HOW CONTEXT IMPACTS ELEMENTARY TEACHERS' DECISIONS ABOUT SCIENCE INSTRUCTION

by

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(Under the Direction of Julie Kittleson)

ABSTRACT

Researchers have noted that most elementary science is didactic, lecture-based, worksheetoriented, and often includes teaching to the test. This situation begs the question: Is this type of instruction a function of the teachers themselves, or is this type of instruction a result of the context in which they teach, or both? This question indicates that elementary science education researchers need to look beyond the 'usual suspects' of content knowledge and attitudes and consider context as a much bigger player. Therefore, the purpose of this study is to explore the ways in which context impacts how three elementary teachers at Rosa Parks Elementary Charter School (RPECS) teach science in their classroom. Using a Cultural Historical Activity Theory (CHAT) lens, this study seeks to view teachers as components of a larger system and examines the contradictions present in these systems. Findings indicate that some components of activity systems are more influential than others; how teachers translate systemic components into instructional practice is dependent upon teachers' internal contexts; there were some contradictions all teachers in this study had in common that are most likely consistent with those of elementary teachers across the country; and while most contradictions led to more tension, teachers can and do find ways to push for growth within their systems. These findings have

implications for elementary school administrators, pre-service teacher educators, and policymakers in terms of professional development, administrational support, arming teachers with productive ways to cope with the realities of today's elementary schools, and the need to bridge the gap between policymakers and teachers to better understand the enactment of 'onesize-fits-all' reform initiatives.

INDEX WORDS: Elementary science, School reform, Cultural Historical Activity Theory, Context

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DEDICATION

This dissertation is dedicated to my elementary teaching colleagues who, day in and day

out, demonstrate a passion for educating children, regardless of the personal cost. I hope this

manuscript gives you voice and honors your intentions.

* * *

I mean, you're a teacher... Be honest. What do you make?

... I make kids work harder than they ever thought they could. I can make a C+ feel like a Congressional Medal of Honor and an A- feel like a slap in the face... I make kids sit through 40 minutes of study hall in absolute silence... I make parents see their children for who they are and what they can be. You want to know what I make? I make kids wonder. I make them question. I make them criticize. I make them apologize and mean it. I make them write. I make them read, read, read. I make them spell *definitely beautiful*, *definitely beautiful*, *definitely beautiful* over and over again until they will never misspell either one of those words again. I make them show all their work in math and hide it on their final drafts in English. I make them understand that if you've got *this* [a brain], then you follow this [your heart], and if someone ever tries to judge you by what you make, you give them *this* [the finger].

Here, let me break it down for you, so you know what I say is true: Teachers make a...difference! Now what about you?

From Taylor Mali's poem "What Teachers Make" (2002, p. 28-29)

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...and saving the best for last...

Thank you to my amazing husband, Trey, for believing in me when I didn't believe in myself, for pushing me when I wanted to give up, for editing and formatting papers, for drying my tears, for feeding my frustration with your delicious cooking, and for supporting me as I take this huge leap into the unknown. Your daughter and I are incredibly lucky to have you in our lives.

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CHAPTER 1

INTRODUCTION

In October of 2004, the National Public Radio affiliate WBEZ Chicago aired an episode of *This American Life* entitled "Two Steps Back" in which the host, Ira Glass, updated the listeners about a story he first reported on in 1994 when he was a contributor to NPR's *All Things Considered*. The subject of the original story was Washington Irving Elementary School in Chicago, a school that had beaten the odds through innovative teaching, focused school-wide reforms, and dedicated faculty. Their high-poverty, high-minority population progressed from 15% of students meeting national reading and math standards to two-thirds of the students doing so within five years. And then, slowly, everything that made Irving successful was taken away by the Chicago Public School district through a number of small mandates that demanded conformity as well as by a new principal who unquestioningly accepted those mandates. Irving had created very high expectations for their students, parents, and teachers, and the district required much lower, one-size-fits-all standards that destroyed Irving's key to success with their population. As a result, Glass's focus for the 2004 update was on outstanding teacher Cathy La Luz and how she was contemplating quitting.

