPC). The micro-actions in this phase include: liking science based on early influences, being exposed to science or teaching, transitioning paths, and training to become a science teacher. Several of the teachers described an early experience that influenced their passion for science or an experience that stimulated their thinking about becoming a science teacher. These influences regarding the passion for science often had to do with an experience of being outdoors or with nature during childhood/adolescents. Several of the teachers provide examples of their outdoors/nature experience below:

- Kerri - …as a kid I loved to camp and I loved being outside and I loved hiking and all that stuff so it was just, why wouldn't I teach?

- Michael - …my Grandfather was a farmer. And he owned a John Deere dealership. And, I was intrigued by that. …It was just a natural inkling for that [science]. Uh, I'd been around the world. I remember going out in the little tidal pools, we lived in Indonesia, and collecting sea shells and seeing whale sharks and monkeys and stuff. Then we had the saltwater aquarium when I was growing up. That was really neat to watch, so I think that's where it probably started.

- Danny - …we would just do all kinds of crazy stuff because we had a farm and we had the area so we were always doing all kinds of things outside and trying out whatever kind of experiment type thing we wanted to do, it was just fun because we had the room to do a lot of fun stuff. And so with science we always were nerdy anyways.

- Colleen - I've always had a ton of animals. I love nature. I was always outdoors and so I really like to learn about what makes us and how our bodies work and the cells, and I just love the natural life world.

From collecting shells in Indonesia to just being outdoors, several teachers' early influences drove their passion and interest for science. Interestingly not a single participating teacher mentioned another teacher as the reason they became interested in science. Teachers reported being influenced by something outside school, something in the informal science learning world that got them interested in science. A few of the teachers reported just "liking science" without a given reason. In addition to these early influences driving some to like science, there were also influences or things exposing them to teaching as a possible career. This helped many of the teachers decide teaching was the next career step. The teachers tell about these experiences by discussing the following:

- Kathy - My mother's a teacher, my grandmother's a teacher, everybody's a teacher. I wasn't going to be a teacher, I went to dental school for a year in Boston Dental School, and I came to find that I really liked the science part of it okay, but I didn't like the office part of it…

- Kerri - I love teaching…. my mom went back to school and graduated my senior year of high school and she's lifetime.

- Danny - …[Regarding] why I became a teacher, there are four or five teachers in my family that is always just how it was, my wife is a teacher, my sister in-law is a teacher. It always been I always said I would never ever be one, I would always tell my mom I'm not doing it… I just kind of fell into this, but I like it.

- Gabriela - Since I was in elementary, I used to stay after school helping my peers, and my father always told me that I was a teacher. I said that I was not a teacher and I was not going to be a teacher. My father said, "Yes, you are a teacher," and he was right.

- Mariana - I remember when I was a little kid that the way I used to study, is that I used to teach myself – feels like a teacher. I would go in front of the board and give classes to myself. I kind of knew I had that in me. But my first option was always to be a coach, but then that didn't go the way I wanted and went back to teaching.

- Colleen - I read those books, *What Color Is Your Parachute*, and a lot of things led me towards teaching.

At some point along their journeys, these teachers came to the decision to teach science because they were influenced by science when they were young or exposed to teaching as a career. Notably, every single teacher mentioned being interested in another career, or another subject, before deciding to become a science teacher. You start to see some of this trend in the quotes above leading to transitioning paths, which is the next action within this phase.

In Table 3.5, I present a quote from every single teacher about their transitioning path into teaching science. Several conditions caused teachers' paths to transition into teaching science. Elizabeth and Colleen did not fill fulfilled in their career and decided to become a teacher. Many teachers started their original fields of interest in college, and then decided it wasn't going to work out or it didn't fit their passion. Therefore, the teachers transitioned into teaching science (i.e., Gabriela, Kathy, Danny, Jason). Other teachers, such as Kerri, Mariana, and Jason became interested in teaching as a compliment to their passion for athletics. Finally, some of the teachers went into teaching for family reasons (i.e, Michael and Gabriela). Only one teacher literally pointed out that teaching was “Plan B.” She was discouraged from her original path of wanting to be a doctor. Finally, the teachers completed some type of training to become a teacher. All of the participating teachers had different educational backgrounds and participated in different teacher training routes. See Table 3.6 to review the different training paths the teachers took to become certified. All but one of the teachers has a degree in science and most of the teachers have a master’s degree. After teachers went through the Phase 1 processes of deciding to become a teacher they entered into the TPC and began the recruitment and induction processes of becoming a teacher. I have called this next phase, *Phase 2: Starting to teach*.

Table 3.5

Quotes Regarding Every Teachers' Transitioning Path

Name	Previous interest/career	Why did you want to become a science teacher?
Kerri	Athletic trainer	I LOVE science, why would you NOT want to teach science?...Umm, Oh my gosh, I don't know. I'm an athletic trainer so as a trainer you do teach, and I am definitely not one of those people that because I'm a trainer I have to teach, I don't feel that way at all, I love teaching. I have so much fun. But, as a kid I loved to camp and I loved being outside and I loved hiking and all that stuff so it was just, why wouldn't I teach?
Elizabeth	Physician Assistant, Research assistant	I did a year of volunteer work where I worked at a shelter with kids, and I really liked kids. And then, I decided to go back to research, and I really liked science. So, when I got tired of working with the mice, I tried to figure out where do people and science meet? And I was thinking of teaching…Well, I started out in a five-year program to become a physician's assistant. And then I decided I really liked chemistry, and I like bio and how the body works and everything. So, I changed my major to bio-chem, and then I didn't know what I wanted to do when I got out. You think, 'oh, there's so much to do.' And, there's nothing; there's not.
Michael	PhD plant pathology	Well, I enjoy science. I was a biology major, in college. I actually was going to try to get a PhD in plant pathology. And, my Grandfather was a farmer. And he owned a John Deere dealership. And, I was intrigued by that. So, but then I fell in love with my wife. And um, I went ahead and applied at the school of education. At the time I was working at UPS. I worked there for about two or three years. So, I went ahead and applied for that. And, we came down to Texas because she had a job opportunity at HEB. And so, we came down from Oklahoma. And, I picked up on science right away.
Gabriela	Business, Teller, Lab chemist at hospital	First of all, I like science. I went to school in Mexico; I never came to high school in the US. I went to high school in Mexico. ..Since I was in elementary, I used to stay after school helping my peers, and my father always told me that I was a teacher. I said that I was not a teacher and I was not going to be a teacher. My father said, "Yes, you are a teacher," and he was right.
Kathy	Spanish major, Dental school	My mother's a teacher, my grandmother's a teacher, everybody's a teacher. I wasn't going to be a teacher, I went to dental school for a year in Boston Dental School, and I came to find that I really liked the science part of it okay, but I didn't like the office part of it.
Danny	Sports medicine	I don't even really remember exactly why, I just remember I was like "I like science it's cool. And I like math, but then I got turned off on math. So I kinda I was like "Uh I'll pick something else knew I couldn't do English, I knew I couldn't do Social studies or anything and Science just seemed more like I could do more fun stuff and be more kinda hands on and…I guess the only thing, why I became a teacher, there are four or five teachers in my family that is always just how it was, my wife is a teacher, my sister in-law is a teacher. It always been I always said I would never ever be one, I would always tell my mom I'm not doing it. My wife was always, she wanted to be an elementary teacher that was her dream, I just kind of fell into this, but I like it.

Table 3.5 Continued

Mariana	Volleyball coach	I graduated in kinesiology, I was an athlete, I'm a volleyball coach here at [the] High School and that's actually what got me hired. So I had already that background in science with the whole kinesiology part of it and the physiology and everything else, so it was always an area that I really liked it…But my first option was always to be a coach, but then that didn't go the way I wanted…
Colleen	Graphic designer	I decided to teach science because I was a graphic designer for 10 years before and when I quit my job, I felt like I wasn't doing something that was purposeful. So when I thought really hard about what I wanted to do and I read those books, What Colour Is Your Parachute, and a lot of things led me towards teaching. Then I was like, What am I going to teach? What subject? So I took the generalist 438 and as I was studying for that, I realized that I loved biology. So I just got into biology and studied that, then I took the life science certification.
Jason	Interested in math	First of all, I had to have so many hours in my major - science. I like science. I really like math more but when I looked at what I had to take in math compared to what I had to take in science, I say, "I'm going to teach science." I like Math but I said-- I struggled in the first math class and I went, "I can't do this." I like science. So I went ahead and went into science and I enjoy science. I enjoy teaching.
Kyra	Medical school, Physical therapy	Being that science was undergrad major, masters in bio and went to school for PT. I was always fascinated with the human body and how it works. I teach anatomy. I like the medical field helping student figure out medical field so with biology I love when we talk about cells, genetics, human body. Undergrad was just science and wanted to go to med school and Plan B was teaching.

Table 3.6

Teachers' Training to Become Certified

Teacher	Undergraduate Degree	Master's Degree	Route to Certification
Kerri	Kinesiology/Biology	None	Classes during undergrad
Elizabeth	Bio-Chemistry	None	Alternative certification
Michael	Biology/Education	Composite Science	Classes during undergrad
Gabriela	Science	None	Certification through local university
Kathy	Science	Education	Masters
Danny	Science	None	Classes during undergrad
Mariana	Kinesiology	Special Education	Classes during undergrad
Colleen	Graphic Design/Arts	Curriculum and Instruction	Alternative certification
Jason	Science	Administration	Classes during undergrad
Kyra	Science	Biology	Alternative Certification

Phase 2: Starting to teach. In this phase, participating teachers described the mirco-actions guiding their process of starting to teach at an HSHD school. These micro-actions took place during the recruitment and induction part of the TPC. Stuessy (2010) stated, "Recruitment begins a teacher's journey in the teacher professional continuum" (p. 1). Therefore, phase 2 is where teachers entered their journey into the TPC. The micro-actions in this phase included: deciding a location to teach, staying ahead/surviving, becoming comfortable, and seeking learning opportunities. At this point teachers were in the very early stage of committing to teach at an HSHD school, and they were very dependent on support from the school and mentors. Deciding a

location to teach was an interesting process. Teachers cited a range of methods including; job fairs, shotgun method, family reasons, school district reputation, a coaching position, and knowing people at the school to get their foot in the door. The quotes below, in Table 3.7, represent the variety of properties within this micro-action:

Table 3.7

Quotes Regarding Every Teachers' Process of Deciding to go to an HSHD School

Teacher	Recruitment properties	Why did you come to this district and this school?
Kerri	Family, reputation, athletic position	I really did just end up here. Like, my sister. Ok, so I worked for 5 years at my first school…So then I took a year off and my sister was living down here so I came down and had applied… at both of these school districts...after talking to people…and after looking up some stuff about [the district] and talking to some of the people, oh my gosh, everybody I talked to was awesome, so I definitely jumped in.
Elizabeth	Job fair	The job fair that I went to. The job fair that I went to…and, surprisingly there was no line at [the district]. I went over and was like 'why isn't there a line over here?' Because I know it's a good district. She talked to me for a little bit. I told her I wasn't certified, and I hadn't taken the test yet, but I was getting ready to take my composite test. And she had me talk to someone… Then, I got a call to interview here for bio. So, that's kinda how I ended up at [this school].
Michael	Family, pay	I came to San Antonio because of the HEB position [for my wife]. Then while in San Antonio, I just started applying shotgun method. I really didn't know any districts. I did look at pay… And, I think within about 20 hours, 24 hours, I had 20 people who wanted to interview me… I didn't know at that time that school districts in Texas paid differently. I thought well, they all paid the same because in Oklahoma they all pay the same you know…[This district] was paying higher. So, I decided to come to [this district]. And, something that just caught my attention with the school was the classroom had a window.
Gabriela	Family, knowing someone to get foot in door	My family is here…The principal from [the other] High School contacted the principal from [this school]. He had heard something about a possible position here, so he spoke with the principal and said very good things.
Kathy	Job fair, living expenses	I was at a job fair because it's very expensive in Boston to live - especially when you're a single teacher - and it was going to be very hard to make rent… So you can't afford to live there very well as a teacher, so I went to the job fair, just kind of looking around at different districts, and I was never West of like Albany, probably, so I went, "Sure. What the heck."….

Table 3.7 Continued

Teacher	Recruitment properties	Why did you come to this district and this school?
Danny	Job fair, family, pay	When I was in college they had a job fair, educator fair at the college there and you just go and interview at all these different booths and sign up for one's you like…I had the two offers on the table. At the time my wife, she was in college too, I really didn't want to move to [another city] because she was here and that would be a long distance… but my family was up there so it was kind of a hard…and they also had a signing bonus at the time for Math and Science. And so [the other district], gave me quite a bit less, and they bumped it up even still but I mean it couldn't compare to here, and the pay here was a lot better.
Mariana	Athletic position, knowing someone to get foot in door	Since I came to [the city], I was living in the west side. Then when I found out there was a volleyball position, it was here in [this school], so I ended up staying here in [this school]…
Colleen	Reputation, knowing someone to get foot in door	[The district] had a good reputation and being from Ohio, I didn't know a lot about the different school districts, and it was this school district that I lived in when I first moved here. I just a lot of good things about the district, and all the teachers really liked-- I was her long term sub, and that's what got my foot in the door here.
Jason	Knowing someone to get foot in door, athletic position, pay	I came to [this district] because the head coach that hired me was my eighth grade coach…He had an opening in the junior high…and I knew I had a chance to go from the junior high to move to the high school - I knew [the district] was a good district. And I've been here ever since…I came over to [this school] because I really didn't want to lose the money financially. I didn't know what kind of job I was going to have at [the other school] when they let the head coach go.
Kyra	Reputation	I always wanted to live in Houston and started researching schools. I found [this district] was good district and I applied. I did the interview with the principal. It was a phone interview and I was between two schools but decided on this one because it felt right.

Sometimes teachers decided to go to a district for one reason and the specific school for different reasons or there were multiple reasons influencing their decision to go to the district/school. The three males participating in the study made a direct link between money and their decision on school location. Only one female in the study mentioned money, Kathy discussed not being able to make a living wage in Boston, and she emphasized taking a chance on moving to Texas stating “Sure, what the heck?” as her reason for coming to the school. However, money was never the primary reason for teachers deciding to go to the district. For one, however, it was the reason for switching schools in order to remain a varsity level coach. Note that teacher switched from a school which was diverse (more than 50% students of color) to a school that was highly diverse (more than 75% students of color).

The teachers’ experiences about *deciding on a school location* follow similar trends that were found in the larger PRISE study, which was described in the discussion section of this study. After teachers decided their location, they worked on staying ahead (surviving) and becoming comfortable in teaching. They often did this by seeking out learning opportunities to help them become comfortable with content or pedagogy. The idea of staying ahead/surviving (mostly surviving) was represented well by the current feelings of Elizabeth.

- Elizabeth - I think I’ve learned that that’s all they have to know. If I can add more than those five things, then that’s great. If they learn those five things, then that’s all they have to know. I hate teaching towards the test. I would like to just be able to teach.

Additionally, Mariana, Colleen, and Jason reflected on their first few years teaching and their process of attempting to stay ahead (as seen in the quotes below). However, they also discussed seeking out new learning opportunities to help themselves. All of these learning opportunities were self-initiated and often paid out of pocket by the individual teacher. The learning opportunities were everything from reading a book to getting a master’s degree.

- Mariana - I took the test, I passed, I got hired, and I went and I did a master's in special education. So I said, "Okay, I don't have education for special ed so let me at least prepare myself for it."… so that's basically how I have been doing. I have first been given the job and then preparing myself basically.

- Colleen - …If you can really teach yourself, then you can be one step ahead, and then you just continually learn…Because I didn't have a degree in education, I felt a little intimidated by the fact that I was teaching and I didn't have that foundation. Even though I knew I would be a good teacher, I wanted to have that background to say, "Hey, I can do this." So I went back to get my get masters in Curriculum and Instruction at [the university], and that's where I got all of my educational technique and diversity training.

- Jason - You really think you know something when you get out there until you start doing it…I learned a lot real quick that first year and then second year when I taught biology I learned a lot more. It was almost like staying one day ahead. It really was. I was looking in the book, I was reading the book and other resources that I could find to help stay one day ahead, really…Basically, first two years, first couple of years, really was. I stayed ahead of them. I had to go home and study and make sure I knew the information...I immediately got my master's from [a university in Texas].

Some of the teachers reflected on the process of becoming comfortable at the school, in one or both ways: (1) to become comfortable with the content, and/or (2) to become comfortable with how to teach the content to such a diverse group of students. The teachers noted that you just had to "jump in" and figure it out. However, as seen in the quotes above, some teachers went back to school to help them figure out more about teaching to diverse students. Below are some of the experiences that the teachers went through in becoming comfortable at the schools:

- Kerri - My first year was really tough here because it was so different than what I was used to... I mean I researched; I knew the population was going to be different but it didn't occur to me how different it was until you jump in and actually see it. So my first year I kept trying to do things like I used to do, and it was not successful…but then, once we got going, the teachers that had taught here I'd be like this and they were, that's not going to work, you need to da da da da da. I'm like no, no, it will be fine and they're like, no no. One of the ladies who was here would let me screw it up and then she'd come and fix it the second period. She'd be like; see I told you, ok here's what you need to do.

- Danny - Where I am from nobody was really rich at all, so it was like them talking about the maids and all these things at their house…but then there is also the complete opposite side of it too, so it is just the amount of diversity. I am more use to it now that I now know the parts of the area around here so I kind of know where they are, what their from. Just getting use to a new place… I grew up on a farm, so I would be like "oh yeah the compost pile we had…" I had to figure out well these kids don't live like I did, I had to relearn, kind of get to know the area. [Now] that's not as bad, that was hard for a while, I couldn't find a way to relate sometimes to them, especially like the kid with the air hockey table and maid.

- Jason -When I looked down at the hallway the first day, I thought, "What have I gotten myself into?" I really did. Then when I got in my class, I thought, "These kids aren't any different than the kids I had in [the other school]. They're just the same, that they want to learn. They might not be as well off financially, but they are not any indifferent. And I found out real quick. They just need a little bit more attention and that type of thing. That's what I found out real quick.

- Kyra - This is a new world. It is very different than Mississippi. In Mississippi it was not diverse, it was all urban. I have not had professional development for diversity here. I just got into and learned by doing…

Teachers' quotes made it difficult to tell the context, but these teachers were referring to three types of diversity: linguistic, racial/ethnic, and/or socioeconomic. Reviewing the quote from Danny, it was notable that he was getting accustomed to the students' socioeconomic culture within the schools in ways that are counterintuitive to traditional urban school culture. Even he taught at a Title I school with more than 40% of students on free and reduced lunch, a huge gap existed in the socioeconomic status of the students at the school. Danny came from a farm area with less money than some of his students, and he mentioned having a hard time relating to the kids with maids and an air hockey table. Teachers characterized *Phase 2: Starting to Teach* by reflecting on their processes in deciding a school, staying ahead/surviving, seeking learning opportunities, and becoming comfortable in the school environment.

The majority of teachers in this study were past the initial phases (Phase 1 and Phase 2). Nonetheless, all of the teachers reflected on actions that led them to become a science teacher at the HSHD schools. The only new teacher in the study, Elizabeth, was the only teacher still currently in Phase 2. Additionally, Colleen was in the process of transitioning through Phase 3. It would be interesting to see whether they make it past the 5-year teacher-leaver statistic. Once teachers had gone through the process of *becoming a science teacher at an HSHD scho*ol, they then moved onto the next macro-action, *remaining a teacher at an HSHD school*.

Remaining a science teacher at an HSHD school. *Remaining a science teacher* is a macro-action happening in two phases which built on Phases 1 and 2 from *becoming a science teacher*. These two phases include: *Phase 3: Settling into Teaching* and *Phase 4: Remaining at the School*. Refer back to Table 3.3 to review details of the overall committing process. Again, looking back on PRISE, the researchers described the TPC (i.e., recruitment, induction, retention, and the professional development) of teachers. It is natural to see that retention and professional development became the main focus of these next two phases. *Phase 3: Settling into Teaching,* is a meso-action in which the participating teachers described the process of becoming comfortable and confident in teaching science. Finally, *Phase 4: Remaining a Science Teacher at the HSHD School*, takes place and wraps up the entire early stage of committing to teaching science at an HSHD school. In this final phase, the transition began toward the advanced stage of committing.

Phase 3: Settling into teaching. In this phase, participating teachers described how they became comfortable and confident science teachers. All except Elizabeth had progressed past this phase. Additionally, Colleen was just starting the transition through this phase. As teachers progressed through this phase, they really started to figure out who they were as teachers. This was the make or break phase regarding these teachers commitment to a school. This was the point where there needed to be a balanced harmony among the teachers' beliefs (philosophy), the support they were receiving, and the overall school environment. The micro-actions in this phase included: feeling comfortable with pedagogy/content, being confident in their roles a teacher/philosophy, and the process of beginning to contribute. With regard to feeling comfortable with the pedagogy/content, I saw some teachers reflecting on the action of settling into teaching and one teacher demonstrating his comfort/expertise with the curriculum.

- Kerri-...and now it's just like second hand. Things are so much different than the first 5 years when I taught, however, I'm probably a better teacher for it. And I have a good time. I don't really stress… I don't really stress.

- Michael - when I assessed body systems, it was not terrific. The window the district provided us was four days. That's just not enough for body systems. Yea. And then three weeks for macromolecules…So, inside a macromolecule, you'll see me throw in some body systems stuff.

- Danny - That and then just the amount of stuff we have to teach them. And get through in a year is ridiculous when you sit back and look at it. It's impressive that we can get through it. But you're running through it. That's the hard part, now I'm getting comfortable with it because I've done biology for a few years now, so I kind of know how to get going, but when I first started it was like "you want me to teach what and how fast?" Then after you get use to it, it's just how it is; you just tell them "hey we got to get through it, you got to know it, so you can

> pass that test, pass the class, learn some stuff and get out of here." The time is still a challenge, but is a little less now that I have a little more comfort with it.

The teachers here described how things previously were and how they were currently. Both Michael and Danny made note of timing with regard to the content. Danny described how he was more comfortable with the biology content, and Michael demonstrated his comfort via his expertise in being able to adapt what he knows to what the students need while also staying in line with the scope and sequence. Watching Michael's teaching in the classroom was fascinating because of the connections he made among the information. I saw a true case of transfer. Although Michael had progressed far beyond this phase, his discussion and my observations in his classroom demonstrated what it looks like to be comfortable with pedagogy/content. Settling into teaching also meant the teachers became confident with their role/philosophy.

- Colleen-The first year for anybody is really difficult, and I came back probably 200% more confident the next year. I didn't know it would be that much better, and I think that, that what's helped me is the diversity [classes at in the master's program] because I can handle so many different situations now.

- Mariana-I'm very, very big about respect… I'm normally very, very, very hard at the beginning, like the bottom line where they don't know if they fear me or if they respect me. And not everybody understands that. Not everybody will get along with me. But that's okay, because that is my philosophy.

- Michael- My philosophy is to treat everybody like I would want to be treated in my class. So, I come prepared. I come with something that's meaningful and interesting. I don't, if it's, if it's not meaningful and interesting, I don't waste their time with it. I make sure everything counts.

- Jason - My role as a teacher is to help guide them. I can give them the basic concepts and the information, but try to give them as many different ways as I can for their learning styles.

While Colleen clearly pointed out she was much more confident in her role teaching, quotes from others were a little less clear for me to see the confidence. I saw Mariana's confidence in her philosophy when she stated "But that's okay, because that is my philosophy." She was very comfortable with how she runs her classroom. When I observed her teaching, it was clear that everyone knew her philosophy, too. With Michael and Jason, their demonstration of confidence was a little more nuanced. When I asked all of the teachers about their philosophy or role as a teacher many of them started with "umm, I think, I guess." They started with hesitation or fumbled on their words, as seen in the examples below. However, Michael and Jason did not think for a second or hesitate; they knew and were confident when they stated their philosophy or role.

- Kerri - I feel like I'm a facilitator…I guess…
- Mariana - I guess my philosophy is to…
- Colleen - I guess my role as a teacher is
- Kathy - I think it's to project the information…
- Danny - I like I mean we have to do our lecture and stuff…

Finally, as teachers were settling into teaching, they were able to start contributing to the team, to professional activities, or to other teachers. This really comes out from the data on the TPSST questionnaire. However, I saw two contrasting examples from discussions with Mariana and Elizabeth. The examples below show how Mariana had settled into teaching and was feeling comfortable contributing in team meetings, and how Elizabeth had not made it to this phase yet. Elizabeth was not comfortable yet with contributing to the needs of her collaborative teacher.

- Mariana- Exactly, so the first two years, I was like, "Okay, I'm just going to do whatever they tell me, and I'm just going to follow whatever they do." But now that I'm getting more and more into it, and I'm getting more and more experience, I'm able to actually participate.

- Elizabeth - I'm still a new teacher. People kinda treat you like 'well, you gotta pull your own weight, and you gotta pull our weight, too.' But, I can't do that…I can't do it.

In addition to these two contrasting quotes about contributing, I reviewed the TPSST data to see how teachers were contributing to others. All of the teachers Phase 2, indicated on the TPSST that they were contributing to other teachers, mostly by providing teachers with lesson materials. Through feeling comfortable, being confident and beginning to contribute, we see how the teachers in this study processed through *Phase 3: Settling into Teaching*. All but two of the participating teachers (see Table 3.8) had moved on to or past the next phase of commitment, *Phase 4: Remaining at the School*.

Table 3.8

Teachers' Stages/Phases in the Committing to Science Teaching Process

Pseudonym	Committing Stage/Phase	Years at the HSHD School	Years of Science Teaching Experience
Elizabeth	Early/2	2	2
Colleen	Early/3	4	4
Danny	Early/4	5	8
Kyra	Early/4	5	11
Mariana	Advanced	7	7
Kerri	Advanced	7	12
Kathy	Advanced	7	12
Michael	Advanced	7	17
Gabriela	Advanced	9	30
Jason	Advanced	13	40

Phase 4: Remaining at the school. In this phase, participating teachers expressed a passion, appreciation, or reason for liking the school or remaining at the school. The micro-actions in this phase included: appreciating the type of support received; bonding with the school, team, and students; focusing on creating success; and moving on to the advanced stage of committing to science teaching. Teachers who remained at the HSHD school expressed their appreciation for the type of support they were receiving from the administration and from their science teams. This support was

very different then the support they mentioned in the earlier phases. This was a type of support advanced teachers needed if they were going to stay at the school. Several of the teachers really focused on the fact that they felt independent and not micromanaged because of the type of support they received from the leaders at the school. Additionally, teachers mentioned that they were able to get the resources they needed from technology, and extending to lab supplies. Finally, one teacher mentioned how the science coach was able to "protect" the science teachers at the school.

Examples of the teachers appreciating the support they received included:

- Michael - … I don't really feel micromanaged here. You know, other schools tend to dictate. Like, the nuances, too…And I don't feel like I have to do that. Um, I have access to a lot more technology… they're willing to pay for it. They're willing to pay for more training – not in just more training but whatever you need.

- Gabriela - They're very supportive. They're very, very supportive…I'm very happy with them. She's [the principal] a hardworking lady, and she respects teachers. She's a teacher over at the school, and she cares for the kids. I have the support of administration all the time. I have the support from all of the teachers. They work very hard, you have seen. I have problems of technology, and I always ask for help, and everybody's helping here.

- Danny - But this one they are real good at least from the other schools I've seen. They are real good about leaving us on our own to do what we think is best and they try to stay out of our hair as much as possible…. within biology we're more collaborative…. I mean once she got on as a science coach it's been awesome, because she really is good about keeping us in the loop and also making sure were being protected. She's not going to let us get messed up.

- Mariana - …as long as you're doing what you're supposed to do, you're working, they leave you alone, and I like that…. So that is really good to work in a place where you know that you can get the things, and you can use them…And again, we have a great support system from the administrators, because they basically just let us do, and they support us when it comes to students, and they always back us up so that's a good thing…

This support helped the teachers bond with the school. It was obvious to me that many of the teachers who decided to remain at the school had bonded with the school, and/or the science team or the students. While several of the teachers at the same school had been offered an opportunity to move, none of the teachers had taken the opportunity.

- Kerri -Yeah so, but it's fun, I love teaching here, love it.

- Gabriela - Yeah, but I didn't want to do it. I like this place. At this school, everybody works really hard. It's a very good school... I like the principal, because she has high expectations, but she respects you…The principal is very nice, very supportive…I like kids, I like all kids….. I love a principal who is very supportive. I love the teachers who work very hard.

- Michael - There's a lot better like team experience.

- Kathy - So coming here, everybody is real nice. No matter which school you're at…I found out the kids are real nice here.

- Kathy - I like teaching at this school, and I got a job offer from another school the other day and I was like, no… and didn't do it.

- Mariana - I've been offered other positions as a head coach in other districts, and I said, "Know what? No." I don't want to move, I like the school, I like the way things work here, the way you're very independent…

- Colleen - The school is very, very, very supportive, and I think that's one thing that when I did sub, I went to other schools and they weren't as welcoming. Here, everybody is really friendly and welcoming, and I think you need that when you're in such a stressful job.

- Jason - … I just like [working with the] kids. It keeps me young. Really does. Honestly, it really does. It keeps me young… It keeps me going. It keeps me energized…

Once teachers had settled into teaching, and decided to stay at the school, I started to see them truly focus their energy on creating success. Arguably, every teacher wants their students to be successful, but sometimes those who are just trying to stay ahead are not at the stage where they can truly focus on creating successful practices for students. Also, all of the teachers participating in this study work at HSHD schools so of course they discussed some type of practice to create successful learning environments. However, as teachers progressed through the process of committing to teaching science they were able to shift their energies. The teachers who were more advanced in the committing process were able to focus on creating success for the students in such a way that they clearly mentioned the need for follow up, transfer, and critical connections. I saw both Michael and Gabriela discuss college, whereas the other teachers had not. Michael and Gabriela both also discussed needing to really monitor the students to make sure they were not just getting by, which takes more energy than the early phase committers would have been able to contribute. Thus, I made *focusing on creating success* an action within Phase 4. The examples of this action are below:

- Michael - I like to get them up to the point where they understand reading a book on my own time is worthwhile. You know, that's where they need it. ..You have to fill your gaps and time with something meaningful. Fill in every single gap because that's what you have to do in college, if you want to be successful.

- Gabriela - I'm going to teach you so you have the confidence so whenever you go to college, you're ready. You're ready. You're not going to be panicking because you may have a grade that is not going to be that real.

- Michael - …in my environment, whenever I teach, unless you're going to follow-up and monitor constantly, they're just not going to do, I mean, the scores will look like they are doing what they are supposed to be doing, because they can copy.

- Gabriela - But it cannot be just giving the paper to the students…I have to monitor that they were doing it. That's something you have to do over time. You have to be after them to make sure that they would do it.

- Kyra - not only get students successful at passing exam but prepare them for life after high school, critical thinking, prepare them not just science but connecting it…

Harcombe, Knight, and Bellamy (2003) completed extensive research on urban science teachers in Houston. In this case, teachers in both early and advanced stages of committing to science teaching participated in a one-year program called the Model Science Laboratory. The program helped teachers truly understand students and noted, "when teachers monitor thinking rather than recall, it is useful to have a great awareness of the students as individuals" (Harcombe, Knight, & Bellamy, 2003, p. 139). I clearly saw Michael and Gabriela report doing this in their classrooms.

The final action in this final phase is actually only the beginning of a new stage for the teachers committing to teaching science at HSHD schools. The final action is, *moving onto the advanced stage of committing*. At this point, teachers had progressed through the entire early phase of committing to science teaching. They had completed each of the four phases: *deciding to become a teacher, starting to teach, settling into teaching*, and *remaining at the HSHD school*. The majority of the teachers in this study (60%) had moved onto this advanced stage of committing. See Table 3.8 for details regarding teachers and their phases in the committing process.

Each one of the advanced stage teachers had been at the school longer than five years and discussed/demonstrated their confidence, comfort and bond with the school and with teaching science. However, their reflections on their personal experiences from the early stage of committing revealed that prior experiences had helped them progress from stage to stage, which has been laid out in this study. Moving into the advanced stage of committing to teaching science leads to an entirely new layer of complex actions (requiring adapted supports for these teachers who are truly committed to the profession).

The Advanced Stage of Committing to Science Teaching at HSHD Schools

Unlike the more linear early stage of committing, the advanced stage of committing to science teaching is a continuous cycle. The actions in the advanced stage can happen in any order for any amount of time. Often the teachers in the advanced stages were engaged in multiple actions, which they indicated helped them to stay energized in the profession. Refer back to Table 3.4 to see the details about the advanced stage of committing. Teachers in this stage were often giving support as well as learning/incorporating new ideas from the teachers in the earlier phases. Additionally, teachers in this advanced stage often participated in professional activities in new or challenging ways. The actions within this phase included: seeking new/innovative/challenging opportunities for learning/growth, incorporating new/innovative technology/ideas into the classroom, mentoring teachers, providing professional development, and reflecting on the old days/thoughts about role/philosophy.

Many of the teachers were actively seeking out new learning opportunities or challenges. These included taking free classes online, and paying for innovative professional development. As I was doing research at one of the school sites, I was able to attend a regional science teacher conference with one. Some teachers were seeking opportunities as a challenge for themselves:

- Gabriela - Every year, they give us some training, but other times I look for it. It's like, for example, I can tell you that last year, I found out about a workshop at the University of Massachusetts on nanotechnology. And I wanted to know about nanotechnology…so I used my tax return to pay for it. Because they didn't pay for it. I was lucky that I was accepted and I was there for one week. I learned a lot. It was nurturing. I've always been willing to learn. I believe I'm learning all the time…I'm fascinated with nanotechnology and I don't regret investing my income tax return on this in order to be exposed to the new era of science.

- Michael - But I never taught physics anywhere. So, I really wanted to challenge myself and keep pushing myself.

- Mariana - And then with science, I already had a background in science just because…but what I'm doing now is that I found this really cool website where you take these online classes without paying anything, so I've been watching those and preparing for the learning more.

Teachers in this advanced stage also incorporated new/innovative technology/ideas into their classrooms. They were "stealing" good ideas, using the internet to find new ideas, or beginning to move into the "new biology." Others incorporated technology with their new ideas. For example, one teacher used electronic clickers for a quiz; and he was excited to show me how the system worked. This same teacher allowed the students to actively use laptops in the classroom as part of their learning activities. Below are some of the examples from the interviews with the teachers regarding their incorporation of new ideas:

- Gabriela - … I'm not that much for dissection. The new biology is molecular biology and genetic engineering.

- Jason - It's like the new [membrane] bubble [activity]. I don't know where it came from. I think it came from our student teacher. I think he brought it with him…I thought, "Oh, it's great, things like that." Because they used to use a lot of the stuff that I had. I could always pull stuff out of my drawer. We got this, we got that. And now we're kind of past that now. Now we're just coming up with new things. Now, we pull them off the internet.

- Kathy - I like to just kind of peek in everybody's room and see what they're doing, "Oh, that looks good. Can I steal that?" …

My analysis of the TPSST survey revealed that several of the teachers in this advanced stage participate in mentoring teachers. They reported doing things such as assisting with classroom management, providing lesson materials, modeling instruction, assisting with orientation, observing other science teachers, and performing other formal mentoring duties. During my observations I noticed these advanced teachers helping other teachers during their off periods. While Gabriela did not report on the survey that she mentored teachers, in her interview she discussed almost an ethical obligation to mentor or contribute. She stated:

- Gabriela - I always try to give my input…your voice you have to contribute. So, every week I try to contribute to something and say, "What are you doing? Okay, let me see what I can do... I always say the thing I have to give something, especially if I have these years of experience.

These confounding results possibly indicated that Gabriella viewed mentoring as a crucial part of her job and not a specialized action. She had been teaching for 30 years. It is indeed possible that she shared her experience and contributed to others as just a part of how she viewed her role as a teacher.

Providing professional development is another thing the advanced stage science teachers reported in the TPSST. Some of the teachers reported that they presented at a science workshop, conference, or training session. Some of them were involved with professional development by being members of a science teacher professional organization. Actually, one teacher asked me for a reference letter because she wanted to be nominated for a science teacher award with the National Science Teachers

Association. She ended up winning the award, and was able to go to the national conference and then bring strategies back to her school to train the teachers at the school. Her interest in receiving the benefits of the award was an indication of an advanced stage teacher describing to go above and beyond the expected duties of her profession.

Finally, I observed advanced stage teachers reflecting on the old days/or thoughts about their roles/philosophy. These teachers were the ones within the sample that had been teaching for at least 15 years. Michael called it the “golden years.” Gabriela emphasized that old materials were still good and seemed to be missing the multiple planning periods she used to have. Finally, Jason was perplexed by the vocabulary instruction that “got away.”

- Michael - it was kind of in the golden years of teaching. The pay raises were going up. And there was a lot of money in teaching. And so they offered free masters.

- Gabriela - It is not easy. What is sad now is that teachers are being overloaded. And that is not going to help. That is not going to help, because so many classes, so much work, and your personal life, this is killing you. Before now, we had seven periods, we were teaching five, then we went to six, and now they wanted us to teach seven.

- Gabriela - When we went over this, I keep it better. I love this activity. It is old, okay? But not because it's old does it mean that it's no good for the country. In the country we have some old materials which are awesome, awesome. And in the past, we were able to teach them with this activity. And you see just by those diagrams they had to come out on how to write a lab report.

- Jason - They need to see it and then they can make a concept map from it and do those things. We got away from it somehow. We don't do as much vocabulary.

I observed advanced stage teachers spiraling through, seeking new/innovative/challenging opportunities for learning/growth, incorporating new/innovative technology/ideas into the classroom, mentoring teachers, providing professional development, and reflecting on the old days/thoughts about role/philosophy. Again, the actions within this advanced stage were not linear. The teachers could be going through all these at the same time, or they might have been more focused on one action such as mentoring teachers. They went through these different actions based on their beliefs, support, confidence and professional comfort.

Discussion

Overall, the teachers at these HSHD schools went through two stages of committing to science teaching. In the early stage the teachers completed four linear phases with micro-actions. In the advanced stage of committing to science teaching, the teachers participated in several different actions to challenge themselves, grow professionally, and give back. Refer back to Tables 3.3 and 3.4 to review details of the stages of committing.

Previous PRISE research focused on the TPC using teacher interviews and surveys as well as principals' interviews and surveys in order to describe individual TPC stages at various types of high schools in Texas. Specifically, previous PRISE researchers zoomed in on a specific stage of the TPC (i.e., recruitment, induction, professional development, retention) and described the stage across various school contexts (i.e., a representative sample of 50 schools across Texas; McNamara & Bozeman, 2007). Each stage was extensively researched using quantitative and mixed methods research. However, in this study I have zoomed out to examine the entire TPC (and pre-recruitment) within a specialized school context (i.e, large, urban, HSHD high schools).

By zooming out on the TPC and zooming into a very specific and unique school context I have developed a framework for the process of committing to science teaching at HSHD schools. The grounded theory described here comes from very detailed qualitative descriptions of science teachers' experiences as they became and remained science teachers at HSHD schools. According to Razak, Darmawan, and Keeves (2009), "Commitment has received a great deal of attention in business and organizational studies, compared to the relatively little research that has addressed commitment among teachers" (p. 346). Razak et al. (2009) go on to say the research on teacher commitment "has become a critical field," but not much has been done on teacher commitment because there is such a focus on "the performance of students and the effectiveness of schools, and not the work of teachers within schools" (pp. 356-357).

In a very early white paper from the PRISE research team, Troncoso-Skidmore (2007) described how PRISE defined professionally committed teachers. However, Troncoso-Skidmore's comments were based on literature review to conclude:

> Continued efforts of professionally committed science teachers flourish in supportive collegial environments that encourage continual professional growth and development throughout the career of a teacher. In this way, the joint vision of professionally committed teachers and supportive administrators to produce well prepared students becomes a reality. (p. 6)

The theoretical constructs about commitment defined by Troncoso-Skidmore (2007) are helpful descriptors. My research followed up on the original PRISE definition regarding teacher commitment by studying teachers who have stayed and taught in large urban schools specifically, identified as high schools with learning environments enabling diverse learners to demonstrate successful outcomes in science. Instead of saying commitment and support create "well prepared students," I am looking at schools identified as having well-prepared students and using the teachers' experiences to describe the process of committing to science teaching.

Researchers examining teacher commitment in education have described types of commitment, levels of commitment, behaviors of committed teachers, and factors contributing to commitment (i.e., Bogler & Somech, 2004; Razak et al., 2009; Somech & Bogler, 2002; Troncoso-Skidmore, 2007). However, no one has described the process of teachers committing to teaching science in HSHD schools. In this study, the grounded theory emerged as the process of committing. It is important to note that I reviewed the literature after I had developed the original framework for the committing process. The literature, therefore, served as a form of theoretical sampling within this study, thus confirming and saturating codes and categories (Charmaz, 2005).

As noted in the findings, all the teachers were in the process of committing to science teaching at different phases based on their experience. All of the teachers in the study reflected on Phase 1- *Deciding to Become a Science Teacher*. Findings from the teachers reflecting on this phase paralleled findings from "pathways to science" (Crowley, Brigid, Knutson, & Martin, 2015). As the teachers in this study reflected on deciding to become a science teacher, they noted that they started liking science based on early influences specifically relating to "being outside" (Kerri, Colleen, Michael), having "a ton of animals" (Colleen), and really liking to learn about "how our bodies work" (Colleen). Crowley et al. (2015) investigated how scientists and engineers became interested in science pathways. They found that the majority of the participants became "interested in science during childhood … [with topical interest] such as the outdoors, animals, and biology" (p. 299). Additionally, they found some of the participants became interested in science because of tinkering and mathematics interest (Crowley et al., 2015). This is similar to responses from teachers in my study such as Danny who just did experiments out at the farm growing up and Jason who had a strong interest in math. However, something that has not been well defined is the point at which an early interest in the path to science diverts to a path to science teaching. Every teacher in the study had some type of shift in interest. Research exists about scientists or STEM majors who become teachers in urban schools, but the focus is on beliefs, training, and induction (Jeanpierre, 2007). In order to better understand the diverted path it would be helpful to complete life history research on science teachers similar to what Crowley et al., (2015) completed on scientists and engineers.

Phase 2: Starting to Teach, was the next phase in the commitment process for teachers. Deciding a location was the first micro-action within this phase and Richardson (2012) had completed extensive research on why Texas science teachers accepted their positions at their current schools. Richardson (2012) described 12 categories which influenced teachers' decisions. She noted that teachers in large schools were more likely to accept a position because of a "desire to teach a new course" (Richardson, 2012, p. 112). She also found that teachers in highly diverse schools were more likely than teachers in less diverse schools to accept a position based on location or money. These findings are congruent with findings from my research. For example, Michael mentioned he moved to the school because he wanted to teach physics. Additionally, four of the ten teachers in this study mentioned pay as a reason to move to the HSHD school, however, it was not the primary reason for their move. Interesting though, three of those four teachers who mentioned pay were males. One spot where my research does not align with Richardson (2012) is reputation. She noted that not a single teacher from a highly diverse school mentioned reputation as the reason for deciding to take the positon and she said some of the teachers at the highly diverse schools mentioned just needing a job. In my research three of the ten teachers mentioned reputation and not a single one said they just needed a job.

Also, regarding recruitment techniques specific to science teachers in urban schools, Colley (2003) noted two pathways to being recruited which he dubbed "rabbit" and "turtle" recruitment. Both of these recruitment pathways were visible with the teachers in this study. For example, Michael applied to 20 schools and had 19 schools wanting to hire him. Rapidly applying to many schools is an example of the speedy "rabbit" pathway. Colleen would be an example of the slower "turtle" pathway in which she took some classes in science while substituting. She got her foot in the door while substituting and eventually got hired at the school.

Another action that teachers completed in this phase was the process of seeking learning opportunities to become comfortable. Somech and Bogler (2002) noted, "highly committed professional teachers are expected to acquire expertise in new subjects that contribute to their work, to enhance their ability to deal with students' special needs, and to improve their classroom performance" (p. 561). When teachers in this study reflected on their early starts in teaching they noted that they pursued masters' degrees focusing on diversity, special education, or composite science. They also stated they would go home and study the book or take free online science classes to know more about the content. Clearly, the teachers at the HSHD schools were highly committed from the start.

Next, teachers reflected on and discussed *Phase 3: Settling into Teaching*. After completing the findings section in this study, I followed up on the teachers. A year later, all but one of the teachers were still teaching at the same HSHD school. The only teacher that left the school, not surprisingly, was a teacher in *Phase 3* of the early stage of committing. *Phase 3* is what I very early on termed the "make or break phase". In this phase teachers truly start to settle into their philosophy/role as a teacher which is driven by their beliefs. If their philosophy/role is not a good "teacher-to-school match" (Richardson, 2012), then the teachers are not going to stay. However, for those who do stay, they begin to contribute and give back to the school. We see this when Mariana expressed that she is "able to actually participate" in the team meetings. Another example is when Gabriela described her feelings of obligation to contribute. This parallels science teacher retention research from Fong (2003), who argued:

> When the new teachers become a veteran in three to five years, he or she will feel a responsibility to look after new teachers, and a cycle of learning is created. Teaching becomes a profession in which the training of new members is a responsibility all teachers must assume. (p. 160)

Finally, teachers decided to remain at the school in *Phase 4*. Several actions are associated with this decision. First teachers truly appreciate the support they receive. Each phase in the process of committing requires adaptive and continuous support. However, teachers deciding to remain at the school received support that was matched with their professional stage. Teachers really appreciated this support. For example, teachers within West Ridge Mount HS reported on their autonomy in the classroom noting, “we have a great support from the administration, because the basically just let us do” (Mariana). Another comment was that from Danny, at the same school, saying “they are real good about leaving us on our own to do what we think is best and they try to stay out of our hair.”

Sosu, McWilliam, and Gray (2008) completed mixed methods research on teachers’ commitment to teaching environmental education and they found “perception of control or autonomy is the most significant factor that influences teachers’ decisions…To increase commitment to teaching environmental education, teachers must be made to believe that they have control over the subject” (p. 185). The culture of professional support at the HSHD schools seemed to be where the teachers who committed to remaining at the school were able to be autonomous from the administration, but not necessarily from the science team: a form of balanced autonomy.

I argue, with balanced autonomy teachers received extensive support regarding instructional methods from their science team, but based on communication from administration they perceived autonomy to do what they needed to do. Regardless, this autonomy from the administration shows a type of trust the teachers felt from the administration. Alhashem (2012) discussed why nine teachers remained teaching in an urban setting. Using mixed methods, Alhashem found teachers did not leave when they felt trusted by the administration. Additionally, Alhashem (2012) found that teachers stayed when they loved their students and felt appreciated by the community. In this study, science teachers who remained at the HSHD schools also noted similar reasons, such as different bonding with the school, team, or students. The quote from Gabriela encapsulates these bonds:

- Gabriela - I like the principal, because she has high expectations, but she respects you…The principal is very nice, very supportive…I like kids, I like all kids….. I love a principal who is very supportive. I love the teachers who work very hard.

Montaya (2015) reported results of survey based research examining why science teachers stay in Texas schools, finding that support from administration was the most important factors for teachers staying. However, when I look back on my research, I found that the support teachers need at this phase is shared among team leaders, department heads, and principals and it must be carefully balanced to create respectful autonomy among team members.

Teachers who decided to remain as science teachers at HSHD schools moved on to the advanced stage of committing. I found that this stage did not occur in a linear set of phases. In the advanced stage of committing, teachers can be engaged in one or more actions for any amount of time. Somech and Bogler (2002) noted:

> Regarding organizational commitment, teachers who are committed to their schools are expected to engage in behaviors that would help the employing organization achieve its goals, regardless of whether these behaviors are part of

> the teachers' role. These behaviors should be oriented toward the team, such as working collaboratively with others and orienting new teachers, as well as toward the organization as a whole, by volunteering for roles and tasks that are not a prescribed part of their job. (p. 561)

I observed this among the teachers who were in the advanced stage of committing to teaching science. Many of the teachers were mentoring other teachers (as evidence by both the teachers' responses on the TPSST and observations). Additionally, all the schools had weekly collaboration/team meetings in which the teachers reported contributing ideas. Finally, some of the advanced stage teachers in the study volunteered to attend professional developments on a Saturday even though they had accrued all their hours, or getting students involved in after school outdoor adventures around parks close to the school campus. Some teachers voluntarily paid to go to professional development for no other reason than to learn about the new era of science. Others mentored new teachers without any formal stipend. Something interesting that Baldacci and Moore-Johnson (2006) found in his research on retention was:

> There were three distinct kinds of schools—and only one of them was doing a good job supporting, and holding on to new teachers. The key was in the schools' professional culture. The first kind of school had a mix of veterans and novices, but teachers worked in isolation instead of learning from one another. The second kind had a teaching staff comprised almost entirely of novices who were bound by their enthusiasm, but lacking skill. The third kind had veterans and novices who were encouraged to work together, sharing expertise and fresh

ideas. In our sample of 50 new Massachusetts teachers, 17 began their careers in schools that fostered such collaborations—and 82 percent of them stayed in those schools after the first year of our study. (p.21)

I would argue that all three of the schools in this study would fall into Baldicci's third category. These three HSHD schools had a nice mix of early-career and veteran teachers. In a way, I think the veteran teachers modeled the commitment process through the collaborations that were so apparent in every school.