"Two Steps Back" caught my attention because LaLuz's story resonated with me; it prompted me to wonder if the same thing that happened to Irving on a large scale happens to science instruction on a smaller scale in elementary schools. It could be entirely conceivable that teachers want to do much more in their classrooms – particularly pertaining to science – yet are hemmed in by standardized, top-down initiatives. In "Two Steps Back," Glass commented that

teachers often 'kill' school reform because, "[They] don't want to do it. They don't agree it'll work. They try it, it doesn't work at first. They fight among themselves, and it dies" (Glass, Dorr, Blumberg, Cook, Feltes, Koenig, Pollak, 2004). While it is perhaps too much to suggest that reform-oriented science instruction has been 'killed' in our elementary schools, it may be plausible to state that reform-oriented science has been pushed to the side because teachers do not believe it possible, considering the context in which they teach.

Researchers have noted that most elementary science is didactic, lecture-based, worksheet-oriented, and often includes teaching to the test (Fulp 2002; Smith & Southerland, 2007; Upadhyay, 2009). This begs the question: Is this type of instruction a function of the teachers themselves and their content knowledge about, as well as attitudes towards, teaching science, or is this type of instruction a result of the context in which they teach, or both? In the case of Irving, there were a number of small mandates on the part of the district that made a big difference in the way the teachers were then expected to teach. This scenario indicates that elementary science education researchers need to look beyond the 'usual suspects' of content knowledge and attitudes, and consider context as a much bigger player.

The context in which teachers teach is an incredibly complex arena, filled with myriad details that make the context different for each teacher. Consequently, it could be possible that what is restrictive for one teacher could buoy another up. When reading through literature concerning elementary science instruction and the problems found therein, the context of the studies are often given a paragraph's-worth of attention before the author then moves on to describe their data collection methods. However, mentioning the demographics of a school or the academic achievement levels of the students in the class hardly provides readers with enough information to truly understand the motivations for teachers' actions. I argue that without fully

acknowledging the complex context of schools, we paint an incomplete picture of the stimuli for instructional decisions because context may be exacerbating that which we already know is difficult for elementary teachers (i.e. issues of time, content, confidence, etc.). Moreover, while I acknowledge that some reform initiatives truly benefit children by assisting with reading, math, or writing, we must better understand what the trade-offs of these initiatives are, especially pertaining to science instruction at the elementary level. Therefore, this research seeks to explore the ways in which context impacts how three elementary teachers at Rosa Parks Elementary Charter School (RPECS) teach science in their classrooms.

In order to more accurately analyze the context and the actions resulting from that context, I used Cultural Historical Activity Theory (CHAT). CHAT is a framework that can allow a researcher to view teachers as components of a larger activity system, including the rules, tools, community, and division of labor. In this way, no teacher is seen as an isolate entity, but rather an actor in a very intricately interconnected activity system, reacting to and reflecting upon the context. Additionally, CHAT allows the researcher to examine contradictions, or tensions that may be present within and between components of the activity system. These contradictions may motivate teachers to promote the status quo despite the increasing tension, or to challenge the status quo to break the tension. Therefore, this research also investigates contradictions present within teachers' instructional context and whether these contradictions result in systemic growth, such as a change in rules or a request for more resources, or more tension and frustration on the parts of the teachers. Specifically, the questions guiding this research are:

1. How do elementary teachers' perceptions of the context in which they work impact their science instructional practices?

2. In what ways do contradictions present in the context result in tension or growth?

Findings from this research have implications for a number of stakeholders. First, preservice science teacher educators often struggle with how to prepare elementary teachers for the 'real world' while still keeping sound educational theory as a foundation. This research may provide insight concerning key skills and tools that may assist new elementary teachers to navigate the context so that they may teach reform-oriented science. School administrators may also benefit from the results of this research, as they will be able to observe the impact of multiple initiatives, how to streamline or integrate these initiatives, and support teachers in the difficult task of teaching science at the elementary level. Through examining systemic contradictions that result from multiple and often mutually detrimental initiatives, stakeholders may gain an awareness of types of tensions that exist in today's schools as well as how to transform contradictions into growth opportunities. Finally, policymakers may better observe the ramifications of multiple initiatives implemented within a school as well as the steps that may need to be taken in order to implement policies as they were designed.

In the next chapter, I will present a brief literature review outlining the state of elementary science education, the current educational context of the United States, and the outcomes of the intersection of these two. Chapter 3 describes the conceptual and theoretical frameworks that provide structure for this research, as well as the data collection and analysis methods undertaken. The findings will be presented in Chapter 4 in the form of cases studies for each of the three teachers and analyzed in a cross-case analysis. The conclusions and implications of these findings are in Chapter 5, as are the directions for future research.

CHAPTER 2

LITERATURE REVIEW

Introduction

The overarching purpose of this study is to better understand the context in which elementary teachers instruct and, more specifically, to understand how this context impacts instructional decisions concerning science. I hope to gain insight into why elementary teachers teach as they do, why reform-oriented science is often so difficult to implement at the elementary level, and why seemingly identical contexts may allow for or inhibit growth, depending on the teacher. Smith and Southerland (2007) observed:

[R]eform initiatives historically have often failed to account for the impact of unique situations within specific classrooms, classrooms that are found deep within the multiple complex layers of the overall school system...Until recently, the influence of particular institutional contexts and the role of individual classroom teachers (arguably the most critical layer of the school system in terms

In light of this frequent omission of context when discussing elementary science, it is imperative that this exploration of context and instructional decisions be a multidimensional exploration, with a deep understanding of exactly what the context entails, as well as a coherent lens through which to view this context. The literature review serves as a foundation for exploration, focusing on topics that the reader will find necessary in order to truly appreciate the participants' stories as well as the analysis of these stories.

of efforts to change what happens in schools) have been disregarded.... (p. 397).

The bedrock of this chapter is the lens through which I chose to view this research:

Cultural Historical Activity Theory (CHAT). Therefore, I will begin with a brief overview of the tenets of CHAT so readers can better understand the motivations for focusing on certain issues in the literature review and throughout the dissertation. Following this discussion, I will describe the present state of elementary science in the United States, including possible reasons for its current condition, as well as a summary of the national and state context within which this research occurs. Finally, the intersection of elementary science and school reform will be surveyed, as this intersection creates the reality for elementary science teachers.

Cultural Historical Activity Theory: A Brief Overview

While CHAT will be discussed in further detail in Chapter Three, the basic tenets of CHAT will be explained here, as they undergird each decision made in this study. Engeström (2001) listed the following as the five basic tenets of CHAT:

- The activity system is unit of analysis
- There is multi-voicedness within a system
- Activity systems evolve over time and can only be understood against their own history
- Contradictions are a source of change
- There is the possibility of expansive transformations as a result of contradictions over time

According to CHAT scholars, examining an activity system as a whole is much more fruitful than examining individual pieces. When considering the system, it is easier to see multivoicedness, or multiple perspectives, within the system. Each teacher in this study is viewed as a component of a larger activity system, or context.¹ Therefore, studying the teachers' activity systems in their entirety will allow a better glimpse into the multiple factors a teacher must take into account when teaching science, as well as multiple perspectives that come from others as well as from the teacher herself.