In the research of Harcombe et al. (2003) on urban science teachers in Houston participating in the Model Science Laboratory, teachers in both early and advanced stages of committing to science teaching participated in the program. Researchers discovered seven factors that impacted retention. Networking, life-long learning, and time were among the relevant factors in the process of teachers committing to science teaching at HSHD schools.

Conclusion, Implications, and Future Research

Conclusion

Oakes et al. (2002) state the importance of studying the processes "that support urban teachers as they forge connections to schools…that sustain their commitment and hence keep them in urban schools" (p. 232). The guiding question for this research study was, *Why do science teachers go to and remain at high schools identified as HSHD?* In this study, I used constructivist grounded theory to explore teachers coming to and remaining at the identified HSHD schools. In developing theory, I described these actions and developed a framework to map the process of committing to science teaching. Teachers went through stages, phases, and levels of actions in the committing process (see Tables 3.3 and 3.4 to review details about the stages, phases, and levels of actions). In general, teacher researchers have studied types of commitment, levels of commitment, behaviors of committed teachers, and factors contributing to commitment (i.e., Bogler & Somech, 2004; Razak et al., 2009; Somech & Bogler, 2002; Troncoso-Skidmore, 2007). However, my research yielding a developing theory on the process of committing to teaching is new. Even more specifically, the process of committing to teaching science at HSHD schools has never been studied.

Implications and Future Research

The framework for the process of committing to science teaching at HSHD schools is relevant because "…developmental stages in the teacher's journey can be supported by a school's professional culture" (Stuessy, 2010, p. 1). Therefore, I found it was important to understand these developmental stages as they specifically related to the process of committing to science teaching. Knowing where science teachers are in the committing process helps those providing support to adapt the support to fit the needs of the teacher. Additionally, for teachers in *Phase 3*, what I call the make or break phase, effective support providers ensure appropriate supports are provided to those teachers especially, who are settling into teaching. Knowledge from understanding the stages and phases of committing to science teaching at HSHD schools can transfer to LSHD (low success-highly diverse) schools in the hopes of creating a more adaptive and appropriately supportive professional culture.

Finally, by understanding the process of committing to science teaching, stake-holders can adapt reform implementation practices to the specific needs of the teachers in the school, and administrators can ensure reform strategies are congruent with their teachers' current phase in the committing process. This is especially significant as the new wave of reform, *Every Student Succeeds Act* (ESSA), sweeps down giving states more "responsibility for curriculum, standards, and testing" (Robison, 2015, para. 3). Thus, future research could follow the implementation of ESSA as it relates to teachers' stages in the process of committing to science teaching.

Additionally, future research could focus more on the continuous cycle of supports and beliefs that influence teachers' decision making along the phases of committing. A continuous longitudinal study with teachers such as those participating in this study would be helpful to further developing actions in the advanced stage of committing to science teaching. Also, knowing where teachers are in the committing process, analyzing their beliefs, and comparing those to actual classroom practices would be beneficial in providing more information regarding *how* teachers remain in HSHD schools (*how* referring to how they actively engage in teaching science).

Limitations

While I was able to purposively sample school sites, I had no control over the biology teachers selected within the school site. Therefore, the teachers selected represent a wide range of experience from novice to veteran teachers. This process of seemingly random teacher selection at the school level actually worked in my favor for developing the story about the process of teachers committing to HSHD schools because I was able to have teachers at different stages and phases of commitment. Additionally, my sample technique used data from the 2011-2012 school year to identify HSHD schools. The new teachers in my study might not have been teaching at the school during these data collection years. Finally, while I made sincere efforts to utilize theoretical sampling, I was constrained by IRB, school administrators, resources, and time. Therefore, following suggestions from Corbin and Strauss (2007), I accepted what data was available. As I collected data, I followed leads via literature for theoretical sampling. Also, as I was analyzing the collected data in the field, my findings would have led me to follow leads to sample more teachers from different HSHD schools. However, due to a priori sampling, I had three to four teachers in my sample from three different HSHD schools across the state of Texas.

Charmaz (2006) noted that the strategy of theoretical sampling is a process of "going back into the empirical world and collecting more data about properties of your category, so you can saturate its properties…" (p. 96). Birks and Mills (2011) stated that data can encompass a variety of sources, including literature. Therefore, once I developed categories, I turned to the literature and revisited the original school data to saturate the properties of the categories instead of sampling more teachers. As Charmaz (2006) stated, "theoretical sampling can entail studying documents, conducting observations, or participating in new social worlds as well as interviewing or re-interviewing with a focus on your theoretical categories" (p. 107). Documents in my sample included everything from PRISE white papers, policy briefs, dissertations, and relevant literature on commitment and urban science teacher retention. Despite these various limitations, understanding the science teachers' experiences regarding the process of committing to science teaching at HSHD is invaluable as we move forward to further sustain the TPC for science teachers in urban schools.

PORTRAITS OF OPPORTUNITIES TO LEARN SCIENCE: AN EMBEDDED-DESIGN MULTIPLE CASE STUDY OF SCIENCE CLASSROOMS IN TEXAS HIGH SCHOOLS IDENTIFIED AS SUCCESSFUL AND DIVERSE

Current education researchers and education policy makers have increasingly focused on the issue of underrepresented students' participation in science education (NRC, 2011a, b; NRC, 2012). Carter et al. (2003) stated, "there is powerful evidence that traditional ways of teaching are not increasing the number of students of color who are interested in science and science related careers" (p. 5). Evidence from aggregated student data from Texas high schools indicates Texas is following the national trend of leaving traditionally underrepresented students out of the STEM equation. For example, in my related research I found that too few diverse high schools in Texas are identified as having successful science programs (less than 2% of 1,308 traditional high schools; refer back to the first section of this dissertation titled, *A Demographic Overview of Secondary Science Education in Texas*).

Additionally, limited literature exists in which researchers describe successful high school science learning environments for diverse students (especially Hispanics; see literature matrix Appendix A). What happens in schools identified as successfully preparing diverse students for science career and college readiness? Ladson-Billings (2013) argued that the genre of urban success stories is underrepresented in the area of secondary science education. Not only is research needed on successful secondary science teaching, research is also needed in science classroom observations focused on the quality of implementation of science instruction. The research committee from the National Academies of Sciences, Engineering, and Medicine (NASEM, 2016) support this and reported:

> Although teachers' estimates of the frequency of different instructional practices offer some insight into what is happening in science classrooms, they do not provide information about the quality of implementation of those practices. Few large-scale observational studies of science classrooms provide assessments of the quality of instruction. The few that are available suggest that science lessons are often inadequate. (p. 50)

Lee and Gay (2013) took observation based research a step further than NASEM and argued that systems need to be examined from a sociological perspective, at a level of micro-specificity. The *Every Student Succeeds Act* (ESSA, 2015) further supports this notion as new education laws are currently being released to allow for context specific interventions and more state level control of education. A focus on local context (micro-specificity) is important as "context shapes teaching and learning. The cultures of schools and districts, the roles assigned to teachers, and the opportunities teachers have to continue growing vary across districts, stated, and school networks" (NASEM, 2016, p. 200). In this study, I sought to answer the call for micro-specific/context-based, observational, secondary science education research in schools predominantely serving Hispanic learners that have been identified as successful, thus providing a portrait of opportunities to learn science.

Purpose and Research Questions

In this study, I explored science teachers' orchestrations of their biology classrooms in three Texas high schools identified as HSHD. Furthermore, I reviewed teachers' beliefs and self-reported practices in comparison to their actual classroom orchestrations. I observed selected science classrooms for three to four consecutive days to gain a better understanding of science teachers' classroom orchestrations. I chose *How People Learn* (*HPL*) to identify common characteristics among the observed classrooms. Through detailed description and in-depth cross-case analysis I casted a light on common science teaching practices used by teachers in schools identified as HSHD. The guiding question for this research was: *How do science teachers from high schools identified as HSHD employ recommended teaching practices in their science classrooms?* More specifically, I answered these additional questions:

(1) What elements of the *How People Learn* (*HPL*) framework are evident in the science classroom learning environments of highly successful, highly diverse (HSHD) high schools?

(2) How do these science teachers orchestrate the complexity dimensions of their science lessons?

(3) Across all cases observed, what patterns of *HPL* design and practices characterize the science classroom learning environments of HSHD schools?

Conceptual Framework

Based on the guiding question in this study, I used the *HPL* framework (Bransford et al., 2000) as the overarching lens for identifying recommended teaching practices. My rationale for selecting the *HPL* lens was that it has been foundational for several current standards documents in science education, including current standards document in science education, *Next Generation of Science Standards* (NGSS, 2013). NGSS is based on National Research Council (NRC) docuemtns. Additionally, over the last decade evidence exists from *How Students Learn Science (*National Academies Press, 2005), *Taking Science to School* (Duschl et al., 2007) and *A Framework for K-12 Science Education* (NRC, 2012) that the *HPL* framework substantially laid the foundation for the NGSS.

Learning scientists created the elegant yet simple *HPL* framework for the design of effective learning environments resulting from a convergence of research from cognitive psychology, social psychology, neuroscience, developmental research, anthropology, evaluation of learning environments, and research based on the "wisdom of practice" (Bransford et al., 2000). The *HPL* framework has been used to train pre-service teachers at Stanford as well as used as an organizing framework for technology-base learning modules at Vanderbilt (Bransford, Derry, Berliner, Hammerness, & Beckett, 2005). The *HPL* framework consists of four components. All four components (i.e., Learner-centered, Knowledge-centered, Assessment-centered, and Community-centered) of the *HPL* framework work together while at the same time offer distinguishing elements that can be observed in science classroom learning environments. See Figure 4.1.

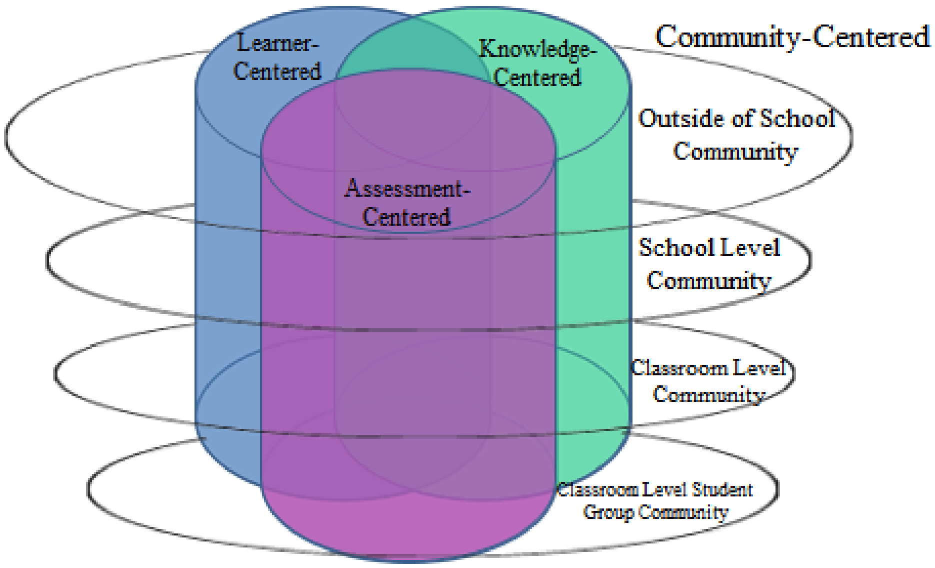

Figure 4.1. A second look at the visual of the community adapted *How People Learn* framework. Adapted from Bransford, Brown, and Cocking (2000).

Components of the HPL Framework

Learner-centered practices focus on students' beliefs, knowledge and skills (Bransford et al., 2000). Within learner-centered environments teachers are cognizant that students construct their own meaning (Bransford et al., 2000). Elements within the learner-centered component include culturally relevant pedagogy (CRP) with emphasis on diagnostic teaching practices and respecting language practices. While science is often thought of as absent from culture, Aikenhead (1996) argued, "in addition to the subcultures of science and school science, students must deal with, and participate in, an array of other important subcultures in their lives…Participation in different subcultures creates the need to cross borders between these subcultures" (p. 14). Helping students cross borders between these cultures is what a learner-centered teachers does. Bransford et al. (2000) stated:

> If teaching is conceived as constructing a bridge between the subject matter and the student, learner-centered teachers keep a constant eye on both ends of the bridge. The teachers attempt to get a sense of what students know and can do as well as their interests and passions—what each student knows, cares about, is able to do, and wants to do. (p. 136)

The *knowledge-centered* component focuses on learning for understanding. Specific elements include sense-making, authentic practices, funds of knowledge, and learning for understanding. Within the knowledge-centered component, the scientific proficiencies promote authenticity of science practices and guide the knowledge construction within the content of science.

Assessment-centered practices include student feedback, which is absolutely necessary for teachers to scaffold students' knowledge construction. The main way to get feedback is through assessment-centered practices that focus on both formative and summative assessments (Bransford et al., 2000). Assessments should be critically aligned with learning goals. Within science, I used the strands of scientific proficiencies (Duschl, Schweingruber,& Shouse, 2007) as the learning goals focus for this study. These learning proficiencies address active scientific knowledge goals of using scientific information, process goals of actively collecting and analyzing scientific data, actively participating in the scientific community, and understanding the narrative of science and how scientific knowledge is generated. Additionally, assessment played a major role in the selection of the determination of HSHD schools with the assumption that alignment exist among summative assessment and successful learning environments.

Finally, grounding the *HPL* framework is the *community-centered* component. This concept embeds every perspective, component, and element within the learning environment. Community is the heart of effective learning environments, such that it focuses on elements of classroom community, school community and connections to the broader community (Bransford et al., 2000). Additionally, Carter et al. (2003) noted that getting community involved in the science classroom is an important approach for incorporating multicultural education practices.

Culturally Relevant Pedagogy

In addition to the *HPL* framework, I also examined principles of culturally relevent pedagogical practices (Ladson-Billings,1995). The learner-centered component of the *HPL* framework encompasses practices related to culturally relevant pedagogy (CRP). Embedding CRP within the *HPL* framework allowed me to critically analyze classroom orchestrations based on Ladson-Billings' (1995) criteria for CRP practices which include: "an ability to develop students academically, a willingness to nurture and support cultural competence, and the development of a sociopolitical or critical consciousness" (p. 483). In order to examine CRP, I used Banks' (2013) *Levels of Integration of Multicultural Content* (LIMC) as my primary framework. The levels include the contribution approach, the additive approach, the transformation approach, and the social action approach (Banks, 2013). I coded the observation data using Banks (2013).

Finally, complementary to *HPL* and CRP, I also examine teachers' beliefs and their self-reported teaching practices. Bransford et al. (2005) stated, the *HPL* "framework's four components can be used to highlight areas where we all tend to have 'mini theories' (often tacit) about learning and teaching" (p. 41). Additionally, Bryan and Atwater (2002) postulated teachers' beliefs about learning influence their lesson planning, teaching efforts, assessment and other decisions in the classroom. Unfortunately, too often, these tacit "mini theories" or beliefs about learning remain unexamined (Bransford et al., 2005). This trend is even more prevalent in researchers' attempts to understand science teachers' beliefs. Several science education researchers have noted that teachers' beliefs are a critical component in how science teachers decide to orchestrate their classroom learning environments for diverse learners (Bryan & Atwater, 2002; Johnson, 2009; Southerland et al., 2011). In a longitudinal study examing science teachers' characteristics and the use of culturally relevant pedagogy, Johnson (2011) concluded, "teacher characteristics that are essential to producing these CRP student outcomes include: teacher conceptions of students and others, teacher structured social relations, and teacher conceptions of knowledge" (p. 193). Even though the evidence points to a connection between teachers' beliefs and actions in the classroom, "scant" literature exists on the beliefs of science teachers who teach in diverse classrooms (Bryan & Atwater, 2002; Southerland et al., 2011). Teacher beliefs are important in understanding how teachers decide to orchestrate classrooms and enact science for all (Southerland et al., 2011). Bryan and Atwater (2002) reviewed literature on teachers' beliefs and noted, "beliefs are part of a group of constructs that describe the structure and content of a person's thinking that are presumed to drive his/her actions" (p.823). If there is an influence between teachers' beliefs and their actions in the classroom as posited by Bryan and Atwater (2011) as well as Southerland et al. (2011), then it is important to understand what science teachers believe about the design of effective learning environments and what support they receive to create these environments in science classrooms for diverse learners.

Methods

Research Design

I used an embedded multiple-case study design (Yin, 2014) to analyze the data collected at three HSHD school sites. See the first study in this dissertation, *A Demographic Overview of Secondary Science Education in Texas*, for extensive details about the selection of the HSHD school sites. The embedded multiple-case design allowed me to collect data holistically and then use mixed method techniques to analyze information at the individual teacher level and then at the school level (Yin, 2014). Using the mixed method design within a case study allowed me to address the complexity of the current questions, which required answers using both numerical and verbal description (Yin, 2014).

Data Collection Procedures

For this study I spent four to six days at three school sites to gain an understanding of teachers' science classroom orchestrations on a day to day basis (Yin, 2014). I collected data from classroom observations, interviews, field noted, and a survey administered to the teachers who were observed. The main sources for this study were the classroom observations and interviews. However, in case study research it is necessary to collect various forms of data to develop converging lines of inquiry (Yin, 2014).

I completed classroom observations for three to four consecutive days during one class period for each teacher participating in the study. In total, I observed three teachers at three separate schools. See Table 4.1 for demographic information about the participating teachers. See the first study of this dissertation, *A Demographic Overview of Secondary Science Education in Texas*, to review detailed demographic information about the student population at each school. Note in Table 4.1, I listed schools in order of district approval. For example, North Bend River High School (NBR HS) was listed first because that school district was the first to approve the research. Then the teachers within the school are listed by order of observations. The number of lessons observed was determined based on notable previous large-scale science classroom-observation research completed by Corcoran and Gerry (2011) who observed four to six science lessons within each of the 20 schools participating in their study.

Table 4.1

Pseudonyms and Information for Each of the Participating Teachers

High School	Teachers' Pseudonym	Gender	Race/Ethnicity	Years of Teaching Experience	Years at the HSHD School
North Bend River	Kerri	F	W	12	7
	Elizabeth	F	W	2	2
	Michael	M	W	17	7
West Ridge Mount	Gabriela	F	H	30	9
	Danny	M	W	8	5
	Mariana	F	H	7	7
Bridge Rail Creek	Colleen	F	W	4	4
	Jason	M	W	40	13
	Kyra	F	AA	11	5

Note. F = Female, M = Male, W=White, H = Hispanic, AA = African American

Even though North Bend River was the first school with the district approving the research, West Ridge Mount happened to be the first school I completed observations due to scheduling with the teachers. I completed all classroom observations, interviews, and survey administration from September 26, 2014 to October 31, 2014. As the first day of school for each observed school was August 25, 2014, all the classes I observed were only in the first or second month of the school year. Observation schedules were restricted at the schools. Observations were allowed to start mid-September and had to be completed by mid-December. Within that time frame, typically one to two weeks were designated for state or finals testing and almost a week and a half for holidays. In the fall, therefore, there was about seven open weeks for observations in the schools. However, teachers would not schedule me on days that district or science unit test were being administered. This left the time frame for observation very limited. I recognize the limitation of observing classrooms very early in the school year, but the school calendar is complex. Additionally, I needed to ensure my observations were minimally invasive and respectful of the teachers' schedules. I originally attempted to observe classrooms later in the school year during the spring semester. However, during the spring of 2014 every single school district rejected my proposal for research because of state testing taking place. State testing starts in March and goes through May for different subjects. This is why I re-applied to each district for fall 2014 data collection.

NASEM (2016) researchers discussed notable findings from the National Survey of Science and Mathematics Education (NSSME). NASEM noted this was the only national level data including samples from all grade levels. The national self-report data from science teachers about their instructional practices was useful to me in providing a generalized big picture regarding current science teachers' practices. At the local level of Texas, the Policy Research Initiative in Science Education (PRISE) was able to extensively examine science teachers' instructional practices based on self-report data. However, the self-report data regarding science classroom practices did not provide the full picture regarding the "quality of implementation of those practices" (NASEM, 2016, p. 51).

Sources and Analysis of Data

Classroom observation. Classroom observations occurred across three to four consecutive days for nine science teachers for a total of 28 classroom observations (1,316 total minutes observed in classrooms). See Table 4.2 for the break-down of minutes per class per teacher. Also note the column indicating the number of M-SCOPS segments per class per teacher. I used the *Math and Science Observation Protocol System* (M-SCOPS) to script observations of science classrooms in order to capture teachers' continuous, minute-by-minute, classroom orchestrations. The M-SCOPS was developed by Stuessy (2009) to quantify the complexity of elements within a particular classroom lesson in terms of the teachers' enactments and provisions for instructional and representational scaffolding. The observer divides the lessons into segments, which she then assesses to their levels of complexity regarding levels of direction for learning activities (in which teacher-directed activities are of lower complexity than student-directed activities), information focusing the learning activity (in which less complex information is of a lower level than information levels at higher complexity), and students' cognitive actions on the information (in which listening is at a lower level of action than hypothesizing or designing).

While I was in the classroom, I hand scripted the observation data on an M-SCOPS scripting sheet. I scripted each classroom observation by segment, determining segments on the basis of observed changes in student activity. A segment ended when the activity of the student changed. For instance, when students moved from listening to directions for performing an experiment to actually performing the experiment, students moved from one segment to the next. When the listening ended (which might be segment 1), actions in the laboratory began (which would then follow as segment 2). I then applied codes on the scripting sheet for each of three complexity dimensions. The *Performance and Initiative* (PI) dimension in a segment was related to the level of student-directed activities in the classroom. A higher PI level meant that the segments was more student-directed. I referred to activities high in PI as *student-directed* activities; in the medium range as *teacher-student- shared*; and activities low in PI as *teacher-directed*. The *Model-Eliciting Information* (ME) referred to the level of complexity of the scientific information the students received during the segment. Higher ME levels meant the information students received during the segment was more cognitively complex. For example, describing the external structure of the leaf of a plant (low-level science information) would be less complex than describing the cellular components and their functions in a chloroplast (high-level information). The Model-Building (MB) dimension referred to student activity, i.e., to what the students were doing and/or how they acted on the information received. Higher MB levels meant the students were acting on the information they were receiving in more cognitively complex ways. While the M-SCOPS protocol provides six levels of complexity for each of the three dimensions, I compressed M-SCOPS levels 1 and 2 to form a *low level* of complexity; levels 3 and 4 to represent a *medium level* of complexity; and 5 and 6 to represent a *high level* of complexity. I applied the compressed M-SCOPS codes assessing the levels of complexity (low, medium, and high) for the three dimensions for every segment (i.e., instructional event) in the lesson, then constructed a graph to summarize the teacher's orchestration of the complexity dimensions of the lesson.

Using the same scripting sheet, I also coded each segment to examine the quality of the teacher's implementation of the *HPL* practices. I further distinguished codes and elaborations for each of the four *HPL* components (e.g., see Appendix K). For example, the *Learner-centered* dimension was further coded to indicate that the teacher employed one of the following: *Recognize/build on Cultural Knowledge*; *Respect Language Practices*; *or Diagnostic Teaching*.

Field notes and memos. After each school and/or classroom visit I wrote field notes and created memos.

Interviews and teacher surveys. Additional data sources included two interviews and a completed survey. Teachers participated in pre- and post-observation interviews. The pre-observation interview was focused on examining the teachers' general experiences. The post-observation interview was focused on the teachers' beliefs/ideas regarding components of the *HPL* framework. I used the *HPL* framework because "the framework's four components can be used to highlight areas where we all tend to have 'mini theories' about learning and teaching" (Bransford, Derry, Berliner, Hammerness, & Beckett, 2005, p. 41). See Appendix G for the pre- and post-observation interview protocols. These interviews allowed me understand teachers' "mini theories" about classroom orchestration. Then, through observation I could see how those "mini theories" aligned with their actions in the classroom.

Finally, teachers completed the *Texas Poll of Secondary Science Teachers* (TPSST) survey. The TPSST was developed by PRISE researchers who administered the survey to hundreds of science teachers across the state of Texas (see Appendix I for the TPSST survey). This survey was administered online, through Qualtrics. The survey provided me with information about the classroom teachers' professional development, teaching supports, and some of their ideas about instruction. Again, multiple sources of data allowed me to analyze converging lines of inquiry to develop a robust case (Yin, 2014).

Table 4.2

Total Classroom Minutes Observed and Daily M-SCOPS Segments per Teacher

High School	Teacher	Day 1	Day 2	Day 3	Day 4	Total
		Total Minutes (Number of M-SCOPS segments)				
North Bend River	Kerri	49 (11)	46 (10)	49 (8)	Not observed	144 (29)
	Elizabeth	48 (7)	47 (7)	48 (13)	Not observed	143 (27)
	Michael	48 (18)	45 (8)	48 (9)	Not observed	141 (35)
	School Total					428 (91)
West Ridge Mount	Gabriela	40 (6)	45 (6)	45 (6)	Not observed	130 (18)
	Danny	44 (9)	44 (7)	44 (6)	44 (5)	176 (27)
	Mariana	40 (7)	44 (8)	44 (5)	Not observed	128 (20)
	School Total					434 (65)
Bridge Rail Creek	Colleen	51 (10)	51 (11)	51 (9)	Not observed	153 (30)
	Jason	51 (9)	46 (7)	51 (6)	Not observed	148 (22)
	Kyra	51 (13)	51 (10)	51 (7)	Not observed	153 (30)
	School Total					454 (82)
Total						1,316 (238)

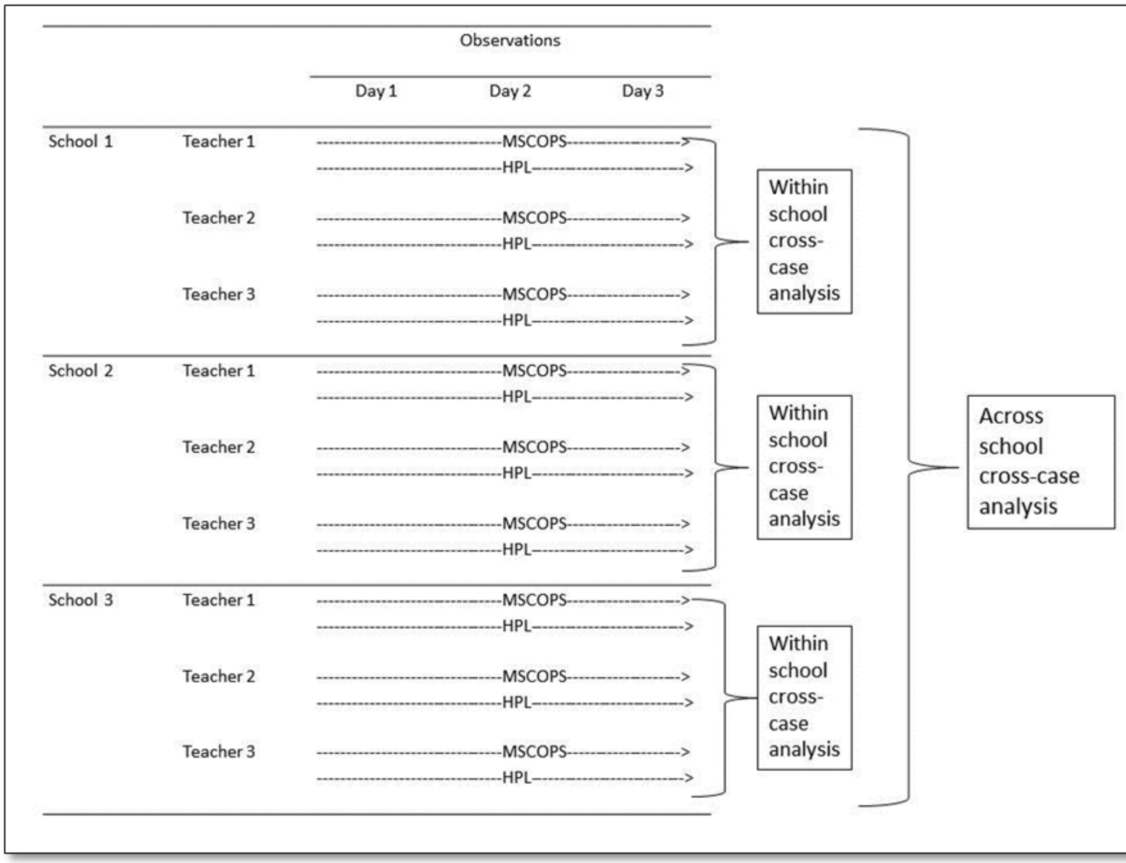

Figure 4.2. A visual overview of the teacher level case data, the school level cross-case data, and the across school level cross-case data.

Format for Reporting the Findings

I reported my findings to reflect the use of the multiple-case, embedded research design. In the findings, I used descriptive vignettes and graphical representations for each teacher and each school to answer the research questions guiding this journey into the science classrooms at identified HSHD schools. I followed a specific pattern of zooming in and out at different ecological levels within a school while also describing proximal processes within the classroom, as suggested by Wilcox (2013).

I presented my findings in sub-sections, one for each HSHD school. I began each sub-section with a big picture of the school, which introduced the reader to the school as a whole. Immediately after the introduction, I then provided a general description of the teachers at that school, one teacher at a time, in the form of teacher mini-cases. To write the mini-cases, I used data from interviews and classroom observations to answer the two research questions. Additionally, I used the TPSST for data triangulation purposes.

I used both sources of data to answer the first question regarding the *HPL* components: *What elements of the HPL framework are evident in the science classroom learning environments of highly successful, highly diverse (HSHD) high schools?* I quantified the qualitative data from interviews and observations to construct an *HPL Component Profile* for the teacher to compare percentages of *HPL* components that I observed in the classroom with the *HPL* components self-reported by the teacher in the interview. To highlight moments from these two data sources, I also provided some classroom and interview excerpts from the teachers.

Next, I answered the second question for each teacher: *How do these science teachers orchestrate the complexity dimensions of their science classrooms?* I scripted classroom events using the M-SCOPS classroom observation system to describe the dynamics of the teaching and learning events occurring within each of the lessons observed. I profiled the three complexity dimensions of the M-SCOPS: *Performance and Initiative* (i.e., instructional scaffolding), *Model-Eliciting Information* (i.e., complexity of scientific information), and *Model-Building Actions* (i.e., complexity of student's actions on the scientific information). For this study, I examined the percent of time each teacher spent at different levels of complexity during each of the classroom observations in order to characterize the complexity at which science teachers orchestrated their lessons. Finally, I zoomed out and summarized my findings about the teacher's classroom learning environment.

Once I had described all three teachers in that school, I zoomed even further out to summarize and compare information about the *HPL* components and complexity dimensions for all the teachers within the school. This description was the product of the within-school cross-case analysis I performed for each of the three schools in the study.

Strategies for Establishing Credibility

In qualitative research, validating the findings is referred to as credibility or "truth value" (Baxter & Jack, 2008). According to Shenton (2004), credibility can be established by several methods including: adoption of appropriate research methods, triangulation via use of different types of information, peer scrutiny of the project, thick description and member checking. Miles and Huberman (1994) and Yin (2014) provided the format for my development of case study research methods. As mentioned, I collected several sources of data which allowed me to triangulate information to create converging lines of inquiry (Yin, 2014). Throughout data collection, data analysis and the interpretation phase, I took time to identify the emerging patterns with a peer or the principle investigator of this research study. I have created a detailed audit trail. Finally, Lincoln (2016) argued that spending time in the field creates "high face validity," as you were present in the context. I was the one collecting all of the data, making several site visits to each school, and spending several days in the classroom observing each teacher. I did not perform a secondary data analysis on data collected by someone else. I was present and the observer at every school. Therefore, my data had "high face validity" (Lincoln, 2016; Lincoln & Denzin, 2003). These various methods allowed me to establish the trustworthiness of the data within this study.

Positionality

My role as the researcher in this case study was to act an observer and inquirer within the selected school settings. I taught general science to diverse learners for five years in a large district in the Houston, TX area. During my time as a science teacher I attended hundreds of hours of professional development to become a better science teacher as well as a more culturally competent teacher. In my journey to becoming a more culturally competent science teacher I transformed my teaching practices. This journey included working with a professional learning community for learning about inquiry in science, earning my masters' degree in urban education, traveling abroad to learn and present at conferences, publishing an study regarding culturally responsive teaching in science, and starting a Ph.D. in curriculum and instruction.

It took time for to me to create a more culturally relevant pedagogy but as it developed I began receiving teaching awards. These awards included being named the school level teacher of the year, being selected to become an NSTA science teaching fellow, and I was one of 15 selected out of hundreds to be the Houston Rocket's teacher who was recognized at a basketball game. The transformation in my teaching practices occurred because my ideas about how to orchestrate an effective classroom changed. I am curious to know how other teachers in diverse classroom orchestrate their classroom environments. This curiosity is driving my current research study. See Appendix E to review an expanded version of my positionality.

Ethical Issues

This study required IRB approval because I studied human subjects to generalize the findings across teachers in schools. In March of 2014, Texas A&M University (TAMU) IRB approved classroom observations, teacher pre- and post-observation interviews, and survey administration to participating teachers (see Appendix F for IRB approval). Once I received IRB approval, I contacted selected HSHD schools to receive site authorization. Three schools agreed to participate in the research. After a representative from the selected schools signed site authorization, I then pursued teachers' signed consents at each of the schools. Teachers signed consents allowed me to begin the research study in September 2014. In a process to protect the anonymity of districts, schools, and teachers, I used pseudonyms to replace all names. Once the data was collected from the school it was (and still is) kept in a secured location on TAMU's campus and on a secured location on my computer.

School 1: North Bend River High School

An Introduction to North Bend River High School

The North Bend River HS (NBR HS) school district was the first school district to approve my research study at the district level. The district quickly returned its decision on the research protocol; the district science chair contacted the science department head at the school. I then contacted the science department head for help with the site authorization. Once she returned the authorization to me, I was allowed to contact the teachers she had identified as being interested in the study. On my first scheduled visit to the school (September 19, 2014), I prepared to review the consent procedures with just one of the teachers (Kerri). However, this visit turned into so much more. When I arrived at the school I was greeted by students at the front desk. The students took my driver's license and signed me in. I then waited for Kerri to come escort me from the front office to a science team office. As we walked, I observed that the walls were covered with college logos, students' work, club/organization posters, and announcements about international trips the students could take.

The science team office had a copy machine, restroom, refrigerator, two tables, a computer, and cabinets with supplies. We reviewed my research project and completed the consent protocol. After we finished consent, she happily gave me a tour of the school. The school is huge and spread out. The main section of the school is three stories. The cafeteria is on the first floor, and on the other side of the cafeteria, there is an entrance to another part of the building. The other side of the building is a long single story hall. The hall had several branches off of it and it seemed to be where all the extracurricular activities were located (i.e., gym, ROTC, home economics, technology class). As we walked around the school, I watched as this teacher interacted joyfully with students and other teachers in the hall. I watched as she encouraged one student in the cafeteria to come into tutoring to make up some work. Additionally, as we were passing through the cafeteria on the tour, parents were selling spirit t-shirts. The school community was vibrant.

Later, I met the department head and two more of the teachers. The department head took me on a tour around the different science labs and spoke about the science program, lab equipment, hiring practices, community events such as "La Noche Ciencia," and the student organization she leads. She was the sponsor for student version of the Society of Hispanic and Professional Engineers (SHPE), which does things after school and on weekends. Additionally, she described herself as a "servant-leader." She has been at the school since it first opened and is driven by the motto:

I have no special talent. I am only passionately curious – Albert Einstein

After meeting with the department head, I completed consent procedures with Elizabeth. The next morning, I met with Michael, the last teacher. That last morning, I arrived at the school almost an hour before classes started. Even at that time, the school was buzzing with activity. Students were gathering in the cafeteria preparing for a morning pep rally, as it was a before a big football game. As I waited for Michael to arrive, I observed a few students come by looking for him (it was a good 40 minutes before the first bell rang). Additionally, while I was waiting, I observed students' science work on display in the hallways.

Finally, I saw Michael come around the corner with two bicycles. I asked him the reason for two. He described his outdoor activity club that he runs. He explained they were going for a trail ride in the afternoon. As some of the kids might not have a bike, he brought in an extra. The community at this school was dynamic and there were lots of activities for the students to be involved in after school. Once he was settled in his classroom, I described the research and he signed consent. This entire time, students were in and out of his classroom dropping off supplies, making up work, and asking quick questions. It was clear to see all the students knew he had an open door policy.

After Michael signed consent, I left the school. I agreed to return for observations on another date, and a couple of the teachers wanted to schedule observations via email. I emailed Kerri to set up a time to come back to the school and we scheduled the first visit for mid-October 2014. After I scheduled Kerri, I coordinated classroom observations during that same time period with Bethany and Michael. While the district for NBR was the first to approve my research, NBR was the second school on my observation and interview visits. I observed and interviewed in this school from October 16 - October 22.

Kerri

An introduction to Kerri. I observed Kerri's classroom during the first class period in the morning. As Kerri is an athletic trainer for the district and she had some leadership responsibilities for the biology team, Kerri did not teach afternoon classes. Kerri's classroom was in a portable building far away from the rest of the biology and science classroom, even though most of the science classrooms are located on the third floor on the other side of the building. I arrived at her classroom before the students and sat at a desk in the back corner as Kerri prepared for the day after taking the time to greet me. As students came into the classroom, they all received a joyful and awake greeting from Kerri. She would ask the students questions about their plans for the day, about tutoring, or about life in general.

As they came in, the students picked up their science binders from a file cabinet by the door. Then they sat down in one of the desks, which were aligned in rows. They started on warm-ups before the bell for class rang. Some students spent a little bit of time socializing before getting started. When the bell for class rang Kerri reminded students to start on the warm up and she gave them some time to complete it. While the students were working on their warm-up Kerri reminded the students about tutoring, walked around the room doing a visual check of the warm up, and stamped students' papers as they completed the warm-up. As she walked around, she noticed a common vocabulary problem among the students so she stopped briefly to talk to the entire class about the meaning of "quantity." Then students resumed their routine. Kerri started her class with greetings, reminders, and warm-ups every day. Kerri's joyful energy never diminished no matter what day it was. Over the next few days I observed this routine as well as discussions, note based lecture with a video and song, a demonstration, an interactive lab, a foldable for review, and a lab quiz.

Kerri's *HPL* component profile. What elements of the *HPL* Framework were obvious in Kerri's orchestration of science lessons? I constructed an *HPL* Component Profile (see Figure 4.3) to summarize Kerri's emphases in her orchestration of science lessons. I used both classroom observation and self-report interview data to represent the percentages of *HPL* components observed in the classroom versus those recorded during the post-observation interview. I used number of thought segments (TS) as the unit of analysis for the interview and time in minutes (Min) as the unit of analysis for the classroom observation. While the *HPL* framework is a highly interconnected model with the community-centered (CC) component being the base that is deeply integrated into every aspect of the framework, I broke down the *HPL* components into individual parts and applied the most relevant components to each unit of analysis, using codes and elaborations for each *HPL* component. (See Appendix K.)

As I indicated in Figure 4.3, higher percentages were found for knowledge-, and community-centeredness in both the interview and the classroom observation for Kerri. With specific regard to community-centered (CC) activities during Kerri's observations, I noticed that she greeted the students, scheduled a daily warm-up routine, encouraged students to sing the organic compound song to other teachers, provided specific directions during transitions among activities, allowed students to work in groups, and assisted students in their organization of science binders. (*Note:* The science binders had taken place of the interactive notebook at North Bend River HS. Each student had his/her own binder, stayed on the same page, and kept it in the classroom. This standard classroom community procedure was an attempt to help the students keep their conceptual knowledge organized.)

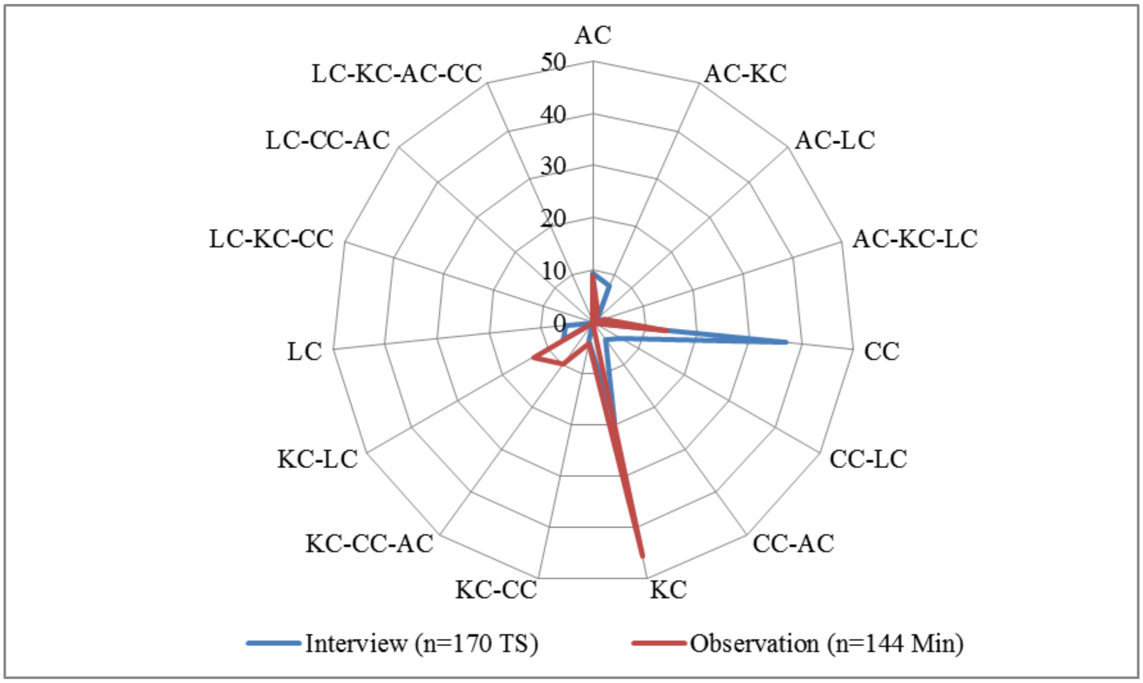

Figure 4.3. Kerri's *HPL* component profile. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

The care Kerri employed in regard to the community she created among teachers and students was apparent from the interview as well. In the interview Kerri reported several CC activities at the classroom, science program, and school level. For example, Kerri mentioned the following with regard to the different ecological levels (Wilcox, 2013) of community:

- I try to make [the classroom] like it's very homey. That's kind of why I like being in the portable, it's very homey, it's very like ok, this is our classroom, we need to take care of it, we need to…I feel like I try to make it their place so then they're very comfortable to speak up, ask questions, participate.

- The big thing right now is PLC's. We all have our PLC's…biology meets every Wednesday morning…we talk about where you should be, what's going on, what are you doing, what's not working, working, not, whatever. Try to plan for the future.

- I love this school, um, they're very, I think as a whole, we're very accepting of all the different types of students that we get and all the different things that those kids can bring to the table regardless of their academic levels.

With regard to knowledge-centered (KC) activities, Kerri focused on the *content knowledge* code within the KC component in her classroom. However, in her interview she really focused on the *understanding* code within the KC component. (See Appendix K for distinctions between these codes.) Kerri's review on knowledge from the previous lab and lecture days was an example of a time segment I coded as *content knowledge* within the KC component. Students listened as Kerri reviewed information such as:

- The characteristics of enzymes…each one has an active site and substrate, enzymes speed up the reaction, enzyme reacts with the substrate to create a product, enzymes are specific-each one can only bond with one type of substrate, enzymes are recycled (summarized from M-SCOPS S1-T1-D3-S3).

Within this 5-minute segment students listened and did not respond, and they received only content. In comparison, I applied an *understanding* code to a KC segment in which Kerri discussed both positives and negatives when describing the balancing of process skills and content in science. In the interview, Kerri and I discussed in detail her concerns about her students' ability to create graphs, but in the classroom she did manage to create moments when she balanced science process skills with the content, thus relaying an understanding of science. In this example, she noted:

- I really spend a lot of time doing it orally without even thinking about it, like what do you think is going to happen, draw an inference…

- I make them, like when we do labs and I'll say ok, let's write our hypothesis. So, it needs to start, I'll start with a sentence stem and then let them finish it however they want to, and then at the end refer back to it. Ok, go back to your hypothesis, what did you write? Were you right or wrong? Write about it in your conclusion.

Process questions like this were apparent in the classroom on the first observation day in Kerri's class. In Figure 4.4, in the next section (Kerri's complexity dimensions), I illustrate how she orchestrated complexity levels when balancing science process skills with the content on the first day of observations.

Kerri's M-SCOPS complexity dimensions. In Figure 4.4, I present the percent of time spent at different complexity dimensions for Kerri for the three days I observed her classroom. The classroom I observed was a co-teach class with many students requiring modifications. I compared the three complexity dimensions for every observation day.

On the first day, Kerri spent most of the time in teacher-directed activity (i.e., low levels of PI); her levels of teacher-directed activities were more prevalent when she spent more time medium levels of information (ME). (Note: This could possibly be a result of Kerri feeling the need to scaffold her learners as she introduced more complex information.)

On Day 2, when there was more time spent doing shared student-teacher activities, Kerri facilitated a laboratory. The students were receiving lower levels of ME and acting at lower levels of MB during this lab because they spent most of the time "being enzymes breaking bonds." During this time, students were breaking and then counting toothpicks. Towards the end of class students, were required to synthesize the analogy from the lab, which brought them to medium levels of ME and MB (specifically a level 4 for 8% of the class time; see Appendix J for level 4 ME/MB description).

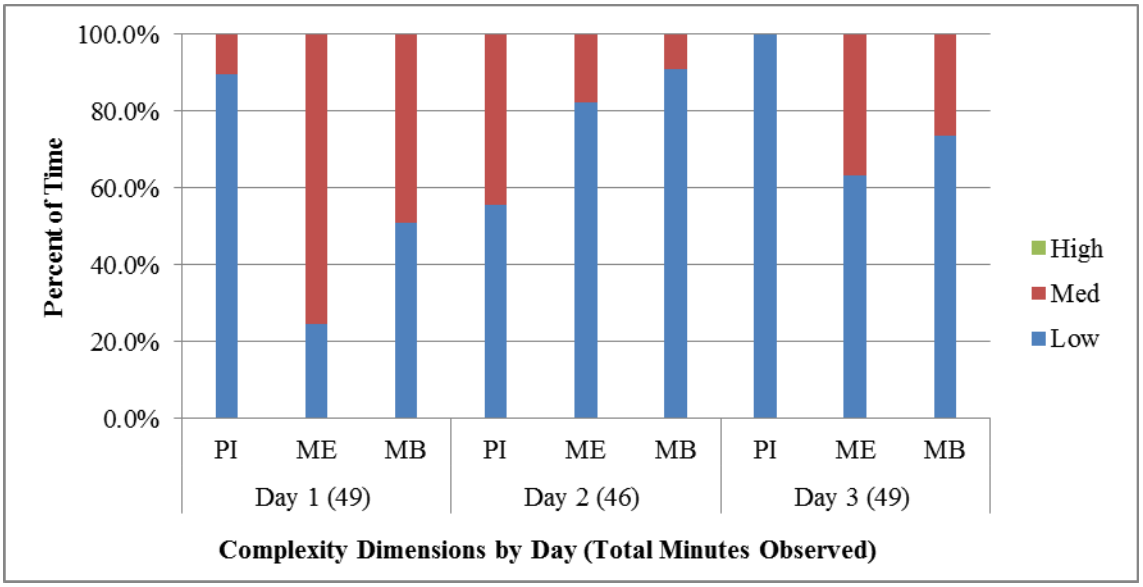

Figure 4.4. Kerri's percent of time spent at different levels of complexity dimensions for each day observed. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions.

Finally on Day 3, Kerri spent the entire time directing class (low level PI). The class started with a review of the lab from Day 2 and the information from Day 1; see *content knowledge* KC component from the *HPL* discussion for micro-level details of Kerri's class. Then the students took a lab quiz, and then worked independently to put notes in a foldable to help them review biomolecules. During the quiz and foldable time Kerri helped individual students. It is important to note that teacher-directed activity does not necessarily mean the teacher is talking at the front of the classroom the entire time. Teacher-directed activity could also be a time when students are all doing the same thing during independent learning (i.e., taking a quiz, writing review notes in a foldable).

Summary of Kerri's classroom orchestration. Overall, Kerri had community-centeredness (CC) at the heart of her classroom, which was noticeable from her interview and clear when you observed her classroom. She wanted to make it a place where each student was "comfortable to speak up, ask questions, and participate." While Kerri spent the largest percentage of class time (45.5%; 65 out of 144 minutes) in the knowledge-centered (KC) component of the *HPL* framework, she either explained complex content knowledge in a very teacher-directed manner, or spent shared student-teacher time having students participate in a simple lab acting as an analogy to the complex process of enzyme functioning. At the end of this mini-concept cycle, she administered a lab quiz regarding enzymes and then had the students work on the bigger picture by reviewing information they previously learned about biomolecules. Overall, I would characterize her three lessons as very low in student-directed activity, providing students with moderately complex information and few opportunities for students to act on that information at higher cognitive levels.

Elizabeth

An introduction to Elizabeth. Every day after the lunch period, I observed Elizabeth's classroom. As she discussed biomolecules she was able to make connections to food the students had just eaten at lunch. For example, one day at the start of class she said "You need to study because these are not words you use every day…you don't get fatty french fries at lunch and say you're eating triglycerides…no one does that unless you're on The Big Bang Theory". The students laughed, seeming to appreciate the connection of their science vocabulary to a favorite lunch time food and pop culture. Elizabeth's humor, connectedness and stories were a consistent way to add a little relief during the class filled with complex science talk and difficult science vocabulary. Throughout class, students would excitedly blurt out questions and, no matter how bizarre the question, Elizabeth made sure to take time to address the question in class. It was clear that every student's voice and curiosity mattered in this classroom.

After lunch, the students would come into Elizabeth's classroom and go to the back corner of the room to pick up their binders. Elizabeth's classroom was on the third floor of the building near all the other science classrooms. In her class students sat at tables in groups. Once the students got their binders they were reminded to do their warm-up. After reviewing the warm-up Elizabeth would go over the plan for the class that day. This was their daily routine. Over the next few days in Elizabeth's classroom I observed interactive group work, discussion based lecture, a lab, demonstrations, and a review.

Elizabeth's *HPL* component profile. In Figure 4.5, I present Elizabeth's *HPL* component profile. Her profile was similar to Kerri's percent of time in both the KC and CC component of the classroom observation and interview. This was interesting because Kerri is one of Elizabeth's main informal mentors. Kerri helped Elizabeth with lesson plans and activities for regular Biology. However, Elizabeth stood out in particular combinations of *HPL* components which included: knowledge- and community-centered (KC-CC); knowledge- and learner-centered (KC-LC); and assessment- and knowledge-centered (AC-KC). Specifically, with regards to KC-CC activities (the second highest observed component for Elizabeth) I noticed her include activities such as having students work in groups on a review activity or work in groups for the enzyme lab, like in Kerri's class. Details of these activities from the M-SCOPS scripts are below:

- Students work as a group sorting cards for structure and function and examples of biomolecules (carbohydrates, lipids, proteins, nucleic acid), discussing their rationale with group members, and then writing down the notes (M-SCOPS S1-T2-D1-S7).

- Students working in groups on enzyme lab and Elizabeth prompting the students or asking questions saying "you need to graph the conditional data…how are you going to show the difference?" (M-SCOPS S1-T2-D3-S8,9,10).

Her KC-LC moments in the classroom were fun to observe. This is where the students' spontaneous curiosity combined with Elizabeth's previous science lab career experience created a dynamic discourse. Elizabeth's KC-LC moments are best displayed in the M-SCOPS scripts on day 1 of observations:

- "The main function in the body of a protein is to make enzymes and build up muscle…" She then connects this to body builders and people who are hungry. A student asks a question: how do you die from being hungry? Teacher gets into how the heart is muscle and discusses other body systems eventually stating the students will be able to synthesize this later when they analyze events from the Holocaust. Then discussion continues and someone ask about protein shakes. Further down the conversation she pulls a protein bar out of her bag to discuss the misconceptions of what they might be learning regarding foods that have protein. (M-SCOPS script S1-T2-D1-S4).

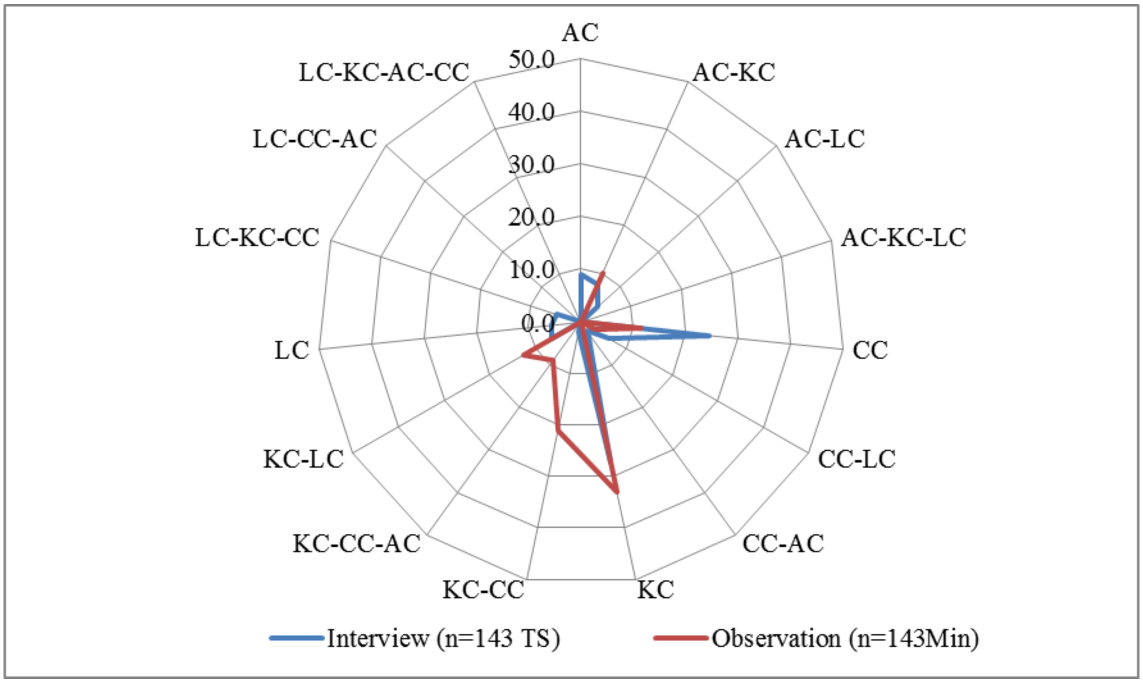

Figure 4.5. Elizabeth's *HPL* component profile. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

Finally, during Elizabeth's observation, I saw the AC-KC component enacted in the classroom throughout the warm-up routine. While the other teachers in North Bend River HS did a daily warm-up and had percentages of the AC-KC component in their respective classrooms, Elizabeth had the highest percent (10% of 143 observed minutes). Elizabeth spent time assessing her students' knowledge during the warm-up routine, she gave extensive examples, and asked them questions in an interactive back-and-forth with the students.

One would think AC-KC would be observed every single time there is an assessment, however, I coded AC-KC to represent moments when there is a back-and-forth among the teacher and student regarding the knowledge. AC happens when students are sitting silently taking a test or quiz. AC is a one-way exchange in a moment where students demonstrate previously acquired knowledge. No new knowledge is being formed in an AC moment. AC-KC, however, defines moments which help students develop understanding because there is an immediate feedback cycle among the students and teacher.

As mentioned in the interview, we saw percentages of the KC and CC components peak. However, based on the interview, Elizabeth had the highest percentage within her school for the combined components of learner-knowledge-community centered (LC-KC-CC). While the percentage of thought segments in the interview for LC-KC-CC was only about 5%, it is more than any other observed teacher at her school and tied only with Kyra among all schools. In her interview she brought up a story about learning how to connect science to the students' background of knowledge through collaborative class conversations as seen below:

- I think you need to ask them. We had a conversation because I forgot the word *tortilla*, which apparently in [this city] you really shouldn't forget. We got into my background, and some of them talked about where they're from. They're not all from here. One of the kids was from Wisconsin. Not everyone in Wisconsin knows what a tortilla is.

- I think also sometimes being vulnerable, saying, "I don't know what that means. Please, explain that to me." They like that. They like telling me about their culture. They get excited, and I think that helps build the relationship.

In her interview Elizabeth also discussed being out in the community as a volunteer and how that helped her to get to know the culture when she first moved here. She was describing how she discovered the core funds of knowledge within the city by active involvement in the community. Referring to this volunteer experience she stated "part of the experience was to get to know the neighborhood and the culture…I think that really exposed me to a lot of Texas stuff and a more Hispanic culture because most of [the city] is Hispanic." Elizabeth was not from Texas, but did everything she could to get to know about the students and the community.

Elizabeth's M-SCOPS complexity dimensions. As seen in Figure 4.6, in Elizabeth's classroom, she spent most of the time in class doing TD activities. Just like in her mentor Kerri's class, her levels of TD activities were most prevalent when there was greater time spent at more complex levels of ME. See day 2 in Figure 6 to observe this pattern. On day 2, students had a shortened class period because of a prep-rally and they had to switch classrooms. After class on day 2, Elizabeth expressed her personal insecurities about the instruction for that class period. She stated that the mostly TD activities of this day were not typical of her way of teaching. Looking at her other two days, she spent almost one-third of the time doing some type of SST activity. For example, on day 3 she did the same enzyme lab as Kerri, giving the students a chance to work in groups. However, Elizabeth's questioning style was much different than Kerri and the way she facilitated the enzyme lab allowed for more time spent at slightly more complex ME levels. Refer back to the KC-CC component discussion to view an example of a question during the lab.

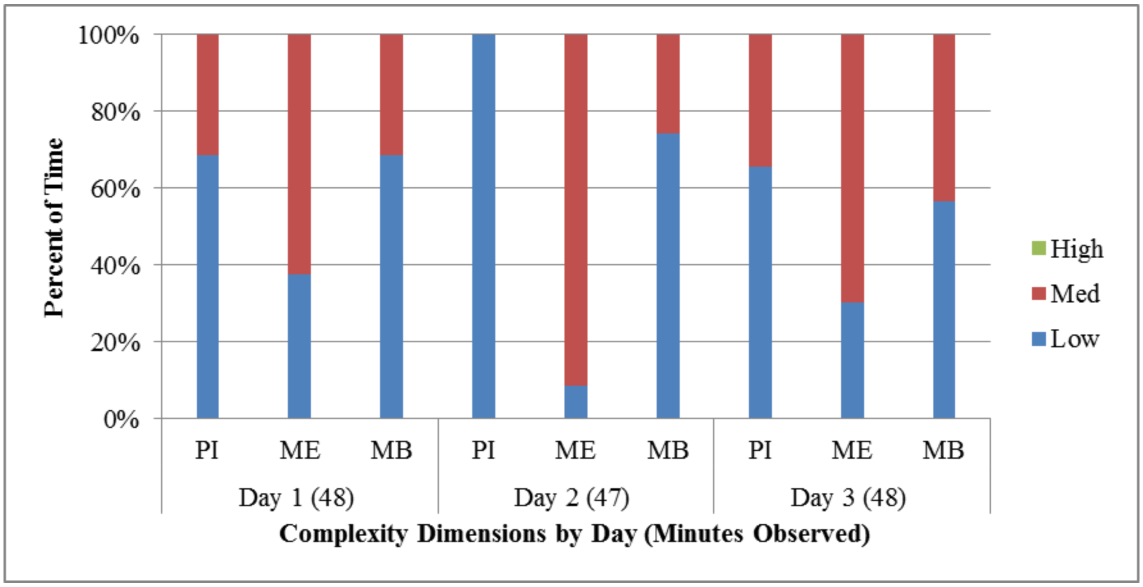

Figure 4.6. Elizabeth’s percent of time spent at different levels of complexity dimensions for each day observed. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions.

Summary of Elizabeth’s classroom orchestration. Even though KC is the most prevalent (33% of 143 minutes observed) *HPL* component observed during Elizabeth’s classes, as seen in Figure 4.5, it is important to look further into the pattern. KC combination components were added together and actually make-up most of the observation time. For example, add KC-CC (21.2%), KC-CC-AC (9.1%), and KC-LC (12.5%) and you see that 42.8% of class time was spent connecting knowledge, community, and learners in some way. These ideas came out in her interview. While most of Elizabeth’s class was spent doing TD activities, she was consistently introducing ME information at a medium level. She made a point to mention that she does not enjoy spending an entire day doing TD activities.

The TD activities on day 2 we actually provided to her, not created by her. Referring back the section in this dissertation titled, *Committing to Science Teaching: The Process of Becoming and Remaining a Science Teacher in Urban High Schools*, it is clear that Elizabeth is in the early stages of committing to science teaching and is just starting to settle into her role. Once she becomes more comfortable in her teaching role, I believe there will be more class days that are mostly SST, developing towards SD activities. I think this because in the interview Elizabeth mentioned “I don’t teach it like most of the teachers…” and went on to describe additional student driven research projects she has had other classes complete. As she continues to become more comfortable and confident, she will truly shine.

Michael

An introduction to Michael. As previously mentioned, my first encounter with Michael was him bringing two bikes down the hallway at 7:30 am on a Friday. The bikes were for the outdoor club and after school trail rides. Of course the extra bike was for a student who might not have one. No excuse not to participate, no excuse not to be involved, which seemed to be his theme in class as well. He had the highest expectations of all his students. He used positive reinforcement in his classroom. Instead of pointing out students not on task he picked a specific student’s who was diligently working and said to the entire class “[student name] is creating pathways for success”. Michael’s classroom was filled with ecosystem bottles by the windows and under the grow lights. There were fish tanks in the classroom and laptops for students.

I observed Michael's class the last period of the day. The students would enthusiastically come into the classroom and, without prompting, go straight to their ecosystem bottle to observe any changes and record new daily observations in their notes. Also, when students walked into the classroom, they knew to pick up whatever was on the front table. Sometimes it was individual dry erase boards, or clickers for the quiz, lab instructions, homework, or notes. Once students picked up supplies and finished observing their ecosystem bottles they went to their desks, which were lined up in long rows, and started on their warm-up. Some of the students used laptops to assist them with the warm-up. On my first day in this classroom I observed a unique process for going over the warm-up answers.

Every student had a small white board and as Michael asked different questions, the students would respond on the white boards and hold them up. He looked at the white boards held high above the students' heads to get a general idea of what the students were thinking. The white boards became the thought bubbles in the classroom. If a student left a white board blank, Michael theatrically exclaimed "Oh no, worst case scenario, a blank board" demonstrating further evidence of his no excuse, high expectation attitude which drove every minute in the class. His theatrics, dynamic voice, and non-stop energy in the classroom made me feel like I was watching a science story book come to life. Over the next few days in Michael's classroom I observed dynamic lectures, technology being used by students, a lab about enzymes, lab review, and a clicker quiz.

Michael's *HPL* component profile. In Figure 4.7, I present Michael's *HPL* component profile. Like Kerri and Elizabeth, his interview peaked within the CC component. However, Michael was especially high in the CC component with about half of the interview referring to CC components from the classroom, science program, and school level. *Note*, all teachers had the same interview questions; refer to Appendix G for interview protocol. Michael had several wonderful things he discussed about his classroom community. For example, he stated:

- I focus on rights instead of rules. And so, that changes the game a lot of times because they know, 'He cares about me,' instead of, he's dictating. He only cares about himself.' That's what I feel like, you know…
- And a lot of the times, if there is a disconnect between they love the class and they're not doing well on the class, that's me. You know, somewhere along the lines, it's not the student anymore.
- I try to let them know that I'm human and that I need help to, you know.

Like Elizabeth, Michael showed the students his vulnerable side when he stated he needed help to create a supportive community in the classroom, which focused on "rights instead of rules." When talking about the science program level and school level community he mentioned several things he appreciates as well as many suggestions for improvement. He also focused on the transitions within the school and Biology leadership. I think recognizing areas for needed improvement rather than settling for the status quo is the mark of a highly committed teacher.

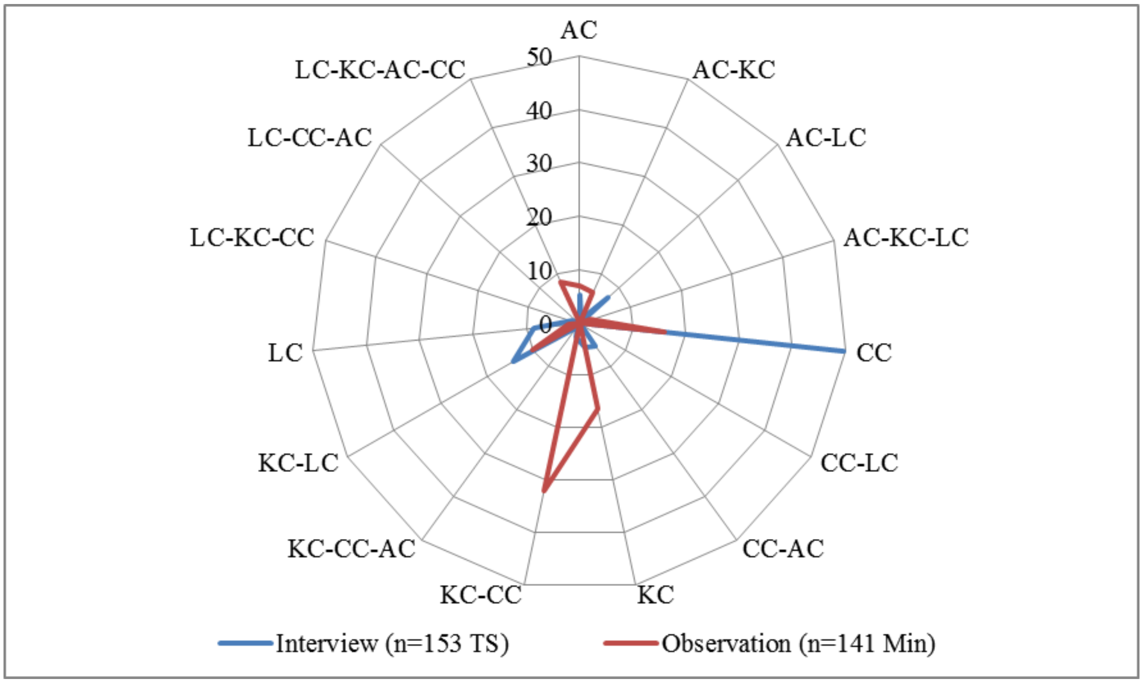

Figure 4.7. Michael's *HPL* component profile. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

With regards to the community at the science program level within Biology he recognized and appreciated working with a team. He did mention, however, the Biology team was in a state of shared leadership without a single designated leader. He stated the following:

- I've been in situations where I had to work as a team. And every single time, if you're working as a team, you're going to do way better Yea, rather than working as individuals.

- We had a pull-out last week. Um, nobody wants to be the leader in ours. And, that's really difficult.

With regards to the community at the school level, he mentioned some good things but also mentioned parents could be more involved and the school administration was in transition. Below Michael described the transition among the administration, also mentioning he appreciated the overall support he has, especially with regards to technology.

- We've had one, two, three new assistant principals, a new vice principal. A new academic dean, and a new principal all in a three-year period. So yea, it's a little chaotic right now.

- …but overall, I can't complain man. It's top notch. They really support technology…I don't really have a whole lot of challenges.

Additionally, where Kerri and Elizabeth discussed KC, Michael is more focused on discussing KC-LC or LC during the interview. All teachers discussed KC-LC but Michael had the highest percent at 14.4 % of TS versus the other two who had about 6.5% of interview TS coded as KC-LC. Examples of his discussion about connecting KC and LC are below:

- Well, I've had a lot of experiences going around the world and then I've had experience out in the real world, you know… scientific background, the military and stuff... So, um, I can bring that in a lot of times…So, there's a lot of things I can bring in from insight with that that these kids don't get from any other teacher.

- I think I can fill color in with a story, you know, better than a coloring book. And I can make a connection that sticks with them.

Finally, the last notable patterns in Michael's *HPL* component profile were with regards to his observation. Outside of individual CC or KC components, the highest percentages of time observed in Michael's classroom were classified as KC-CC (32 % of 141 minutes) and LC-KC-AC-CC (8.5 % of 141 minutes). KC-CC components were apparent during the daily warm-up activities in Michael's classroom. The daily warm-up routine was a classroom level community expectation and all three teachers at NBR

HS participated in this routine. However, what pushed Michael's class into higher percentages of time in the KC-CC component was a lab day. In this particular lab the students were working with hydrogen peroxide and liver to figure out reactions that take place with enzymes. During the lab day students worked on KC specifically within the *understanding* (see Appendix K) code because during a lab they were learning both science content and process skills (i.e., truly learning the *what* and *how* of science). It becomes KC-CC because during the lab students were also working in small groups. While both Kerri and Elizabeth also did group based lab work, they provided a little more teacher based scaffolding and students spent a little less time completing the lab. For example, Michael in total spent 45 minutes across all three days orchestrating group work, Elizabeth was not far behind orchestrating 31 minutes of group work.

Where Michael stood out the most within NBR HS is the LC-KC-AC-CC component. The LC-KC-AC-CC is actually the fully balanced *HPL* moment and for this reason I will call LC-KC-AC-CC the full *HPL* component. The full *HPL* component was mostly observed on the first day of class (M-SCOPS S1-T3-D1-S9,10,11,13,15-17). As students filed into the room they picked up white boards and dry erase makers that were waiting for them at the front of the room. Without prompting, they saw them and knew what to do. During the daily warm-up routine, I saw the white boards go into action! Michael asked the students: "Which component of the human diet contains the most amount of sugar?" While this was multiple choice, he followed up with "What is a component?" to figure out if they understood the vocabulary. Students were allowed to look for information on the laptops they picked up from class or on their personal devices. He had the students write their answer on the board, share with a neighbor, and then raise the boards up above their heads.

While students were still writing on their board Michael noted “I am seeing pathways to excellence"; specifically referring to a student up near the front of the classroom who was on task. Once the students held their boards up he scanned the boards looking up and down the rows of desk, across the class of 30 plus students. While doing this he stopped and exclaimed, “worst-case scenario – a blank board!” It was a classroom expectation for students to write something on the board, no matter what. He made sure to let the students know that every thought matters and he told the students “a blank board is unacceptable.”

He followed this pattern throughout his lecture as he introduced increasingly tough concepts such as the chemical process of cellular respiration and the ideas of products and reactants during a chemical reaction. He then linked that to the catalyst function of an enzyme, specifically referring activation energy (see M-SCOPS complexity dimensions; Figure 4.8). Every few minutes within the lecture, Michael stopped to go back to the white boards, bringing the class back into the full *HPL* components. At one point he showed graphs on the board and asking students, “which graph could represent a reaction in which food is broken down?” He allowed students to share with a partner before holding them up. For the remainder of class, the white boards stayed in action. These balanced *HPL* moments included *diagnostic teaching* from LC, *content knowledge* from KC, *feedback* from AC, and *class expectations* and pair work from CC (see Appendix K for details about *HPL* component codes).

Michael's M-SCOPS complexity dimensions. Michael's class was the first time across the teachers at NBR HS where high levels of ME and MB are present (see Figure 4.8). It might be noteworthy that I observed his pre-Advanced Placement (AP) Biology course whereas, with Elizabeth and Kerri, I observed the "basic" Biology class. The mini-learning cycle here was similar to the other teachers at North Bend River HS. He started by introducing new information on day 1 with higher levels of TD, but also higher levels of ME/MB. Then on day 2 the students completed the enzyme catalyst lab. Finally, on day 3 they reviewed, answered questions about the lab and completed a lab assessment. Refer to Michael's *HPL* profile section to see examples of the high levels of ME during the *HPL* full component discussion.

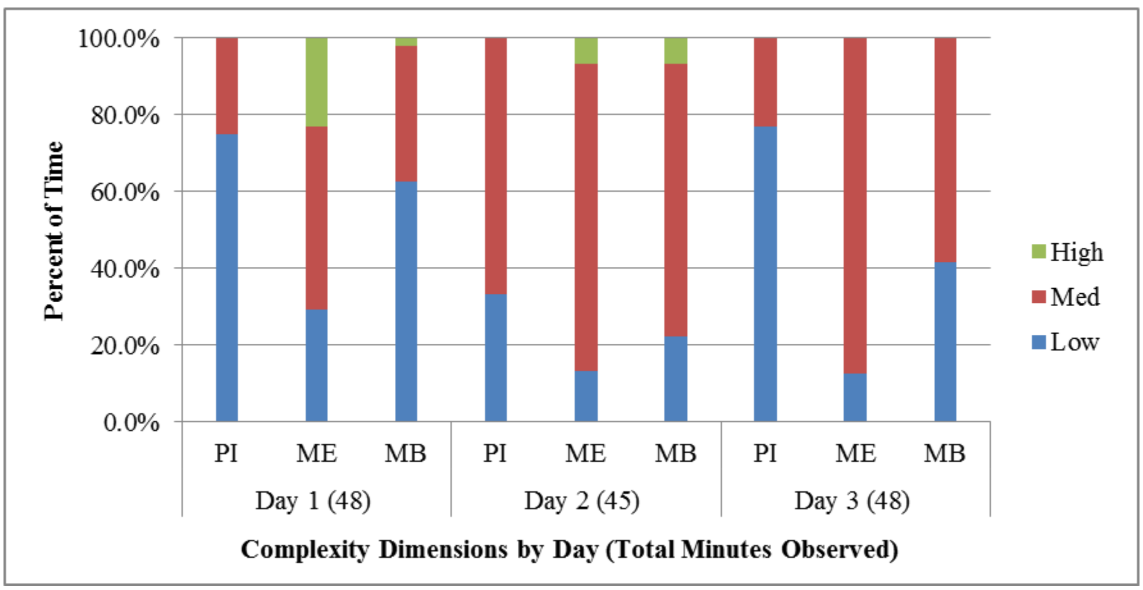

Figure 4.8. Michael's percent of time spent at different levels of complexity dimensions for each day observed. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions.

Michael's enzyme lab was not like what Kerri and Elizabeth did for their enzyme lab. Kerri presented a mini-version of Michael's enzyme lab to her students as a demo on day 1. Michael spent all of day 2 focused on the enzyme lab. This is why more than half the time in day 2 spent for SST activities. This was coded as SST and not student-directed, because if you refer to Appendix K, you will see that the level 4 for PI (which is medium level or SST activity) is where students are working at their own pace with minimal supervision, but are all working on the same type of task, such as a verification lab. The enzyme catalyst lab was a verification type laboratory investigation where all students worked on the exact same procedures at different rates. The students did not take control and design the experiment or come up with a research question. All students followed the same procedure, which is why this was a level 4 PI or SST type activity.

Summary of Michael's classroom orchestration. Overall, Michael was a "pathways to excellence" and technology driven teacher who focused on the community at all levels. He also made huge efforts to understand what the students were thinking in an efficient manner (i.e., clicker quiz, white boards, online homework). Integrating KC-CC and AC-KC-LC components within the classroom and pushing for higher levels of ME were classic characteristics of Michael's science class orchestration. He exemplified this when he stated, "if it's not meaningful and interesting, I don't waste their time with it. I make sure everything counts."

Concluding Thoughts for North Bend River High School

In total, I spent 428 minutes observing classrooms at NBR HS and coded 466 thought segments from the teachers' post-observation interview. In Figure 4.9, I compared the average percent of *HPL* components across the school for the interviews and observation to answer:

- Across all cases observed, what patterns of *HPL* design and practice characterize the science classroom learning environments?

Not surprisingly, during interviews, teachers stated that the community (CC) mattered most. During instruction, teachers focused most on knowledge (KC). As seen in Figure 4.9, what teachers say (CC) and what they do (KC) merged during the classroom observations predominately when the teachers were orchestrating a lab. The lab orchestration also explained the average 20-40% of time we saw the three teachers doing SST activities; see Figure 4.10. Michael was the only one who pushed high levels of ME and it could be argued this was because he was teaching a pre-AP Biology class.

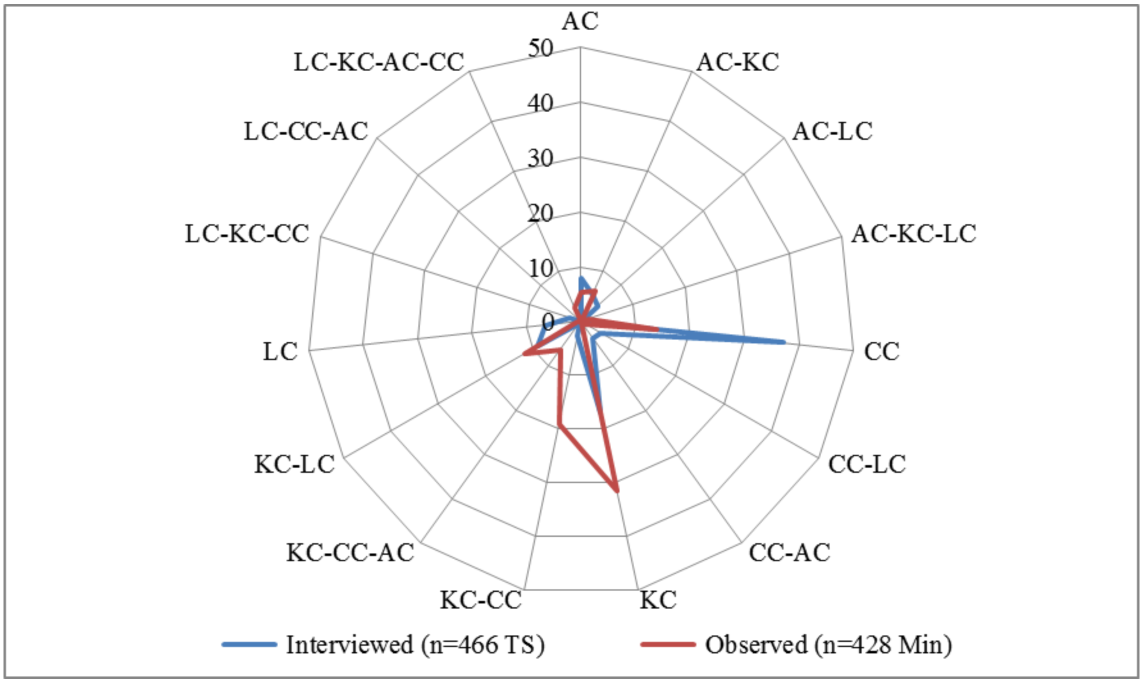

Figure 4.9. Teachers' averaged *HPL* component profile for North Bend River High School. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

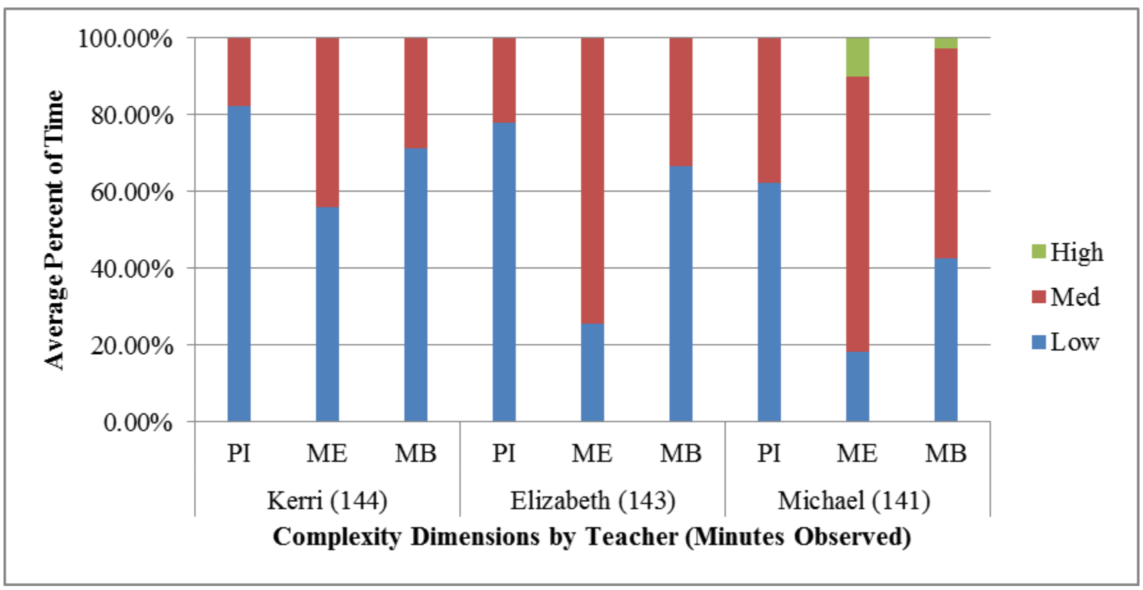

Figure 4.10. Average percent of time spent at different levels of complexity dimensions for teachers at North Bend River HS. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions.

School 2: West Ridge Mount High School

An Introduction to West Ridge Mount High School

West Ridge Mount HS (WRM HS) was the second school to approve my research at the district level. My first visit to this school was in May 2014. The purpose of the first visit was to have the principal sign a site authorization letter. I had to have the site authorization letter signed before I could go to the district and request permission to do the research study. I called to set up an appointment with the principal and stayed in town until the principal could meet with me. We had a wonderful conversation about the school and she happily signed the site authorization. It was an open campus, and there were separate buildings. When I first arrived at this school I remember thinking it was so unique. The separate buildings made it feel like I was visiting a small college.

My second visit to the school was to recruit the teachers for the research study and have the teachers sign consent. This second visit occurred during the last week in September of 2014. I walked in and was greeted by a secretary at a small check-in desk right before the attendance office. I told her who I was there to meet, I signed in, and was given directions to the classroom. I got lost going to the classroom because there were a few different buildings. As I walked around I noticed a really nice open courtyard surround by classrooms. The outside walls were painted with murals. There were some posters about organizations and clubs. I met the department head of science on a Friday. I went into her classroom and discussed with her about the research project. She thought it was good and decided to take me around to the other science teachers. I happened to be there during the common science planning period so we walked around to talk to the teachers. As we walked, she stopped into different science teachers' room to give them updates, and ask if they needed anything. Additionally, she asked if any of the teachers wanted to go to the regional science teacher conference which was occurring the next day. One of the participating teachers said he was going. While we talked I told him about the research, he agreed and signed consent. He told me I could start observations on Monday. Mariana was not in her classroom so I was not able to meet her but I did go back upstairs to meet Gabriela. Gabriela was messing with technology and had another teacher helping her. She stopped and came to listen to my research study, agreed and signed consent. She invited me to stay and start observations the next period. I stayed and did my very first observation of the entire research study. I observed and interviewed in this school from September 26 – October 3 (the sixth week of school).

Gabriela

An introduction to Gabriela. When I first entered Gabriel's room, she was working on technology with the help of another teacher. I explained my research and she immediately signed up and let me know I could observe the next period if I wanted. There was no need for scheduling with Gabriela. Her classroom was my home base at West Ridge Mount HS. She let me know I was welcome to sit in there any time during the day. It was almost like I was a student teacher and she was my mentor. She was clearly excited about what she does, she was excited to help me, and she was ready for me to start as soon as possible.

Gabriela was passionately dedicated to teaching science and she would go to any length to make sure the students got what she considered the best possible education. In the second interview she stated “education gives you freedom.” She was passionate about this idea. She also told me about how another high school in the same district had this beautiful quote similar to the idea that education gives you freedom. She was so dedicated to this idea that when she couldn’t remember the quote she offered to lead the way over to the other high school so I could take a picture. Sure enough, one evening after a long day of school and an interview with me, she drove and I followed her over to the other high school to take a picture of this essential quote. The quote was above the main doors of the building and it reads:

> *A cultivated mind is the genius of democracy: It is the only dictator that free men acknowledge and the only security that free men desire: Mirabeau B. Lamar.*

During the time I observed in Gabriela’s classroom I noticed she used the newest technologies to demonstrate intangible concepts in science in a new way. If the technology she wanted to use didn’t work, she would spend hours figuring it out or asking for help to figure it out. I observed her class towards the end of the day, the second to last period. When the students came into class she always had something for them to add to their science notebooks. Every day she walked between the students’ rows of desk in the classroom, monitoring the students because she would never let a student get away with doing anything less than their best. She spent a lot of time providing information, reviewing the information, and checking for students’ understandings. Choral response was a classic strategy in her classroom and it reminded me of some of the urban classrooms I observed while I was in Taiwan; which is interesting because Gabriela prided herself on her international teaching experiences as well as her work experiences as a chemist in hospital labs in Mexico.

Gabriela was the second most experienced teacher in the entire study with 30 years of teaching experience. During class she often pulled from her experiences and continuously created analogies to break down science concepts. Gabriela was a tirelessly dedicated teacher. She worked very hard in her classroom, viewing every single task as the most important task of the day. Over the next few days in Gabriela's classroom I observed lectures, review, and technology being used to model cell structures and functions.

Gabriela's *HPL* component profile. In Figure 4.11, I presents Gabriela's *HPL* component profile. Her profile was very pronounced in the KC component for observation and the CC component for her interview and observation. Gabriela had the highest KC component out of all the teachers. However, during the observation I also noticed her conduct KC-LC, and AC-KC moments in the classroom. Gabriela's focus on the KC component was exhibited on the first day I overserved in her classroom and she did a lecture. She introduced cell theory, reviewed types of cells (prokaryotic cells and eukaryotic cells), then started to go into details about the two types of eukaryotic cells (plant and animal cells), and finally discussed different structures within cells such as ribosomes, cytoplasm, and cilia. She connected some of this information to antibiotics or a type of wiring making the KC moments both *content* focused and *relevant*.

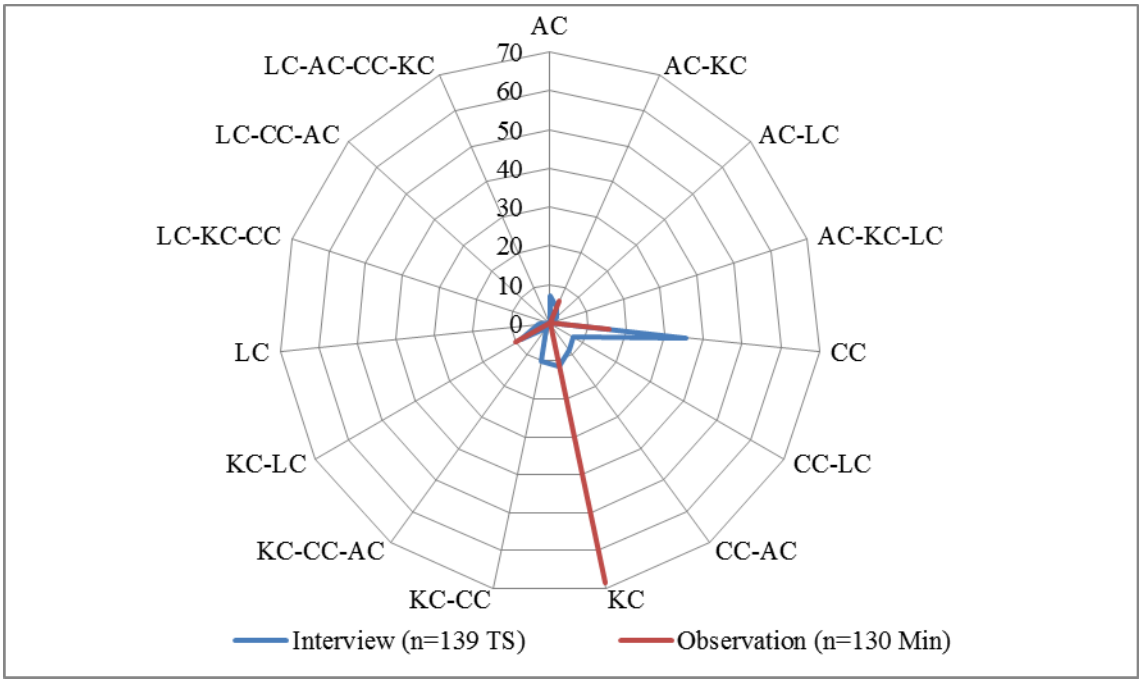

Figure 4.11. Gabriela's *HPL* component profile. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

After lecture, she did a brief review; which brought the KC moments to KC-AC as she asked questions like: "what are the two main type of cells? Which has DNA within nucleus? …Which type is more complex?" Some of the students respond in unison to these questions. She then continued this cycle of introducing information about the structure and function of parts of the cell, conducting KC moments, and then reviewing through a questions/answer session, conducting KC-AC moments. We saw KC-LC moments when she took the content and used analogies to connect the content to information or experiences the students have already had based on where they live. For example, during a lecture she stated:

- As an analogy we have many ports of entry in the US to allow people in and out and to protect. The cell has the same thing with the cell membrane, it protects and lets things in and out.

She used this analogy after KC moments where she introduced the structure and function of the cell membrane and explained the phospholipid bilayer. To help the students visualize this she brought up an app from her tablet and ran a simulation showing a cell and the process of things passing in and out of the membrane. These high KC moments correlated with high TD activities in the classroom (see Gabriela's M-SCOPS complexity dimensions). The high TD activities could have been related to her belief that the students need a lot of structure in the classroom and this belief came out during her interview.

During the interview Gabriela heavily discussed the CC component. She discussed the need for students to have structure in the classroom, how she helped the students feel comfortable in the classroom, the reputation of the school, the importance of parent involvement in the school, and the helpfulness of the other science teachers. Below are examples from her interview exhibiting all these different CC based perspectives:

- It's very important for the students to have a structure - what to expect and be consistent... You're following them and you expect them to do good, you have high expectations, then they do good. That's something that they see, the caring and that is important and especially the majority of the students are more sensitive then they need that closeness, they need that recognition, they need that feedback. And most of them are not that independent.

- I tell them [the students], "You know what, I don't know all the answers. I don't know all the answers, but I always try it, and you give me one that is challenging and that is great. You send me back to study, which is good."… So you have to feel free to make mistakes… we are not perfect, we are in the process of learning.

- We [the team of science teachers] are always trying to help each other. "Hey, I've got this idea we want to try," but we all work.

- There is something that I have noticed, all the schools where there is more parental involvement, the students are more successful. The school is more successful. Parents are a key thing… believe me, many of those parents who are coming from a low economical background, they would love to come and help this school, but they have been ignored… it's very polarized. We have people here who have lots of money, people who have nothing, and those who have nothing, they feel embarrassed.

Several things Gabriela brought up in her interview were similar to other teachers at NBR HS. Like Michael and Elizabeth, Gabriela mentioned how she lets the students know that she is not perfect, she doesn't know everything. She was showing vulnerability and letting the students know it is okay to ask questions. Additionally, like Michael at NBR HS, she thought WRM HS could do a better job with parental involvement. During the interview she also discussed KC-CC component more than any of the other teachers within WRM HS. Specifically, she focused on how being an expert in science outside of school, as a chemist at the hospital, has helped her make connections with the knowledge in the classroom for the students. This linked to the KC *relevance* code and the CC *outside of school* code (see Appendix K for *HPL* codes). Linking content based on real world work experience before becoming a teacher is similar to what Michael discussed in his interview. Below is an excerpt from the interview in which Gabriela discussed her previous experiences:

- To me what has been very, very helpful was my experience when I was working in a hospital in the real world. I would really make lots of connections and I always relate it to some experience by talking about something, that this is something practical because of that experience I have. That's the advantage of a teacher who has experience, has more resources to relate it to. They say that intelligence is related to experience. The more things you can associate so you can remember. So that's why I try to associate it to something they carry in the real life so they can remember it. The experience I had when I worked in the hospital and my chemistry background…

Gabriela's M-SCOPS complexity dimensions. As seen in Figure 4.12, Gabriela spent the entire class time doing TD type activities. She structured her class to monitor and actively support her students. Since all of the class time was spent doing TD activities, the level at which students acted on the information (MB) stayed relatively low. During low levels of MB students were listening, attending to, observing, and conjecturing simple connections without needing to grasp the significance of the connection to whole (Stuessy, 2009).

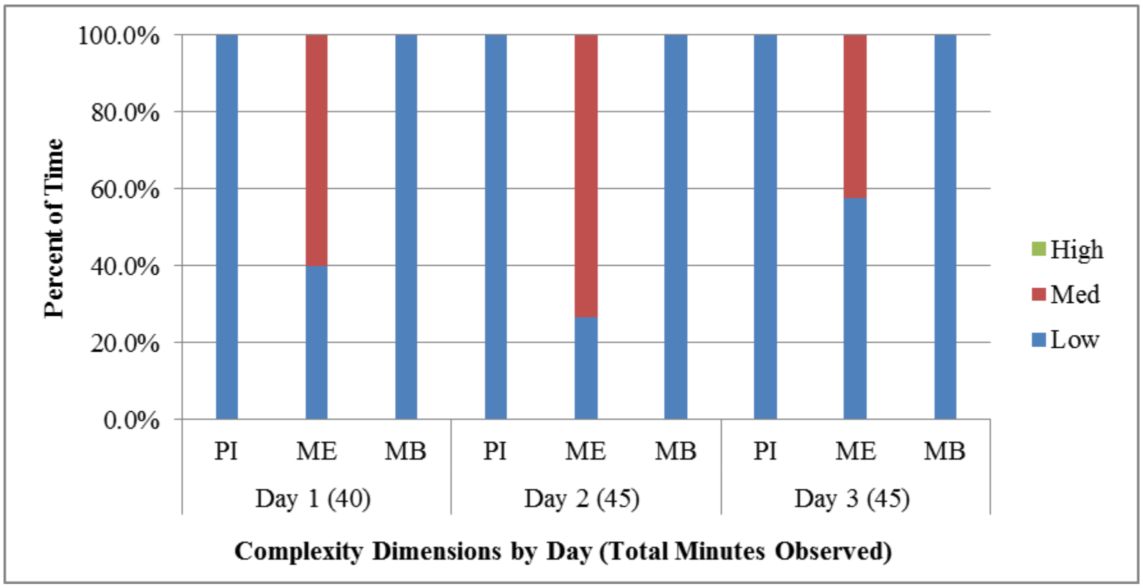

Figure 4.12. Gabriela's percent of time spent at different levels of complexity dimensions for each day observed. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions.

However, during every class she introduced medium levels of ME information. She focused on discussing the structure and function of different cell organelles. This coordinated with medium levels of ME as it related to presenting "disassembled part of a whole, and early processes of putting parts together" (Stuessy, 2009). While I was in Gabriela's classroom I did not observe a lab but she was going to do a microscope lab a few days after I left the city.

Summary of Gabriela's classroom orchestration. Overall, Gabriela was a caring and determined teacher who focused on the importance of education creating freedom for the future paths of her students. She made sure that every student was closely paid attention to and worked tirelessly to create examples, analogies, and share models to help students understand the information. Focusing on KC and KC-LC components within the classroom while doing mostly TD activities shows how deeply committed she is to her own teaching style; while also accepting technology as a way to connect with students. She was passionate about the idea that the process of science helps students in all aspects of their life, noting "It always helps to follow the laws of science."

Danny

An introduction to Danny. Danny is the type of teacher who would spend an entire Saturday at a regional state science teacher conference and that is exactly what we did the day after I met him. I walked into Danny's room on a Friday afternoon; he signed consent and scheduled me to start observations on Monday. He happened to be going to the regional state science teacher conference the next day. The conference was located directly across the street from where I was staying in the city so I had already planned on attending. He stayed at the conference the entire day. We discussed the different breakout sessions we had attended during the lunch break while we watched a local organization shoot off rockets on the football field. It was clear he really enjoyed teaching science, he really enjoyed learning, and he was dedicated to learning new ways to make science interesting for his students.

Danny was originally a middle school science teacher; so the unique energy, continuous calm, and extreme patience needed for middle school students easily carried over into his high school Biology classroom. When students came into his classroom they would grab their journals from the back of the room and sit in their desks, which were lined up in rows. All around the classroom were science posters, inspirational quotes, and comical posters on the wall. Every day Danny started the class by telling them exactly what they would be doing, like giving a mini overview of the class period so the students knew what to expect. Then he would go about the lesson by carefully chunking the information and making sure the students were never sitting still and listening for more than 10 to 15 minutes. Everything he did is his classroom was calm in nature and engaging. Much like Gabriela, he always attempted to break down the information or use an analogy to make science concepts relevant to the students. When I walked into Danny's classroom I knew it was a friendly and welcoming environment. Over the next four days in Danny's classroom I observed interactive group review, lecture, group work, and a microscope based cell lab.

Danny's *HPL* component profile. In Figure 4.13, I present Danny's *HPL* component profile. His profile was very pronounced in CC component during the interview, like all of the other teachers. KC-LC was also very prominent among all the thought segments during the interview. However, unlike the other teachers, his KC-CC was the highest component observed in the classroom. In fact, Danny's time spent orchestrating KC-CC components (35.2%) in the classroom was higher than any other teacher across all schools. Additionally, he presented balanced moments of the full *HPL* components (LC-AC-KC-CC) during the observation. KC-CC components were present in Danny's classroom when students worked in small groups on review sheets, and when students worked on a microscope lab the last day I observed. During his interview he mentioned "The groups, usually, at least, part of the day, they'll be in the groups" and we see this with high levels of KC-CC and again in the M-SCOPS complexity dimensions in the next section. Group work, small pair work, sharing among peers, and discussion were all important aspects in Danny's classroom.