Concerning the historicity of a system, the old adage, *You can't know where you're going until you know where you've been*, holds true. In this case, one cannot understand the present state of science instruction in elementary classrooms without also understanding the history that has brought it to this point as well as what lies on the horizon. Engeström (1993) stated, "An activity system always contains sediments of earlier historical modes, as well as buds or shoots of its possible future. These sediments and buds – historically meaningful differences – are found in the different components of the activity system..." (p. 68). Consequently, the history of not only RPECS but also the district, state, and nation, in terms of education, is relevant to this study. It is also important to keep in mind educational reforms or programs coming in the future, such as the Common Core Standards or Race To The Top.

Finally, contradictions are not fights or problems, but rather tensions that accumulate over time (Engeström, 2001). There are four major types of contradictions as described by CHAT; these will be discussed in more detail in Chapter Three. Contradictions may be within or between particular components of the context. What is important to note is that contradictions or tensions are what cause contexts to change over time, although it may happen in fits and starts. In this way, systems can function for a great deal of time, ignoring contradictions and keeping equilibrium, until the contradictions can no longer be ignored. It is then that expansive learning takes place and the system can change.

¹ In this study, I will treat 'activity system' and 'context' as synonymous. See Chapter 3 for further detail on CHAT and context.

CHAT tenets are key in understanding the decisions made concerning this research.

Pertaining specifically to the following literature review, the topics of elementary science and the history/future of school reform in the United States aid readers in seeing teachers as a component of a much larger context that has a past, present, and future, and incorporates multiple viewpoints. Moreover, these topics give readers the background necessary to recognize contradictions in the American educational system that trickle down to Rosa Parks Elementary Charter School and motivations as to why teachers may choose to maintain the status quo or push for change.

Elementary Science

For many science educators, the instruction of science at the elementary level is often a vexing topic due to many reports of low-quality instruction. Literature on how to 'save' or 'fix' the ills of elementary science abounds. While this frustration probably began much earlier in the century, Tilgner (1990) referred to an American report that stated, "Science instruction at the elementary level, if occurring at all, is low in quality...too infrequent... [and] ineffective" (p. 421). Twenty-one years later little had changed, as Sandholtz and Ringstaff (2011) observed, "Despite concerns about global competition and student achievement in STEM fields, the status of science education, particularly in elementary schools, is weak." (p. 514). And while there have been large strides made towards higher quality elementary science in the past forty years, most science instruction at the elementary level is still book-rich and inquiry-poor (Fulp, 2002; Johnson, 2007). Lee and Houseal (2003) noted that there are several factors that may result in low-quality elementary science instruction, such as content preparation, confidence, and physical resources for teaching science. Compounding these difficulties, elementary teachers may

struggle with the notion of science as inquiry (Johnson, 2006) and may not receive a great deal of science professional development (Sandholtz & Ringstaff, 2011).

It is common to find elementary teachers exhibiting avoidance behavior when it comes to elementary science instruction (Miller, 2010). This behavior may take the form of "finding ways not to teach science at all; postponing science lessons on flimsy pretexts; using fortuitous events to organise the science curriculum; and teaching using integrating themes as curriculum organisers, in which science has only token inclusion" (Appleton, 2003, p. 9). Perhaps the most commonly cited reason for this avoidance is that elementary teachers often lack the science content knowledge required to teach science well (Davis & Smithey, 2009; Miller, 2010). Elementary teachers are not only expected to be experts in all subject areas (i.e. math, reading, writing, social studies, and science), but also all areas of science (i.e. life, physical, earth/space) (Davis, Petish & Smithey, 2006), leaving elementary teachers to be a 'jack of all trades, master of none.' This lack of content knowledge then contributes to a lack of confidence in the ability to teach science (Appleton, 2003; Queenan, 2011). Many researchers have investigated this phenomenon, with one study reporting that 18% of elementary teachers feel well qualified to teach physical science, 25% for earth science, and 29% for life science, as compared to 76% for reading/language arts (Weiss, Banilower, McMahon & Smith, 2001).

If elementary teachers who are intimidated by teaching science are unable to avoid teaching science, they often resort to low-quality instructional strategies, focusing on fun activities that allow them to maintain control of the classroom rather than activities that actively engage students in science (Appleton, 2003). Fulp (2002) found that lecture was a common technique in elementary science, and that as the grades advance and the science content becomes more difficult, there is much more reliance on textbooks and worksheets (35% of K-2 lessons;

52% of 3-5 lessons) and less use of laboratory and hands-on activities (35% of K-2 lessons; 25% 3-5 lessons). This type of instruction lends itself to creating a fragmented view of science, making it difficult for students to create conceptual understandings (Appleton, 2002). Additionally, elementary teachers may keep to their own high-confidence topics while ignoring others (Fulp, 2002), resulting in a version of science that looks much more like language arts or social studies rather than science (Appleton, 2008). But while low-quality instructional strategies are disappointing, the most deleterious effect of inadequate science content knowledge/confidence is that teachers may pass on inaccurate information or fail to challenge students' misconceptions (Ball & McDiarmid, 1990).

While weak science content knowledge and confidence are major factors impacting the quality of elementary science instruction, ineffective elementary science instruction can also be a result of few or low-quality physical resources. Johnson (2006) stated that lack of equipment, consumable supplies, and curriculum materials can be barriers for elementary teachers attempting to teach high-quality science. Moreover, schools may specifically lack inquiry-oriented materials that could potentially guide teachers in science instruction (Davis & Krajcik, 2005). Wanting for materials can certainly impact a teacher's ability to teach science as inquiry. Marx and Harris (2006) noted, "Although it is clear that science inquiry is both a promising and achievable approach to science instruction, in most elementary schools today diminished...resources are available for the kind of high-quality instruction called for by science education reforms" (p. 469).

Lacking the physical materials necessary to teach reform-oriented science is problematic, but perhaps more so is the fact that many elementary teachers struggle with the notion of science as inquiry advanced by science education reform documents (Johnson, 2006). Teaching science

as inquiry is a difficult task in and of itself (Crawford, 2000), but can be exceedingly difficult for teachers who are attempting to teach in ways other than how they were taught themselves (Windschitl, 2003). Documents such as the National Science Education Standards (NSES; National Research Council [NRC], 1996, 2000) not only describe the benefits of teaching science as inquiry, but also what 'scientific inquiry' means and how to teach in this manner. However, in a 2000 national survey, it was discovered that nearly two-thirds of elementary teachers overall – 70% of K-2 teacher and 58% of 3-5 teachers – were unfamiliar with these documents (Fulp, 2002). Consequently, through a combination of ignorance of the standards and a deficiency in supporting materials,

...very few teachers of science have been empowered to teach science as it is conducted in the real world and, instead, settle for teaching science as isolated facts that are to be memorized and recalled for assessment purposes. Inquiry is a luxury, rather than a necessity... (Johnson, 2007, p. 133)

Even when they have adequate science content knowledge and physical resources, if elementary teachers are not familiar with what is involved in teaching science as inquiry, elementary students will continue to memorize facts and call this process 'science'.

It is possible that the aforementioned problems pertaining to elementary science education could be ameliorated through science professional development. Unfortunately, in a 2000 survey, Fulp (2002) determined that 24% of K-5 teachers had received no professional development in science within the previous three years. Further, Weiss et al. (2001) found that half of the teachers they surveyed had received fewer than six hours of science professional development. Thus, elementary teachers in need of the science process/content knowledge,

confidence, and materials essential to teaching science as inquiry are not receiving adequate assistance in order to make current and future science reform documents a reality.