The full *HPL* component was present on the first day I observed Danny's classroom (M-SCOPS S2-T3-D1-S4). Students spent 25 % of the class time working on a test review. However, this was not a review for an upcoming test; it was a process to review wrong answers on the most recently taken test. This was unlike any test review I have ever seen. Instead of just going over the answers on the most recent test, Danny had the students work in small groups to select the best wrong answer, the worst answer, and the correct answer for the test questions. Before starting this activity, Danny found out which test questions were the most frequently missed for that specific class period.

The students would look at those multiple choice test questions, discuss amongst themselves, and then present their arguments to the larges group. This happened for every frequently missed class level question. This was one of the rare activities where I witnessed KC time for *sense-making* (metacognition) in the classroom. Students were able to think about why they were thinking the way they thought, reflect on their wrong answers, and figure out how to improve for next time. This gave the students some true feedback (AC) regarding the most recent test. Additionally, they were able to work in groups (CC) and it allowed Danny to do some *diagnostic teaching* (LC) in the sense he could understand students' misconceptions.

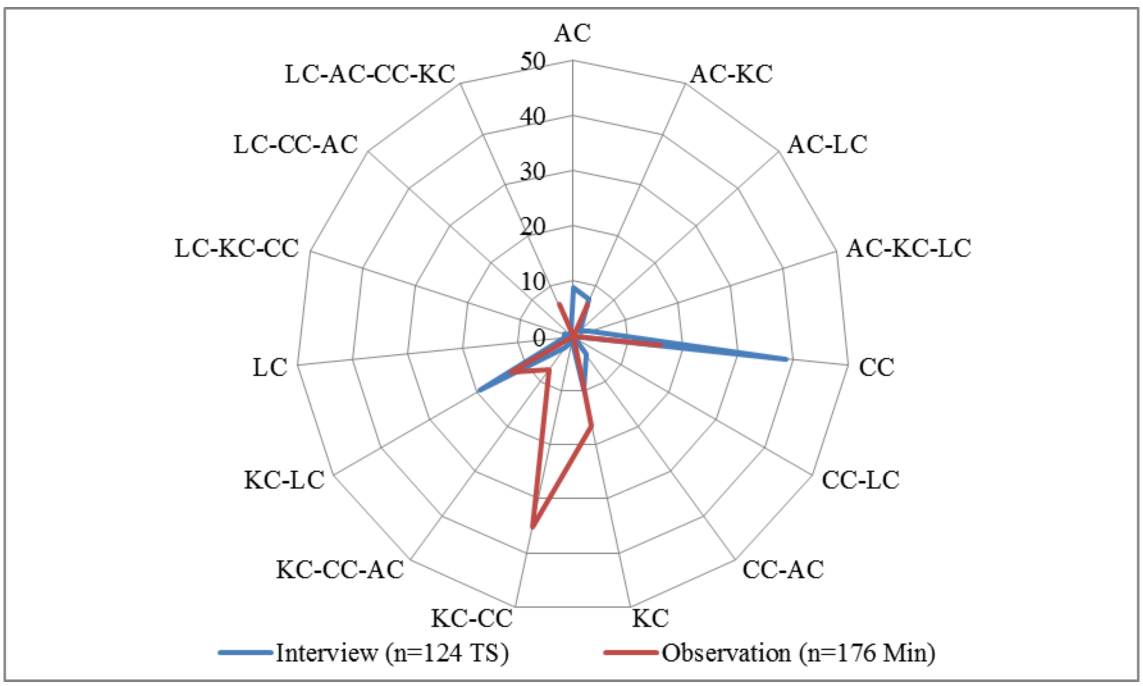

Figure 4.13. Danny's *HPL* component profile. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

Danny really cared about making class engaging and connected. This was obvious during the interview because of the frequency of the KC-LC component. Danny talked about the importance of connecting the content knowledge to the students' life experiences. He spent time connecting information or making analogies to the area around them or a common food. He asked the students to spend time observing their environments so they could reflect on, or discuss connections to what they had just learned. Examples of KC-LC components from the interview with Danny are below:

- I try to think of places or things we see that - no matter where you live - if you're here, you've probably noticed it or you've seen it, especially when we get to ecology. Everybody's seen the desert, and everybody's seen an animal in it, and kind of has an idea - even if you've moved here. Maybe it'll help them figure it out.

- But just asking them, "Go home and look at this, or when you're on your way to the house, just look out of the window and do-- look at this environment."

- We'll be talking about the intestines, and someone-- "Yeah, when you're eating menudo" And then, they're like----"Yeah." I was like, "Have you ever seen it?"…

- We were talking about sugar and glucose. There's a kid in there who is diabetic, and he's like, "I'm diabetic." I was like, "So you know more about it than I do, probably."

- If it's genetics, it's like, "Go home and look at your parents, your brother and sisters, and just take what you learned today and just don't-- I'm not saying make a Punnet square, but look at them and go, "Hey, how would that be possible? Is it the big possibility, or was it the small one?"

Interestingly enough, the post observation interview actually took place before the last day of observations. The day after the interview I observed Danny's classroom and I noticed him put the KC-LC component in action throughout the entire lecture. For example, when he discussed active and passive transport he created an analogy to the border. One of many analogies from the third day of observation is below:

- A semi-permeable membrane allows certain things to pass through and some not. It is the border patrol of your body - let some things in and somethings out. Kind of checks to make sure it is the right stuff…you have been close to the border fence right - so could a fly get through? Yes, because it is small enough to sneak through so that is like these small particles. The border control is not trying to stop flies, that is just like these guys. But if they are big particles like protein or sugars they are too big - like I'm too big to walk through the fence (giggle) right. So I have to find a gate or another way in. So these big particles can't freely go in they have to be transported… [starts discussing types of diffusion] Then there is the facilitated [diffusion] and that means it needs some help and this is where the protein helps it out. It would be like going through border patrol - they see your passport and they say go on through - they helped you by not stopping you but you go through that gate.

Danny's M-SCOPS complexity dimensions. As seen in Figure 4.14, Danny typically spent almost half of the class time doing SST activities (medium levels of PI). This connected with his comments from the *HPL* component profile regarding students spending at least "part of the time in groups" on a daily basis. However, on the third day of observations, the entire class time was spent doing TD activities. This third day was a quiz day and after the quiz Danny introduced new information about diffusion, osmosis, and transport. An interesting pattern to note; high levels of TD activities occurred most often when new information is being introduced to the students. With new information being introduced on the third day, students were spending most of class receiving medium levels of MI.

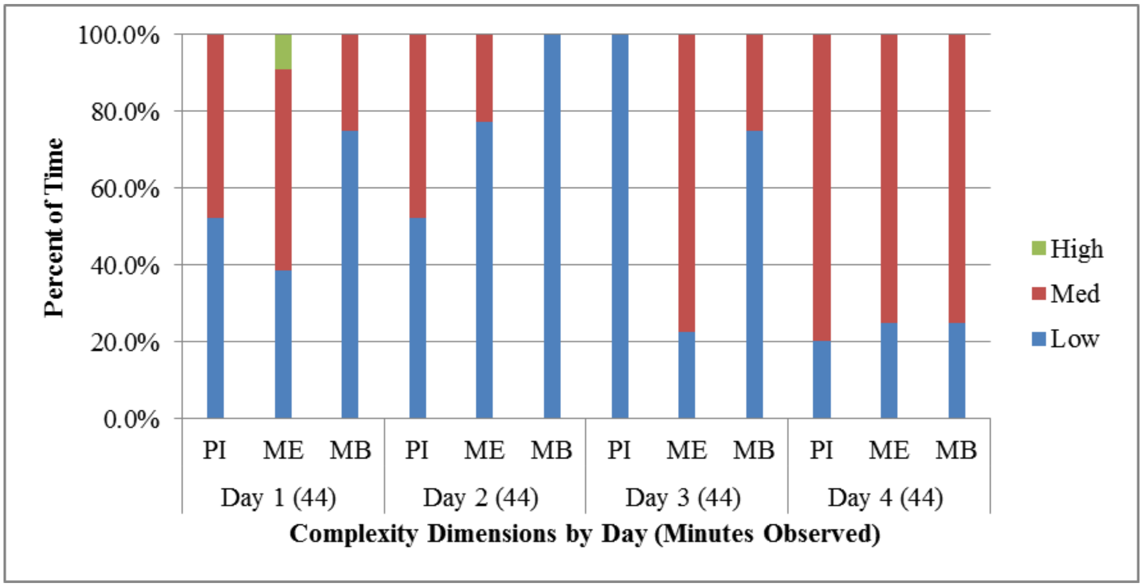

Figure 4.14. Danny's percent of time spent at different levels of complexity dimensions for each day observed. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions.

During this third day, which was spent doing all TD activities, Danny told the students that lab days were coming up regarding these concepts. The very next day was a lab day and students spent almost the entire class doing SST activities. Danny mentioned that he attempts to create a balance of TD and SST activities. He also attempts to let the students know that after a notes day of TD based activities there are labs days coming up, for example:

- [Response to question from interview] When they come in they go "uh notes," and I say "Yeah but if we get them done today, then look at Thursday you don't have to do notes we get to do a lab… Making sure to do the lab or activity of some kind because if nothing else you give them a little thing to look forward to.

- [During the classroom observation] Today we are talking about three ideas and next week we will have some labs that you will actually have these ideas sink in.

Summary of Danny's classroom orchestration. Overall, Danny was a calm, kind, and group-work oriented teacher. His calm and kind demeanor created a friendly classroom environment where the students felt comfortable to ask questions. Danny recognized when students were the expert, like when a student mentioned he had diabetes when Danny was talking about glucose. This pattern of learning from the students or letting the students know that teachers don't know everything was present in most of the other teachers' observations or interviews (i.e., Elizabeth, Michael, Gabriela). With the diabetic student, Danny was letting the student know he is the expert. Yet in other moments Danny followed the "I don't know everything" pattern like many other teachers and stated:

- If I'm wrong, which is quite a bit, if I'm wrong I'll say "hey you know what I was wrong on this, or I'll figure it out." I think figuring it out is kind of the fun part, I think that that's where they get some more of their knowledge because they had to work through it…

It is clear Danny believed students should be taking control of figuring things out in the classroom. He preferred to orchestrate his class with KC-CC components, utilizing mostly SST activities. When there was a day that was all TD activities, he used analogies, connections to the local area, stories, and student questions to drive the lecture. Working through it as a team, figuring things out, getting through lectures to get to the fun labs--these are the things that characterized Danny's classroom.

Mariana

An introduction to Mariana. When I first walked into Mariana's classroom it was clear there were very structured routines and high expectations in place. Mariana was a "to the point" type of teacher who did not waste any time in the. If it was not related to Biology, then it was not meant for the classroom. I observed Mariana's classroom after lunch and the students knew to come in and get to business as soon as possible. As students came into the classroom they picked up the papers for their notebooks, or papers for the lab that day, and filed into their desk which were in rows. Her high expectations and no excuse attitude were clear throughout every day I observed in her classroom. Mariana also applied the no excuse attitude she had for her students to herself. For example, Mariana is a volleyball coach at the school and she was going to miss teaching an afternoon Biology class. Instead of just giving book work or classic substitute type work she decided to make a video of the lecture. She used a little bit of time in class while the students were reviewing to finish up the video. Even though she was having technical problems she did not let this stop her. Mariana eagerly learned from her students. She had some enthusiastic students help her to problem solve the technology issue.

Mariana was one that constantly monitored her students' progress. One day she had them turn in their journals and she reviewed every single one. As she was reviewing them she stopped to briefly discuss a misconception she noticed the students were having regarding the difference between the smooth and rough endoplasmic reticulum. In addition to quickly addressing misconceptions, Mariana stressed the importance of prefixes and vocabulary in her classroom. She had a word wall and expected the students to use science vocabulary. Finally, she would willingly stop class to satisfy students' curiosity. For example, when she was discussing the function of an electron scanning microscope, a student wanted to know what it looked like and what did the images from the microscope look like. Mariana stopped the lecture, pulled up google images and they looked at pictures of the microscope and images produced by the electron scanning microscope. Over the next few days in Mariana's classroom I observed a lecture, a few reviews, and a microscope based cell lab.

Mariana's *HPL* component profile. In Figure 4.15, I present Mariana's *HPL* component profile. Her profile followed the common pattern among most of the teachers, where the KC and CC components were the highest in both the interview and observation. After those two highest components, Mariana stood out with KC-CC and KC-LC components during the observation. During the interview Mariana stood out from the rest of her colleagues with LC components. KC-CC took place in Mariana's class during the microscope lab. This was similar to Danny's classroom. KC-CC was present in her classroom outside of group work during labs. Mariana expressed KC-CC when she was talking about an upcoming vocabulary assignment and her expectations (see below for excerpt from M-SCOPS S2-T4-D1-S7).

- Remember these are Biology terms…make sure you go deep. How do cells maintain homeostasis? You have to research this. How do athletes maintain homeostasis? For what was Gatorade designed? What do you lose? You can use your phone, your friend's phone, the library; there are no excuses! If you are using the same term then I will assume you are copying. Don't copy. You have 13 words to look up make sure you look it up. Everything is on the website I just posted it.

This showed that CC did not always mean group work. CC can relate to classroom level expectations. She was talking about the vocabulary content (KC) and explaining her expectations; go deep into the content, there are no excuses, and do not copy. These were her foundational class level expectations for this routine vocabulary homework assignment. Additionally, you notice she was encouraging them to use the community resources outside of class to complete this assignment.

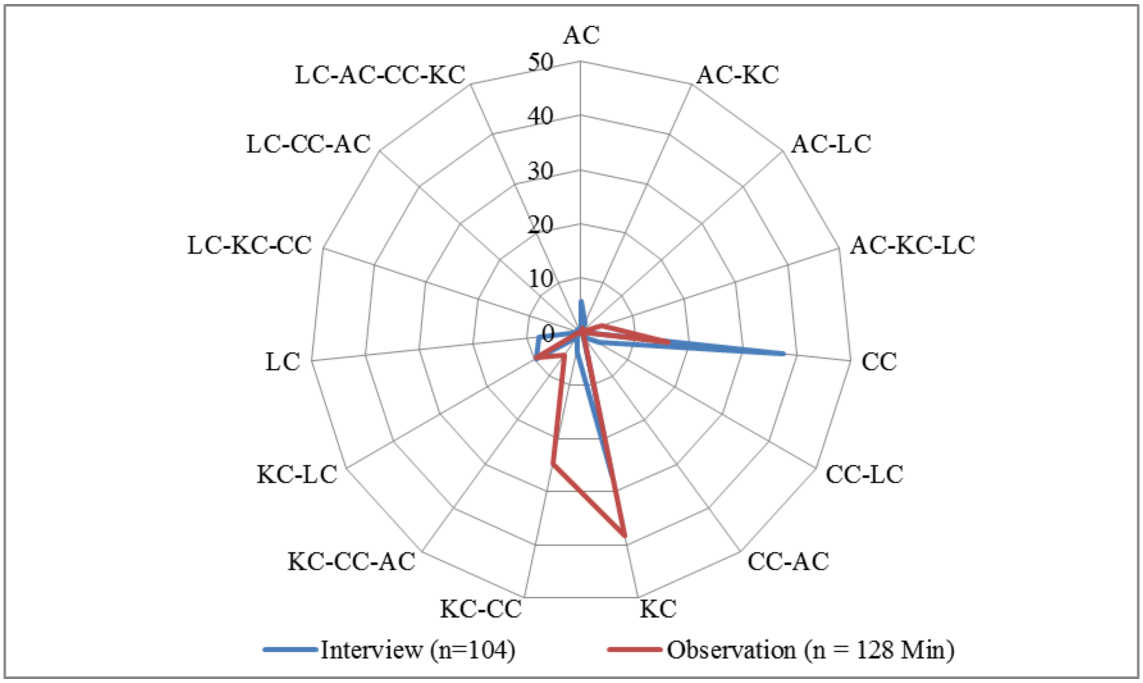

Figure 4.15. Mariana's *HPL* component profile. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

During other time in the classroom, Mariana had the students working independently or taking notes. KC-LC components are most often presented in the classroom during lecture or note taking time. This was true for Mariana's classroom as well. Mariana made a genuine effort to connect knowledge to students' previous experiences. She respected their language practices while she was describing the history, types, and parts of a microscope or reviewing prefixes:

- Now we are going to go over parts of microscope. This will be on your test. [Pointing at the parts on the microscope]…This is the ocular. Ocular for ojos, eyes right. Ocular related to eyes. You have the ocular lens then you have your objective.

- [This is a description of an event in the class where she is being responsive to the students] The students ask to see what an electron scanning microscope looks like. Mariana goes to google and pulls up a picture of the microscope.

- [Reviewing prefixes] Aqua - water everyone knew this one…Derma - skin if you go to the skin doctor you go to dermatologist.

These KC-LC moments in the classroom connected to the LC components Mariana discussed during her interview. Notably, during the interview, Mariana had the highest percentage (7.7%) of LC components among the teachers at WRM HS and the second highest percentage of LC components among all teachers across all schools (Michael had the highest percent of LC components during the interview at 8.5%). Mariana mentioned all three codes from the LC component during her interview: *build on cultural knowledge*, *respect language practices,* and *diagnostic teaching* (see Appendix K for *HPL* components and codes).

- [*Build on cultural knowledge*] And then because I'm very familiar with the Hispanic and Latin culture, I always try to bring it up.

- [*Respect language practices*] I do that especially the language all the time… Because both languages are from Latin, a lot of the terms—prefixes-- They should be easier for the Spanish kids. But what I do is that every once in a while I say the word in Spanish. Like yesterday ocular, ojos. In Portuguese, we actually have a word for ocular; óculos, that is the glasses. So it's all referring to it. That's what I'm trying.

- [*Diagnostic teaching*] You ask them. I asked them, "Have you guys done this? Have you guys covered it? Who knows this? Who doesn't know that?"… [Additional response to question about getting to know the students' misconceptions] You always have one student that is not afraid to say things and it just comes out and that's when you address it. You always trying to make it

> personal in a certain way like, "When I was in school, I did this, this and that," so they don't see it as a completely different thing. We say, "Okay, I was there, I experienced that." Of course you don't want say all your faults.

Regarding diagnostic teaching, when I asked the teachers about how they got to know about the students' previous experiences/misconceptions the most frequent answer I received was just like Mariana's; "you ask them."

Mariana's M-SCOPS complexity dimensions. As seen in Figure 4.16, Mariana spent most of the class time doing TD activities (low levels of PI). This was similar to Gabriela's classroom orchestration on the PI complexity dimension. Interestingly, Gabriela and Mariana did not grow up in the United Stated. Gabriela grew up in Mexico and Mariana grew up in Brazil. Mariana noted:

- It doesn't make sense for me at all…For me it's just like, I come in, I do my work, I teach, you guys are supposed to study, and we go home and then you do your social life…In Brazil, you go to school, you do your things, and then after class, that is when you go to your social life. You have these two different blocks of things in your life. You focus here this time...

With Mariana stating this I was curious to know more about their thoughts on SST or SD type activities. I wondered if Mariana and Gabriela believed the teacher's role was shifted towards more TD based activities because of where they grew up. Going back to Figure 16, on the first day we saw a pattern we have seen before; new information was being provided to the students so it was mostly TD activities.

On the second day in the classroom students were working on a review. They had a worksheet and they were allowed to use their notes or their book to fill in the blanks on the worksheet. The students worked on this independently and Mariana helped individual students, reviewed the students' notebooks, or worked on preparing a video lecture for the next class. Even though it was all TD activities on day 2, Mariana was not standing in the front of the room lecturing. TD activities can also occur when students are working on independent seatwork and this was the case for Mariana's class. One thing Mariana did note in her interview was that just because students were well behaved doesn't mean they were engaged. She stated:

- You see my kids here, yeah? They're all great. They're all quiet [referring to the second day I observed the classroom]. But sometimes their minds are just like out of it. And it's funny because I have noticed in the past three years that most loud classes are the ones with the best results… The loud ones yes…The loud classes are normally the ones that they're-- whenever they're working they're very loud but then at the same time they're really there, they're discussing things.

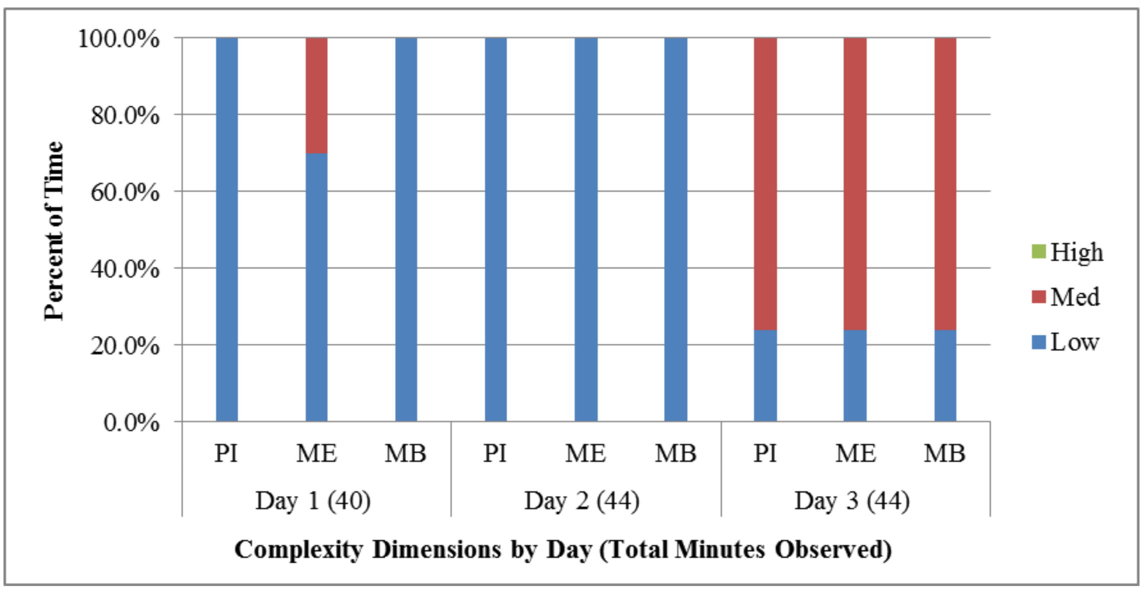

Figure 4.16. Mariana's percent of time spent at different levels of complexity dimensions for each day observed. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions.

Finally, on the third day of observation the students were let loose to work in small groups to complete a microscope lab (the same lab Danny's class did on day 4). It was almost like Mariana spent two days scaffolding the students to prepare for the lab where she let them loose to work in groups, with very minimal intervention, on the microscope lab. As seen in Figure 16, on the third day all three complexity dimensions were at medium levels for almost 80% of the class time. This was almost exactly like Danny's orchestration of the microscope lab which is interesting because Danny was teaching a Pre-AP class and Mariana was teaching a regular level class.

Summary of Mariana's classroom orchestration. Overall, Mariana's no excuse, no nonsense, high expectation classroom orchestrations created a very structured environment where students were focused on the task at hand at all times. Mariana recognized her stringent structure and, as a teacher committed to WRM HS, she was very comfortable and confident in her philosophy. However, even with this structure, she still followed the pattern seen with the other teachers; creating a community and letting the students see a vulnerable side. She specifically mentioned this vulnerable side when she talked about being a student herself. Of course not sharing all her faults, but letting the students know it is ok to have misconceptions by relating it to what she thought when she was a student. Finally, Mariana's high expectations allowed her to orchestrate a lab in the same way it is orchestrated for the more "advanced" students in Danny's classroom. This is different than what we saw at NRB HS. Michael's Pre-AP students worked on an enzyme lab that was very different than the enzyme lab the regular students worked on in Kerri and Elizabeth's classroom.

Concluding Thoughts for West Ridge Mount High School

In total, I spent 434 minutes observing classrooms at WRM HS and coded 367 thought segments from the teachers' post-observation interview. In Figure 4.17, I compared the average percent of *HPL* components across the school for the interviews and observation. Across the three teachers at WRM HS, there was a focus on KC and CC components during the observations and interviews. As mentioned in Kerri's *HPL* profile and the summary of NBR HS, this pattern of KC and CC components continued throughout the teachers in NBR and continued through observations at the others schools as well. The pattern for WRM HS seen in Figure 4.17 is similar to the pattern for NBR HS seen in Figure 4.9; the KC component was most frequently observed in the classroom and the CC component was most frequently observed during the interviews. The majority of the KC time observed across the teachers was spent delivering content. One of the teachers noted a concern with this stating:

- [Response to a question about balancing process skills and content knowledge]. That is something that in some way I'm kind of like not satisfied. Because these kids, we just sit over here and we lecture. We think they understand and most of the times they don't understand. So they're just kind of like floating because we think, "Okay. I explain so well. They automatically understand." But they don't because they really-- they cannot apply to it. They cannot transfer that to this.

Reflecting on what can be done better within the school is something Michael, Gabriela, and Mariana discussed during the interview. All of these teachers were committed to WRM HS and I think finding areas for improvement is a sign of a continuously committed teacher. Despite being mostly content focused, each of the teachers discussed how the administration pretty much leaves them to do what is best because they are working hard or they are doing well on the state science test. This idea of autonomy came across as a school level CC component. Examples below are excerpts from each teacher regarding this autonomy:

- They're real good about leaving us on our own to do what we think is best and they try to stay out of our hair as much as possible…and we do well on the STAAR test and everything thing so I think that kinda allows them to.

- As long as you're doing what you're supposed to do, you're working, they leave you alone, and I like that.

- She [the principal] knows that if you're working hard. She doesn't bother you.

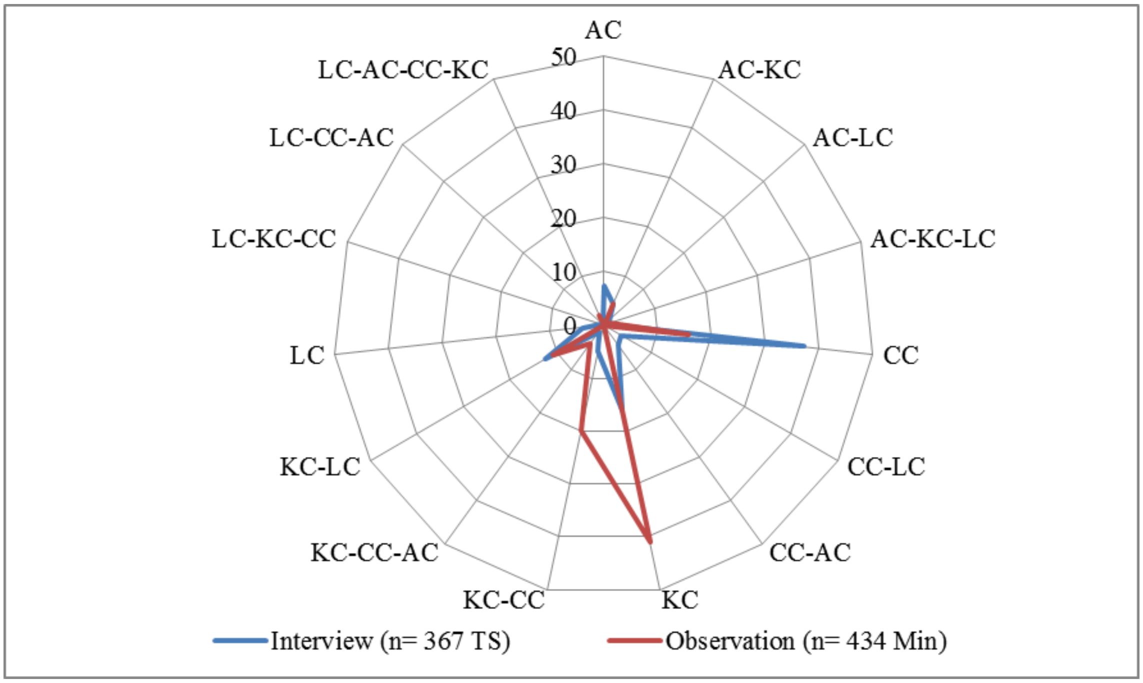

Figure 4.17. Teachers' averaged *HPL* component profile for West Ridge Mount High School. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

Additionally, when the teachers talked about the CC component across the school, science, and Biology team they mention the following: they all seemed to feel supported, they felt lucky to have all the resources they need, and they liked the help they received in planning lessons. Regarding the CC component at classroom level, this was the only school without a warm-up routine at the start of class. However, every class focused on an interactive notebook. This was a common practice at NBR HS as well. KC-CC also frequently occurred during the classroom observations at WRM HS, mostly during lab time. Danny and Gabriela had very different teaching styles, whereas Mariana was somewhere in between. Danny was SST activity (see Figure 4.18) and KC-CC focused, where Gabriela was TD activity and KC focused. Mariana had both, some fully TD days and a majority SST day and she focused on KC and KC-CC. Overall, these teachers came together, supported each other, and had high expectations for their students.

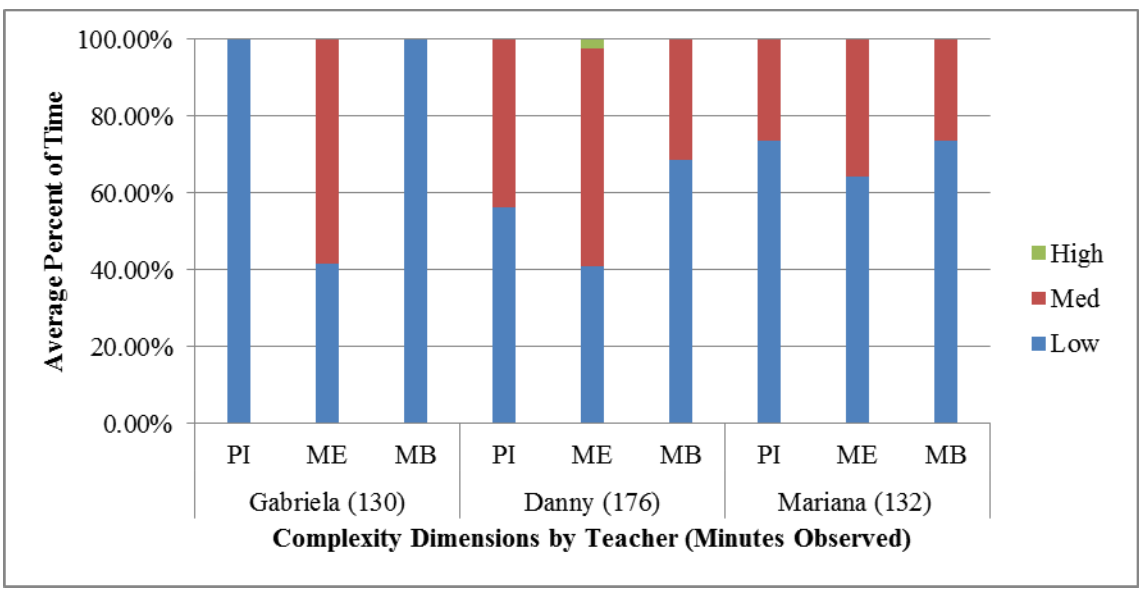

Figure 4.18. Average percent of time spent at different levels of complexity dimensions for teachers at West Ridge Mount HS. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions.

School 3: Bridge Rail Creek High School

An Introduction to Bridge Rail Creek High School

When you walk into this school you are greeted by a secretary sitting at a huge round desk. It was clear to see you "do not pass go" at this school. Every visitor was expected to stop and talk to her and she helped visitors navigate the school. This school is a huge two story building. Past the round desk, there is a long split hallway, a split staircase, and the cafeteria. The cafeteria is in the middle of the school. Looking down the split hallway, it almost looked like a mall. There are open hallways on the second floor. At the time every up-stairs banister had a sign for a different event or organization/club. Down the hallway, near the counselors' offices, there were college signs displayed. Anytime I walked in the school there were administrators in the hallways. During lunch, almost the entire administrative staff were monitoring or talking with the students.

My first visit to this school was in December of 2013 to meet with the principal to discuss site authorization. The undergraduate researcher, who was working on the project with me, was in this meeting. The principal was very busy preparing for a huge community event as well as dealing with the everyday complexities of running a school with about 3,000 students. He had students working around the office preparing for the event. He met with us in his office and mentioned he would be fine participating in the study but the district would have to approve the research before he could technically agree. He helped me get in contact with another person in the school who then helped me get in contact with the district personnel. I went to the district to discuss the research. I was told the best way to communicate was via email. Through email I received very quick responses. However, by the time IRB was approved a spring 2014 data collection was not possible because of testing. I had to re-apply for fall data collection. The district research coordinator took care of everything with regards to teacher consent and site authorization. At this school the teachers signed consent before I ever arrived. Therefore, I only had to schedule my observation and interview visits.

My second trip to the school was to complete observations. The principal I previously met in December of 2013 retired not too long after I met with him. He was such an effective and well-loved principal that a former student helped get the state of Texas to name a day after him. It was clear that the community he created at the school was deeply established. When I asked a teacher about the transition she noted:

- It's still the same environment because [the new principal] worked directly under [the old principal], and so she just filled in his shoes… It was a very easy [transition], there's not really much of a difference.

BRC HS is really large, but as soon as you turned down a hallway there seemed to be a particular hominess to the area. All the Biology classes were clustered together in the same general area. I walked into the first teacher's classroom, Colleen, and I was able to chat with her some before starting the observation because it was her lunch break. Entering her room made me feel transported. She had colorful posters on the wall, several different animals (i.e., birds, reptiles), and she had decorative things hanging from the ceiling. Every Biology classroom at this school had lab tables and there were no desks in the classrooms. This was different from the other schools where most of the classrooms had desks. Observations began in Colleen's classroom, which started my journey at this school. It was the last week in October from October 27 to October 30, 2014.

Colleen

An introduction to Colleen. Birds, reptiles, and students were the daily audience in Colleen's classroom. Teaching science was Colleen's second career. Her first career was as a graphic designer. In her interview she mentioned always loving science and wanting to do something meaningful in her life. This, she explained, is why she ended up teaching science. Her classroom was colorful and full of multiple types of energy. I observed Colleen's class before lunch every day. The students had a normal routine in this class. They came in and picked up their notebooks, sat at their table group, and started on their warm-up. All students sat at lab tables in groups of three or four. The warm-up would be reviewed and then the activities for the day were explained. She was quick to assist students with every single part of the class. She liked being able to have hands on activities for the students so they could truly understand the science concepts. Over the next few days in Colleen's classroom I observed an osmosis lab, a cell membrane activity, a lecture, a lab assessment, and a review.

Colleen's *HPL* component profile. In Figure 4.19, I present Colleen's *HPL* component profile. Her profile followed the same pattern as many of the other teachers; with the most frequently occurring *HPL* components in both the interview and observation are the CC and KC components. Besides these two components, the next most frequently occurring component for Colleen in both her interview and observation was KC-LC. Again this is a common pattern among teachers. Notable *HPL* components for Colleen's classroom observations included; KC-CC (13.1%), AC-KC (9.8%), and CC-AC (2.6%). These three components were observed at a higher rate in Colleen's class than any other teachers' class at NBR HS. Additionally, Colleen had the most frequently observed CC-AC component out of all the teachers across all schools.

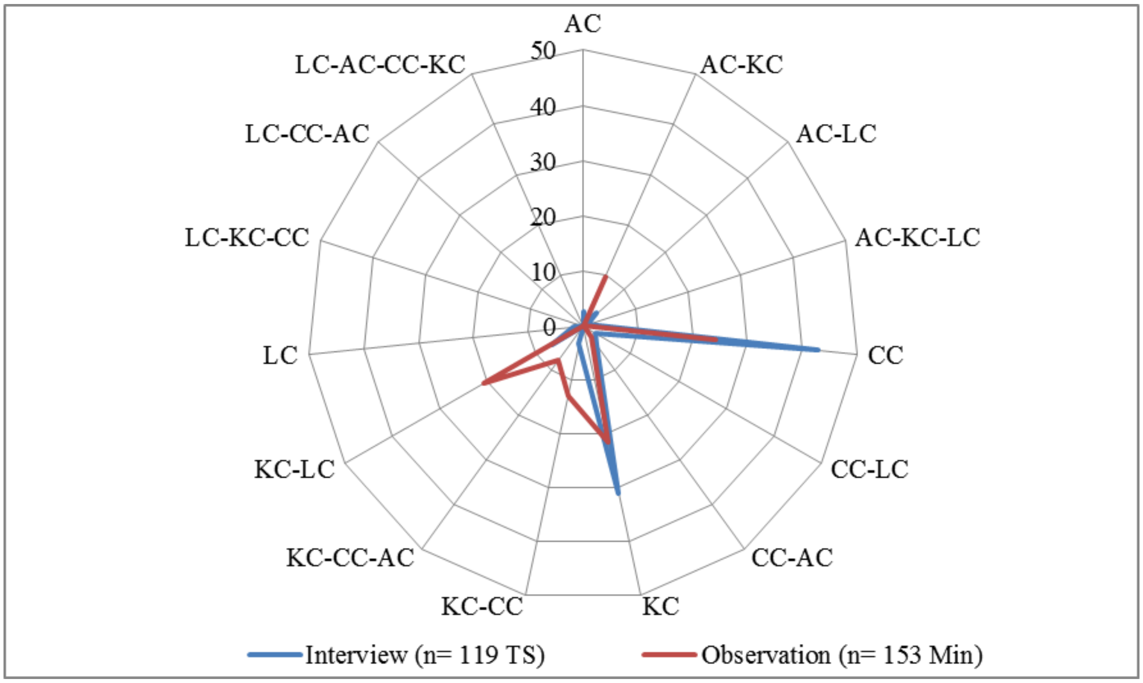

Figure 4.19. Colleen's *HPL* component profile. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

CC components observed were related to classroom routines and expectations. The majority of KC components observed were related to content only. The KC-LC component was present in the classroom when Colleen attempted to understand what the students thought during the osmosis egg lab (M-SCOPS S3-T1-D1-S6,7). During the interview KC-LC components were present when Colleen discussed getting to know about the students' misconceptions, connecting the content to their experiences, and described how she really does not connect the content to the students' cultural backgrounds. Below are examples of KC-LC from the observation and the interview:

- [During the classroom observation] What happened to egg? [students respond] Why did it do that? [students respond] So where did the water go? [students respond]
- [During the classroom observation] Every cell has a cell membrane, it allows some things in...like a bouncer at a night club, it is selectively permeable.
- [Response to interview questions about getting to know students misconceptions] I try to engage in the students by-- I always ask a question to see what they know already, and then take that information and try to build on it…
- [Response to interview questions about connecting content to students' cultural knowledge] … we're not allowed to talk about their cultures. I, actually, don't touch on that, to be honest, I kind of stay very neutral.
- [Response to question about how to connect content to experiences outside of class] For example, there was a girl playing soccer and she quit sweating because she was so dehydrated, and they like hearing these things, so I try to implement a lot of stories.

Overall, the KC-LC components looked a little different in Colleen's classroom. She mostly focused on what students think to understand their misconceptions but she stayed neutral when it came to connecting content and culture. However, the comment she made about the cell membrane was similar to the comment Danny made about the cell membrane. In both cases the teachers created analogies.

The KC-CC components in Colleen's classroom, like most of the other teachers, were orchestrated during a lab. While I was observing Colleen's classroom, students worked on an osmosis egg lab and they completed a model based activity that helped them understand the processes of active and passive transport across the cell membrane.

This activity had the students using string, straws, toothpicks, and pencils to create a bubble and pass objects through the bubble without popping the bubble. Students had freedom to be creative. They received no instructions on how to complete the task and after the end of the activity the students were introduced to ideas of passive and active transport. This bubble activity, called "The Bubble Challenge" led to AC-KC moments.

The AC-KC components were when Colleen asked the students about the bubble challenge (M-SCOPS S3-T1-D2-S9,11). Finally, the very unique CC-AC moment took place when Colleen spent time (about 5 minutes) at the beginning of one class period passing out a slip of all the grades to each student in the class (M-SCOPS S3-T1-D2-S2). She went on to give students information about missing grades, and answered questions about grades. Mariana was the only other teacher I observed orchestrating CC-AC components. At the start of one of the class days I observed, Mariana had her students turn in their interactive notebooks so she could check them (only took about 2 minutes). This process of passing out grades, or getting the notebooks checked, provided the students with grade based feedback. The fact that students knew what the small slips of paper meant, or how all the students knew to turn in their notebook opened to the exact page that was going to be reviewed, made this a classroom community level practice.

Colleen's M-SCOPS complexity dimensions. As seen in Figure 4.20, Colleen typically spent most of the class time doing TD activities (low level PI). The first day had the highest levels of TD activities and on this day Colleen introduced new information to the students. This followed the previously mentioned pattern regarding TD activities occurring when new information is being presented. On the first day the students mostly worked on the osmosis egg lab, but the students did everything in unison with a lot of structure provided by the teacher. The other two teachers at BRC HS orchestrated this osmosis lab differently (see Jason's and Kyra's complexity dimensions.) Towards the end of class on the first day, Colleen provided her students some notes about hypertonic, hypotonic, and isotonic solutions, which related back to osmosis. This pushed medium levels of ME and MB higher on the first day than any other day.

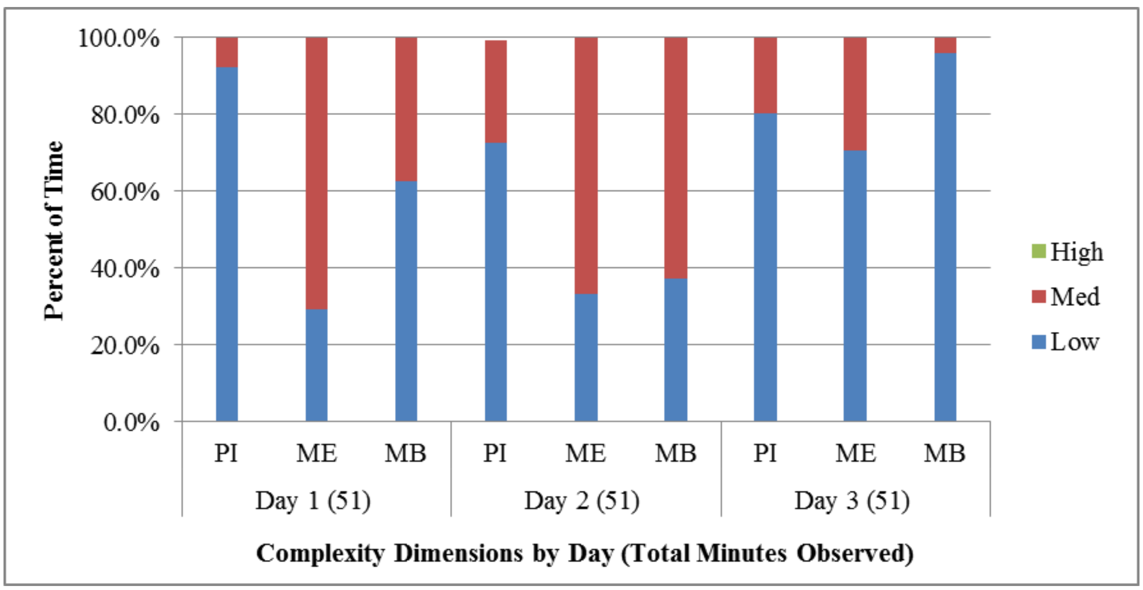

Figure 4.20. Colleen's percent of time spent at different levels of complexity dimensions for each day observed. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions.

On the second day students continued to work in the osmosis egg lab under very specific instructions. Then students worked on the Bubble Challenge. Students were allowed to work in small groups to solve a problem and then transferred that knowledge to the content they were learning. During the Bubble Challenge, students were doing SST activities, which resulted in the second day having the highest levels of SST. Finally, on the third day the students listened to a lecture that connected the bubble challenge and the osmosis egg lab to ideas about passive transport, hypertonic, cell membrane, selectively permeable, osmosis, diffusion, and homeostasis. The students wrote these concepts out on a pre-arranged mind map. On this day students were mostly listening or writing notes, therefore their levels of MB were predominately low. After the lecture students finished up questions that were on the osmosis egg lab. Again, this was completed with high levels of teacher scaffolding.

Summary of Colleen's classroom orchestration. Overall, Colleen was a teacher who was enthusiastic about science and learning about the natural world. Colleen created a welcoming, intriguing and fun science learning environment with her different animals in the classroom. She was the only teacher, besides Michael, to have animals in the classroom. Colleen spent a significant amount of time scaffolding student actions in the classroom. It is obvious she wanted her students to do well. She was a nurturing teacher who had good intentions for all her students. However, as Milner and Laughter (2015) state, good intentions are not enough.

Jason

An introduction to Jason. Coach is what the students called Jason. Yes, he is a football coach but teaching Biology was his main priority. Coach was not only the name given by his students; it was a fitting adjective for Jason as a teacher. He was a coach in his Biology classroom. He expected the table groups to work as teams, figure out things together, respect each other, and come to him for clarification and advice. He allowed a great deal of independence among his students. He coordinated and called the plays in the classroom but he expected the students to fully participate and drive every aspect of the classroom orchestration. This idea of a coach type role came through in his interview when he mentioned "My role as a teacher is to help guide them… we all know the more times that they can see things and do things, the more and more they can, then the better to greater chance they have." Jason was the most experienced teacher in this entire study with 40 years of teaching.

One thing I observed was he never missed a single beat in his classroom, regardless of what was going on outside the classroom. His commitment to teaching, to the school and, most of all, to the students was unprecedented. I observed Jason's class the very first period of the day. The students had a similar routine in this class as in Colleen's class with regards to starting with a warm-up. They all came into class, unstacked their chairs, settled into their table groups of 3-4 students, and started on their warm-ups. Over the next few days in Jason's classroom I observed an osmosis lab, a cell membrane activity, a lecture, review, and a lab assessment.

Jason's *HPL* component profile. In Figure 4.21, I present Jason's *HPL* component profile. His profile was unique when it came to the classroom observations. The KC-CC-AC component was the most frequently (45.3%) observed *HPL* component in Jason's classroom. KC-LC was the second most frequently observed *HPL* component in his classroom and the frequency of occurrence was identical to Colleen's orchestration of KC-LC at 20.9%. Compared to all teachers across all schools, Jason spent the second most amount of time (11.5%) orchestrating the full HPL (LC-AC-CC-KC) component during his observation. Most other teachers were highest in CC and KC components during the observation. Even though Jason's observation *HPL* profile was unique compared to the other teachers; when looking at the KC and CC components during his interview, his profile was similar.

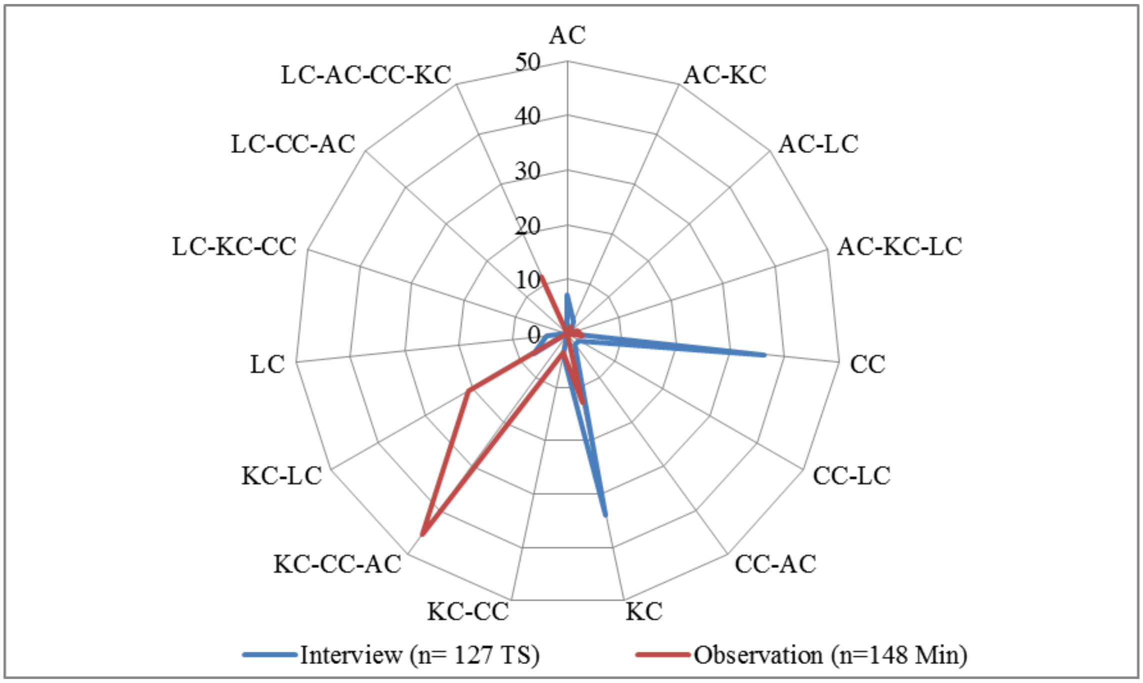

Figure 4.21. Jason's *HPL* component profile. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

The KC-CC-AC component occurred most frequently (45.3%) during the daily warm-up routine where the content knowledge (KC) was met with an assessment of what the student knew (AC) all wrapped up into a daily classroom routine (CC). The daily warm-up questions are below, provided in order by day observed:

- What surrounds all cells and lets things in an out? What is the difference between prokaryotic and eukaryotic cells? The diffusion across selectively permeable membrane is called…? Why is the cell membrane called selectively permeable?

All three teachers at BRC HS participated in a daily warm-up as soon as the students entered the classroom. Therefore, they all orchestrated these KC-CC-AC moments similar to NBR HS. Jason and Colleen used the exact same warm-up questions, whereas Kyra (the third teacher I observed at BRC) ventured out on her own with the warm-up questions. The thing that really pushed Jason's time spent orchestrating KC-CC-AC components in the classroom was the osmosis egg lab and the Bubble challenge (previously described in Colleen's classroom orchestration). The way Jason orchestrated the osmosis egg lab and the Bubble Challenge was much different than Colleen. Instead of step-by-step structured instruction like Colleen, Jason provided the students with time to work in small groups (CC) to answer lab questions (AC-KC) and manipulate their egg (M-SCOPS S3-T2-D2-S5). While the students were doing this Jason was working with small groups of students who had asked for help. The students spent about 10 minutes doing this on day two and then spent 39 minutes doing this on day three. When the students worked on their osmosis egg lab on day three they were given additional quiz type questions to answer regarding content and processes from the lab (M-SCOPS S3-T2-D3-S6). Even with the additional quiz questions, students were still allowed to work in small groups. Below is a quote from Jason's interview where his beliefs about group work are exhibited and it is clear to see why he orchestrated the osmosis egg lab with KC-CC-AC components:

- I'll walk up and say "Guys, we're working together. We're coming up with the answer together here. It's not just you're doing this over here, and you're doing

> this over there. Work together, help each other out. If you guys find somethings going to help them, let them know what it is." And I guess that is the essence of creating a community. But when we're doing that, I try to get all of them to get a little voice in what's going on.

KC-LC was the second most frequently observed *HPL* component. Like other teachers, Jason orchestrated these moments during lecture in the classroom. More specifically, he created analogies like many of the other teachers in this study. Additionally, like Colleen, Jason spent time trying to figure out what the students were thinking and where their misconceptions might be at within the content. Interestingly, when I asked Jason about connecting content to students' cultural knowledge he struggled a little so we skipped the questions and I came back to it at the end of the interview. His final response was "I'm sure we do, …[we] probably do it without ever thinking about knowing that we're actually doing it."

- Discussing homeostasis…Do you realize your body creates waste and the waste has to go through your liver and kidney [he goes on to talk about the function of the liver and kidneys and how they help maintain homeostasis in the body]
- [Attempting to figure out what students are thinking about recent Bubble Challenge] The cell membrane is like a bubble…[students respond with their thoughts]
- Permeable is kind of like a fence it lets some things in and some things out
- The cell membrane is the gatekeeper

Finally, Jason spent the most amount of time (11.5%) orchestrating the full *HPL* component (LC-AC-CC-KC). This occurred when the students were doing the Bubble Challenge (M-SCOPS S3-T2-D1-S4). Again the way Jason orchestrated the Bubble Challenge was different than how Colleen orchestrated the challenge. Jason gave the students 17 minutes, working in groups (CC) with the materials to attempt the different challenges on their own (KC) while also answering the questions (AC) for the challenge. While the groups were doing this, some of the students were going over to check on their eggs and take measurements and then reporting this information back to their groups (KC-CC). During this chunk of time Jason worked with students trying to figure out what they were thinking with regards to the Bubble Challenge or he attempted to figure out any misconceptions the students might have had regarding the osmosis egg lab (AC). Simple shifts in how activities were orchestrated can make a difference in the overall *HPL* environment in the classroom.

Jason's M-SCOPS complexity dimensions. As seen in Figure 4.22, Jason orchestrated some SST activities every day. On the last day I observed, the students spent almost the entire class period doing SST activities. Jason's third day followed a pattern I have yet to mention. A common pattern already discussed is the one in which the teachers present medium levels of ME using mostly TD activities. The other pattern that is seen across teachers at all schools and not yet discussed is one in which the teachers orchestrate medium levels of ME/MB using predominately SST activities (medium levels of PI). This pattern only happened on days where a lab was being orchestrated, and can be seen in the figures associated with Michael's, Danny's, and Mariana's complexity dimensions.

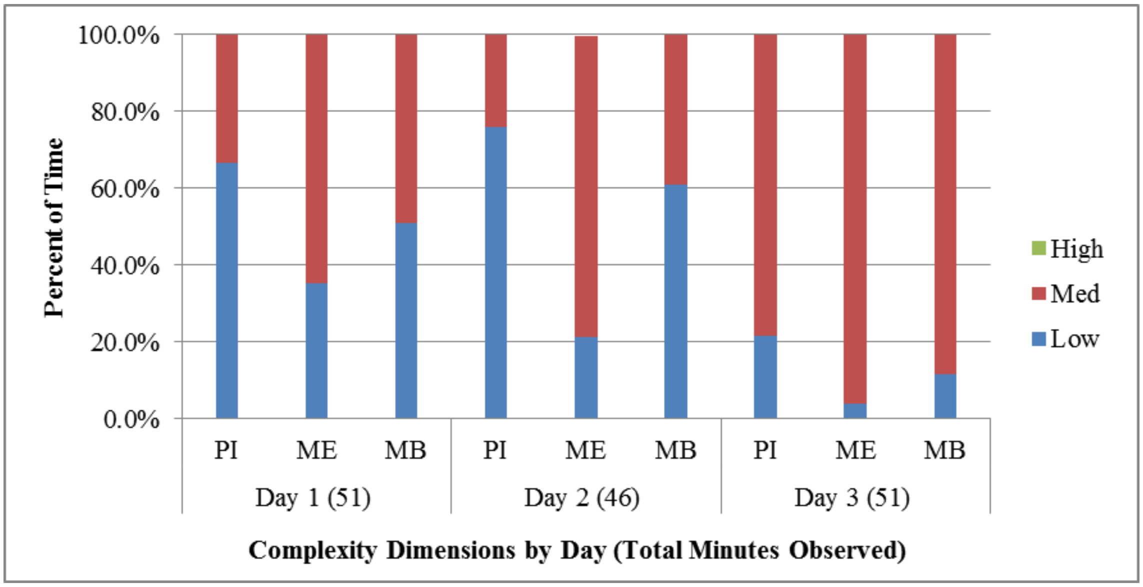

Figure 4.22. Jason's percent of time spent at different levels of complexity dimensions for each day observed. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions.

Summary of Jason's classroom orchestration. Overall, Jason was a highly committed and compassionate teacher. Jason created a collaborative environment focused on KC-AC-CC components and SST type activities. Within this collaborative environment he allowed the students to figure out things for themselves with the collaboration of group members. He guided them but expected them to be independent with their learning. This combination created an environment where fully balanced *HPL* components were orchestrated. With 40 years of teaching experience, he didn't let anything stop him from working for the students. His experience and compassion was best exhibited by the following quotes from his interview:

- I'm not here for myself. I'm here to try to make you a better person anyway I can, whether it's through Biology - which I'd like more to do - but just through life in general.

- I tell them, if they've got problems, I'd be more than happy to solve them. Especially I've been around a long time, I've had lots of kids, I got grandkids. I know what's going on. I've been around. I know you don't like to trust older people, but I can at least give you some ideas. And with some of them, I've gotten to know, and they've gotten to trust me.

- If you're showing me an attitude or a presence of mind that you want to be successful, then I'm going to help you as much as I can…

Helping students to become better people in any way possible was his way of contributing to society at large. He understood success is about a mindset, an attitude. He showed up every day ready to give his all to his students and expected his students to do the same.

Kyra

An introduction to Kyra. She stood by the door greeting every single student, every day, before every period. Kyra was never in her classroom busily preparing for students before class because everything was already done. She was very with-it and she expected her students to be totally ready when they walked in the classroom. She exuded and modeled these expectations by greeting her students at the door. Through her simple "hello" or "good morning" to the students, she seemed to be saying "I am ready, you need to be ready, because it's time to learn Biology!" Just like the other classes I observed at Bridge Rail Creek HS, the students in Kyra's class would come into the room, settle into their table groups of four, and start on a warm-up. She was all about "discovery learning" in her classroom, giving the students an opportunity to experience a concept before teaching the actual concept. During these discovery learning episodes, she would enthusiastically tell the students "let your brain go, try it out, and try again" in an attempt to get the students to use their creative thinking and critical problem solving skills.

Kyra expected every single student to participate and collaborate with their table groups. In Kyra's classroom every students' voice was important and figuring out what and how students thought about a concept was a central focus every day. For example, one day she asked the students to make up their own analogy for a cell membrane. She also asked many questions to get what the students were thinking: how did you get it to work, how do you know, why did you do it that way, what do you think will happen, what did you notice? Over the next few days in Kyra's classroom I observed an osmosis lab, a cell membrane activity, a lecture, and a review.

Kyra's *HPL* component profile. In Figure 4.23, present Kyra's *HPL* component profile. Her profile was unique because she spent the most amount of time (21%) out of all the teachers orchestrating fully balanced *HPL* components (LC-AC-KC-CC). Additionally, she orchestrated KC-CC-AC (19 %) and KC-LC (12.8%) components. However, her interview followed the same pattern we have seen among all the other teachers; CC and KC were the most frequently occurring *HPL* components. Interestingly though, AC and AC-LC components were also prevalent during her interview. Kyra orchestrated fully balanced *HPL* components (LC-AC-KC-CC) during the osmosis egg lab, and during warm-up. An example of a warm-up question is below:

- Why is the cell membrane considered to be selectively permeable? Make up an analogy for the cell membrane. (Ex: The cell membrane is to a cell as a garage is to a car)

Normally warm-ups were KC-CC-AC but this was brought to the next level because she asked the students to provide their own analogy. This allowed her to understand what types of experiences were important to them. During the osmosis egg lab, she orchestrated it most similarly to Jason. The students worked in small groups (CC) while autonomously working through the lab (KC). As they worked through the lab they had to answer questions on their lab sheet (AC). What brought this orchestration to the next level was the LC type questioning Kyra was doing during the second day of the lab. She went around to each table and asked *diagnostic teaching* type questions such as; "why do you think…?" or "what did you see happen when…?". This process of going to each small group of students allowed her to figure out students' misconceptions regarding the process of osmosis based on their personal experiences with the lab. Again, these subtle changes in the way things are orchestrated in the classroom can bring something towards fully balanced *HPL* components.

KC-CC-AC (19 %) components were orchestrated during the daily warm-up, like the other teachers at BRC HS. However, she also orchestrated KC-CC-AC moments during the osmosis egg lab. Warm-ups were a formative assessment based on knowledge learned on the previous day. For example, "what is the difference between cells?" was a warm-up question the first day I was in class. As mentioned previously, warm-ups were a daily classroom routine and they are considered CC. During the osmosis egg lab (KC) students worked in groups (CC), and answered lab questions (AC). The teacher monitored the students during this time but she was not yet asking those LC based questions because it was the first day the students worked on the lab.

KC-LC (12.8%) moments took place during the lecture. We mostly saw this happening on the third day during a short lecture where the students took some notes. Like many other teachers, she created analogies to relate structure, functions, and processes within the cell to things the students could conceptually grasp. Below are some examples of these analogies:

- We will focus on passive. Let's think of students; we have one that just listens and one that does all the extra stuff. Out of the 2 who will be more successful? Student 2. The first one is a passive learner just took it in. The second one actively engaged.

- Teacher discusses isotonic, hypertonic, and hypotonic solutions and described levels of concentration. As she is describing this she connects it to Kool Aid or Crystal Light packets in water and goes on to discuss concentrated vs diluted substances.

- Teacher discusses the cell membrane and stated "It acts as a football gate. If you are at the gate you can't just walk in."

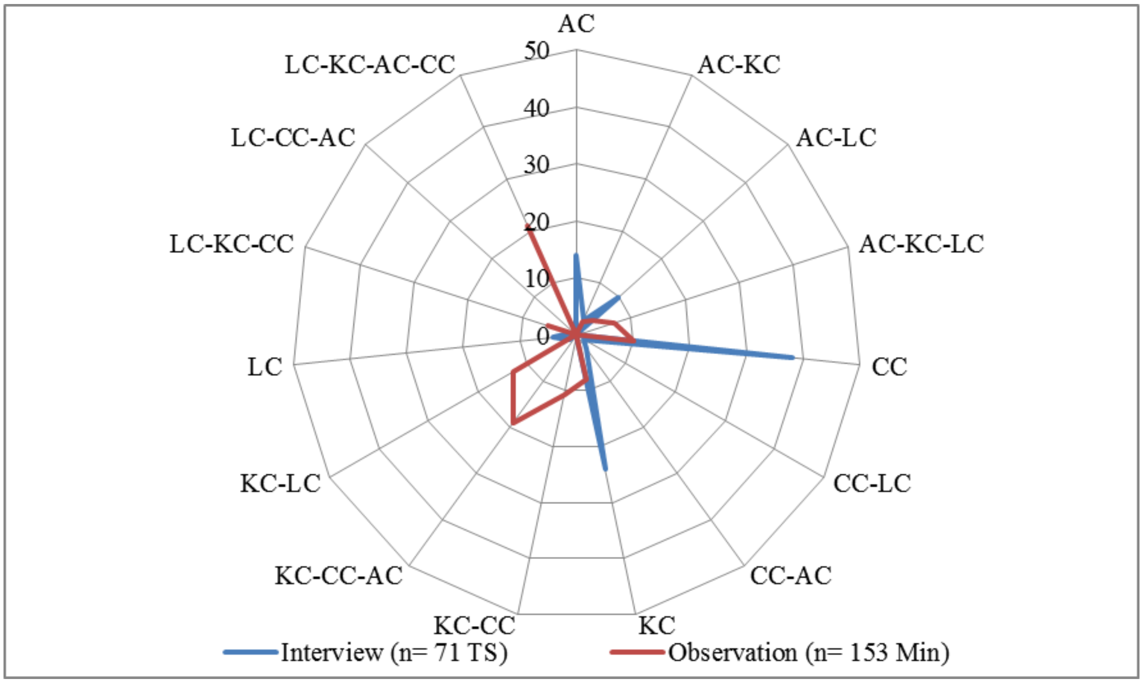

Figure 4.23. Kyra's *HPL* component profile. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

In addition to these moments during the lecture, Kyra also utilized "exit tickets" as a *diagnostic teaching* tool. Specifically, the day she used the exit tickets she asked the students, "why did we use the bubble activity to simulate the cell membrane?" As Bransford et al., (2000) note, diagnostic teaching is a process of "attempting to discover what students think in relation to the problems on hand" (p. 134). She asked the students about knowledge they had just learned during class, and the students wrote down their answers on a piece of paper before the bell rung. When the bell rung they turned in the paper to the teacher as they exited the door.

As mentioned, during the interview AC and AC-LC components were present. In the interview she mentioned the importance of making changes in transitions and differentiation based on feedback from the students. It is important to note that Kyra did not allow me to audio record her interview so her thought segments were captured by me in writing during her interview as closely to verbatim as possible. For AC-LC she mentioned using warm-ups to understand what the students know. Additionally, she mentioned she would have students come in during tutoring so she could better understand where the students' misconceptions were. If the warm-up was something from the previous day she said she would walk around and look at their paper. If she was noticing common misconceptions she would clear it up there. These things are all part of the formative assessment process as well as diagnostic teaching process. She also expected the students to not only answer a question, but know why the other answers were wrong. Additionally, with regards to assessments, Kyra mentioned she would often involve the students by allowing them to come up with pre-assessment questions and put them on the board. Then, once all the questions were on the board, the students were able to throw out some of the questions. This was a unique process, only mentioned by Kyra, for involving students in the assessment process.

Kyra's M-SCOPS complexity dimensions. As seen in Figure 4.24, Kyra typically spent about 1/3 of the daily class time doing SST activities (medium levels of PI). Additionally, she spent every day orchestrating about 80% of the class time at medium levels of ME and students never spent less than 55% of the class time engaged in medium levels of MB activities. Every day in Kyra's classroom there was something hands-on that the students were doing. The first day students worked on the Bubble Challenge and Kyra called this "discovery learning." She really encouraged the students to “let their brain go” during this activity. Then on the second and third day she orchestrated the osmosis egg lab. Also, on the third day, with the most percent of time spent at medium levels of ME, Kyra orchestrated a short lecture.

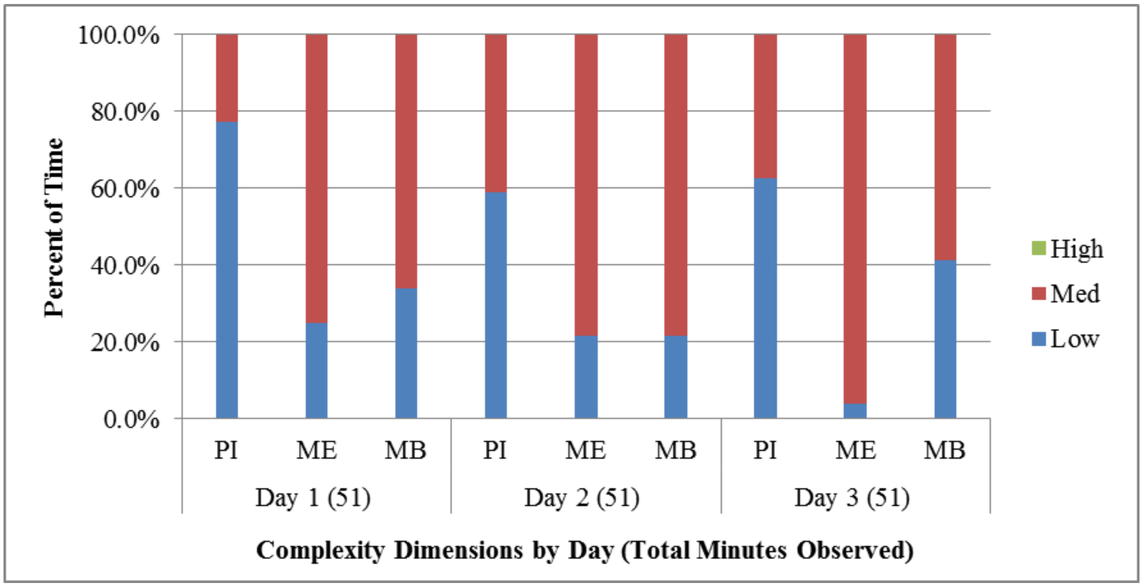

Figure 4.24. Kyra’s percent of time spent at different levels of complexity dimensions for each day observed. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions.

Summary of Kyra’s classroom orchestration. Overall, Kyra was a high-expectation, creativity-encouraging, and collaborative-natured teacher. She made sure that every student knew their voice mattered and they must at least try during classroom based discussions. Consistent with many of the other teachers she mentioned “It is okay to be wrong and I let them know I don’t know everything.” Additionally, she let the students know within the classroom “this is our little family” but she also liked to add a little friendly competition. She spent the most amount of class time allowing students to share what they were thinking and why they were thinking it. Bransford et al. (2000) state, "Teaching practices congruent with a metacognitive approach to learning include those that focus on sense- making, self-assessment, and reflection on what worked and what needs improving" (p. 12). These meta-cognitive processes were present during the Bubble Challenge, exit tickets, development of their own pre-assessment questions, the warm-ups, and the osmosis egg lab. The general essence of Kyra's classroom was best captured in her comment to the students when she said "Let your brain go. Try it out and try again"!

Concluding Thoughts for Bridge Rail Creek High School

In total, I spent 454 minutes observing classrooms at BRC HS and coded 317 thought segments from the teachers' post-observation interview. In Figure 4.25, I compared the average percent of *HPL* components across the school for the interviews and observation. Across the three teachers at BRC HS, there was a focus on KC-LC and KC-AC-CC components during the observations. During the interviews among the teachers at BRC HS there was a focus on KC and CC components. The pattern for BRC HS, seen in Figure 4.25, is different from the observation patterns seen in the *HPL* component profiles for NBR HS and WRM HS. At BRC HS the *HPL* components of KC-AC-CC were the most frequently observed when compared to KC at the other schools. However, the interview pattern is the same as the other schools where KC and CC components are the most frequently discussed items. When the three teachers at BRC HS talked about CC components at the school level they all agreed that the school was safe and structured. One teacher even discussed how the school really focused on attendance. Below are some examples from the interview regarding what the BRC HS teachers thought about the school:

- I think that the overall school climate is strict. I think we also care, and I think that the students know that, and I think we're supportive, so I would say it's a structured safe place.

- We do a great job of getting our kids to school. At least they've got the chance to be successful if they're here. We do a good job of getting our kids to school…

- They just want them to be successful in that sense. Learn to do the things that it takes to be successful: get your work turned in on time, show respect to each other - whether it's to your teachers or whether it's to your peers. And the administration and all the teachers, they all work. Our school does a good job of working that way…

- I think it is comfortable and safe. Admin is supportive. Big on building relationships.

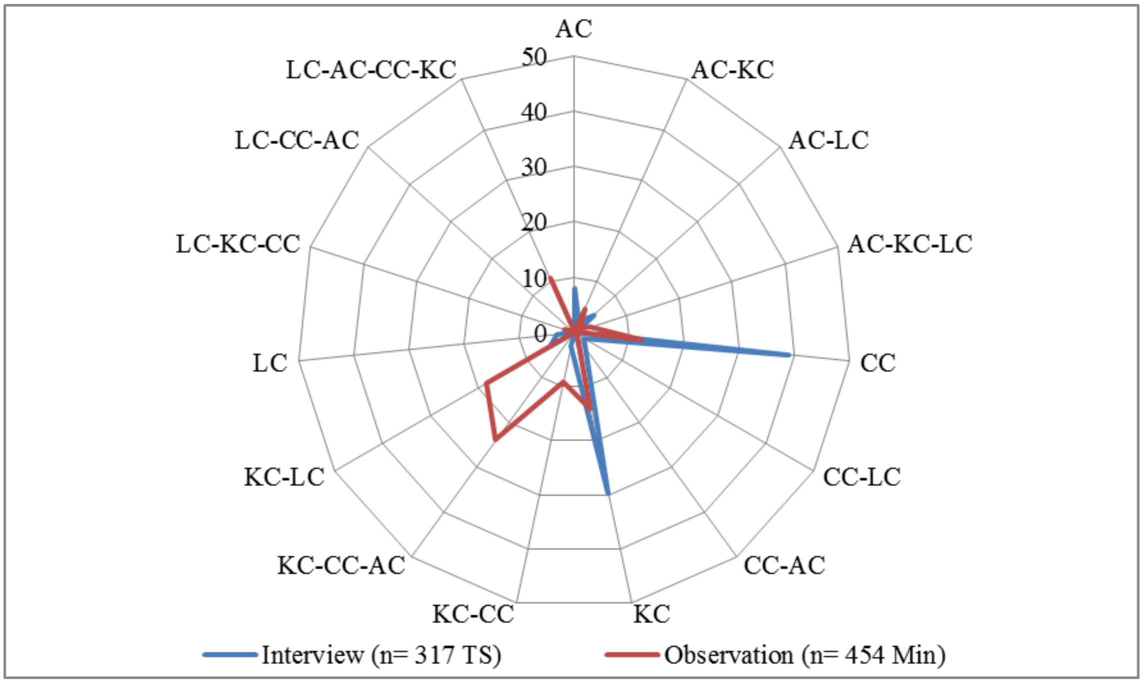

Figure 4.25. Teachers' averaged *HPL* component profile for Bridge Rail Creek High School. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

Reflecting on the higher percentages of observed class time orchestrating KC-CC-AC and KC-LC components I think subtle changes in the class set up and the teachers' questioning really helped. This was the only school where every single classroom had tables for the students to sit in groups. I think the tables might have helped with this shift from KC to KC-AC-CC, but even more helpful was the teachers' orchestration. Even with tables we can see teachers fell into more structured TD activities, such as Colleen. Again, when comparing complexity dimensions Jason and Kyra had almost identical classes. See comparisons of BRC HS teachers' complexity dimensions in Figure 4.26. Even though Colleen often helped Jason out, he seemed to be more comfortable letting the students loose to work among their group. Interestingly, Jason and Colleen teach regular Biology and Kyra teaches pre-AP Biology. However, Jason and Kyra's orchestrations were more similar than Jason and Colleen. This had to do with how Jason and Kyra orchestrated the osmosis egg lab and the Bubble Challenge.

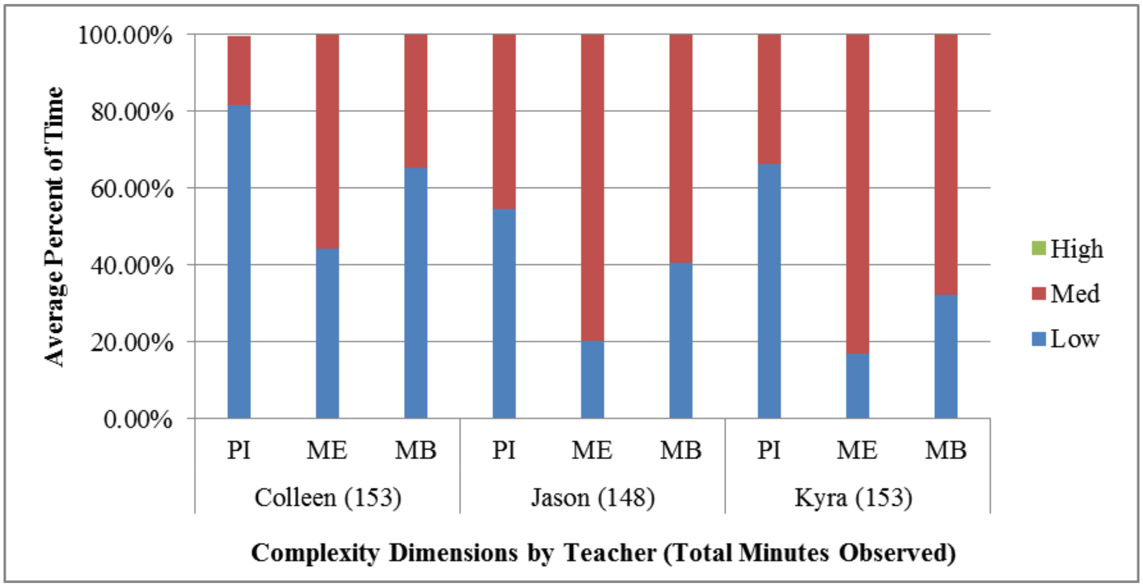

Figure 4.26. Average percent of time spent at different levels of complexity dimensions for teachers at Bridge Rail Creek High School. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions.

Looking Across All Three Schools

Finally, looking across all schools, I described the notable patterns among all three schools and across all nine teachers to answer the last question: *Across all cases observed, what patterns of HPL design and practice characterize the science classroom learning environments of HSHD schools?* Overall, my goal for this final examination across all cases observed was to highlight patterns from all the teachers' practices and connect it to findings from the literature.

HPL Component Profiles Across all Schools

In Figure 4.27 (interview data) and Figure 4.28 (observation data) I represented the average percent of time teachers within schools (i.e., all data collapsed by school level) spent orchestrating or discussing the various *HPL* components. As seen in Figure 4.27, across all three schools, teachers were self-reporting very similar beliefs about the *HPL* practices. Teachers extensively described KC and CC based practices during the interview. When I observed teachers, the KC and CC components discussed in the interviews seemed to come together in the classroom as KC-CC or KC-CC-AC orchestration (see Figure 4.28). KC-CC orchestration in the classroom was the third highest component observed across two of the three schools. The first and second highest observed *HPL* components in two of the three schools (KC and CC), mimicked the highest self-reported (interview) *HPL* components.

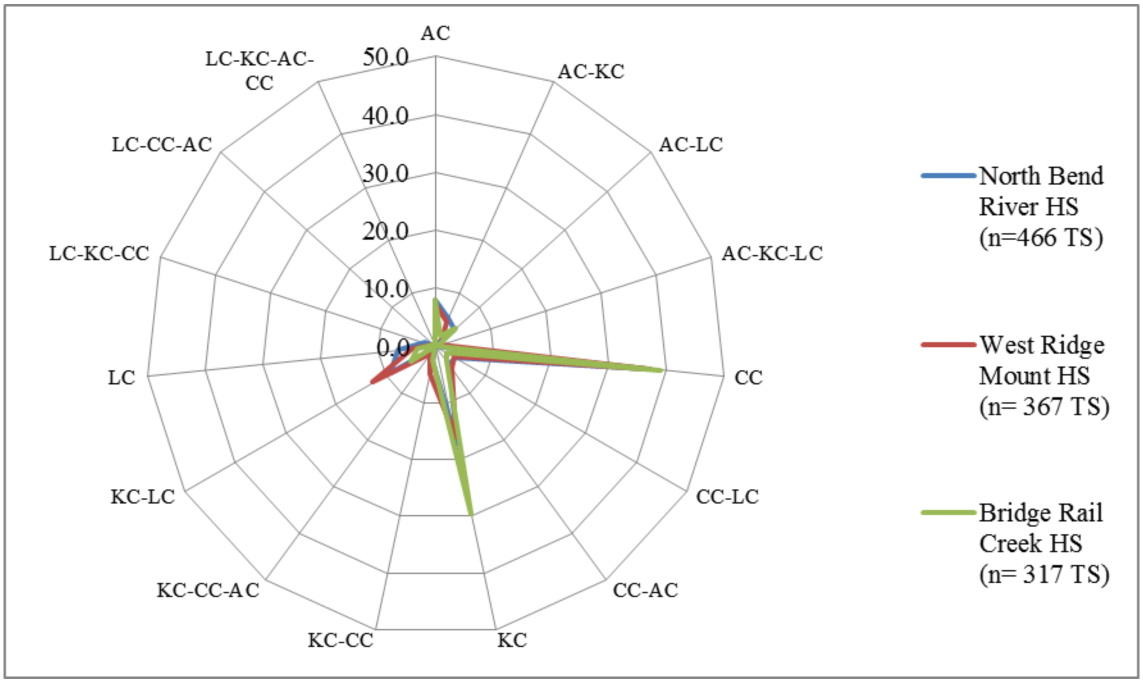

Figure 4.27. Averaged percent of thought segments sorted by *HPL* components for all schools. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

KC-LC was the third highest self-reported *HPL* component, and often the third highest observed *HPL* component. While NBR HS and WRM HS had the most similar patterns of observed *HPL* components; BRC HS really stood out with KC-LC components observed in the classroom (see Figure 4.28). The average *HPL* component profile for BRC HS is notably different. There could be two possible explanations for this; (a) I observed at NBR HS later in the school year than the other two schools, (b) NBR HS had a different demographic composition than the other two schools.

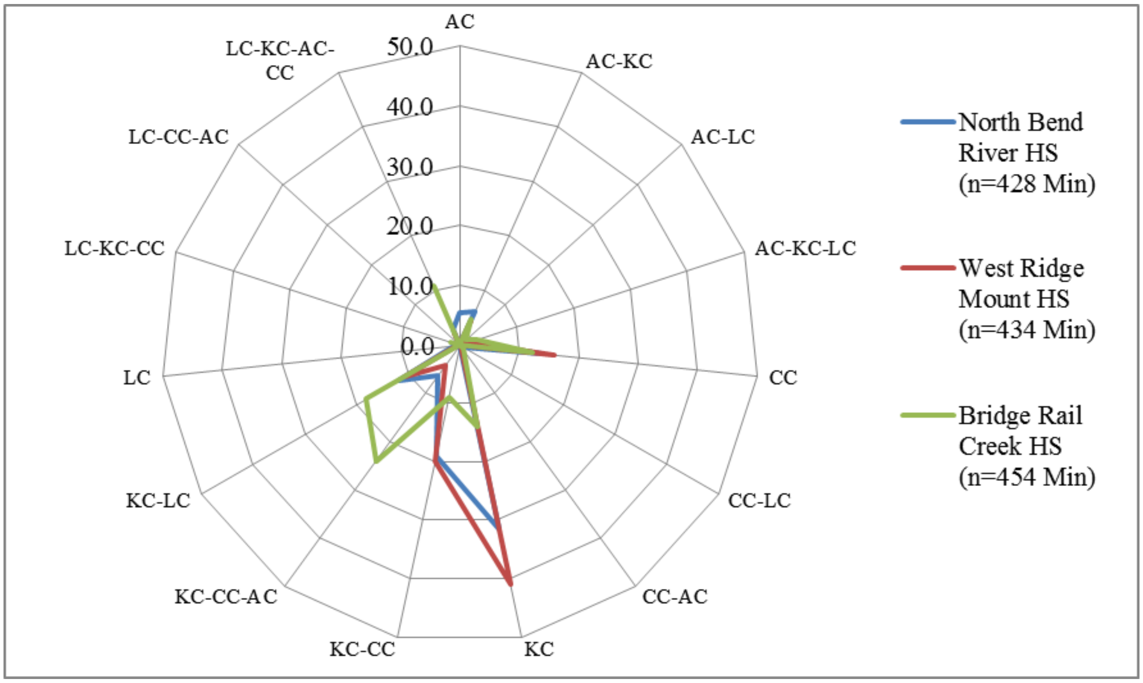

Figure 4.28. Averaged percent of observation time sorted by *HPL* components for all schools. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

I have already discussed the timing of observations within the school. It could be possible that because I observed NBR HS a little later in the fall semester, the teachers had a little more time to get to know their students, thus were more likely to be able to comfortably orchestrate KC-LC moments in the classroom. Reflecting back on the schools' student demographics, it is interesting to see that NBR HS and WRM HS are the most demographically similar schools in this study. Both NBR and WRM HS have over a 70% Hispanic student population. Whereas, BRC HS has a 53% Hispanic, 18% African American, and 13% Asian/Pacific Islander/Native American student population. Teachers at both NBR and WRM HS discussed the students at their school as a relatively homogenous diverse population.

- Teacher at WRM HS - I think that it's one of the few places where you're probably going to be in such a homogeneous, it's diverse but homogeneous, so it's diverse in comparison to the country but very homogeneous here.

- Teacher at NBR HS - And it was very interesting though because they [another school in a different state] didn't consider Hispanic as a sub-group… So, when I came down here and they were classifying a lot of the Hispanic people are in the sub-population, I was like, 'What?' I was like, 'Why?'

The teachers at BRC HS recognized high levels of diversity in general. It could be that teachers at BRC HS orchestrated more KC-LC to help bridge the diversity among the students and science. Bransford et al. (2000) follow this line of thought and note "if teaching is conceived as constructing a bridge between the subject matter and the student, learner-centered teachers keep a constant eye on both ends of the bridge" (p. 136). Below are some of examples the teachers at BRC HS recognizing the diversity within the school:

- Teacher at BRC HS - This is a new world, very different than Mississippi. In the Mississippi school where I taught it was not diverse, it was all urban… The professional development for diversity was not really here. I just got into and learned by doing.

- Teacher at BRC HS - Well, when I came from [another school] - I will be honest with you - when I looked down at the hallway the first day, I thought, "What have I gotten myself into?" I really did. Then when I got in my class, I thought, "These kids aren't any different than the kids I had in [the other school]. They're just the same, they want to learn."

In Figure 4.29, I presented the comparison of interview, observation, and literature based percentages of *HPL* components. In this comparison I averaged the percentages of what all the participating teachers were reporting regarding *HPL* components and I averaged the percentages of what all the participating teachers were doing in the classroom with regards to the *HPL* components. I compare these averages to what I found in the literature regarding research on multicultural/urban science education. Refer to Appendix A for details about the literature and details about how I collapsed the literature data for the comparison in Figure 4.29. Overall, as seen in Figure 4.29, CC was the most frequently **discussed** *HPL* component, KC was the most frequently **observed** *HPL* component, and in the **literature** the common *HPL* component for research was LC.

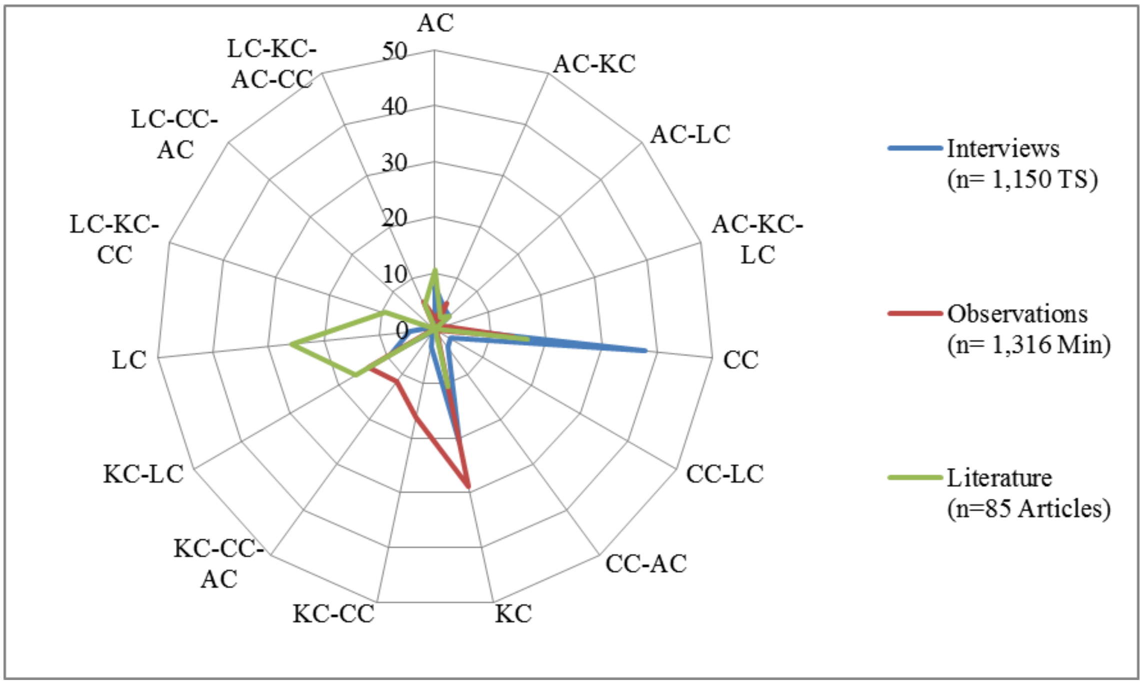

Figure 4.29. Average school level percent of interview thought segments versus average school level percent of observation time compared with percent of *HPL* science literature sorted by *HPL* components. *HPL* components: AC= assessment centered; CC= community-centered; KC= knowledge centered; LC=learner-centered. See Appendix K for details regarding *HPL* components, codes, and elaborations.

CC was the most frequently **discussed** (interview data) *HPL* component across all schools. Community is the core of the *HPL* framework and referring back to Figure 4.1, CC encompasses the entire *HP*L framework. Within the CC component there are classroom, school, and outside-school community elements. When teachers' discussed their classroom community they often referred to it as a little family, stressed the importance of creating a safe environment in which students could ask questions, described the importance of friendly competition, expected respect among all members within the community, and described weekly small group work as a standard routine. All of this related back to research from Bransford et al., (2000) and NASEM (2016) in which they reported that communities provide students an opportunity to feel like they matter and research on science classrooms in general report a positive, respectful, and well organized climate was commonly observed. Within the school community teachers discussed the administration, their science team members, and the overall environment of the school. When discussing the overall environment, one teacher commented on the school's location, "We're on the borderline now for urban/suburban. We're right on that, on the border." Other teachers discussed the economic divide; the extreme differences between the socioeconomic statuses of the students within the school. With regards to the science program level community teachers discussed their group planning and collaboration. All the teachers mentioned some type of activity in professional learning communities and said they spent time at least once a week or every other week group planning. This contradicted data reported by NASEM (2016) in which fewer than 60% of science teachers said they had time allocated for planning with colleagues.

Most teachers in this study reported relying on the science team collaborations. Bransford et al., (2000) report CC at the teacher level is important because expertise is able to be shared across the teachers and this “improves the overall quality of instruction” (p. 75). However, some teachers felt that the group planning sometimes got “in the way” or that there was a lack of leadership among the team so the planning time was not effective. Finally, with regards to community outside of school the teachers reported on the critical importance of parental involvement. Several of the teachers noted that parental involvement could be improved. Some teachers noted science themed activity nights at their school in which community members got involved. Teachers rarely mentioned fields trips or after school science activities. This aligns with findings from Scogin, Cavlazoglu, LeBlanc and Stuessy (2012) regarding HSHD schools not focusing on field trips as much as other important student-centered practices. However, each school did have some time of club related to science. Inviting science experts to come into the schools was only mentioned by one teacher. However, some of the teachers spent time in labs, hospitals, and other science related fields before becoming teachers.

Next, the most commonly **observed** *HPL* component was KC. This is an obvious finding. However, the *HPL* framework is meant to be balanced, not centered on one single component. Additionally, when I disaggregated the data by codes and elaborations (see Appendix K) for the observed KC components I noticed that content is the primary focus. Making the content relevant and balancing understanding (i.e., process skills vs. content skills/deep understanding vs. automaticity) was the next most prevalent code with KC component. Finally, spending time on transfer activities and taking time for sense-making were grossly underrepresented codes within the KC component. This finding parallels finding from NASEM (2016); “current science instruction places greater emphasis on ensuring that the learning environment is organized than on students’ sense-making activities” (p. 65). Finally, LC was the most common component discussed in the literature. LC includes codes related to culturally responsive teaching, building on students’ cultural knowledge, respecting students’ language practices, discourses facilitated to assist students develop concepts, and diagnostic teaching (Bransford et al., 2000).

While the literature peaks in the LC component the observation and interview percentages were much lower. This pattern aligned with findings regarding patterns of the Levels of Integration of Multicultural Content (LIMC; Banks, 2013). I have yet to report on LICM because the percentages were minimal but I think it fits well within this discussion. LIMC was barely present when I observed or interviewed the teachers. LICM across all three schools was observed for a total of 8.9% of the time (i.e., 117 minutes out of 1,316 minutes observed). When it was observed it was at an integration level 1; the contributions approach (Banks, 2013). The same is true for the interview; 1.9% of all thought segments were coded for LICM at a level 1 (i.e., 22 TS out of 1,150 TS). Suriel and Atwater (2012) completed case study research on science teachers’ integration of multicultural content and they noticed the teachers were often leaner-centered but their levels of LICM were wide-ranging “from non-existent to transformative in nature” (p. 1,287). I did not observe any transformative LICM.

Research and literature does exist regarding multicultural infusion and culturally responsive teaching in science education. However, the majority of the research is focused on helping English Language Learners (Lee & Buxton, 2013; NASEM, 2016). Other learner-centered multicultural science education research is not making its way to classroom based practices. Overall, the literature and research on learner-centered (culturally responsive) science education is not transferring to the most important level of the school ecology: the classroom. This has been a classic problem in urban or multicultural science education for several reasons: science teachers tend to think science is absent from culture, there is really great research out there in urban or multicultural science education but it seems to conclude with lofty generalization and no action points, or teachers claim there is not enough time for that "stuff." As previously mentioned, "teachers do not teach diverse learners on Tuesdays and science on Wednesdays; they teach the two together," (NASEM, 2016, p. 230). For this reason, being a learner-centered teacher needs to be more ingrained in what science teachers do on a daily basis in diverse classrooms.

Based on interviews, the teachers in this study reported only having one or two multicultural classes. The multicultural classes were absent from content. Additionally, few reported actually having training as teachers to teach science to diverse learners. When specifically asked about training regarding how to teach science to diverse learners, most focused on special education or ESL training but they did not say these trainings were specifically connected to science. There simply is not enough content-focused diversity courses/professional development which train teachers how to seamlessly transfer the research into action.

The AC component was not something extensively **discussed** during the interviews, or **observed** in the classroom, or researched within the **literature** on multicultural/urban science education. I did observe teachers using formative assessments and feedback techniques but other practices dominated the lessons. Teachers did discuss how they developed an understanding of where the students were struggling by asking them questions but noted they often didn't have time for the students to stop and reflect on how they're learning/progressing.

When I asked teachers about how their schools measure success, most teachers noted that their schools' idea of success is related to "tests, flat out" or being well rounded and doing well in academics, sports, and extracurricular activities. Other teachers noted their schools' assessment of success relied heavily on attendance. However, all the participating teachers' reported that their individual ideas of success dealt with students' progress in any form way beyond just science content/test based success. Some teachers even talked about how students can make a grade but you have to really monitor them to know what they understand. Additionally, some used assessment and their ideas of success as a way to reflect on their own practices. Michael and Jason's quotes exemplify this common thought:

- Jason-Some people's success is different than others. If you're showing me, I guess, an attitude or a presence of mind that you want to be successful, then I'm going to help you as much as I can.

- Michael-In my environment, whenever I teach, unless you're going to follow-up and monitor constantly, they're just not going to do, I mean, the scores will look like they are doing what they are supposed to be doing, because they can copy… and, unless you're staying on top of them through the learning process, through the labs, through the notes, they're maybe taking a pathway that's not going to lead to success.

- Michael-Nobody will learn your information unless they love it first. So, if I can get my kids to just love the environment and love what's going on, then I feel like I'm at a high level of success. Then, if I can get a kid to do well on a test, then I'm really hitting home. And a lot of the times, if there's a disconnect between they love the class and they're not doing well on the class, that's me.

Overall, this general idea the teachers had regarding focusing on any type of student progress as success is supported by Bransford et al., (2005) in which they state, "the sole use of static assessment may mask the learning gains of many students, as well as mask learning advantages that various kinds of educational experiences provide" (p. 70). The advantages of additional educational experiences not considered in assessments were another thing teachers at these schools discussed. Teachers within the HSHD schools believed teaching successful practices-or as Michael would say "pathways to excellence"-were just as important as teaching Biology concepts. Again, Jason supports and exemplifies this idea stating:

- I'm not here for myself. I'm here to try to make you a better person anyway I can, whether it's through Biology - which I'd like more to do - but just through life in general.

Unintentional embedded *HPL* interventions. Due to the complexities of the teachers' schedules, an unintentional deviation happened in the timing of the post-observation interviews. Five of the nine teachers had to complete the post-observation interview one day before I completed observations. This was necessary because of the teachers' busy schedule. When I came back to the classroom the next day after the *HPL*-based post-observation interview, these five teachers made a point to do a little something during the instruction to connect to the *HPL* practices discussed in the interview. Or some of these five teachers took time to point out an instructional practice that connected to the *HPL* practices discussed in the interview. This is an important finding because NASEM (2016) researchers state, "efforts to reform science instruction will depend on working closely with educators to alter or expand their current perceptions and aspirations" (p. 64).

Examples of these changes or reflections included Danny connecting parts of his lecture to the local geographic area and making analogies between the cell wall and the border patrol gates/fence. Mariana had planned to put her students in groups but she made a point to use the exact words from the interview to encourage how students grouped up, and then she looked at me almost like "did you see how I implemented what we discussed"; we both smiled knowing the connection was there.

Michael discussed clickers during the AC portion of the interview. He already planned to use the clickers the next day in class. However, because of our discussion during the interview he invited me up to his computer to see how the clicker system worked in the classroom. He spent some time showing me all the really neat functions of the clicker system and the efficiency of feedback. Additionally, Michael showed me the online textbook and how he was able to quickly see where the students are based on their online assignments.

Finally, Kyra changed her warm-up on the final day to be more focused on balancing the "what" and "how" of science based on one of my KC questions. In other words, she connected the process skills from the lab to the content being learned. This was an attempt to really help students make critical connections regarding the process of science. In each of these little cases it seemed like the teachers suddenly realized what I was looking for and were happy to show how these practices were enacted in their classroom. By explicitly asking about and discussing various *HPL* components with the teachers before the last day of observation, an unintentional embedded intervention took place. I say embedded intervention because the teacher learning/reflection took place with the teachers' time, in the teachers' context (NASEM, 2016). These tiny instances showed how teacher learning/reflection does not have to be an extended/expensive professional development. Interventions can be brief discussions of practices to create small changes in instruction or cause the teachers to reflect on what they are already doing well. Notably, NASEM (2016) researchers report "the available research on the school and classroom as a learning environment for teachers of science is both limited and diffuse, particularly in science…" (p. 148). Additionally, NASEM (2016) goes on to discuss teachers' learning within their own school context has been repeatedly called upon for at least 30 years. These in school learning opportunities are valuable because they provide contextually specific learning and are often more scalable (NASEM, 2016).

M-SCOPS Complexity Dimensions Across all Schools

Within this study I not only discussed frequencies of *HPL* practices observed and reported, I used the M-SCOPS to discuss the levels of cognitive complexities in which these practices are implemented within the classroom across three dimensions (PI, ME, ME). Looking at the M-SCOPS complexity dimensions across all schools clarified understandings regarding the "quality of implementation of these practices" as brought up by NASEM (2016). In Figures 4.30, 4.31, and 4.32, I displayed individual complexity dimensions (PI, ME, and MB) averaged by each teacher. By doing this, it becomes easier to see the whole picture for each complexity dimension across all nine teachers. Then in Figure 4.33, I collapsed all teachers' complexity dimensions within schools and I compared averaged teachers' complexity dimension orchestration across the three schools.