While not a science reform document per se, *Taking Science to School* (Duschl, Schweingruber, & Shouse, 2007) is a guiding resource which states that our elementary students will demonstrate proficiency in science if they can work with scientific explanations, generate and evaluate data, understand the dynamic nature of science, and participate productively in scientific discussions. Obviously, the foundation for students' science experiences, then, should be built in elementary school. Therefore, hoping to improve the United States' global standing in science test scores and STEM careers while ignoring the distressing state of science at the elementary level is akin to hoping for ripe, juicy tomatoes to sprout from a neglected garden. Education researchers note that "to be fully, effective, reform efforts must begin in elementary school (Levy, Pasquale & Marco, 2008, p. 3) and that "better teaching is the lever for change" (U.S. Department of Education, 2000, p. 15). Therefore, the realities of elementary science instruction must be closely examined in order to pinpoint difficulties, and possible remedies must be discussed with stakeholders before being thoughtfully implemented. As one involved in both scientific and political realms, Ohio Senator John Glenn has wisely pointed out, "The future of our nation and people depends not on just how well we educate our children generally, but on how well we educate them in mathematics and science specifically" (as cited by National Academy of Science, 2010, p. 73).

School Reform in the United States

Elementary science education does not function in a vacuum; it is part of the larger American educational system. Elementary teachers are not free to teach whatever they wish whenever they wish because they work within a complex milieu involving multiple national- and

state-level school reform initiatives, past, present, and future. While the intersection of elementary science and the context of school reform in the United States will be discussed in detail later in this literature review, I will describe the national and state educational context in general in order to make readers cognizant of the complexities elementary teachers face on a daily basis *before* considering science instruction.

American educational reforms: A brief overview. American public education is just that: public. It is open to public opinion and scrutiny, as American tax-payers fund what happens inside school walls. Accordingly, since the dawn of American public education, there have been educational reforms, interventions, and initiatives enforced through national policies (Pajak, 2011). The foundation for the 'recent' school reforms was laid with the National Defense Education Act (NDEA) of 1958 and the first Elementary and Secondary Education Act (ESEA) in 1965. Educational reform then became so popular at the national level that the Department of Education was created in 1979 and made a cabinet-level agency in 1980 (Kessinger, 2011). In general, the school reform trends over the last 50 years can be described as follows:

The 1950s were characterized by a race not to the top, but into outer space, resulting in more emphasis on mathematics and science in the curriculum. The 1960s were defined by policies on equity issues related to race, gender, and special needs. The 1970s introduced the minimum competency standards movement...The 1980s thrust the issue of education onto the policy agenda with the release of the National Commission on Excellence in Education's report, *A Nation at Risk: The Imperative for Educational Reform* (U.S. Department of Education, 1983), making education a national priority in the United States. (Futrell, 2010, p. 433)

The remainder of the 1980s saw the publication of *A Nation Prepared: Teachers for the 21st Century* (Carnegie Forum on Education and the Economy, 1986), the creation of the National Board for Professional Teaching Standards (NBPTS), and a governors' Education Summit. Most recently, and most relevant to teachers in today's classrooms, was the 2002 passage of the No Child Left Behind Act (NCLB), which is a reauthorization of the 1965 ESEA (Futrell, 2010). Additionally, the Race To The Top (RTTT) initiative introduced in 2009 has provided impetus for change in classrooms across the country. Observing today's classrooms, one can see they are a reflection of the reform initiatives of the past, present, and future.

The popularity and abundance of school reform at the national level is most likely due to "society...view[ing] public education as both a vehicle and obstacle to effecting change" (Goldstein, 2010, p. 546). This is understandable, as change can be produced at an enormous level; currently, we have approximately 57 million students enrolled in K-12 schools, and will have 59 million students enrolled by 2015 (Futrell, 2010). In order to focus that change, there has been a recent push to increase the rigor at the early childhood level in all subjects (Brown, 2009). Therefore, while time is often spent in schools on reading and math in order to meet the objectives of these reforms, the current national standards state that science instruction should begin at the elementary level (Sandholtz & Ringstaff, 2011). Exactly how this push for increased rigor will happen is still under discussion, resulting in a very public and political national debate concerning our nation's schools.