At the teacher level for PI (Figure 4.30) we see that Michael, Danny, and Jason (all the men in the study) orchestrated shared student-teacher (SST; medium levels of PI) type activities about 40% of class time. Mariana and Kyra orchestrated SST type activities about 30% of class time. Kerri, Elizabeth, and Colleen orchestrated SST type activities about 20% of class time and Gabriela orchestrated only teacher-directed (TD) type activities during the days I observed her classroom. These patterns show that student-directed (SD) activities never took place (high level PI) while I observed in the classrooms. Additionally, it shows the most popular teaching method among all teachers was TD based instructional practices such as whole group discussion, and lecture. This finding paralleled national science teacher research; NASEM (2016) found science teachers "spend most class time explaining science ideas or leading whole-class discussions" (p. 66).

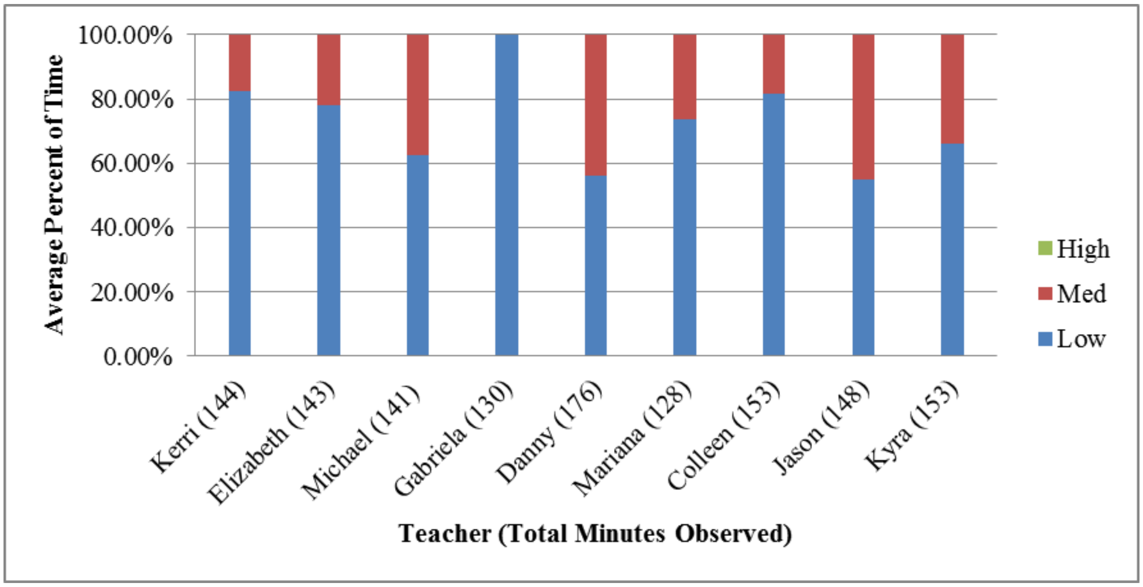

Figure 4.30. Average percent of time spent at different levels of Performance and Initiative by teacher. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions. Refer to Appendix J for details regarding M-SCOPS coding variables.

However, all but one teacher allowed the students to work in small groups at least one day during my observations. Again this correlated with national science teacher survey based research in which 70-80 % of science teachers allow group work at least once a week (Banilower, et al., 2013). The majority of the group work took place when the teachers were facilitating some type of lab. I observed all but one teacher facilitating lab work during my observations. The one teacher that I did not observe do lab work was going to complete a lab within the next day or two after I left.

In Figure 4.31, all the teachers' levels of ME are compared. Elizabeth, Michael, Jason, and Kyra spent about 80% of class time providing information at medium levels of ME. Interestingly, Michael and Kyra were the teachers who I observed teaching Pre-AP level Biology. Elizabeth and Jason were teaching "regular/on-level" Biology. I think their questioning strategies and how they orchestrated the labs allowed them to provide a little more time enacting medium levels of ME in the classroom. Gabriela, Danny, and Colleen spent about 60% of class time providing ME at medium levels.

Michael and Danny were the only two teachers to orchestrate high levels of ME during class. Michael and Danny were teaching Pre-AP Biology when I observed them orchestrating these high levels of ME. Notably, science teacher research from NASEM (2016) reports, “classes with high achieving students were more likely than classes consisting mainly of low-achieving students to stress reform-oriented objectives...” (p. 54). One of the science teachers participating in the study expressed concerns regarding the systematic academic segregation of high and low achieving students within the school. She stated:

- One thing that is a very serious problem that I see in this school and that I have seen in the system in the past three years is that we're so big at trying not to segregate our kids. To include the special ed, to include this, but what we doing is that now we have these IB, these Pre-AP, these AP programs. We end up with these really, really smart kids, and then we end up with this like kids that are not as bright… So we are really segregating our kids because these kids have no idea what it is to be a good student, what it is to be smart, what it is to be prepared.

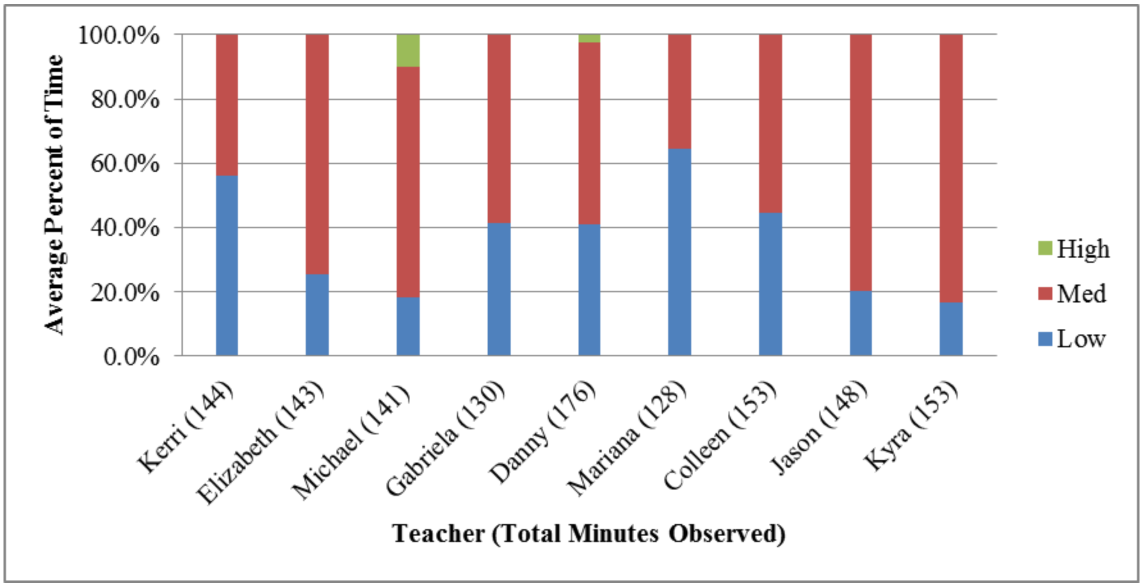

Figure 4.31. Average percent of time spent at different levels of Model Eliciting (ME) Information for each teacher. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions. Refer to Appendix J for details regarding M-SCOPS coding variables.

This is problematic when trying to advance the objective of "science for all." Unfortunately, based on the findings, the schools within this study were not exempt from this practice. For example, the teachers who were teaching regular or co-teach classes, Kerri and Mariana spent less than 50% of class time providing medium levels of ME to their students. I would like to note that Elizabeth was also teaching a co-teach class and she spent about the same amount of time as the Pre-AP teachers orchestrating medium levels of ME. Therefore, there are teachers who work against the pattern.

In Figure 4.32, all the teachers' levels of orchestrated MB actions are compared. Krya (70%), Jason (60%), and Michael (50%) spent the most amount of class time allowing the students to explore medium levels of MB actions. Examples of students participating in medium levels of MB actions included: manipulating parts of the system to yield understanding about connections but missing meta-connections, searching for patterns among parts of the system by representing symbolically or pictorially, and interpreting and making logical connections (Stuessy, 2009). Again, Michael was the only teacher to provide students an opportunity to interact with the information from class at high level of MB actions. The remaining teachers (Kerri, Elizabeth, Danny, Mariana, and Colleen) provided about 30% of class time to allow students to interact with the information they were receiving at medium levels of MB actions. The science classroom observation based research out of Newark Public schools noted similar findings; “the observers saw low cognitive demand lessons in half of the classrooms, and there was little extended student discussion…” (Corcoran & Gerry, 2011, p. 16).

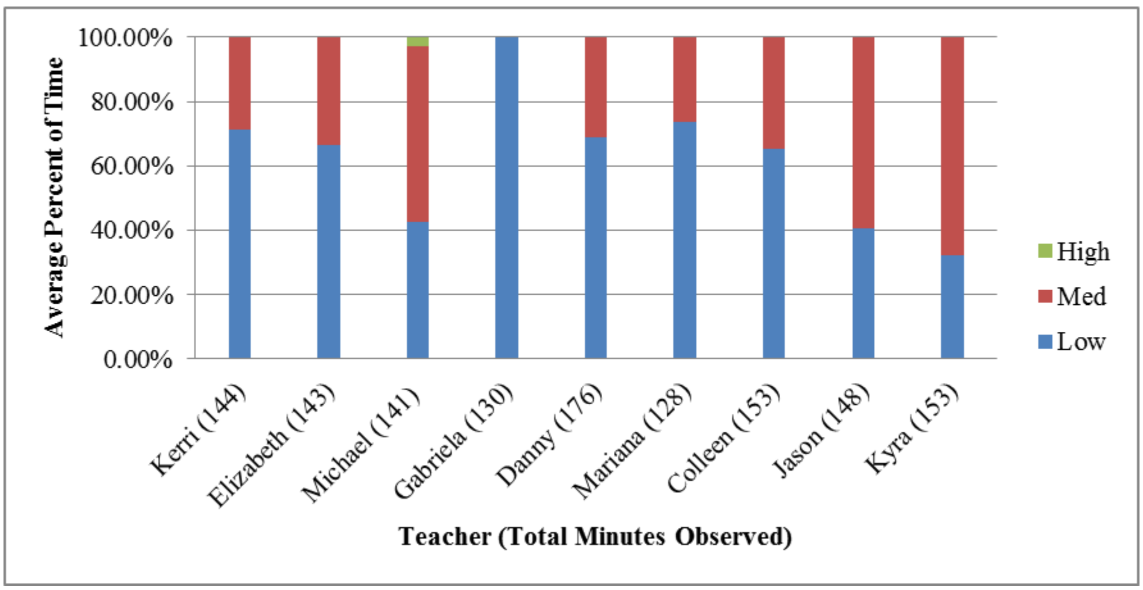

Figure 4.32. Average percent of time spent at different levels of Model Building Actions for each teacher. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions. Refer to Appendix J for details regarding M-SCOPS coding variables.

At the school level, as seen in Figure 4.33, I collapsed each complexity dimension for each teacher within the school. By collapsing teacher data within schools, I was able to compare the orchestration of complexity dimensions across schools. The overall pattern of orchestration across schools is very similar. However, a foreseeable pattern occurred among the schools. The later it was in the school year that I observed, the more percentage of time I observed teachers orchestrating medium levels of all complexity dimension. For example, WRM HS was the first school I observed, and it was within the first month and a half of the school year. Overall, the teachers at WRM HS orchestrated the least percentage of time at medium levels of all complexity dimensions. The next school I observed, NBR HS, spent slightly higher percentages of time orchestrating medium levels of ME. Finally, the last school I observed (at the end of October) was BRC HS; here the teachers there spent the highest percent of time orchestrating medium levels of all complexity levels. I observed all of these classrooms within the first or second month of the school year. Based on this pattern, I would possibly imagine seeing the scaffolding change as the year progressed.

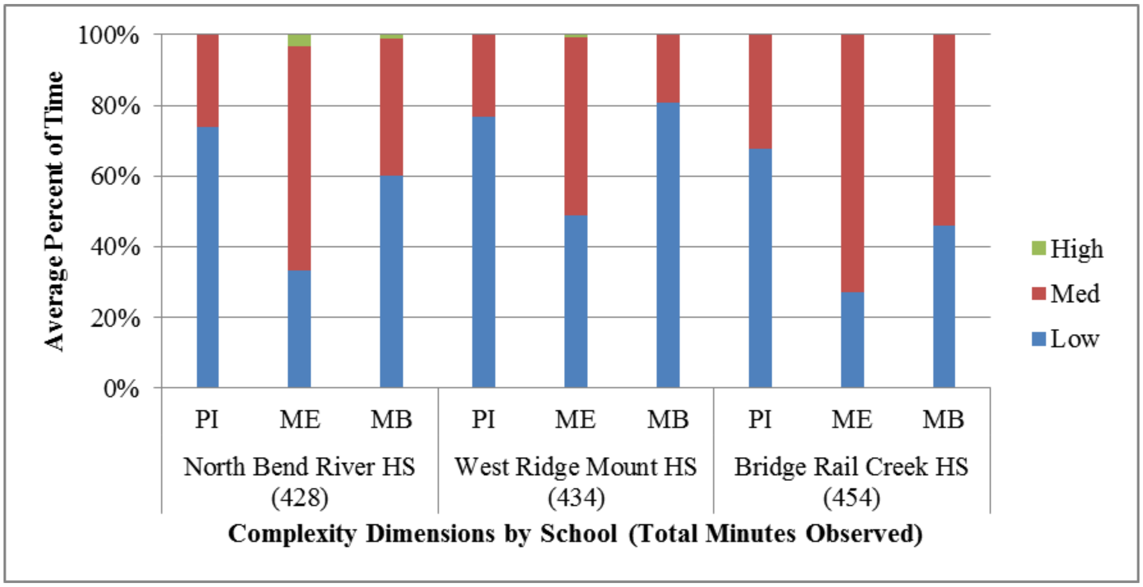

Figure 4.33. Average percent of time spent at different levels of complexity dimensions across all high schools. Complexity dimensions: PI= Performance and Imitative; ME = Modeling Eliciting Information; MB = Model Building Actions. Refer to Appendix J for details regarding M-SCOPS coding variables.

Throughout all schools, I observed mostly low levels of PI orchestrated in the classroom (i.e., mostly teacher direct activities). The levels of ME information provided to the students was mostly at medium levels and students spent about one-third or less of class time engaged in medium levels of MB actions. This finding is again consistent with the most recently released literature on science classroom practices. Researchers note, "qualitative reports on these [science] classrooms indicated that although the lessons appeared to be well organized, students were often disengaged, and didacticism dominated instruction" (NASEM, 2016, p. 54).

Summary of Classroom Orchestration Across all Cases

The teachers within this case study ranged in years of experience, geographic location, previous career experiences, and general cultural backgrounds. However, they all pushed forward in the science classroom with the goal of helping their students be successful, not just in science but in life (from study skills to attitudes of success). The idea of success was pretty consistent across the teachers. Each teacher considered success as something that students can progress or as an attitude they demonstrate. Whereas, the teachers reported the school administration (or district office) as seeing success related to numbers (i.e., test score and attendance). Additionally, teachers at the school were a little surprised they were considered HSHD. They knew they were acceptable, but they also knew they were not the top school in the district. One teacher noted they were second best in the district. The school within their district that was higher than them had fewer students classified as "economically disadvantaged". One teacher noted that several other schools in the district were ranked higher regarding scores. For example the teacher stated, "if I was rating our school, I would give it a high C". This teacher clearly expected more of the school and the students. Within this district there were several schools classified as HSHD. Some of them were magnet schools. The schools that were not magnet schools would be useful for a district based case study. One teacher at another school noted they didn't know what happened because they use to be the top in the district among the diverse schools but they were not anymore. The important thing to recognize about all of these schools is the fact that when you zoom out and look at big picture, these schools are doing so much better than the other schools in the state.

It was interesting being at all the schools within one month. Texas has standards based curriculum and typically large districts create a very structured scope and sequence for schools to follow based on these standards. This was the case for all the schools. All the schools seemed to be teaching the standards in a similar pattern. In each school I went to, the teachers were talking about biomolecules or had just finished biomolecules, structure/function of cells, enzyme synthesis, or osmosis/diffusion. It was also interesting having such a wide range of experiences among the teachers. Based on the case study data, years of experience had little influence on the type of practices and levels of complexity dimensions orchestrated within the classroom. However, cultural background did influence how teachers taught.

Overall, I did not see any innovative practices among the teachers nor did I witness much reformed based teaching. However, I can't help but question; maybe it is not so much how the teachers teach but more about what is being assessed? If the way the teachers are teaching is getting an acceptable outcome by the state requirements then where is the motivation to change? Or if the reform based practices are not being tested then how is there time to ensure those are being incorporated when the curriculum is already packed. Currently, as a nation, science education is pushing an agenda of preparing teachers to teach to the NGSS practices. However, NGSS was founded upon research from *HPL*. If teachers never had a chance to master balancing *HPL* based practices in their classroom, then how will they master NGSS practices? Furthermore, I would argue, the reason *HPL* practices have not been well balanced in the classroom is because the state level end goal (i.e., the test) does not match with well with the practices in *HPL*. If we want the input to change, then we first must change the expected output.

Limitations

In this study I was not able to select teachers within the participating schools. Not selecting the teachers caused the pool of participating teachers to have a wide range in experience from 2 - 40 years. However, all but one participating teacher had been at the selected schools since the quantitative sampling data had been collected (2011-2012). As previously mentioned, I had to observe these classrooms during the fall semester very close to the beginning of the school year. I had previously attempted to observe in schools during the spring semester but schools would not let me in because of state testing during the spring semester. However, this issue goes beyond Texas. In science classroom observation-based research completed in Newark, the researchers noted, "twenty-two high school classrooms (grades 9-12) were observed during October; only seven additional high school classrooms were observed in April" (Corcoran & Gerry, 2011, p. 16). Spring observations are just more difficult to schedule due to district/school based restrictions. In future research, it would be recommended to follow up with the participating teachers during a spring semester. Additionally, nine teachers is a small sample to be discussing descriptive statistics. However, the unit of analysis for the descriptive statistics became the teachers' thought segments from the interviews (n= 1,150 TS) and the percentage of time teachers' spent orchestrating *HPL* components/various complexity dimensions (n = 1,316 min). Another limitation deals with data collection; one school did not allow me to audio record the classroom observations and one teacher did not allow me to audio record the interviews. During this time, I scripted as closely to verbatim as possible and after the observation was complete I took time to fill in any missing pieces. I also asked the teachers to share the worksheets, lab sheets, or PowerPoints with me so I would have reference material.

From a critical lens I must problematize my field based research; I recognize "current empirical studies of non-dominant communities may perpetuate deficit and one-dimensional portraits of cultural groups" (Gutiérrez & Arzubiaga, 2012, p. 204). In using thick description, verbatim transcription, and continual assessment of my own bias I tried to ensure I am not perpetuating deficit ideologies. Furthermore, throughout this study I focused on teachers' actions and voices within diverse communities. Throughout the findings I allowed the teachers' voices to tell the story and spirit of the school.

Finally, I was not able to interact with the students at all or collect data from students during the observations at the school. This was a restriction by the participating school district. Future research will need to follow up the students within HSHD schools. Regardless of these limitations, this study still has valuable findings in moving forward with understanding science practices in HSHD schools. We now have a better idea of where we are at and where we need to improve in science education within diverse schools.

Conclusion, Implications, and Future Research

The purpose of this study was to answer: *How do science teachers from high schools identified as HSHD employ recommended teaching practices in their science classrooms?* The "recommended teaching practices" I decided to focus on were practices based on the *HPL* framework, practices relating to teacher-directed versus student-directed activities, and an examination of complexity dimensions regarding model-eliciting (ME) information and model building (MB) actions. In my findings, I reveal that science teachers (within schools identified as HSHD, and serving a predominantly Hispanic student population) believe in the priority of community and focus on content.

The teachers employed teaching practices such as labs and small group work at least once a week, which is similar to national findings regarding science teacher practices (NASEM, 2016). Finally, the teachers were orchestrating mostly teacher-directed activities at medium levels of complexity. Again, this is consistent with national findings from NASEM (2016) regarding "quality of implementation." However, there is the possibility these results are related to the timing of my observations. I had to observe at the beginning of the school year and it is expected that levels of complexity and scaffolding dynamically shift throughout the school year. The participating science teachers within these schools had high expectations of their students and they all truly cared about making a difference in their students' life. All teachers' ideas of success dealt with students' progress in any form, not just science content/test best scores.

As a part of community building (CC) and to encourage diagnostic teaching (LC), the teachers often expressed their own vulnerabilities so the students would feel free and comfortable to ask any question in the classroom. Teachers in these schools actively used analogies to create bridges (KC-LC) among students' interest/experiences with more abstract science concepts (i.e., cell processes). The most common analogies related to the function of the cell wall. Additionally, commonly used strategies among teachers in the schools were word walls, interactive notebooks/binders, foldables (folding noted/graphic organizers), and warm-ups (KC-AC). Less commonly used strategies, but notable were clicker quizzes, individual white boards for making the students' thinking visible, mind maps, demos, analogy-based student activities such as the Bubble challenge, and curiosity support.

Comparing the interviews, literature, and observations showed there is a gap in what the literature discusses versus what is done in the classroom (refer back to Figure 4.29). Redundantly, this is consistent with findings from NASEM (2016) in which researchers stated, "a notable gap exists between the reality of current teaching practices and the vision of science learning that emerges from research on learning and teaching" (p. 65). There is a transfer problem. However, massive top-down reform is not what is needed (Cuban, 2013). There should be a focus on reform that starts with, and spreads from the teachers. Interestingly, with small interventions, such as a post-observation interview taking place a day early, tiny changes began to take place in the classroom.

Reality is, science in schools is a place where students must transgress cultural borders and even more so for students in highly diverse schools (Aguilar-Valdez et al., 2013; Aikenhead, 1996). The HSHD schools within this study exist in complex/shifting urban -suburban borders, socioeconomic borders of extreme highs and unfortunate lows, ethnically/racially diverse borderlands, linguistically diverse borderlands, and in a literal border state. The teachers within these schools navigate school science and the culture of science while also engaging with the dynamic cultural borderlands/borders present within the highly diverse schools. How can we expect our teachers to be the bridges on the border of culture and science when they are not provided enough professional development? We see what works in science education (NASEM, 2016), but where is the research showing how to transfer what works among science programs serving diverse learners?

Implications

Through this study, I provided portraits of the current opportunities to learn science in diverse schools in Texas; a portrait of steps being taken to create a seal in the leaky STEM pipeline for underrepresented students. As previously stated, education research in Texas is important because it is a Mega-State and researchers claim evaluating Mega-States is critical:

> As policymakers and educators look at the nation's changing demographics and explore ways to close achievement gaps, the educational progress of children in these stated is of interest far beyond their state borders. (NCES, 2013, p. 1)

With this study I further contributed to the literature regarding the genre for successful urban science education. Additionally, with this study I added to the literature regarding science teachers' practices specific to the use of the *HPL* framework as well as their implementation of culturally responsive teaching techniques in science classrooms for diverse learners. Furthermore, this research provides those in power, such as the ones making education policy decision, some answers regarding their use of aggregate student data to describe school success.

In an era of education reform (i.e., NCLB to ESSA), increasing demographic diversity, and rising awareness of the "gathering storm" (NAP, 2007), I provided information about observed secondary science teaching practices within the specific context of schools identified as HSHD. As ESSA slowly becomes incorporated into local education policy, states will have to decide how to help diverse schools that are struggling as well as using local-evidenced based interventions within schools. Specifically, the Department of Education (DOE) noted ESSA will "help to support and grow local innovations-including evidence-based and place-based interventions developed by local leaders and educators" (U.S. DOE, 2015, para. 6). Texas has already started turning to local best-practice case studies but not within science (TEA, 2014). The goal of the Texas case studies is to share the identified best practices to help lower performing schools "in hopes of replicating that success" (TEA, 2014, para. 4). Turning to teachers for suggestions, practices, and advice about the state of science education is crucial in creating an equitable STEM pipeline. To provide pathways through the STEM pipelines, voice must first be given to those who teach science. This study gives the state, as well as other science education researchers, a template for understanding and observing practices in complex and diverse science classrooms.

Future Research

As educators, researchers and policy makers move forward with agendas of "science for all" we must address the literature gap, the instructional gap, and the opportunity gap - not the achievement gap. A longitudinal study on science teachers in diverse environments needs to take place. This would considerably supplement my limited findings that were based on a one-month observation period during the fall semester. Additionally, due to findings from the unintentional embedded *HPL* intervention, and NASEM's (2016) call for more research on science teacher learning embedded in schools; future research could examine the process of "discussion-reflection-observation-discussion" based science teacher learning within school contexts. Following this line of teaching learning, a systematic literature review on available professional development that intersects science and multicultural education would be helpful in seeing where we are with regards to best ways to support science teachers in diverse environments. In this study I only focused on LIMC (Banks, 2013); however, it might be useful to analyze CRP based science teaching practices using Blocker's (2013) *Systematic Equity Pedagogy Rubric*. Glaringly obvious is the missing voice in this study; the students' voice. Therefore, future research would need to include speaking with students in science classes within HSHD schools to provide a better understanding of the ecological context of science in schools.

A comparison study of demographically different HSHD schools (i.e., a school with a predominantly African American student population versus a school with predominantly Hispanic student population) would help clarify some of the findings within this study. A study regarding transfer of practices, where science teachers in identified HSHD schools provide professional development for science teachers in low-success highly-diverse (LSHD) schools, would be helpful in understanding context based teacher-centered interventions. I started with the idea to use Anzaldúa's Borderland theory to interpret the findings regarding how these science teachers transgress the multiple borders existing within their schools and science education. However, much like the teachers in my study, my pragmatic perspective (*HPL* components/complexity dimensions) dominated the Findings and Discussion section. A more thorough and extensive examination of Anzaldúa's Borderland theory within the science context of HSHD school ecologies would possibly help identify more nuanced beliefs and practices among the teachers. In short, this research only opened up a box of more questions and the list of future research is extensive. There is still so much to understand about the complex dynamic of science education within diverse school ecologies.

My study barely breaches the border of understanding science education in the "borderlands." Based on the findings in this study, in addition to this extensive list of future research and recent reports from NASEM (2016), there is a clear need for PRISE III. Teachers' and students' voices must be heard and used to transform the local context of science education in Texas. In this study, which I have dedicated years of my life to, all I have done is simply provide a portrait of where we are at based on teachers' beliefs, practices, and levels of instructional implementation. While the portraits of teachers' orchestration and development of research processes have been incredibly useful, a future PRISE III could put the process of science education reform where it belongs; in the hands of the students and teachers in Texas. Seeing as Texas is a Mega-State, PRISE III research could lead the revolution of educational change (for science) as state appointed policy makers attempt to figure out how to implement the nation's newest education reform; ESSA.

CONCLUDING SUMMARY: FROM THE TEACHERS TO THE TEACHERS, WHAT DO WE KNOW?

"Children must not learn about freedom theoretically, and then leave schools and be free – they must be free in school" (Del Castillo in La Educación Prohibida, 2012, 1:21:27).

Science literacy is a civil right and a critical part of becoming a participatory citizen in democracy (Michaels et al., 2008; Tate, 2001). However, science in schools is a place where students must transgress cultural borders and even more so for students in highly diverse schools (Aguilar-Valdez et al., 2013; Aikenhead, 1996). In *Science for All Americans* (1989) the authors claim:

> Race, language, sex, or economic circumstances must no longer be permitted to be factors in determining who does and who does not receive a good education in science, mathematics, and technology. To neglect the science education of any (as has happened too often to girls and minority students) is to deprive them of a basic education, handicap them for life, and deprive the nation of talented workers and informed citizens—a loss the nation can ill afford. (AAAS, para. 14)

Unfortunately, almost 30 years after *Science for All Americans* was released, scientific literacy is still not accessible to all. Science education is not inclusive, which becomes obvious in the science career pipeline. Researchers consistently recognize that in the field of science there is "staggering underrepresentation of Latin@s" (Aguilar-Valdez, et al., 2013). Adding to the problem, "little has been discussed in science education literature, regarding broader, more multicultural approaches that specifically include and take into account the specific issues and considerations of this Latin@ demographic" (Aguilar-Valdez, 2013, p. 825). This is especially problematic in Texas. The current student population in Texas is 52% Hispnic.

Gross "underrepresentation of Latin@s" in the field of science, the limited literature on science educationfor Latin@s, and opportunities to learn science for underrepresented students are intricately linked together (National Academies of Sciences, 2011). Carter and Welner (2013) argued that these "opportunity gaps reproduce boundaries between the us and them. They also reproduce a blinkered understanding of the meaning of merit, success, and achievement" (p. 222). These "blinkered" ideas of success have guided policy makers in developing reform agendas, such as *No Child Left Behind* (NCLB, 2001), to address the so called "acheivement gap." This mandate has placed an emphasis on "success" as measured by standardized factors, which might not promote responsive or reformed-based science teaching. Findings from the three studies in my research study provide me the evidence to support the claim that success as measured by standardized factors likely do not promote responsive or reform-based science teaching.

Summary

My overall was to investigate, *how science teachers in high schools identified as highly successful, highly diverse (HSHD) design and orchestrate the learning environments of their science classrooms.* My investigations led to three different research studies all located in traditional Texas high schools. In the first study, I described the place in which the HSHD schools were located, which led to a demographic overview of the schools in the study as well as the current state of secondary science education in Texas. The second study took me into the classroom s of three schools identified as HSHD to focus on the teachers of science, individuals most responsible for the successful preparation of learners for career and college readiness. This resulted in a grounded theory explaining the process of committing to science teaching at HSHD schools. Finally, in the third study, I used the *How People Learn Framework* to focus on the observable practices and patterns of these teachers in their classrooms to uncover unique strategies to enhance students' learning. Each study tightened my lenses to examine the state, schools, and teachers' practices of highly important yet often overlooked school ecologies associated with success in science and college and career readiness.

A Demographic Overview

Of course, to answer this question I had to first identify HSHD schools. In being responsive and pragmatic, I used policy makers' "good intentioned" standardized agendas to measure the "success" of science programs in traditional high schools across Texas. In the first research study, *A Demographic Overview of Secondary Science Education in Texas*, I was able to identify HSHD schools using the Student Aggregate Science Score (SASS), which allowed me to identify 24 HSHD schools. Only 1.8% of all 1,308 traditional high schools in Texas, it was obvious this small subset of schools was clearly unique.

In addition to identifying HSHD schools I also provided an updated demographic overview of the state of science education in Texas for traditional high schools. I not only identify schools and provided a demographic overview; I also detail a process for selecting traditional high schools. This method for selecting traditional high schools in Texas proved to be useful: two of my fellow colleagues were able to use my traditional Texas high school data set, to select traditional high schools, and design their own comparison based studies to complete their dissertations. It becomes really important to categorize and separate high schools by type for research reasons because the dramatic differences among and agency required to attend different types of high schools. This is further supported by findings from science education research completed by Cocoran and Gerry (2011) in which they describe "the striking differences" between school types and how dissimilar schools are between the different types based on "student information and performance data" (p.7). Finally, in this study I described the importance of extensive purposeful sampling for case study research. Through this research, it became clear there was an undeniable gap existing in science education in Texas. My findings confirm my own belief that the gap is one of opportunity and not deficiency. The opportunity gap is one that trickles through the teachers to reach the students not an achievement gap in science.

Committing to Science Teaching

After identifying HSHD schools I moved on to the next step in investigating the question, *How do science teachers in high schools identified as highly successful, highly diverse (HSHD) design and orchestrate the learning environments of their science* *classrooms?* Teacher beliefs are an important part of understanding how teachers decide to orchestrate classrooms and enact science for all (Southerland et al., 2011). Bryan and Atwater (2002) reviewed literature on teachers' beliefs and noted "beliefs are part of a group of constructs that describe the structure and content of a person's thinking that are presumed to drive his/her actions" (p.823). Therefore, to figure out more about the participating teachers' design process I sought to examine their stories and beliefs about instruction. In true grounded theory style I followed the lead of my participants and a different story came to fruition. In an effort to clearly understand teachers' stories, their backgrounds and their beliefs, I found that the information from teachers drove towards the development of a clearer understanding about teachers' processes of committing to science teaching in HSHD schools. Thus in the second study, *Committing to Science Teaching: The Process of Becoming and Remaining a Science Teacher in Urban High Schools,* I developed a ground theory connecting the macro-, meso-, and micro-actions related to teachers' commitments to teaching science in HSHD schools.

Portraits of Opportunities to Learn Science

Finally, I completed the last research study, *Portraits of Opportunities to Learn Science: A Multiple-Case Study of Science Classrooms in Texas High Schools Identified as Successful and Diverse*. I observed classrooms to explore how science teachers in HSHD schools designed and orchestrated the learning environments of their science classrooms. I used interviews, observations, the TPSST survey, and the literature to complete case-studies of each teachers' orchestrations, a cross-case analysis among teachers within each of the schools, and a final cross-case analysis forthe three schools.

More specifically, I quantified data collected on the M-SCOPS regarding complexity dimensions of classroom orchestrations and developed to characterize the elements of *HPL*. Additionally, I quantified data from the teachers' post-observation interviews and the literature matrix using *HPL* codes. By doing this, I compared the *HPL* practices that the teachers talked about with the *HPL* practices I observed in the classroom. I examined the M-SCOPS complexity dimensions in their teaching to estimate the quality of the implementation of teaching practices. Through this mixed method multiple-embedded design case study, I finally answered how teachers orchestrated their learning environments in science classrooms at identified HSHD schools.

From the Teachers - What do We Know?

I have no special talent. I am only passionately curious-Albert Einstein- requoted by the science department head at North Bend River High School.

Paralleling Einstein's quote I conclude that *HSHD schools have no special science practices; the teachers within are only passionately committed.* Notably, I use "only" to parallel the quote, and I would argue that these teachers' passionate commitment is what makes them "perform above" other schools in the system. The teachers within the identified HSHD schools were committed to the students, committed to high expectations, committed to creating classroom community, and committed to teaching science in unique settings across the state of Texas. So, from the teachers, what did I find out about how teachers design and orchestrate learning environments in their classroom at schools identified as HSHD?

Committing to Science Teaching

Previous research on the science teacher professional continuum (TPC) has contributed tremendous amounts of knowledge to the idea of science teacher commitment (see PRISE I and PRISE II). However, my research built on the ideas of committing to science teacher by describing the micro-actions within the process of committing. Additionally, I called for adaptable support catered to each micro-action, in which each phase in the committing process needed something different. Support providers should be asking science teachers where they are and what they need with regards to the TPC. However, when teachers are new or overwhelmed, they may not even know where they are or what support they need. Therefore, I created a table (a visual TPC) based on the teachers' responses, in which I lay out the macro-, meso-, and micro-actions of committing to science teaching. If future researchers were to explore and develop adaptable support for each phase, then teachers could situate themselves within the visual TPC and begin to express their current needs. As for now, I can offer a few suggestions regarding items the teachers within HSHD schools require, appreciate, or ask for (based on findings and teacher quotes from the research studies in this dissertation):

- Two free class periods off as necessary and appreciated items. One class period would be used for science teacher collaboration and another for other necessary teacher duties, such as planning, grading papers, and communicating with various stakeholders in the community (i.e., other teachers, administrators, parents, etc.).

- Keep collaboration among the team, don't try and send people in who will "get in our way."
- Provide a climate where respectful disagreements are constructive and encouraged.
- Create professional development that is embedded within the school and science program such that it is responsive to the micro-specific needs of the school context.

Finally, an area of support majorly lacking across the TPC is multicultural science education professional learning opportunities. NASEM (2016) supports this and stated:

> The committee urges that research on science teacher learning focus on opportunities that help teachers meet the needs of diverse students while teaching to the standards. Accomplishing this goal will require developing and studying professional learning programs—in and outside of schools—that interweave attention to science content with attention to the needs and experiences of all students, including English language learners, special education students, gifted and talented students, and diverse learners. Compelling research exists in many of these areas. But teachers do not teach diverse learners on Tuesdays and science on Wednesdays; they teach the two together, and supportive professional learning experiences for teachers will integrate knowledge across a range of domains. (p. 230)

Following NASEM's position, to work towards closing the opportunity gap, it is key that future researchers focus on how science teachers learn best to meet the needs of diverse learners. When I asked the teachers about their learning opportunities regarding how to teach science to diverse learners in both pre- and in-service teacher education, the majority of the teachers responded that they only had one diversity-based class in pre-service education. Additionally, most of them responded that they only had participated in generalized professional development activities which focused on second language learners or students with disabilities. None of them mentioned science specific diversity-based teacher learning opportunities.

With this being said it is not surprising that "a notable gap exists between the reality of current teaching practices and the vision of science learning that emerges from research on learning and teaching" (NASEM, 2016, p. 65). I agree with the NASEM (2016) researchers when they stated that it is critical to not "blame teachers for the current state of science teaching practices, which reflect the varied and under-conceptualized support teachers receive from schools and districts… teachers at all levels receive little time, structure, and support for their own learning…"(p. 67). This gap in current teaching practices and "the vision of science learning" is exactly what I found when I observed teachers' science classroom orchestrations in identified HSHD schools.

Portraits of Opportunities to Learn Science

In my findings, I revealed that science teachers, who teach within schools identified as HSHD serving a predominantly Hispanic student population, believe in the priority of community and focus their teaching time on content delivery. The teachers employed teaching practices such as labs and small group work at least once a week, which is similar to national findings regarding science teacher practices (NASEM, 2016). Finally, they orchestrated mostly teacher-directed activities at medium levels of complexity. Again, this is consistent with national findings from NASEM (2016). A possibility exists that these results may have been related to the timing of my observations. I received permission at the beginning of the school year. I would expect that levels of complexity and scaffolding would dynamically shift throughout the school year. The participating science teachers within these schools had high expectations of their students and they all truly cared about making a difference in their students' lives. All teachers' ideas of success dealt with students' progress in any form, not just science content/test. Some teachers in the study did not view their schools as successful; thus proving their high expectations and passion towards creating better learning environments for their students. Yet, teachers also expressed they were constrained by time, resources, standards, and administrative policies. Finally, the importance of community stands at the heart of what teachers within HSHD schools discussed.

Ideas of culturally responsive teaching such as high expectations and care are expressed through the interviews and daily actions of the science teachers. However, paralleling my previous discussion regarding supporting science teachers in multicultural science education learning opportunities, other culturally responsive teaching techniques such as sociopolitical action are non-existent. This is also obvious from the Levels of Integration of Multicultural Content (Banks, 2013). Sociopolitical consciousness is drastically missing in the science classroom. Therefore, curriculum standards/developers and teacher educators need to work on integrating this within the learning opportunities for science teachers while also providing the time within the curriculum. From the teachers we do know the following is necessary:

- Time within the curriculum to go in depth with the curriculum combining content and process skills to build on understanding rather than recall.
- Time within the curriculum to allow for metacognition and support for the teachers to understand how to create opportunities for metacognition.
- Smaller class sizes to help create that time.
- Less crammed content to cover within the curriculum to create that time.

Overall, we now know, science education in the borderlands is just where it is expected to be based on the lack of science education literature focused on "the specific issues and considerations of the Latin@ demographic" (Aguilar-Valdez, 2013, p. 825). It is likely standardized measures of success get standard teaching. Admittedly, I found nothing groundbreaking or new throughout my study, I came to wonder why these traditional/ordinary/standard findings are within a unique (24 out of 1,308) set of schools? If traditional/ordinary/standard is what is going on in schools identified as successful then I am curious to see the science classroom orchestrations in the other 265 highly diverse schools which have SASS scores in the bottom two quartiles. Are the diverse schools in the bottom two quartiles ignoring traditional success standards and creating environments of innovation that are not measurable with SASS or are the diverse schools in the bottom quartiles really the pits for science education? Only a comparative study will answer this question.

Adapting to change in instructional practices will take time. As long as the current input is getting the acceptable outputs then there really is no need for adaptation. Just like understanding by design (Wiggins & McTighe, 2005), we must start with the end in mind. The current inputs are creating accepted outputs for the “end” goal which is the test, graduation rates, ACT/SAT (essentially the SASS algorithm). Going off the principals of understanding by design, then the end goal has to change at the district/state/federal level. The teachers in this study have a different idea of success and they all expect more and want more but are constrained by time and class sizes. Teachers operate through a mindset of expertise based success and progression based success. Therefore, as stated gain more control with ESSA and the idea of best practices becomes a needed component for change I hope stakeholders turn to the heart of education; the voices of the students and their teachers.

While there are no new or exciting findings from this research, many processes have been learned. For example, the process of quantitative purposeful sampling for case study research has been described. The process of identifying traditional high schools for research has assisted colleagues in the arena of STEM education. A general protocol for receiving research approval from large urban districts in the state of Texas has been developed and shared with professors and students at science conferences and within the university. Also, answering the call for examining both the frequency and quality of implementation of science practices has been developed. Finally, I have discovered a question still remains for our science classrooms in Texas; how to we get there? Assuming the “there” is reformed-based science teaching practices, then more research must be completed on taking teachers from where they are to where they need to be. However, future researchers need to remember, to not focus on the "achievement gap" and start by looking at the opportunity gap that manifest with students based on the opportunity gaps with teachers.

To the Teachers - What is Next?

Standing on the shoulders of giants

- *Isaac Newton*

With this research study I stood on the shoulders of giants; my entire journey started with "what is next?" from PRISE I and PRISE II. The researchers from the original PRISE studies asked "Where are we ?," "Where do we want to go?," and "How do we get there?" They were able to answer these questions using extensive survey and interview data from principals, science program leaders, and science teachers across the state of Texas. Additionally, through their research they provided influential policy recommendations for science education and the science teacher TPC in Texas. However, they were left with a question about classroom based science practices; looking into classrooms was PRISE II's "What is next?" Therefore, through my research study, I zoomed into HSHD schools and answered the call to examine science classrooms practices. I specifically zoomed into HSHD schools serving predominantly Hispanic learners situated in urban areas because "context shapes teaching and learning" (NASEM, 2016) and researchers are have called for micro-specificity in education research (Lee & Gay, 2013).

In the meantime (during the three years of my research), federal policy makers addressed "What is next?" by making changes to NCLB based policy. In December 2015, policy makers addressed concerns from NCLB by signing into law the new Every Student Succeeds Act (ESSA). This new policy is giving stated more control over educational change. Additionally, Texas state policy makers changed standardized testing procedures from TAKS to EOC/STAAR and have addressed "What is next?" by using case study research to exemplify "best practices" in education. Science education researchers and science education policy makers have addressed "What is next?" with NGSS (2013) and *Science Teachers' Learning* (NASEM, 2016). Finally, learning scientist researchers have addressed "what is next?" by currently working on the development of *HPL II* set to release in 2018. Over a three to five year time span "What is next?" in science education has been and is coming from the top down. However, it should be coming from the teachers, to the teachers based on embedded professional learning opportunities to grow and create context specific learning environments supporting "science for all." NASEM (2016) similarly argues:

> Closing the gap between the new way of teaching science and current instruction in many schools will require attending to individual teachers' learning needs, as well as to the larger system of practices and policies (such as allocation of resources, use of time, and provision of opportunities for collaboration) that shape how science is taught. (p. 219).

It is time "What is next?" comes from the teachers to the teachers. After all, teachers as core researchers and curriculum developers are what the seemingly idolized education system in Finland promotes (Sahlberg, 2010). Teachers in the advanced stages of the committing to science teaching process should be "the giants" in which we "stand on" to build science education professional development, policy, and curriculum. Therefore, "What is next?" is PRISE III, to bring the evolution of science education reform to the hands of the science teachers.

Science Education in the Borderlands: Concluding Thoughts

"Science for all," or the endeavor of creating equitable compulsory education, is as complex as understanding the universe. Infinite unknowns exist with no answers. Diversity is like the stars; trillions of stars in the universe exist, each having a unique but similar composition. Numerous cultural combinations exist, influencing the experiences and knowledge of each learner (i.e., age, gender, race, religion, socioeconomic status, geographic location, self-efficacy, opportunities, friend/family structures, etc.). The combinations are infinite. However, scientists use the Hertzsprung-Russell diagram to categorize stars, as social scientist use categorical data to describe trends among populations. These categories are merely simplistic descriptors leaving so much unknown. Over a life-span stars change categories and so do humans. Our cultural experiences are never stagnant but our cultural roots are experiences that will always be with us. Supporting this Arguilar-Valdez et al. (2013) stated:

> We feel that in order to progress towards a more inclusive, multicultural science education that includes Latin@s' multiple cultural and linguistic identities without subtracting, delegitimizing, or whitewashing them, we must recognize that students are a sum of many (dynamic) parts, and that all these parts must be

made visible and respected, not just those that convenience us as science educators in a Western/Anglocentric world. (p. 828)

I use this metaphor regarding the universe, the stars, and diversity to argue a teacher's job is just as complex as the job of an astrophysicist. Neil deGrasse Tyson, one of the most well-known astrophysicist notably agrees. Tyson (2016) recently stated, "In science, when human behavior enters the equation, things go nonlinear. That's why Physics is easy and Sociology is hard" (February 5, Twitter). Until society recognizes/respects the complexity of teachers' jobs, then generalized policies will continue to stifle teachers' abilities to situate comfortably in keeping "a constant eye on both ends of the bridge" (Bransford et al., 2000, p. 136). Without a view of both ends, teachers cannot fluently assist their students in crossing borders among the culture of sciences and school science with their funds of knowledge, standards, and their students' own borderlands. Thus, the boundaries reproduced by continual opportunity gaps (for both teachers and students) will leave "science for all" as a figurative borderland in which Anzaldúa (2007) described as "a vague and undetermined place created by emotional residue of an unnatural boundary" (p.25). The vague space, in which "science for all" rests, is situated on boundaries created by the top down culture of reform. Consequently, here we are, 26 years after the publication of *Science for All Americans*. We still have the same conversations regarding how to make "science for all" students a reality. Therefore, as educators, researchers, and policy makers move forward with agendas of "science for all" they must address the need to produce a substantive set of empirical literature (which transfers to practice via embedded professional development) regarding successful practices within the lens of designing effective learning environments for diverse learners in science education.

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APPENDIX A

LITERATURE MATRIX

In addressing the rarity of "science for all" researchers and policy makers need to drop the conversation on the so called "achievement gap" and focus the discussion on the literature gap. Examining the "achievement gap" data or policy based accountability data accomplishes nothing more than provide stakeholders descriptive information about aggregate student level data. And it is data based on what people in power have deemed worthy of knowing. Often stakeholders make decisions using this aggregate data without ever looking at the micro-level to see what is really going on in classrooms. However, if we are to truly understand opportunities to learn science we must examine the "ripples of resistance" in which successful science learning environments are being created for diverse learners (Fine et al., 2014).

Despite the clear need to research and examine effective teaching practices for Latina/os learners, the current literature regarding Latina/os in science education is limited. Aguilar-Valdez, et al. (2013) stated:

> Little has been discussed in science education literature regarding broader,more multicultural approaches that specifically include and take into account the specific issues and considerations of the Latin@ demographic. (p. 825)

For my purpose of this literature matrix I use the foundation of current science education reform documents as my primary lens. The current reform document in science education is the *Next Generation of Science Standards* (NGSS, 2013). The foundation of the NGSS is research from the National Research Council (NRC) regarding a compilation of decades of research in the learning sciences. The NRC researchers compiled research from the learning sciences and created an elegant framework for the design of effective learning environments called the *How People Learn* (*HPL*) framework (Bransford, Brown, & Cocking, 2000).

Over the last decade there is evidence provided from *How Students Learn Science (*National Academies Press, 2005), *Taking Science to School* (Duschl et al., 2007) and *A* Framework *for K-12 Science Education* (NRC, 2012) that show how the *HPL* framework substaintially laid the foundation for the NGSS. All four components (learner-centered, knowledge-centered, assessment-centered, and community-centered) of the *HPL* framework work cohesively together while at the same time offering distinguishing elements to observe within the science classroom learning environment.

Findings

Using the four components of *HPL* as my lens I found 183 articles focused on one or more specific component of *HPL*. I coded each of the 183 articles as one or more components of *HPL*. Then I did a secondary analysis of the literature and found that 63 were specific for diverse learners in science education examined successful or effective outcomes. A detailed list of all the articles and the designated codes is provided in Table A-1. With this literature matrix I situate the literature within the *HPL* framework and discuss what we know. Notably, out of the 85 articles for diverse learners examining outcomes in science, only three focus on effective secondary science education for Latin@ learners.

Table A.1

Literature Review Matrix (n=183).

Authors	Year	Component	D1 - Yes or No	D2 -Code	Title of Article	Theoretical or Empirical	Methods
Harris	2014	LC	N	4	Stories of Success: Understanding Academic Achievement of Hispanic Students in Science	Empirical	Qual
Elmesky	2013	KC	N	2	Building Capacity in understanding foundational biology concepts: A K-12 Learning progression in genetics informed by research on children's thinking and learning	Theoretical	T
Duschl & Grandy	2013	KC	N	2	Two views about explicitly teaching Nature of Science	Theoretical	T
Arnseth & Krange	2013	KC	N	4	Reconsidering meaning making and its analytical implication for cultural studies of science education	Theoretical	T
Stiggins & Chappuis	2013	AC	N	3	Using Student Involved Class Assessment to Close the Achievement Gap	Theoretical	T
Dillenbourg, Nussbau, Dimitriadis, & Roschelle	2013	AC	N	2	Design for Classroom Orchestration	Theoretical	T
Wilcox	2013	CC	N	3	A socioecological view of higher performing diverse elementary schools	Empirical	Mixed
Philip et al	2013	CC	N	3	When educators attempt to make community a part of classroom learning: The dangers of mis-appropriating students' communities into schools	Empirical	Qual
Hays	2013	CC	N	3	Narrowing the Gap: Three Key Dimensions of Site Based Leadership in Four Boston charter public schools	Empirical	Qual
Nokes-Malach & Mestre	2013	AC-KC	N	2 and 3	Toward a model of transfer as sense-making	Theoretical	T
Sleeter	2012	LC	N	3	Confronting the Marginalization of Culturally Responsive Pedagogy	Theoretical	T
Villarreal	2012	LC	N	4	Charting a course towards Latino student success in STEM	Theoretical	T

Authors	Year	Component	D1 - Yes or No	D2 –Code	Title of Article	Theoretical or Empirical	Methods
Levinson	2012	KC	N	2	A perspective on knowing about global warming and a critical comment about schools and curriculum in relation to socio-scientific issues	Empirical	Qual
Duschl	2012	KC	N	2	The Second Dimension-Crosscutting Concepts	Theoretical	T
Albe & Gombert	2012	KC	N	2	Students' communication, argumentation and knowledge in a citizens' conference on global warming	Empirical	Qual
Richards & Uhrmacher	2012	CC	N	3	Elliot Eisner as Cultural Theorist	Theoretical	T
Khalifa	2012	CC	N	3	A Re-New-ed Paradigm in Successful Urban School Leadership: Principal as Community Leader	Empirical	Qual
Oliveira, Akerson, Oldfield	2012	KC-LC	N	2	Environmental argumentation as sociocultural activity	Empirical	Qual
Griner-Stewart	2012	AC-LC	N	3	Addressing the achievement gap and disproportionality through the use of culturally responsive teaching practices	Empirical	Mixed
Diamond	2012	AC-CC	N	3	Accountability policy, school organization, and classroom practice: Partial recoupling and educational opportunity	Empirical	Mixed
Pelligrino & Hilton	2012	AC-KC	N	4	Education for life and work: Developing transferable knowledge and skills in the 21st century	Theoretical	T
Goldstone & Day	2012	AC-KC	N	2 and 3	Introduction to new conceptualizations of transfer of learning	Theoretical	T
Subramaniam	2012	*HPL*	N	NA	How web quest can enhance science learning principles in the classroom	Empirical	Qual
Peker & Dolan	2012	KC	N	NA	Helping students make meaning of authentic investigations: findings from a student-teacher-scientist partnership	Empirical	Qual
Lee & Krajcik	2012		N	NA	Large-scale intervention in science education for diverse student groups in varied educational settings	Theoretical	T
Turner	2011	LC	N	3	Student-Centered instruction: Integrating the learning science to support elementary and middle school learners	Theoretical	T

Authors	Year	Component	D1 - Yes or No	D2 -Code	Title of Article	Theoretical or Empirical	Methods
van Eijck & Roth	2011	LC	N	5	Cultural diversity in science education through novelization: Against the epicization of Science and cultural centralization	Empirical	Qual
Mutegi	2011	LC	N	5	The inadequacies of Science for All and the Necessity and nature of a socially transformative curriculum approach for African American Science education	Theoretical	T
Polly & Hannafin	2011	LC	N	2	Examining how learner-centered professional development influences teachers' espoused and enacted practices	Empirical	Qual
Howard & Terry	2011	LC	N	3	Culturally responsive pedagogy for African American students: Promising programs and practice for enhanced academic performance	Empirical	Mixed
Parsons-Rhodes-Brown	2011	LC	N	4	Unpacking the CRT in Negotiating White Science	Theoretical	T
Yoo	2011	KC	N	2	Investigating one science teacher's inquiry unit through an integrated analysis: The SPA-MAP and M-SCOPS	Empirical	Mixed
Hogg	2011	KC	N	3	Funds of knowledge: An investigation of coherence within the literature	Theoretical	T
Duschl, Maeng, & Sezen	2011	KC	N	2	Learning progressions and teaching sequences: a review and analysis	Theoretical	T
Swann, Andrews, Ecclestone	2011	AC	N	2	Rolling out and scaling up: The effects of a problem-based approach to developing teachers' assessment practice	Empirical	Qual
Hill & McNamara	2011	AC	N	3	Developing comprehensive, empirically based research framework for classroom-based assessment	Empirical	Qual
Adams & Wieman	2011	AC	N	2	Development and Validation of Instruments to Measure Learning of Expert Like Thinking	Theoretical	T
Coffey, Hammer, Levin, & Grant	2011	AC	N	2	The Missing Disciplinary Substance of Formative Assessment	Theoretical	T
Peters & Slotta	2010	CC	N	2	Scaffolding knowledge communities in the classroom: New opportunities in the Web 2.0 Era	Empirical	Qual
Seiler	2009	LC	N	5	Becoming a science teacher: Moving toward creolized science and an ethic of cosmopolitanism	Empirical	Qual

Authors	Year	Component	D1 - Yes or No	D2 -Code	Title of Article	Theoretical or Empirical	Methods
Novak	2008	AC	N	2	The Theory Underlying Concept Maps and How to Construct and Use Them	Theoretical	T
Duschl	2008	KC-LC	N	2	Quality argumentation and epistemic criteria	Empirical	Qual
Turner	2008	*HPL*	N	2 and 3	Using the learning sciences and knowledge about *How People Learn* to support reluctant and disengaged secondary learners		
Bang, Medin, Atran	2007	KC	N	4	Cultural Mosaics and mental models of Nature	Theoretical	T
Noblit, Hwang, Seiler, & Elmesky	2007	KC-LC	N	4	Forum: Toward culturally responsive discourses in science education	Theoretical	T
Lee & Blooming	2007	KC-LC	N	3	Modeling as a multidimensional cultural space	Theoretical	T
Schwartz, Bransford, & Sears	2005	AC-KC	N	2 and 3	Efficiency innovation in transfer	Theoretical	T
D. Lee	2006	LC	N	3	Every good-bye ain't gone: Analyzing the cultural underpinnings of classroom talk	Empirical	Qual
Brickhouse, Eisenhart, Tonso	2006	LC	N	3	Forum Identity politics in science and science education	Theoretical	T
Simon, Erduran, & Osborne	2006	KC	N	2	Learning to teach argumentation: Research and development in the science classroom	Empirical	Mixed
Wood, Lawrenz, Huffman, Schultz	2006	CC	N	5	Viewing the school environment through multiple lenses: In search of school level variables tied to student achievement	Empirical	Mixed
Stewart, Cartier, Passmore	2005	KC	N	2	Developing understanding through model based inquiry	Theoretical	T
Minstrell&Kraus	2005	KC	N	2	Guided inquiry in the science classroom	Theoretical	T
Magnusson&Palincsar	2005	KC	N	2	Teaching to promote the development of scientific knowledge and reasoning about light at the elementary school level	Empirical	Qual
Bransford & Donovan	2005	KC	N	2	Scientific Inquiry and *How People Learn*	Theoretical	T
Bransford	2005	*HPL*	N	2	Classroom environments that support learning with understanding	Theoretical	T
Kaivola & Cabral	2004	CC	N	2	Implementing Education for Active Citizenship and Sustainability	Empirical	Qual

Authors	**Year**	**Component**	**D1 - Yes or No**	**D2 -Code**	**Title of Article**	**Theoretical or Empirical**	**Methods**
Brown	2004	CC	N	3	Urban teachers' Professed classroom management strategies: Reflections of Culturally Responsive Teaching	Empirical	Qual
Petrosino	2004	HPL	N	NA	Integrating curriculum, instruction, and assessment in project-based instruction: A case study of an experienced teacher	Empirical	Qual
Walczyk & Ramsey	2003	LC	N	2	Use of learner-centered instruction in college science and mathematics classrooms	Empirical	Quan
Schuh	2003	KC-LC	N	2	Knowledge construction in the leaner-centered classroom	Empirical	Mixed
Lesh & Doerr	2003	AC-KC	N	2 and 3	Foundations of a modeling perspective on mathematics teaching, learning, and problem solving	Theoretical	T
D. Lee	2003	*HPL*	N	3	Toward a framework of culturally responsive design in multimedia computer environment: Cultural modeling as a case	Empirical	Qual
Duschl & Osborne	2002	KC-LC	N	2	Supporting and promoting argumentation discourse in science education	Theoretical	T
Bransford, Vye, Bateman	2002	*HPL*	N	2 and 3	Creating High Quality Learning Environments: Guidelines from Research on How People Learn	Theoretical	T
Osborne & Collins	2001	LC	N	2	Pupils' views of the role and value of the science curriculum: a focus group study	Empirical	Qual
Barnett & Hodson	2001	KC	N	2	Pedagogical content knowledge: Toward a fuller understand of what good science teachers know	Empirical	Qual
Bell & Cowie	2001	AC	N	2	The Characteristics of formative assessment in Science education	Empirical	Qual
Pelligrino et al - NRC	2001	AC	N	3	Knowing what student know: The science and design of educational assessment	Theoretical	T
Lemke	2001	CC	N	2	Articulating Communities: Sociocultural perspectives on science education	Theoretical	T
D. Lee	2001	KC-LC	N	3	Is October brown Chinese? A cultural modeling activity system for underachieving students	Empirical	Qual
Lee & Paik	2000	KC	N	2	Conceptions of Science Achievement in Major Reform Documents	Empirical	Qual
Cobern & Loving	2000	KC-LC	N	4	Defining science in a multicultural world: Implications for science education	Theoretical	T

Authors	Year	Component	D1 - Yes or No	D2 -Code	Title of Article	Theoretical or Empirical	Methods
Wegner	2000	CC	N	3	Communities of practice and social learning systems	Theoretical	T
Preskill & Torres	2000	AC-CC	N	2	The learning dimension of evaluation use	Theoretical	T
Cocking, Mestre, & Brown	2000	HPL	N	NA	New developments in the science of learning: Using research to help students learn science and mathematics	Theoretical	T
Donovan, Bransford, & Pelligrino	1999	*HPL*	N	NA	*How People Learn*: Bridging research and practice	Theoretical	T
Wiggins & McTighe	1998	KC	N	2	Understanding by Design	Theoretical	T
Rosebery &Puttick	1998	KC	N	2	Teacher professional development as situated sense-making: A case study in science education	Empirical	Qua
Krajcik, Blumenfeld, Marx, Bass, Fredricks	1998	KC	N	2	Inquiry in Project Based Science Classrooms: Initial Attempts by Middle School Students	Empirical	Qual
Wiebe	1998	AC-KC	N	2 and 3	A Model of Mathematics	Theoretical	T
Barrron, Schwartz, Vye, Moore, Pertrosino, Zech, Bransford	1998	AC-KC	N	NA	Doing with understanding: Lessons from research on problem- and project-based learning	Theoretical	T
Baker	1997	AC	N	2	Model-Based Performance Assessment	Theoretical	T
Atwater	1996	KC-LC	N	4	Social constructivism: Infusion into the multicultural science education research agenda	Theoretical	T
Wegner	1996	CC	N	3	Communities of practice the social fabric of a learning organization	Theoretical	T
Bruner	1996		N		The culture of education		
Ladson-Billings	1995	LC	N	3	But that's just good teaching! The case for culturally relevant pedagogy	Theoretical	T
Ladson-Billings	1995	LC	N	3	Toward a Theory of Culturally Relevant Pedagogy	Theoretical	T
Atwater & Wiggins	1995	LC	N	4	A study of urban middle school students with high and low attitudes toward science	Empirical	Quan

Authors	Year	Component	D1 - Yes or No	D2 -Code	Title of Article	Theoretical or Empirical	Methods
D. Lee	1995	KC-LC	N	3	A culturally based cognitive apprenticeship: Teaching African American high school students skills in literary interpretation	Empirical	Qual
Eisenhart & Graue	1992	CC	N	3	Constructing Cultural Difference and Educational Achievement in Schools	Theoretical	T
Dufresne, Gerace, Thibodeau-Hardiman, & Mestre	1992	AC-KC	N	2	Constraining novices to perform expert like problem analyses: Effect on schema acquisition	Empirical	Qual
Resnick	1989	KC	N	2	Knowing, Learning, and instruction; Essays in honor of Robert Glaser	Theoretical	
Bereiter & Scardamalia	1989	KC	N	2	Intentional learning as a goal of instruction	Theoretical	T
Brown & Palincsat	1989	AC-CC	N	2 and 3	Guided, cooperative learning and individual knowledge acquisition	Theoretical	T
Collins, Brown, Newman	1989	KC	N	2	Cognitive apprenticeship: Teacher the Crafts of Reading, Writing, and Mathematics	Theoretical	T
Gay & Abrahams	1973	AC-LC	N	3	Does the pot melt, boil, or brew? Black children and white assessment procedures	Theoretical	T
Parker	2014	LC	Y	1	Multiple influences: Latinas, middle school science, and school	Empirical	Qual
Aguilar-Valdez	2014	LC	Y	1	DREAMing of Science: Undocumented Latino@s' Testimonios Across the Borderlands of High School Science	Empirical	Qual
Grimber & Grummer	2013	LC	Y	1	Teaching Science From Cultural Points of Intersection	Empirical	Quan
Hernandez, Morales, & Shoyer	2013	LC	Y	1	The development of a model of cultural responsive science and mathematics teaching	Theoretical	Qual
Lee&Buxton	2013	LC	Y	1 and 2	Integrating science and English proficiency for English Language Learners	Theoretical	T
Calabrese-Barton, Kang, O'Neill, Bautista-Guerra, Brecklin	2013	LC	Y	1	Crafting a Future in Science: Tracing Middle School Girls' Identity Work Over Time and Space	Empirical	Qual
Capraro	2013	AC	Y	3	STEM PBL 2nd Edition	Mixed	Mixed
Young & Young	2013	AC	Y	3	Culturally Responsive PBL STEM Education	Empirical	Mixed

Authors	Year	Component	D1 - Yes or No	D2 -Code	Title of Article	Theoretical or Empirical	Methods
Hang &Bell	2013	AC	Y	1	Formative Assessment as a Cultural Practice: The use of written formative Assessment in Samoan Science Classrooms	Empirical	Qual
Cowie	2013	AC	Y	1	Classroom Assessment: Making Space for Diversity	Theoretical	T
Rodriguez, Collins-Parks, Garza	2013	CC	Y	3	Interpreting Research on Parent Involvement and Connecting it to the Science Classroom	Theoretical	T
Southerland & Scharmann	2013	KC-LC	Y	3 & 1	Acknowledging the Religious Beliefs student Bring into the Science classroom: Using the Bounded Nature of Science	Theoretical	T
Price & McNeill	2013	KC-LC	Y	6&1	Toward a lived science curriculum in intersecting figured worlds: An exploration of individual meaning in science education	Empirical	Qual
Atwater, Lance, Woodard, Johnson	2013	AC-LC	Y	NA	Race and ethnicity: Powerful cultural forecasters of science learning and performance	Theoretical	T
Calabrese Barton & Berchini	2013	CC	Y	NA	Becoming an insider: Teaching science in urban settings	Theoretical	T
Lee & Buxton	2013	CC	Y	NA	This Issue: Theory Into Practice	Theoretical	T
Wallace & Brand	2012	LC	Y	1	Using Critical Race theory to analyze science teachers culturally responsive practices	Empirical	Qual
Xu, Coats, Davidson	2012	LC	Y	1	Promoting Student interest in Science: The Perspectives of Exemplary African American Teachers	Empirical	Qual
Laughter & Adams	2012	LC	Y	1	Culturally Relevant Science Teaching in Middle School	Empirical	Qual
NAP-Framework K-12 Science	2012	KC	Y	4	A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas	Theoretical	National Doc
Pelligrino et al - NGSS	2012	AC	Y	6	Developing Assessments for the Next Generation of Science Standards	Theoretical	T
Coats & Xu	2012	CC	Y	3	No child left behind and outreach to families and communities: The perspectives of exemplary African American science teachers	Empirical	Qual
Chinn	2012	KC-LC	Y	1 & 3	Looking through the lenses of science literacy and cultural diversity: Learning from Helena's mistake	Empirical	Qual

Authors	Year	Component	D1 - Yes or No	D2 -Code	Title of Article	Theoretical or Empirical	Methods
Unsworth, Levin, Bang, Washinawatok, Waxman & Medin	2012	KC-LC	Y	6 & 1	Cultural differences in children's ecological reasoning and psychological closeness to nature: Evidence from Menominee and European American children	Empirical	Qual
Emdin & Lee	2012	KC-LC-CC	Y	NA	Hip-Hop, the 'Obama Effect', and Urban science education	Empirical	Qual
Harris, Phillips, & Penuel	2012	AC-LC	Y	NA	Examining teachers' instructional moves aimed at developing students' ideas and questions in learner-centered science classrooms	Empirical	Qual
Tan	2012	KC	Y	NA	Multicultural chemistry and the nature of science: but what about knowledge?	Theoretical	T
Bayne	2012	CC	Y	NA	Capturing essential understandings of the urban science learning environment		
Lee	2011	LC	Y	4	Effective STEM education strategies for diverse and underserved learners	Theoretical	T
Lee & Buxton	2011	LC	Y	4	Engaging Culturally and linguistically diverse students in learning science	Theoretical	T
Bolshakova, Johnson, Czerniak	2011	LC	Y	3	It depends on what science teacher you got: Urban science self-efficacy from teacher and student voices	Empirical	Qual
Bianchini	2011	CC	Y	NA	How to foster student-student learning of science? The student, the teacher and the subject matter	Empirical	Mixed
O'Neill	2010	LC	Y	1	Fostering spaces of student ownership in Middle school science	Empirical	Qual
Calabrese-Barton&Upadhyay	2010	LC	Y		Teaching and Learning Science for Social Justice	Empirical	Qual
Atwater	2010	LC	Y	1	Interview-Dr. Genva Gay: Multicultural Education for All Disciplines	Theoretical	T
Penfield & Lee	2010	AC	Y	5	Test-Based Accountability: Potential Benefits and Pitfalls of Science Assessment with Student Diversity	Theoretical	T
Gerard, Spitulnik, Linn	2010	AC	Y	2	Teacher Use of Evidence to Customize Inquiry Science Instruction	Empirical	Mixed
Bang, Medin, Washinawatok, Chapman	2010	CC	Y	3	Innovation in culturally based science education through partnerships and community	Empirical	Qual

Authors	Year	Component	D1 - Yes or No	D2 -Code	Title of Article	Theoretical or Empirical	Methods
Tan & Barton	2010	KC-LC	Y	1 & 1	Transforming Science Learning and Student Participation in Sixth Grade Science: A Case study of a low-income urban, racial minority classroom	Empirical	Qual
Fraser-Abder, Doria, Yang,	2010	KC-LC	Y	1 & 1	Using Funds of Knowledge in an ethnically concentrated classroom environment to teach nutrition	Practical	P
Atwater	2010	KC-LC	Y	1 & 1	Multicultural science education and curriculum materials	Theoretical	T
Suriel	2010	KC-LC-CC	Y	NA	Spanish moss: Not just hanging in there	Practical	P
Basu & Barton	2010	KC-LC-CC	Y	NA	A researcher-student-teacher model for democratic science pedagogy: Connections to community, shared authority, and critical science agency	Empirical	Qual
Buxton	2010	KC-LC-CC	Y	NA	Social problem solving through science: An approach to critical, place-based, science teaching and learning	Empirical	Qual
Bang & Medin	2010	CC	Y	NA	Cultural processes in science education: Supporting the navigation of multiple epistemologies	Empirical	Qual
Tzou, Scalone, &Bell	2010	CC	Y	NA	The role of environmental narratives and social positioning in how places gets constructed for and by youth	Empirical	Qual
Rosebery, Ogonowski, DiSchino, & Warren	2010	KC	Y	NA	The coat traps all your body heat: Heterogeneity as fundamental to learning	Empirical	Qual
Elmesky	2009	LC	Y	1 and 2	Rap as a roadway: Creating creolized forms of science in an era of cultural globalization	Empirical	Qual
Calabrese Barton & Tan	2009	KC-LC	Y	1 & 1	Funds of knowledge and Discourses and Hybrid Space	Empirical	Qual
Upadhyay	2009	KC-LC-CC	Y	NA	Teaching science for empowerment in an urban classroom: A case study of a Hmong teacher	Empirical	Qual
Geier, Blumenfeld, Marx, Krajcik, Fishman, Soloway, Clay-Chambers	2008	KC	Y	5	Standardized test outcomes for students engaged in inquiry based science curricula in the context of urban reform	Empirical	Quan

Authors	Year	Component	D1 - Yes or No	D2 -Code	Title of Article	Theoretical or Empirical	Methods
Duschl	2008	*HPL*	Y	NA	Science education in three part harmony: Balancing conceptual, epistemic, and social learning goals	Theoretical	T
Elmesky & Seiler	2007	LC	Y	1	Movement expressiveness, solidarity and the reshaping of African American students' scientific identities	Empirical	Qual
Duschl, Schweingruber, & Shouse	2007	KC	Y	4	Taking Science to School: Learning and Teaching Science in Grades K-8	Theoretical	T
Johnson	2007	KC	Y	3	Effective Science teaching, professional development and No child left behind: Barriers, Dilemmas, and Reality	Theoretical	T
Johnson, Kahle, & Fargo	2007	CC	Y	2	A Study of Effect of Sustained, Whole School Professional Development on student achievement in science	Empirical	Quan
Lee, Buxton, Lewis, and Leroy	2006	KC	Y	5	Science inquiry and student diversity: Enhanced abilities and Continuing difficulties after an instructional intervention	Empirical	Mixed
Aikenhead, Calabrese-Barton, Chinn	2006	CC	Y	3	Forward: Toward Politics of Place-Based Science Education	Empirical	Qual
Brown	2006	KC-LC	Y	6 & 2	It isn't no slang that can be said about this stuff: Language, Identity, and Appropriating science discourse	Empirical	Qual
Buxton	2006	KC-LC	Y	5 & 1	Creating contextually authentic science in Low-Performing urban elementary school	Empirical	Qual
Lim & Calebrese Barton	2006	CC	Y	NA	Science learning and a sense of place in a urban middle school	Empirical	Qual
Wilson & Bertenthal - NRC	2005	AC	Y	6	Systems for State Science assessment	Theoretical	T
Hanrahan	2005	LC	Y	2	Highlight Hybridity: A critical discourse analysis of teacher talk in science classrooms	Empirical	Qual
Southerland, Kittleson, Settlage, & Lanier	2005	KC-LC-CC	Y	NA	Individual and group meaning-making in an urban third grade classroom: Red frog, cold cans, and seeping vapor	Empirical	Mixed

Authors	Year	Component	D1 - Yes or No	D2 -Code	Title of Article	Theoretical or Empirical	Methods
Donovan & Bransford	2005	*HPL*	Y	NA	How students learn: Science in the classroom	Mixed	Mixed
Buxton	2005	CC	Y	NA	Creating a culture of academic success in an urban science and math magnet high school		
Ballenger	2004	KC-LC-CC	Y	NA	The puzzling child: Challenging assumptions about participation and meaning in talking science	Empirical	Qual
Rodriguez & Berryman	2002	KC	y	3	Using sociotransformative constructivism to teach for understanding in diverse classrooms: A beginning teacher's journey	Empirical	Qual
Atwater & Akienhead	2002	SC	Y	NA	Dilemmas of science teaching	Empirical	Qual
Warren, Ballenger, Ogonowski, Rosebery, Hudicourt Barnes	2001	KC	Y	6	Rethinking diversity in learning science: The logic of everyday sense making	Empirical	Qual
Treagust, Jacobowitz, Gallagher, Parker	2001	AC	Y	6	using assessment as a guide in teaching for understanding: A case study of a middle school science class learning about sound	Empirical	Qual
Moje, Collazo, Carrillo, & Marx	2001	KC-LC-CC	Y	NA	Maestro, What is quality? Language, Literacy, and discourse in project-based science	Empirical	Qual
Solano-Flores & Nelson-Barber	2001	AC-LC	Y	NA	On the cultural validity of science assessment	Theoretical	T
Hammond	2001	*HPL*	Y	NA	Notes from California: An anthropological approach to urban science education for language minority families	Empirical	Qual
Blumenfeld, Fishman, Krajcik, Marx & Soloway	2000	AC-KC	Y	NA	Creating usable innovations in systemic reform: Scaling up technology-embedded project-based science in urban schools	Empirical	Mixed
Bransford, Brown, & Cocking	2000	*HPL*	Y	NA	*How People Learn*: Brain, mind, experience, and school: Expanded edition	Theoretical	T
Calabrese Barton & Yang	2000	CC	Y	NA	The culture of power and science education: Learning from Miguel	Empirical	Qual
Westby, Dezale, Fradd, Lee	1999	LC	Y	2	Learning to do science: Influences of Culture and Language	Empirical	Qual
Aikenhead & Jegede	1999	KC-LC	Y	6 & 1	Cross-Cultural science education: A cognitive explanation of cultural phenomenon	Theoretical	T

Authors	Year	Component	D1 - Yes or No	IF yes - D2 -Code	Title of Article	Theoretical or Empirical	Methods
Atwater	1999	KC-LC	Y	1 & 1	Equity for Black Americans in pre-college science	Theoretical	T
Lee & Fradd	1998	KC-LC	Y	1 & 2	Science for all , including students from non-English-Language Backgrounds	Theoretical	T
Lee & Fradd	1996	LC	Y	2	Interactional patterns of linguistically diverse students and teachers: Insights for promoting science learning	Empirical	Qual
Barton & Osborne	1995	LC	Y	1	Science for All Americans? Science Education Reform and Mexican-Americans	Empirical	Qual
Roseberry, Warren, & Conant	1992	KC-LC	Y	5&2	Appropriating Scientific Discourse: Findings from Language Minority Classrooms	Empirical	Quan

APPENDIX B

SELECTING TRADITIONAL HIGH SCHOOLS IN TEXAS

What data base was used to collect school information?
Texas Education Agency Academic Excellence Indicator System 2011-2012
http://ritter.tea.state.tx.us/perfreport/aeis/
How were "traditional public" high schools identified?

From the original download I started with 8,529 schools

a. Delete by Grade Level (Elementary, Middle, Both) (2,257 remain)
b. Delete by Grade Span (10-11, 11.12, 1-5) (2,076 remain)
c. Delete Charters (1,773 remain)
d. Examine the name of each school (1,773) and eliminate (464)
    i. Round one - Eliminate DAEPs, JAAEPs, alternative schools, night schools, home schools, hospital schools, 9th grade campuses, self-identified T-STEM schools, Early College High Schools (see TEA website), New Tech schools (see website TEA), centers (anything labeled a center is by TEA definition not a School), district administration offices, schools of choice (see TEA website), charter schools, recovery schools, special program schools,
    ii. Round two – examine the school websites of schools with a label of: Academy, Magnet, Horizon, Gateway, Lighthouse, High Point, Vision, Opportunity - to see if they are a selective admission schools or alternative campuses (Alternative being a Type I, II or III school as defined by Raywid 1996).
    iii. Round three – begin data imputation – if schools are missing significant amount of data examine the school website and see if it is a selective admission school or a center.
e. Total number of "traditional public" high schools remaining – 1,308

APPENDIX C

CROSS DISTRIBUTION OF SCHOOL SIZE, ECODIS QUARTILE, AND USEP BY SASS SCORE FOR POPULATION OF TEXAS HIGH SCHOOLS

			SASS score				
School size	EcoDis quartile	USEP	Lowest	Low	High	Highest	Total
Small	Lowest	Lowest	0	2	1	5	8
		Low	0	0	0	0	0
		High	0	0	1	0	1
		Highest	0	0	0	0	0
		Total	0	2	2	5	9
	Low	Lowest	15	17	24	24	80
		Low	6	4	3	3	16
		High	6	4	8	3	21
		Highest	3	0	0	0	3
		Total	30	25	35	30	120
	High	Lowest	25	22	12	6	65
		Low	12	8	8	7	35
		High	13	13	9	8	43
		Highest	10	5	0	0	15
		Total	60	48	29	21	158

			SASS score				
School size	EcoDis quartile	USEP	Lowest	Low	High	Highest	Total
Small	Highest	Lowest	4	1	0	2	7
		Low	4	1	0	0	5
		High	6	4	0	0	10
		Highest	17	6	4	1	28
		Total	31	12	4	3	50
	Total	Lowest	44	42	37	37	160
		Low	22	13	11	10	56
		High	25	21	18	11	75
		Highest	30	11	4	1	46
		Total	121	87	70	59	337
Medium	Lowest	Lowest	0	1	7	20	28
		Low	0	0	1	1	2
		High	0	0	0	4	4
		Highest	0	0	0	0	0
		Total	0	1	8	25	34
	Low	Lowest	9	38	60	37	144
		Low	3	10	19	16	48
		High	6	12	10	6	34
		Highest	2	1	0	2	5
		Total	20	61	89	61	231

School size	EcoDis quartile	USEP	SASS score Lowest	Low	High	Highest	Total
Medium	High	Lowest	10	11	11	6	38
		Low	9	10	11	4	34
		High	23	16	18	6	63
		Highest	18	10	3	0	31
		Total	60	47	43	16	166
	Highest	Lowest	1	2	0	0	3
		Low	0	0	2	0	2
		High	5	1	0	0	6
		Highest	31	19	11	0	61
		Total	37	22	13	0	72
	Total	Lowest	20	52	78	63	213
		Low	12	20	33	21	86
		High	34	29	28	16	107
		Highest	51	30	14	2	97
		Total	117	131	153	102	503
Large	Lowest	Lowest	0	2	3	34	39
		Low	0	2	3	29	34
		High	0	2	3	11	16
		Highest	0	0	0	1	1
		Total	0	6	9	75	90

			SASS score				
School size	EcoDis quartile	USEP	Lowest	Low	High	Highest	Total
Large	Low	Lowest	0	3	7	5	15
		Low	2	5	5	23	35
		High	3	5	16	43	67
		Highest	1	4	6	13	24
		Total	6	17	34	84	141
	High	Lowest	0	0	0	1	1
		Low	1	3	3	0	7
		High	11	14	8	4	37
		Highest	13	41	25	7	86
		Total	25	58	36	12	131
	Highest	Lowest	0	0	0	0	0
		Low	0	0	0	0	0
		High	0	0	0	0	0
		Highest	53	31	22	0	106
		Total	53	31	22	0	106
	Total	Lowest	0	5	10	40	55
		Low	3	10	11	52	76
		High	14	21	27	58	120
		Highest	67	76	53	21	217
		Total	84	112	101	171	468

			SASS score				
School size	EcoDis quartile	USEP	Lowest	Low	High	Highest	Total
Total	Lowest	Lowest	0	5	11	59	75
		Low	0	2	4	30	36
		High	0	2	4	15	21
		Highest	0	0	0	1	1
		Total	0	9	19	105	133
	Low	Lowest	24	58	91	66	239
		Low	11	19	27	42	99
		High	15	21	34	52	122
		Highest	6	5	6	15	32
		Total	56	103	158	175	492
	High	Lowest	35	33	23	13	104
		Low	22	21	22	11	76
		High	47	43	35	18	143
		Highest	41	56	28	7	132
		Total	145	153	108	49	455
	Highest	Lowest	5	3	0	2	10
		Low	4	1	2	0	7
		High	11	5	0	0	16
		Highest	101	56	37	1	195
		Total	121	65	39	3	228

			SASS score				
School size	EcoDis quartile	USEP	Lowest	Low	High	Highest	Total
Total	Total	Lowest	64	99	125	140	428
		Low	37	43	55	83	218
		High	73	71	73	85	302
		Highest	148	117	71	24	360
		Total	322	330	324	332	1,308

APPENDIX D

TEA DISTRICT TYPES

Adapted from TEA district types (2011-2012)
http://tea.texas.gov/acctres/analyze/1112/gloss1112.html

Below are TEA's definitions of district types:

Major Urban (10 districts). It is a major urban district if it fits the following criteria: "(a) it is located in a county with a population of at least 825,000; (b) its enrollment is the largest in the county or at least 75 percent of the largest district enrollment in the county; and (c) at least 35 percent of enrolled students are economically disadvantaged. A student is reported as economically disadvantaged if he or she is eligible for free or reduced-price meals under the National School Lunch and Child Nutrition Program" (TEA, 2012, para. 1).

Major Suburban (79 districts). It is a major suburban district if it fits the following criteria: "(a) it does not meet the criteria for classification as major urban; (b) it is contiguous to a major urban district; and (c) its enrollment is at least three percent that of the contiguous major urban district or at least 4,500 students. A district also is classified as major suburban if: (a) it does not meet the criteria for classification as major urban; (b) it is not contiguous to a major urban district; (c) it is located in the same county as a major urban district; and (d) its enrollment is at least 15 percent that of the nearest major urban district in the county or at least 4,500 students" (TEA, 2012, para. 3).

Other Central City (40 districts). It is "other central city" if it fits the following criteria: "(a) it does not meet the criteria for classification in either of the previous subcategories; (b) it is not contiguous to a major urban district; (c) it is located in a county with a population of between 100,000 and 824,999; and (d) its enrollment is the largest in the county or at least 75 percent of the largest district enrollment in the county" (TEA, 2012, para. 5).

Other Central City Suburban (161 districts). It is "other central city suburban" district if it fits the following criteria: "(a) it does not meet the criteria for classification in any of the previous subcategories; (b) it is located in a county with a population of between 100,000 and 824,999; and (c) its enrollment is at least 15 percent of the largest district enrollment in the county. A district also is other central city suburban if: (a) it does not meet the criteria for classification in any of the previous subcategories; (b) it is contiguous to an other central city district; (c) its enrollment is greater than three percent

that of the contiguous other central city district; and (d) its enrollment exceeds the median district enrollment of 807 students for the state" (TEA, 2012, para. 7).
Independent Town (70 districts). It is an independent town district if it fits the following criteria: "(a) it does not meet the criteria for classification in any of the previous subcategories; (b) it is located in a county with a population of 25,000 to 99,999; and (c) its enrollment is the largest in the county or greater than 75 percent of the largest district enrollment in the county" (TEA, 2012, para 9).

Non-Metropolitan: Fast Growing (29 districts). It is a "non-metropolitan: fast growing" district if it fits the following: "(a) it does not meet the criteria for classification in any of the previous subcategories; (b) it has an enrollment of at least 300 students; and (c) its enrollment has increased by at least 20 percent over the past five years" (TEA, 2012, para. 11).

Non-Metropolitan: Stable (192 districts). It is a non-metropolitan: stable district if it fits the following: "(a) it does not meet the criteria for classification in any of the previous subcategories; and (b) its enrollment exceeds the median district enrollment for the state" (TEA, 2012, para. 13).

Rural (448 districts). It is a rural district "if it does not meet the criteria for classification in any of the previous subcategories. A rural district has either: (a) an enrollment of between 300 and the median district enrollment for the state and an enrollment growth rate over the past five years of less than 20 percent; or (b) an enrollment of less than 300 students" (TEA, 2012, para. 15).

Charter School Districts (198 districts). District as considered, "Charter school districts are open-enrollment school districts chartered by the State Board of Education. Established by the Texas Legislature in 1995 to promote local initiative, charter school districts are subject to fewer regulations than other public school districts. Generally, charter school districts are subject to laws and rules that ensure fiscal and academic accountability but that do not unduly regulate instructional methods or pedagogical innovation. Like other public school districts, charter school districts are monitored and accredited under the statewide testing and accountability system" (TEA, 2012, para. 17).

APPENDIX E

EXTENDED POSITIONALITY

My Transformation-My Positionality

I watched the lights as they passed through the machine. I searched belts, bags, binders. I checked the uniforms (khaki pants, white shirts) and behavior sheets at breakfast. This was my morning routine; it was their morning routine; and we performed like robots. It was systematic and efficient. I often leaned against the white cement wall. It was cold, like education. Somehow that wall seemed to support me and cool me down. Typically, I was steaming hot because my blood boiled from the idea of what was happening. This prison like program was what the education system had done to our students. I fought it every day. I fought it with science education.

But I was not always like this. I did not know how to fight when I first started teaching. That first year I was teaching my blood boiled for a different reason. It was December, we were reviewing for finals, and my classroom was the fullest it had been all year. It was the end of the day, second to last period, the students were bored and I was frustrated. At that time, I was working so hard trying to "help" students understand the content. But I was just an awful teacher. I was not taught social justice or urban science education in my traditional teacher training program at a predominately white institute (PWI). I was not taught how to connect content for diverse or disengaged youth. I blamed the students for not wanting to learn. I threw up my hands and yelled "you guys don't [care] about anything." I was done. My own test anxieties, my deficit ideologies, my lack of pedagogical content knowledge, and the system had won. I was not prepared for the situation and every frustration level possible I had met. I was done and my emotions won.

An administration team member at the school (she was previously a science teacher) walked by right when I lost it. Instead of stopping and stepping in to help the situation with her expertise as a science teacher she reported to a higher up administrator. That administrator dismissed me from the classroom. I was thinking I was going to lose my job. I walked to the break room, stood in front of the teacher mail boxes and wondered what to do. I cried. After a few minutes of just standing there and not knowing the situation, not having any communication from anyone, I walked back to my classroom. I looked through the window, the administrator was just standing in front of the room and the students were not paying much attention. The administrator saw me and she walked to the door and opened it. She asked if I was calm and I said yes. She opened the door wide, inviting me back in the classroom, and she left. Really, she left.

My 7th grade students looked at me. They nor I knew what to do. I apologized to them and said what I had done was so very inappropriate. We went back to reviewing.

However, everyone in that room that day knew there was no science education happening. By the end of the day the entire little school had "heard" that I had lost it.

A third education administrator was the only one to confront me on the issue. He came and spoke with me after school and he actually mentored me. I never heard from the other administrator except for quick comment, "don't do that ever again." That is the day I began to seriously question the system. What I did that day was horrible. What I did that day was not teaching; it was prison. Suddenly I realized we were all in prison. Within the white walled room we were in a prison of thoughts, a prison of science education, a prison stealing freedom of critical questioning and understanding. I was the prison guard constricting thought and knowledge. I was a textbook teacher.

I knew I had to change and then I was blessed with the urban education masters' program where a hidden curriculum was exposed and the patterns I was noticing in my small school suddenly had a story to them. I suddenly realized how we, my students and me, could escape prison, and we escaped together through science (science education and scientific research).

The heart of everything I do is for pre/in service teacher education. My position as an education researcher was heavily influenced by my classroom teaching experiences as a middle school science teacher at an alternative school in Houston. The number one thing the students would ask for was better teachers. They would ask me to come back to their home campuses to teach them. They somehow thought I too was being punished by working at the alternative school. I still remember one student. I asked him if I should go back to get a Ph.D. He asked me why I would want to go back to school. I said "so I could teach teachers to be the best they can for you." He encouraged me. An 8^{th} grade student believed I could make a difference in his life by teaching teachers so I took the plunge.

When I came up here full time I realized my narrow ideological view was not going to help me teach an online course in classroom management. As my time in academia continued I was asked to teach elementary science methods, then quickly switched to teach technology in elementary classrooms. After a semester of teaching that course I was once again designated to teach elementary science but again I was switched to be an assistant for the Online Ed. D. My world of critical pedagogy left me in a whirlwind of confusion while trying to navigate and teach pre-service teachers at this PWI. I realized I needed a pragmatic framework that would easily transcend the borders and allow me to adapt to each new task while also persisting against the resistance frameworks constructed by pre-service teachers at PWIs. The *How People Learn* framework and components within it became my foundation for quickly transitioning and adapting to each new teaching, research, or administrative activity.

I often am criticized for being eclectic, but I argue that I am a pragmatic adaptor with foundations in the research agenda that might seem broad but when put within the context of a specific community become very narrow. For the purpose of my dissertation, the community focus is closely related to my classroom teaching experiences. I am choosing to examine urban science classroom environments. More specifically, I want to explore urban science classroom environments that have been identified as highly successful and highly diverse in Texas.

The ultimate end goal (see Figure 4) is to use the findings from this urban science classroom environment research to inform the field of multicultural science education, to inform the development of pre and in service science teacher education, and to further my own knowledge base regarding science classroom environments for diverse learners. From experience in academia, I realize my role as a future teacher educator will be shaped by the politics and needs of the institution, therefore, my use of the *HPL* framework as a guiding theoretical lens has become a pragmatic stance which will allow me to continually adapt to the context of the community and persist again resistant ideologies.

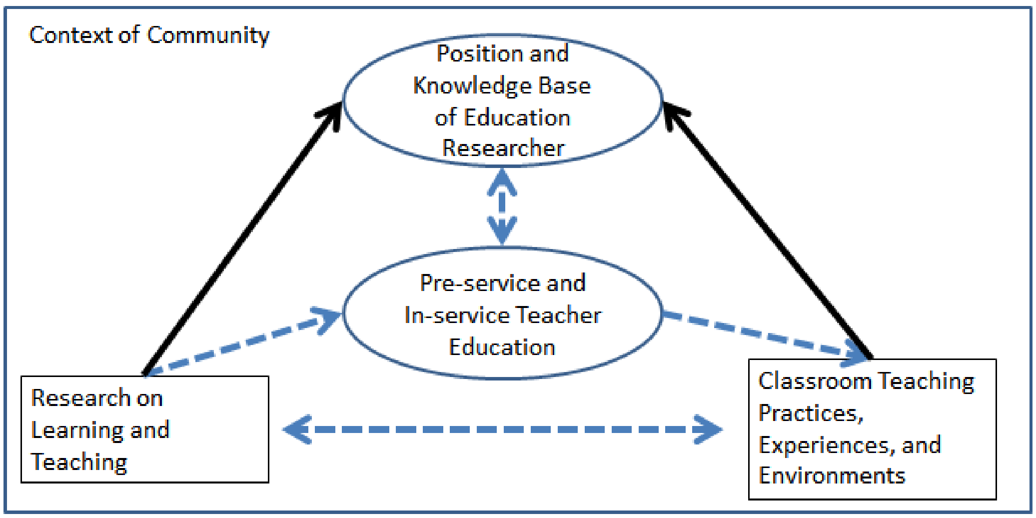


Figure E-1. My guiding purpose and overarching research agenda. Adapted from Bransford, Brown, and Cocking (2000).

APPENDIX F

IRB APPROVAL

DIVISION OF RESEARCH

TEXAS A&M UNIVERSITY

DATE: December 22, 2015

MEMORANDUM

TO: Carol L Stuessy
TAMU - College Of Education & Human Dev - Teaching, Learning And Culture

FROM: Dr. James Fluckey
Chair, TAMU IRB

SUBJECT: Expedited Approval – Continuing Review

Study Number:	IRB2014-0082D
Title:	Highly Successful Highly Diverse Classroom Environment Study
Approval Date:	03/03/2014
Continuing Review Due:	11/15/2016
Expiration Date:	12/15/2016

Document of Consent: Written consent in accordance with 45 CF 46.116/ 21 CFR 50.27

Comments:

- Enrollment closed, follow up only.
- Research is to be conducted according to the study application approved by the IRB prior to implementation.
- Any future correspondence should include the IRB study number and the study title.

APPENDIX G

PRE- AND POST-OBSERVATION INTERVIEW PROTOCOL

HSHD Classroom Environment Study
Protocol for Pre-Classroom Observation Interview

Teacher Story and School Context

Teacher-Participant:____________________________________
Interviewer:____
Date:____

1. How long have you taught science and how many of those years have been at this school? (What is different about teaching science at this school compared to your experiences working at other schools?)

2. Why did you decide to teach science?

3. What attracted you to this district and school? What has been the most surprising thing about teaching science at this school?

4. What qualities do you think your colleagues saw in you that contributed to your hiring at this school?

5. What type of preparation did you have to teach science? Did you learn about teaching ethnically and/or linguistically diverse students in your educational training? (If so, how adequate was that training?)

6. What type of support do you receive that helps you teach science?

7. Have you learned about teaching ethnically and/or linguistically diverse students since you started teaching in this school? (Describe your experiences—how helpful have they been? What kinds of things did you learn?)

8. Can you tell me about your philosophy of teaching? What, in your opinion "works"? What doesn't? What do you believe is the role of the teacher, role of the student? How do you see supporting all students' learning in your classroom? In a typical week, could you tell me about the modes of lesson delivery you use

including ways you assess student learning? (lecture, small group, large group; projects, tests/quizzes)

9. What kinds of challenges do you face in teaching science to ethnically and/or linguistically diverse students? (Can you provide an example of a way you have attempted to meet these challenges?)

10. If you had to choose the one promising practice that positively impacts ethnically and/or linguistically diverse students in your school, what would it be? (Please describe and provide an example.)

11. Is there any additional information about your experience teaching science at this school you would like to share?

12. Where do the lessons we are about to observe occur in your overall instructional sequence? In other words, what activities have your students completed before the lesson and what will they complete after the lessons?

HSHD Classroom Environment Study
Protocol for Post-Classroom Observation Interview
Teacher Perspective *How People Learn* Framework

Learner-Centered Questions:

1. What things have you done in teaching science that has enabled the academic success of ethnically and/or linguistically diverse students?(What do you think motivates the students to be successful in science ? What do you do to motivate students to be engaged during your science class?)

2. How do you engage learners' interests in science and connect to their prior knowledge, experiences and ideas? (What do you do to get to know about your students' prior knowledge and experiences?)

3. How do you connect science to the students' cultural knowledge that they bring to the classroom?

4. How do address students' misconceptions about science?

Knowledge-Centered Questions:

5. What area of the curriculum do you think is most meaningful for the students? (Why is do you think this is meaningful? How do you know this is meaningful?)

6. How do you help students transfer the knowledge they learn in your science class to experiences outside your science class?

7. In what ways do you help the students reflect and make sense of their learning process in science?

8. How do you balance teaching science process skills (i.e., inquiry, problem solving, questioning) and science content knowledge?

Assessment-Centered Questions:

9. Describe how you monitor your students' performance. What assessment data do you use? How are those data used and by whom? Can you give an example of what you have done to help a struggling student?

10. How do students in your class know what they need to improve in their understanding of what they are learning? in what ways do you intentionally design assessments that inform students about their progress?

Community-Centered Questions:

11. How do you construct a community within your science classroom? How often and for how long do your students work in groups to do their work in your class within a typical week of instruction?

12. Please describe this school's climate. What are the key priorities for your school? What are the primary challenges facing your school?

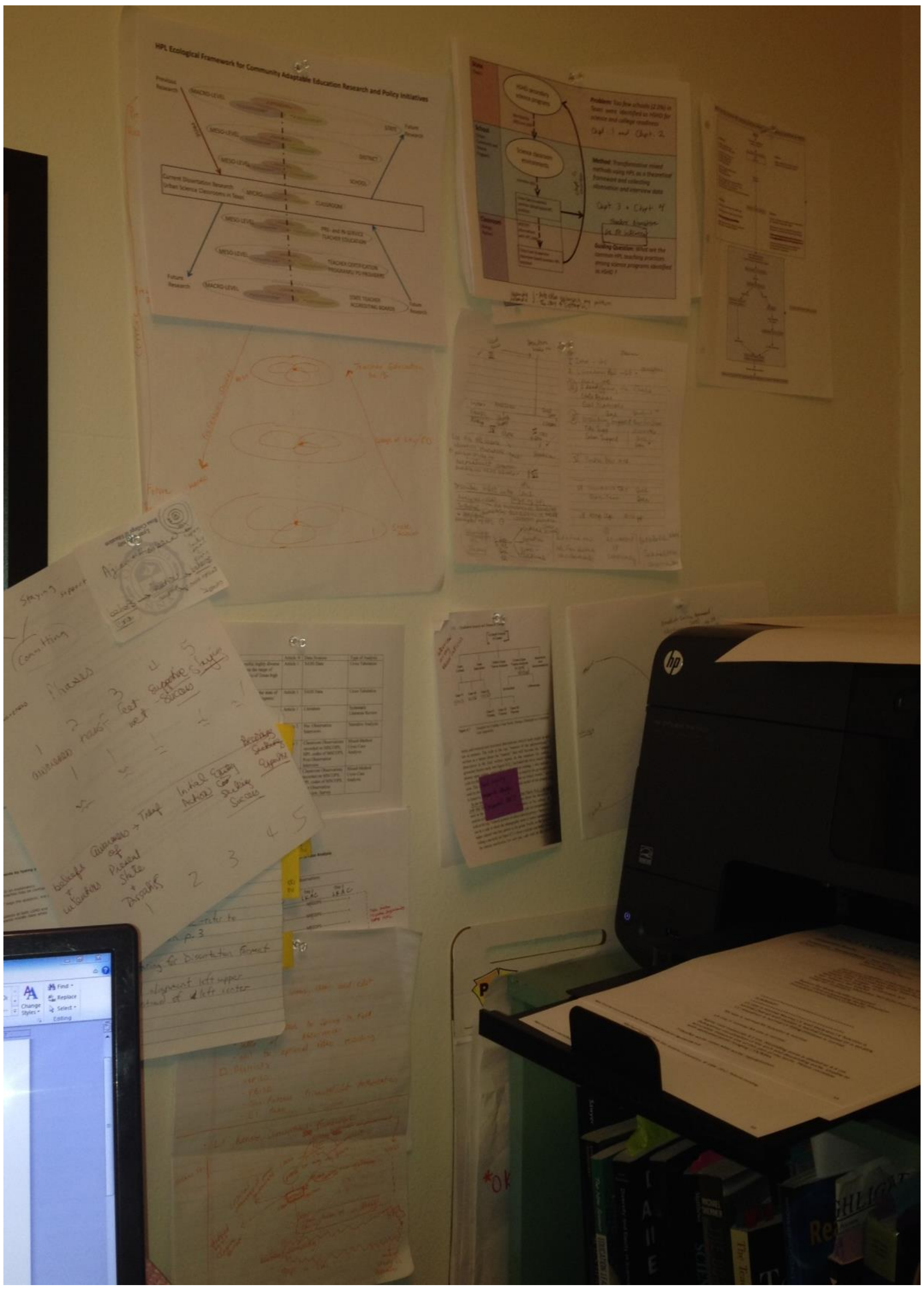
13. To what do you attribute your school's level of success with ethnically and/or linguistically diverse students? How does your school define success for these students? How would you describe your success with these students as a teacher?

14. What forms of collaboration occur between you and your fellow teachers?

15. What actions do you as a teacher or the school take to get parents involved? Besides parental involvement, what other forms of community collaboration exist?

APPENDIX H

MEMO WALL



APPENDIX I

TEXAS POLL OF SECONDARY SCIENCE TEACHERS

1. In the last 12 months, have you participated in recruiting new science teachers ?

#	Answer		Response	%
1	Yes		1	10%
2	No		9	90%
	Total		10	100%

2. Please indicate how you have participated in recruiting science teachers (Please select all that apply).

#	Answer		Response	%
1	Conducted formal interview at the school site		1	100%
2	Conducted informal visit with perspective teachers		0	0%
3	Attended recruitment trip outside school walls		0	0%
4	Attended policy meetings		1	100%
5	Reviewed job applications		1	100%
6	Other		0	0%

3. In the past 12 months, have you participated in the induction/ mentoring of science teachers?

#	Answer		Response	%
1	Yes		5	50%
2	No		5	50%
	Total		10	100%

4. Please indicate how you have participated in the induction/ mentoring of science teachers (Please check all that apply).

#	Answer		Response	%
1	Assisted with orientation to school policies		3	60%
2	Assisted with classroom management		4	80%
3	Observed science teachers in the classroom		2	40%
4	Modeled instruction for science teachers		3	60%
5	Provided science teachers with lesson material		4	80%
6	Developed lesson material with science teachers		3	60%
7	Performed formal mentor duties		3	60%
8	Other		1	20%

Other
helped a new teacher with content materials

5. In the last 12 months, have you served in a leadership role?

#	Answer		Response	%
1	Yes		3	30%
2	No		7	70%
	Total		10	100%

6. Please indicate how you have participated in leadership roles. Please note, only the first 6 leadership roles are science specific (Please check all that apply).

#	Answer		Response	%
1	Chaired science department		1	33%
2	Wrote science curriculum		0	0%
3	Sponsored science club/ organization		0	0%
4	Mentored a science teacher		1	33%
5	Member of a science teacher professional organization		2	67%
6	Presented at a science workshop, conference, or training session		2	67%
7	Mentored a non-science teacher		0	0%
8	Chaired a non-science department		0	0%
9	Member of a teacher professional organization not science related		1	33%
10	Member of a district-level decision-making committee		1	33%
11	Other		1	33%

Other
campus admin decision

7. In the last 12 months, identify the professional development activity in which you participated (Please check all that apply)?

#	Answer		Response	%
1	Teaching science content		9	90%
2	Using technology in the classroom		7	70%
3	Implementing the science Texas Essential Knowledge and Skills (TEKS)		8	80%
4	Preparing students for the State of Texas Assessments of Academic Readiness (STAAR) exam		9	90%
5	Teaching students with special needs		5	50%
6	Conducting laboratory and field investigations		6	60%
7	Teaching science through inquiry		6	60%
8	Assessing students' prior knowledge		6	60%
9	Other		1	10%

Other
Classroom Management

8. In the last 12 months, identify activities you engaged in specific to science or science education (Please check all that apply)?				
#	Answer		Response	%
1	Conducting research on science instruction		2	22%
2	Observing other science teachers		5	56%
3	Taking graduate courses in a science field		0	0%
4	Participating in educator study groups		5	56%
5	Engaging with professional science teaching associations		3	33%
6	Writing curriculum		2	22%
7	Mentoring science student-teachers		3	33%
8	Other		0	0%

9. Identify three challenges you face when implementing science instruction:
Text Response
* The students experience and ability to read science * The students background on math * The students experience and ability to follow directions in writing, ex. lab. procedures
Vocabulary/ Second Language/ Reading comprehension
Student Interest Too much conetnt too little time Teaching to the test
Time. Materials. Connecting to the student's world.
Reaching each student on an individual basis with the content can be difficult. The previous knowledge of each student can vary greatly. The individual student's enthusiasm for science. Sometimes it is hard to help students overcome the idea that they are "bad at science".
To much information to teach in a short amount of time. Large class sizes Lack of field time to enrich student learning.
1. Connecting the science with things the students are interested in 2. Creating challenging questions without making it too difficult for the students and still teaching the basic level of the TEKS 3. Having enough time to truly evaluate and reteach students who need extra help
Time, large classrooms, and language barriers
Limited time Students have a hard time communicating a concept either orally or in writing. Students have a hard time making connections presented in multiple ways.
Vocabulary,completing assignments,ability to read

10. Overall, how satisfied are you in being a science teacher?				
#	Answer		Response	%
1	Very Satisfied		3	30%
2	Satisfied		7	70%
3	Dissatisfied		0	0%
4	Very Dissatisfied		0	0%
	Total		10	100%

11. How much do you agree with the following statement: Improving students' achievement in science is a team effort at this school.

#	Answer		Response	%
1	Strongly Agree		9	90%
2	Agree		1	10%
3	Disagree		0	0%
4	Strongly Disagree		0	0%
	Total		10	100%

12. At your school, how would you rate your personal level of safety?

#	Answer		Response	%
1	Excellent		6	60%
2	Above average		4	40%
3	Below average		0	0%
4	Poor		0	0%
	Total		10	100%

13. Do you have an undergraduate degree in a biological or physical science field?

#	Answer		Response	%
1	Yes		7	70%
2	No		3	30%
	Total		10	100%

14. Do you have an graduate degree in a biological or physical science field?

#	Answer		Response	%
1	Yes		2	20%
2	No		8	80%
	Total		10	100%

15. Please enter your name:

Text Response

16. When teaching students in a classroom, how often do you...

#	Question	Very Often	Sometimes	Seldom	Not Often at All	Total Responses	Mean
1	Vary questioning strategies?	9	1	0	0	10	1.10
2	Link students' prior experience with new knowledge?	9	1	0	0	10	1.10
3	Use manipulatives?	7	3	0	0	10	1.30
4	Vary assessment strategies?	5	4	1	0	10	1.60
5	Use collaborative learning strategies?	5	5	0	0	10	1.50

17. During a semester, how often do you...							
#	Question	Very Often	Sometimes	Seldom	Not Often at All	Total Responses	Mean
1	You use Inquiry as a teaching strategy?	3	7	0	0	10	1.70
2	Use projects to assess learning?	2	6	2	0	10	2.00
3	Use performance assessments?	7	3	0	0	10	1.30
4	Talk with the administration about the academic achievement of students from historically underrepresented groups?	2	4	4	0	10	2.20
5	Talk with other teachers about the academic achievement of students from historically underrepresented groups?	4	5	1	0	10	1.70

18. At your school, how satisfied are you with...

#	Question	Very Satisfied	Satisfied	Dissatisfied	Very Dissatisfied	Total Responses	Mean
1	The cooperation among the teachers?	5	4	1	0	10	1.60
2	Your science program's contribution to students' career development?	1	9	0	0	10	1.90
3	The level of autonomy in making decisions about instructional methods?	4	4	2	0	10	1.80
4	With administrative support for providing students with informal science activities (e.g., field trips, visits to museums, and other off-campus activities)?	3	4	3	0	10	2.00
5	With the options for science-specific professional development?	3	5	2	0	10	1.90
6	The administrative support for participating in professional development?	6	3	1	0	10	1.50
7	With the science laboratory facilities?	4	4	2	0	10	1.80
8	The science laboratory equipment?	5	4	1	0	10	1.60
9	The recognition you receive for your science teaching efforts?	2	8	0	0	10	1.80
10	With your current teaching assignment?	4	4	2	0	10	1.80
11	The administrative communication regarding teaching expectations?	5	3	2	0	10	1.70

APPENDIX J

M-SCOPS CODING VARIABLES

Levels of Complexity[1] in the Engagement of Classroom Discourse in
Model-Based Inquiry Learning Environments

R&D[2]	**P&I[3]**	**Description**	**Examples**
5[a]	**1[b]**	Individual students are directed to listen as the teacher or another student talks to entire group; students are directed to read or do seat work; assimilation and/or accommodation occur passively with little or no interaction	Direct instruction models, including those where the teacher asks rhetorical, yes-no or one-word answers; lecture, silent reading, independent practice, seat work
4	**2**	Individual students respond orally or in writing to questions asked by the teacher, in whole group; responses are shared	Teacher-led discussion with student input (including recitation or presentations); question and answer; discussion led and directed by the teacher
3	**3**	Students in pairs or small groups work together under the teacher's supervision – with discussion; all groups do basically the same task	Student discussion in groups; may include task completion, verification laboratories, cooperative learning models
2	**4**	Groups and/or individual students work on different tasks; while all are participating, tasks may be very varied; but they are coordinated, as when one group presents and others ask questions or evaluate results; loosely supervised by teacher with teacher intervention	Individuals or groups present information while the rest of the class responds; intervals of work are often interrupted by the teacher to coordinate activities or encourage sharing
1	**5**	Students in pairs or small groups discuss, design, and/or formulate their own plans for working in class on a specified task; minimal supervision for longer periods of time; little coordination by the teacher	Open-ended laboratory or project work, invited by the teacher but definitely where students are less restricted
0	**6**	Individuals or groups carry out their own work independently; minimal supervision	Individualized laboratory or project work

Note: Table from Stuessy (2012). Used with permission from the author.

Levels of Complexity in Model-Eliciting Information and Model-Building Actions in
Model-Based Inquiry Learning Environments

Information Complexity Code[1]	**Model-Eliciting Information**	**Action Complexity Code**	**Model Building Actions Focusing on**
1 Very Low Complexity (Pre-structural to Unistructural)	Complex, holistic systems consisting of multiple parts; External or superficial features, pictures, models, duplications, reproductions, challenges to perform a level 1 or level 2 action	**1 Attend**	MBIL Immersion Activities *Listening or attending to, observing, exploring, manipulating*
2 Low (Unistructural)		**2 Replicate**	MBIL Research Questions and Prediction Activities *Conjecturing simple and obvious connections without needing to grasp the significance of the connections to the whole*
3 Low Medium (Low (Multistructural)	Comparisons, groupings, sequences, patterns, rearrangements, balancing, classifications, disassembled parts of a whole, early processes of putting parts together; challenges to perform a level 3 action	**3 Rearrange**	MBIL Experimental Design and Observations Activities *Manipulating parts of the system to yield understanding about connections, but missing the meta-connections between them and their significance in regard to the whole*
4 Medium (Multistructural)	Patterns of relationships between variables in various representational forms, challenges to perform a level 4 action	**4 Transform**	Analysis and Results Activities *Searching for patterns among parts of the system by arranging, representing symbolically or pictorially, interpreting, and making logical connections based `on evidence*
5-6 High (Relational)	Generalized representations (including mathematical, graphical, verbal) of complex systems and their components, models, solutions to complex problems; challenges to perform a level 5 action	**5-6 Connect to the Whole**	Conclusion and Explanation Activities *Focusing on the significance of the parts to the whole; explaining relationships of the connecting parts within a system; constructing conclusions, using and/or building complex models to develop explanations*
6 Very High (Extended Abstract)	Analyses, evaluations, problem scenarios, applications to another context; challenges to perform a level 6 action	**6 Generate New Applications and Transfer Learning**	Future Research and Implications/ Consequential Task Activities Applying and/or testing one's own conceptual models in new systems, transferring learning to generate a new problem and/or solve a problem of one's own generation

Note: Table from Stuessy (2012). Used with permission from the author.

APPENDIX K

HPL CODING VARIABLES

Component	Code – *Elaborations*
Learner - Centered	**Recognize/Build on Cultural Knowledge –** *culturally responsive teaching, respect students' prior experiences, build on their cultural knowledge* **Respect Language Practices –** *discourses coordinated to assist students' understandings* **Diagnostic Teaching –** *attempting to discover what students think, understanding students misconceptions,*
	Funds of knowledge - *historically accumulated and culturally developed bodies of knowledge and skills essential for household or individual functioning and well-being*
Knowledge - Centered	**Relevance-** *connected to curriculum, connected to students' lives and experiences, connects to future task* **Understanding –** *balance between understanding and automaticity, process skills v. content knowledge* **Sense-Making –** *metacognition, progressive formalization*
	Transfer – *what has been learned in one context and applied to new context*
Assessment-Centered	**Formative –** *continuing***,** *provides feedback* **Feedback –** *revisions, technologies for feedback, metacognition* **Performance Assessment –** *transfer, expertise* **Summative-** *teacher made test at the end of a unit; district, state and national assessments*
Community-Centered	**Classroom –** *norms and practices, expectations* **School** – *teacher learning communities, character and quality of relationships among adults in school* **Outside School –** *after school activities, businesses, community centers, experts outside of school, family/home(resources, activities, attitudes)*

APPENDIX L

CURRICULUM VITAE

JENNIFER K. LEBLANC
Department of Teaching, Learning and Culture
College of Education and Human Development Texas A&M University
College Station, TX 77843-4232
leblanc16@tamu.edu
832-724-3683

EDUCATION

Doctor of Philosophy Candidate	Texas A&M University, College Station, TX Major: Curriculum and Instruction Track: Urban Education / Science Education Graduating May 2016
Dissertation Title	Science Education in the Borderlands: An Examination of Science Classrooms in Texas High Schools Identified as Successful and Diverse
Defense Passed	February 24, 2016
M.Ed. (2010)	Texas A&M University, College Station, TX Major: Curriculum and Instruction Track: Urban Education
B.S. (2007)	Texas A&M University, College Station, TX Major: Interdisciplinary Studies Track: Middle School Math and Science Education

RESEARCH INTERESTS

Science Teacher Development Related to Culturally Responsive Teaching Practices
STEM Initiatives in Urban Schools
International Education Collaborations

TEACHING CERTIFICATIONS

Texas	Science Grades 4^{th} - 8^{th} Math Grades 4^{th} – 8^{th} English as a Second Language Supplementary Grades 4^{th} – 8^{th} Texas Virtual School Network - Virtual Instructor Certificate Program

PROFESSIONAL EXPERIENCE

UNIVERSITY

2015 - present ***Instructor***

Texas A&M University, College Station, TX
TEFB 413 Science in the Elementary School

This course is designed to help elementary teachers understand basic concepts of science and scientific methods; content relates to natural phenomena involving physical, chemical and biological processes; elementary students appreciation and interest in science.

2014 **Co-Instructor with Dr. Carol Stuessy**

Texas A&M University, College Station, TX **EDCI 633 Educator as Learner**

This Online Curriculum & Instruction Ed.D. course approached a fundamental question regarding those involved in the business of teaching and learning: From what sources do teachers derive their decisions? This course focused on that part of the teaching profession where teachers must be learners in order to make well-grounded decisions and design effective solutions. A case based learning model was used throughout this course.

EDCI 684 Professional Internship

This Online Curriculum & Instruction Ed.D. course was an internship where the student spent 150 hours on internship activities (with about one-half of the hours spent in the field) related to information gathering at the school site to clarify the situation, reframe the problem, propose a solution to the problem, and develop a plan for assessing the effectiveness of the solution. Internship activities included pre-visit preparation, documentation, analysis, synthesis, and reflection on the information gathered within the context of the individual intern's context for the Record of Study.

EDCI 685 Independent Study

This Online Curriculum & Instruction Ed.D. course provided students with the opportunity to develop a course related to their own research interests. Course of study, timelines, and credit hours were agreed upon between the instructor and student.

2014 ***Graduate Research Assistant for Dr. Valerie Hill-Jackson***

University Study Abroad Program International Learning Experience: Pre-service Teachers in Cardiff, Wales

Texas A&M University, College Station, TX

Served as a graduate student liaison on pre-planning trip details and assisted with the development of a trip information packet.

2013 – 2015 ***Graduate Assistant for Dr. Carol Stuessy***

Texas A&M University, College Station, TX
Online Curriculum & Instruction Ed.D. Program – Department of Teaching, Learning & Culture. Assist in the selection of the 2014/2015 cohorts through applicant review and document management. Assist in the management of the online community portal and webinars. Assist Online Curriculum & Instruction Ed.D. faculty with the online technology component of the program.

2013 ***Graduate Research Assistant for Dr. Carol Stuessy***

Texas A&M University, College Station, TX
Botanical Society of America - A Case Study: Exemplary Teaching in the Blended *Planting Science* Inquiry Learning Environment Involving Scientists as Mentors. Conducted national teacher evaluations in Chicago, IL and Cheyenne, WY. Co-authored final project reports submitted to the National Science Foundation Award 07- 33280.Assisted in coordinating research efforts, including training for videotape and dialogue analysis, engaged in research with other graduate students, assisted in setting up a collaborative database, and communicates and exchanges research information through the use of a community SharePoint portal.

2013 ***Instructor***

Texas A&M University, College Station, TX
EDCI 365 - Technology in Elementary Classrooms
This undergraduate course focused on overview of technology as it relates to the design of instruction and practices that support effective teaching and learning; how learning theories are reflected in and supported by technology; current and emerging applications in technology delivered and supported learning environments.

2013 ***Graduate Teaching Assistant for Dr. Cynthia Boettcher***

Texas A&M University, College Station, TX
INST 322 - Foundations of Education in a Multicultural Society (Grader)

2012 ***Instructor***

Texas A&M University, College Station, TX
TEFB 323 - Teaching Skills
This undergraduate course focused on the study and development of teaching skills necessary for reflective problem solving, managing classroom learning environments, motivating students to learn, and making ethical decisions; emphasis was given to models and theories of human behavior, informal and formal data collection techniques, and diversity of learners. Created and planned lectures, activities and assessments pertaining to the theory, research and instructional practices of teaching skills development.

Graduate Teaching Assistant for Dr. Cynthia Boettcher

Texas A&M University, College Station, TX
INST 322 - Foundations of Education in a Multicultural Society (Grader)

Graduate Teaching Assistant for Dr. Patricia Larke

Texas A&M University, College Station, TX
EDCI 602 - Cultural Foundations of Education
EDCI 645 - Society and Education in World Perspectives
EDCI 677 - Strategies for Teaching in a Culturally and Pluralistic Society

2012 ***Student Group Co-Leader - Center for Urban School Partnerships University Study Abroad Program International Learning Experience: Senegal and The Gambia, Africa***

Texas A&M University, College Station, TX
Planned and coordinated pre-travel meetings, organized country required travel documents, served as student liaison on pre-planning trip details, assisted with travel itinerary development and logistics, coordinated departure and arrival logistics, assisted with financial logistics in-country. Electronically collected, collated and disseminated multimedia material obtained from each participant post study abroad program.

2011 – 2015 ***Graduate Associate for Dr. Norvella Carter***

Center for Urban School Partnerships, Texas A&M University, College Station, TX
Assist recruiting efforts for teachers to pursue advanced degrees. Assist recruiting efforts for undergraduate pre-service teachers to pursue urban education opportunities as student teachers. Assist with technology, specifically in developing, creating and editing videos, PowerPoint and other multimedia presentations for an online master's program and multiple study abroad trips. Assist with IRB applications.

PUBLIC SCHOOL

2007 – 2012 ***Middle School Science Teacher***

Cypress Fairbanks Independent School District, Houston, TX
Alternative Learning Center - East
Taught 6th - 8th grade general science to students who had been placed in the district Discipline Alternative Education Program (DAEP).

MENTORING EXPERIENCE

Undergraduate Pre-Service Teacher Research Mentor (2013-2014)
Texas A&M University, College Station, TX
Provided support to a pre-service teacher in the Department of Teaching, Learning & Culture throughout the conduct of a research project. Activities included hands on experience in Institutional Review Board processes, research design and complete implementation of a research project.

Science Teacher Mentor (2011-2012)
State of Texas Region 4 Education Service Center, Houston, TX
Provided support to science teachers through mentoring and sharing professional development information from the Science Teacher Collaborative Science Teacher Mentor program.

Alternative Certification Program Teacher Mentor (2009-2010)
TEXAS Alternative Certification Program, Houston, TX
Provided support to a new teacher through mentoring and classroom observations for the approved State Board for Educator Certification program.

AWARDS / HONORS

Emerging Scholar Award (2014)
Texas A&M University, College Station, TX

George Bush Presidential Library Foundation Graduate Travel Grant
(2014) Texas A&M University, College Station, TX

Carolyn S. Lohman / Heep Fellowship (2013-
2014) Texas A&M University, College Station, TX

Botanical Society of America - Planting Science Research in Education Fellowship
(2013) Texas A&M University, College Station, TX

Urban Education Service Award (2013)
Texas A&M University, College Station, TX

Teacher of the Game (2012)
Devon Energy / National Basketball Association Houston Rockets, Houston, TX

Science Teacher Mentor (2011-2012)
State of Texas Region 4 Education Service Center, Houston, TX

Spotlight Teacher (2010-2011)
Alternative Learning Center – East, Cypress Fairbanks Independent School District, Houston, TX

New Science Teacher Academy Fellow (2009-2010)
National Science Teachers Association, Arlington, VA

Lohman Learner (2003-2004)
Texas A&M University College of Education, College Station, TX

PEER REVIEWED PUBLICATIONS

Farinde, A., **LeBlanc, J.K.** & Otten, A. (2015). Pathways to teaching: An examination of black females' pursuits of careers as K-12 teachers. *Education Research Quarterly, 38*(3), 32-51.

LeBlanc, J.K., & Farinde, A. (2013). Culturally responsive science techniques: Encouraging African American learners in science education through movement expressiveness. *National Forum of Multicultural Issues Journal, 10*(2), 15-22.

LeBlanc, J. & Larke, P.J. (2011). Culturally responsive teaching in science. *National Forum of Multicultural Issues Journal, 8*(2), 40-51.

SUBMITTED / IN REVISION / IN PROGRESS

Stuessy, C. L., **LeBlanc, J. K.,** Perkins, A., & Peterson, C. A. (2015). Thirty-two classrooms: Classroom complexity in an authentic scientific inquiry learning environment. Manuscript submitted.

LeBlanc, J.K., Otten, A. & Farinde, A. (2014). Preparing teachers for technology-based learning environments: Transformative reflections from pre-service teachers. Manuscript in progress.

LeBlanc, J.K., Otten, A., Farinde, A. (2014). From curriculum control to progressivism: An examination of teaching philosophies from pre-service teachers observing at alternative schools. Manuscript in progress.

Scogin, S.C., Cavlazoglu, B., **LeBlanc, J.K**. & Stuessy, C.L. (2013). Inspiring student success in diverse Texas high schools: A mixed methods examination of student focus within science programs. Manuscript in progress (Submitted, revised, re-submitted).

Cavlazoglu, B., **LeBlanc, J.K**., Peterson, C.A. & Stuessy, C.L. (2013). The role of teachers in orchestrating the PlantingScience learning environment. Manuscript in progress (Submitted, in revision).

LeBlanc, J.K., Cavlazoglu, B., Scogin, S.C., & Stuessy, C.L. (2013). The art of teacher talk in science: Examining the intersections of the strands of scientific proficiencies and the phases of inquiry. Manuscript in progress.

LeBlanc, J.K. & Otten, A. (2013). Transformative teaching and learning: A narrative analysis of secondary pre-service teachers' reflections on alternative school field experiences. Manuscript submitted.

LeBlanc, J.K. & Carter, N. (2011). Global perspectives on urban education: Literature review and personal reflections of parallel equity issues in the United States, India and China. Manuscript in progress.

NATIONAL REPORTS

LeBlanc, J.K., Cavlazoglu, B., Scogin, S.C., & Stuessy, C.L. (2013). *The art of teacher talk in science: Examining the intersections of the strands of scientific proficiencies and the phases of inquiry.* Final Report of the Botanical Society of America Research Teams at Texas A&M University, College Station, TX. Submitted to the National Science Foundation Award 07-33280.

Cavlazoglu, B., **LeBlanc, J.K**., Peterson,C.A. & Stuessy, C.L. (2013). *The role of teachers in orchestrating the PlantingScience learning environment.* Final Report of the Botanical Society of America Research Teams at Texas A&M University, College Station, TX. Submitted to the National Science Foundation Award 07-33280.

Stuessy, C.L., Peterson,C.A. & **LeBlanc, J.K**., (2013). *Thirty-two classrooms: Portraits of classroom complexity in authentic scientific inquiry contexts.* Final Report of the Botanical Society of America Research Teams at Texas A&M University, College Station, TX. Submitted to the National Science Foundation Award 07-33280.

PROGRAM EVALUATIONS

Stuessy, C. L., & **LeBlanc, J. K.** (2015). *Ed.D. in Curriculum and Instruction Self-Study 2014.* College Station, TX: Texas A&M University College of Education and Human Development.

Sweet, K., **LeBlanc, J.K**., & Stough, L.M. (2013). *A qualitative study on social media use by people with disabilities.* Austin, TX: SafePlace

REFEREED CONFERENCE PRESENTATIONS

LeBlanc, J.K., & Hill-Jackson, V. (2016). International Service-Learning for Multicultural Education: An Exploratory Study with Pre-Service Teachers. American Education Research Association 2016 Annual Meeting. Washington, D.C.

LeBlanc, J.K., Stuessy, C.L., & Stone, K. (2016). Opportunities to Learn Science: A Case Study of Science Classrooms in Successful-Diverse High Schools**.** National Association for Research in Science Teaching 2016 Annual International Conference. Baltimore, MD.

Wright, K.L., Hodges, T.S., & **LeBlanc, J.K.** (2016). The Rubric for Scientific Writing: A Tool to Support Research, Assessment, and Instruction**.** National Association for Research in Science Teaching 2016 Annual International Conference. Baltimore, MD.

Stuessy, C.L. & **LeBlanc, J.K.** (2015). Growing Pains: Self-Study Results from an Online Ed.D. Program in Curriculum and Instruction in its Fifth Year of Operation. The Carnegie Project on the Education Doctorate 2015 Convening, Boca Raton, FL.

LeBlanc, J.K., Stuessy, C.L., & Farinde, A. (2015). Teachers' Stories: Becoming and Remaining Effective in Successful and Diverse High Schools. School Science and Mathematics Association 2015 Annual Convention, Oklahoma City, OK.

Steussy, C.L., Killough, J., **LeBlanc, J.K.,** Lyons, L., & Perkins, A. (2015). Avatars and Online Professional Development in STEM and College Career Readiness Skills. School Science and Mathematics Association 2015 Annual Convention, Oklahoma City, OK.
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Capraro, M.M., **LeBlanc, J.K.,** Capraro, R.M., Steussy, C. (2015). Identifying Researchable Topics for an EdD Record of Study. Association for the Advancement of Computing in Education E-Learn 2015 World Conference on E-Learning. Kona, HI.

LeBlanc, J.K., Cavlazoglu, B., Scogin, S. & Stuessy, C.L.(2015). The Art of Teacher Talk: Examining Intersections of the Strands of Scientific Proficiencies and Inquiry. American Education Research Association 2015 Annual Meeting. Chicago, IL.

LeBlanc, J.K., Bozeman, D., Stuessy, C.L., Farinde, A., & Stone, K. (2015). Science Education in the Borderlands: An Examination of Science Readiness for Latina/o Learners in Texas**.** National Association for Research in Science Teaching 2015 Annual International Conference. Chicago, IL.

Hill-Jackson, V. & **LeBlanc, J.K.** (2014). Towards Diversity Consciousness: How Attitudes about Multiculturalism Impact the Experience of Pre-service Teachers during an International Service-Learning Field Experience. International Association for Research on Service-learning and Community Engagement 2014 Conference. New Orleans, LA.

LeBlanc, J.K., Cavlazoglu, B., Peterson, C.A. & Stuessy, C.L. (2014). Understanding the Teacher's Role in Orchestrating Technology Enhanced Inquiry Learning Environments. National Association for Research in Science Teaching 2014 Annual International Conference. Pittsburgh, PA.

Cavlazoglu, B., **LeBlanc, J.K.,** Peterson, C.A. & Stuessy, C.L. (2014). The Next Generation of Inquiry: Examining a Teacher's Scaffolding of Collaborative Technology during Inquiry Learning. National Association for Research in Science Teaching 2014 Annual International Conference. Pittsburgh, PA.

Stuessy, C.L., Peterson, C.A. & **LeBlanc, J.K.** (2014). Thirty-two Lessons: Snapshots of Classroom Complexity and Student Success in Orchestrations of Authentic Scientific Learning. National Association for Research in Science Teaching 2014 Annual International Conference. Pittsburgh, PA.

Stuessy, C.L., Peterson, C., **LeBlanc, J.K.,** Ozturk, G., Cavlazoglu, B., Perkins, A., Scogin, S. (2014). Is It Worth It? What Can a Complex Student-Centered Science Learning Environment Offer to Students Learning Science? Association for Science Teacher Education 2014 International Meeting. San Antonio, TX.

LeBlanc, J.K., Otten, A., Farinde, A. (2014). From Curriculum Control to Progressivism: An Examination of Teaching Philosophies from Pre-Service Teachers Observing at Alternative Schools. American Association for Teaching and Curriculum 2014 Annual Meeting. Tampa, FL.

LeBlanc, J.K., Otten, A. & Farinde, A. (2014). Preparing Teachers for Technology-Based Learning Environments: Transformative Reflections from Pre-service Teachers. American Education Research Association 2014 Annual Meeting. Philadelphia, PA.

Farinde, A., **LeBlanc, J.K.** & Otten, A. (2014). Pathways to Teaching: An Examination of Black Females' Pursuits of Careers as K-12 Teachers. American Education Research Association 2014 Annual Meeting. Philadelphia, PA.

Scogin, S.C., Cavlazoglu, B., **LeBlanc, J.K.** & Stuessy, C.L. (2014). A Mixed-Methods Analysis of Student Success in Diverse High School Science Programs. American Education Research Association 2014 Annual Meeting. Philadelphia, PA.

Stuessy, C.L., **LeBlanc, J.K.** & Peterson, C.A. (2013). Technology, Inquiry, and Scientist-Teacher Partnerships: Addressing Complexity in the Classroom. School Science and Mathematics Association 2013 Annual Convention. San Antonio, TX.

LeBlanc, J.K. & Otten, A. (2013). Transformative Teaching and Learning: A Narrative Analysis of Secondary Pre-service Teachers' Reflections on Alternative School Field Experiences. American Association for Teaching and Curriculum 2013 Annual Meeting. Chicago, IL.

Farinde, A. & **LeBlanc, J.K.** (2013). The Poverty of Cultural Dissonance: Examining the Importance of Culture in the Teaching and Disciplining of Black Female Students. American Education Research Association 2013 Annual Meeting. San Francisco, CA.

LeBlanc, J.K., Winkelman, S., Carter, R., Mobley, M. & Talamantez, J. (2013). From Discipline Class to Science Class: Engaging Strategies for Disruptive Students. Science Teachers Association of Texas 2013 Conference for the Advancement of Science Teaching. Houston, TX.

LeBlanc, J.K. & Farinde, A. (2012). Culturally Responsive Science Techniques: Encouraging African American Learners in Science Education through Movement Expressiveness. 11th Annual Region 6 Texas National Association of Multicultural Education Conference. College Station, TX.

LeBlanc, J.K. (2012). Discipline Class to Science Class: Engaging Strategies for Disruptive Students. Fourth Annual Region 4 Education Service Center Science Conference. Houston, TX.

LeBlanc, J.K. & Carter, N. (2011). Global Perspectives on Urban Education: Literature Review and Personal Reflections of Parallel Equity Issues in the United States, India and China. World Education Research Association Annual Focal Meeting. Kaohsiung, Taiwan.

LeBlanc, J.K. (2010). Disproportionate Demographics at DAEP'S: Possible Solutions to Stop the Leaky School to Prison Pipeline. 1st Annual Conference/Symposium on Research in Urban Education: Best Practices for Global Learners Conference. Johannesburg, South Africa.

LeBlanc, J.K. (2010). Culturally Responsive Teaching in Science. 9th Annual Region 6 Texas National Association of Multicultural Education Conference. Denton, TX.

INVITED PRESENTATIONS

LeBlanc, J.K. (2015). 8th Annual Saturday Morning Biophysics – Image Life! Education and Career Options in Science: "My Journey in Science Education". Department of Medical Physiology, Texas A&M University College of Medicine, College Station, TX.

LeBlanc, J.K. (2014). iVISION: "Teaching in an Alternative School". Department of Teaching, Learning and Culture, Texas A&M University, College Station, TX.

LeBlanc, J.K. (2013). Senior Methods: "What I Wish I Had Known". Department of Teaching, Learning and Culture, Texas A&M University, College Station, TX.

LeBlanc, J.K., & Farinde, A. (2013). Culturally Responsive Science Techniques: Encouraging African American Learners in Science Education through Movement Expressiveness. 12th Annual Region 6 Texas National Association of Multicultural Education Conference. San Marcos, TX.

LeBlanc, J.K. (2012). Symposium on Pre-university Teacher Training. Institute of Electrical and Electronics Engineers Teacher In-service Program. Tampa, FL.

LeBlanc, J.K. (2011). Culturally Responsive Teaching in Science. 10th Annual Region 6 Texas National Association of Multicultural Education Conference. Mesquite, TX.

GRANTS / FELLOWSHIPS

Research Travel Grant - Department of Teaching, Learning & Culture, Texas A&M University, ($500). Role: Paper presentation, 2016 Annual Meeting of the American Education Research Association, Washington, D.C.

Research Travel Grant - Department of Teaching, Learning & Culture, Texas A&M University, ($500). Role: Paper presentation, 2016 National Association of Research in Science Teaching, Baltimore, MD

Graduate Travel Grant - College of Education and Human Development. Texas A&M University, ($500). Role: Paper presentation, 2015 School Science and Mathematics Association Convention, Oklahoma City, OK

Graduate Research Grant - College of Education and Human Development. Texas A&M University, ($850). Role: Researcher, Science Education in the Borderlands: An Examination of Science Classrooms in Texas High Schools Identified as Successful and Diverse, College Station, TX

Research Travel Grant - Department of Teaching, Learning & Culture, Texas A&M University, ($500). Role: Paper presentation, 2015 Annual Meeting of the American Education Research Association, Chicago, IL

Texas Public Education Grant – Texas A&M University ($750). Role: 2015 Recipient

INST222 Extra Credit Module Development with Dr. Valerie Hill-Jackson - Department of Teaching, Learning & Culture, Texas A&M University ($2,700). Role: 2014 Curriculum Specialist

Graduate Challenge Research Grant - College of Education and Human Development, Texas A&M University ($500). Role: Paper presentation, 2014 Annual Meeting of the American Association of Teaching and Curriculum, Tampa, FL

Research Travel Grant - Department of Teaching, Learning & Culture, Texas A&M University, ($350). Role: Paper presentation, 2014 Annual Meeting of the American Association of Teaching and Curriculum, Tampa, FL

Emerging Scholar Award - College of Education and Human Development, Texas A&M University ($4,000). Role: 2014 Recipient

Carolyn S. Lohman/Heep Fellowship - College of Education and Human Development, Texas A&M University, ($10,000). Role: 2013-2014 Recipient

Graduate Enhancement Education Grant - College of Education and Human Development, Texas A&M University ($350). Role: Paper presentation, 2014 Annual Meeting of the American Association of Teaching and Curriculum, Tampa, FL

George Bush Presidential Library Foundation Graduate Travel Grant - Texas A&M University ($625). Role: Paper presentation, 2014 Annual Meeting of the American Education Research Association, Philadelphia, PA

Research Travel Grant - Department of Teaching, Learning & Culture, Texas A&M University, ($500). Role: Paper presentation, 2014 Annual Meeting of the American Education Research Association, Philadelphia, PA

Global Experience Scholarship - College of Education and Human Development, Texas A&M University ($1,250). Role: Graduate Research Assistant, 2014 Cardiff Wales Study Abroad Program

International Education Fee Scholarship - Texas A&M University ($1,000). Role: Graduate Research Assistant, 2014 Cardiff Wales Study Abroad Program

Multicultural Services Campus Climate Grant - Texas A&M University. ($200). Role: Graduate Research Assistant for Dr. Valerie Hill-Jackson. Analyzed Tiger Bride Documentary screening survey data.

Graduate Challenge Research Grant - College of Education and Human Development, Texas A&M University ($500). Role: Paper presentation, 2013 Annual Meeting of the American Association of Teaching and Curriculum, Chicago, IL

Research Travel Grant - Department of Teaching, Learning & Culture, Texas A&M University, ($350). Role: Paper presentation, 2013 Annual Meeting of the American Association of Teaching and Curriculum, Chicago, IL

Botanical Society of America - Planting Science Research in Education Fellowship - Texas A&M University ($5,400 of $644,965). Role: Graduate Research Assistant - Summer 2013 Recipient.

Botanical Society of America - Planting Science Research in Education Research Travel Grant - Texas A&M University ($1,200 of $644,965). Role: 2013 Teacher Evaluator, Chicago, IL

Botanical Society of America - Planting Science Research in Education Research Travel Grant - Texas A&M University ($1,600 of $644,965). Role: 2013 Teacher Evaluator, Cheyenne, WY

Research Travel Grant - Department of Teaching, Learning & Culture, Texas A&M University, ($500). Role: Paper presentation, 2013 Annual Meeting of the American Education Research Association, San Francisco, CA

Institute of Electrical and Electronics Engineers Scholarship – IEEE Houston, TX Chapter ($1,000). Role: 2012 Recipient.

Center for Urban School Partnerships Educational Grant -Texas A&M University ($1,250). Role: Participant 2012 Virtual Instructor Certificate Program

Center for Urban School Partnerships Research Travel Grant -Texas A&M University ($1,000). Role: 2012 Participant, Society and World Perspectives in Education, Dakar, Senegal

Institute of Electrical and Electronics Engineers Scholarship Research Travel Grant - IEEE Houston, TX Chapter ($1,000). Role: 2012 United States Representative, IEEE symposium on pre-university teacher training, Tampa, FL

Center for Urban School Partnerships Research Travel Grant -Texas A&M University ($750). Role: 2012 Observer, Harvard University African American History Lecture Series, Cambridge, MA

Region 4 Education Service Center Classroom Supply Grant - Houston, TX ($1,500). Role: 2012 Science teacher mentor

Region 4 Education Service Center Education Grant - Houston, TX ($500). Role: 2012 Science teacher mentor

Devon Energy / National Basketball Association Houston Rockets Classroom Supply Grant - Houston, TX ($100). Role: 2012 Recipient, Teacher of the Game

Center for Urban School Partnerships Research Travel Grant -Texas A&M University ($2,000). Role: Paper presentation, 2011 World Education Research Association Annual Focal Meeting, Kaoshiung, Taiwan

Office of Graduate Studies Research Travel Grant -Texas A&M University ($400). Role: Paper presentation, 2011 World Education Research Association Annual Focal Meeting, Kaoshiung, Taiwan

Research Travel Grant - Department of Teaching, Learning & Culture, Texas A&M University, ($300). Role: Paper presentation, 2011 World Education Research Association Annual Focal Meeting, Kaoshiung, Taiwan

National Science Teachers Association Travel Grant - ($2,000). Role: New Science Teacher Academy Fellow, 2010 National Science Teachers Association 58th National Conference on Science, Philadelphia, PA

Department of Teaching, Learning and Culture Research Participant Grant - Texas A&M University ($2,000). Role: 2008-2010 Participant, Professional learning community - Model for entry into teaching science

SERVICE

MEMBERSHIPS IN PROFESSIONAL ORGANIZATIONS

American Educational Research Association (2011 – present)

- *Division B - Curriculum Studies(2013 – present)*
- *Division L - Educational Policy and Politics (2012)*
- *Division K - Teaching and Teacher Education (2011 – present)*
- *Learning Sciences SIG (2012)*
- *Science Teaching and Learning SIG (2012 – present)*
- *Critical Examination of Race, Ethnicity, Class and Gender in Education SIG (2011 – present)*
- *Teacher as Researcher SIG (2011 – present)*

Institute of Electrical and Electronics Engineers (2012 – present)
National Association for Research in Science Teaching (2012 – present) Science Teachers Association of Texas (2011 – present)
National Science Teachers Association (2007 – present)
Texas A&M University Department of TLAC Graduate Student Association (2010 – *present) Pi Lambda Theta (2007 – present)*
Kappa Delta Pi (2006 – present)

UNIVERSITY SERVICE

Reviewer (2015)
American Educational Research Association
Proposal reviewer for the 2016 American Educational Research Association Annual Meeting.

Reviewer (2015)
Journal of Teacher Education
Selected to review a manuscript for JTE.

Reviewer (2014)
National Association for Research in Science Teaching
Proposal reviewer for Strand 11 (Cultural, Social and Gender Issues).

Reviewer (2014)
Urban Education
Manuscript reviewer for Urban Education.

Reviewer (2014)
National Journal of Urban Education and Practice
Manuscript reviewer for National Journal of Urban Education and Practice.

Reviewer (2013)
Kappa Delta Pi
Proposal reviewer for the Literacy Alive Project.

Reviewer (2013)
National Association for Research in Science Teaching
Proposal reviewer for Strand 4 (Science Teaching - Middle and High School Grades 5-12: Characteristics and Strategies) and Strand 11 (Cultural, Social and Gender Issues).

Reviewer (2013)
American Association for Teaching & Curriculum
Proposal reviewer for the 20th Annual American Association for Teaching and Curriculum Conference.

Reviewer (2013)
Science Teachers Association of Texas, Austin, TX
Selected as a Texas representative for the second draft review of the National Next Generation of Science Standards.

Committee Member (2015 -present)
Department of Teaching, Learning & Culture, Texas A&M University, College Station, TX
Invited committee member for the Climate & Diversity Graduate Student Grant Project.

Session Facilitator (2015)
Department of Teaching, Learning & Culture, Texas A&M University, College Station, TX
2015 Conference on Technology in Education: Connect & Engage!

Officer – Ad Hoc Committee (2014 - present)
Graduate Student Association, Department of Teaching, Learning & Culture, Texas A&M University, College Station, TX
Serve as Technology Coordinator for Distance Learners.

Officer – Secretary (2014 – 2015)
Kappa Delta Pi, Mu Chi Chapter, Texas A&M University, College Station, TX
International Honor Society in Education with the vision to help committed educators be leaders in improving education for global citizenship.

Officer – Vice President (2013 – 2014)
Kappa Delta Pi, Mu Chi Chapter, Texas A&M University, College Station, TX
International Honor Society in Education with the vision to help committed educators be leaders in improving education for global citizenship.

Officer – Program Chair (2013)
Kappa Delta Pi, Mu Chi Chapter, Texas A&M University, College Station, TX
International Honor Society in Education with the vision to help committed educators be leaders in improving education for global citizenship.

Webinar Presenter (2013)
College of Education and Human Development, Texas A&M University, College Station, TX Invited webinar presenter for the Project English Language and Literary Acquisition-Validation (ELLA-V) in the Center for Research & Development in Dual Language & Literacy Acquisition

Guest Lecturer (2013)
Department of Teaching, Learning & Culture, Texas A&M University, College Station, TX
Invited guest lecturer for Mixed Methods (EDCI 661) course.

Guest Lecturer (2011)
Department of Teaching, Learning & Culture, Texas A&M University, College Station, TX
Invited guest lecturer for the Planning and Development for Middle Grades (MEFB 352) course.

PUBLIC SCHOOL SERVICE

Institute of Electrical and Electronics Engineers (IEEE) Teacher In-Service Program Curriculum Trainer (2012)
Travis High School, Fort Bend Independent School District, Richmond, TX
Co-trained teachers participating in the Science, Technology, Engineering, Math (STEM) Made Easy workshop.

Ending Placement Initiative Committee Member (2011 – 2012)
Alternative Learning Center East, Cypress Fairbanks ISD, Houston, TX
Served on a committee established to discuss, design and implement new discipline procedures at CFISD's discipline alternative learning program in order to comply with new legislation for students to successfully return to home campus.

Texas English Language Proficiency Assessment System Rater (2010 – 2012)
Alternative Learning Center East, Cypress Fairbanks ISD, Houston, TX
Holistically rated the English language proficiency level of the English language learners enrolled at ALC – East.

Campus Improvement Plan Committee Member (2009 – 2012)
Alternative Learning Center East, Cypress Fairbanks ISD, Houston, TX
Developed, revised and monitored the implementation of the school district required campus improvement plan.

Building Better Relationships Campus Consultant (2009 – 2011)
Alternative Learning Center East, Cypress Fairbanks ISD, Houston, TX
Attended district meetings, acted as a consultant to new teachers, provided support for teachers struggling with classroom behavior issues and completed classroom observations in order to help teachers build better relationships in the classroom.

Personnel Service Committee Campus Representative (2008 – 2012)
Alternative Learning Center East, Cypress Fairbanks ISD, Houston, TX
Attended school district human resource meetings and communicated campus concerns to school district human resource personnel.

COMMUNITY SERVICE

Caring Aggies Mentoring Program Mentor (2011 – present)
Treasure Forest Elementary School, Spring Branch Independent School District, Houston, TX Serve as a monthly mentor to children as they develop through school; inspire them to pursue higher education by reinforcing excellent academic standards; build confidence and leadership skills; provide fun, life-enriching experiences; and present role modeling qualities of success.

Citizen School Volunteer Teacher (2011)
Sharpstown International School, Houston Independent School District, Houston, TX Designed *Chemistry in the Kitchen* curriculum for Citizen School and served as a volunteer teacher with a local middle school to expand the learning day for children in a low-income community promoting student achievement, school transformation and education re-imaging.

Forensic Competition Judge (2010 – 2013)
University Interscholastic League, State of Texas
Served as a high school forensic judge for various competitions including Dramatic Interpretation, Humorous Interpretation, Extemporaneous Speaking, Original Oratory, Duet Acting, Duo Interpretation, Impromptu, Prose/Poetry/POI, Public Forum Debate, Lincoln-Douglas Debate, Policy Debate, Debate Speaker and Congressional Debate.

NEWS MEDIA

Teachers present at statewide science teaching conference (2013, November 13)
http://www.cfisd.net/newsmedia/press/2013/1113cast.htm http://www.cfisd.net/en/news-media/district/teachers-present-statewide-science-teaching-conference/

ALC-East's LeBlanc named Rockets Teacher of the Game (2012, April 18)
http://www.cfisd.net/en/news-media/district/alc-easts-leblanc-named-rockets-teacher-game/

ALC-East teacher selected to speak at education research conference (2011, December 9)
http://www.cfisd.net/en/news-media/district/alc-east-teacher-selected-speak-education-research-conference/

Board recognizes Spotlight Teachers (2010, May 4)
http://www.thecfef.org/salutetostarspreview101.pdf

Science teachers chosen as NSTA fellows (2009, September 24)
http://www.examiner.com/article/nsta-honors-two-cy-fair-science-teachers

INTERNATIONAL EDUCATIONAL EXPERIENCES

Austria, Botswana, Canada, China, England, France, Germany, Greece, India, Italy, Malta, Mexico, Puerto Rico, Senegal, South Africa, Spain, Switzerland, Taiwan, Wales, Zambia

TECHNOLOGY PROFICIENCIES

Microsoft Office, Movie Maker, Camtasia Studio, Audacity, Video and Voice Podcast
Blackboard Collaborate, GoToMeeting, eLearning, eCampus, Moodle, Share Point
SMARTBOARD, Promethean Board Skype, YouTube