No Child Left Behind. NCLB was signed into law by President George W. Bush on January 8, 2002. Since then, NCLB has been a lightning rod for controversy. Originally designed to increase achievement, particularly for disadvantaged students, while simultaneously increasing the role of the federal government in education, now-Secretary of Education Arne

Duncan labels NCLB as a 'toxic' brand such that the Department of Education tore down the NCLB logo outside its main entrance (Cruz, 2009). Although NCLB is now 10 years old and on its way to being replaced by Race To The Top (RTTT), it is imperative to understand NCLB and its consequences in order to better understand the present state of education in the United States. The major points of NCLB are as follows:

- Annual Testing → By the 2005-2006 school year, all students in grades 3-8 were to be tested each year in math and reading; by 2007-2008, students had to be tested in science at least once in elementary, middle, and high school. Samples of students in 4th and 8th grade from each state were required to participate in the math and reading National Assessment of Educational Progress (NAEP) tests
- Academic Progress (AYP) → AYP is calculated through students' participation in standardized testing (the state in which this research takes place requires 95% participation), their performance on those tests, and a second indicator, which is typically the attendance or graduation rate. The most important piece of this equation is that by the 2013-2014 school year, 100% of students should be 'proficient' as measured by the annual tests. During each year preceding this cut-off date, schools are to make adequate yearly progress (AYP) towards this goal as determined by state formulas. Different interventions/penalties exist for schools which do not make AYP for multiple years in a row.
- Teacher Qualifications → By the 2005-2006 school year, all core subject area teachers as well as all paraprofessionals had to be 'highly qualified' as determined by years of college completed and certification tests passed ("No Child Left Behind", 2011).

The basic criticisms of NCLB follow these points, as each major point has been quite controversial. Concerning annual testing, administrators and teachers alike have found that tests have become the main driver for the curriculum and that teaching to the test has become a common practice in order to meet the AYP objectives (Kober, Jennings, & Peltason, 2010). Regarding this push for testing and the often early March administration of tests, teachers in a study conducted by Shaver, Cuevas, Lee, and Avalos (2007) made comments such as, "'I have to cram everything in," and "[I'm] not completing anything in detail, just exposing them [the students to the material]" (p. 735). Moreover, teachers in this study commented that once testing was over, teaching was an exercise in futility, as students knew whether or not they were passing to the next grade before the school year was complete. Perhaps the best summary of how yearly testing has impacted the elementary classroom comes from yet another teacher in Shaver et al.'s study:

[In] fourth grade: reading, writing, reading, writing Forget everything else, fifth grade: math, math, math...So whatever grade you're testing, that's where your focus is. ...so you do what you gotta do to get it done. And that's what happens. (p. 735)

While the cry for accountability is strong, the consequences of yearly testing may not necessarily be what the policymakers had in mind.

Another criticism concerning NCLB is that it does not account for diversity in student populations, which can have fall-out related to annual testing and AYP. One of the main goals of NCLB was to close the achievement gap, but holding all students to the same expectations, regardless of class and other factors related to poverty, has led to some controversy. Data from NAEP testing shows that child poverty can be linked to 40% of the variation in averages on

reading scores and 46% of the variation in averages on math scores (Ladd & Fiske, 2011). Consequently, the Center on Educational Policy (CEP) has recommended that the next reauthorization of ESEA, "Consider broader social factors that affect students' achievement and readiness for school" (Kober et al., 2010, p. 8). Factors that can affect students' achievement in school include health and nutrition, parental education and involvement, and availability of community resources for learning, which are related to rates of poverty. CEP notes that students in high-poverty, high-minority districts typically receive less state and local funding than lowpoverty, low-minority districts. This is felt by teachers in high-poverty schools through the lack of resources for their classroom and professional development (Kober et al., 2010).

The measurement and concept of AYP is a third criticism of NCLB. By the 2013-2014 school year, 100% of students are to be proficient in math and reading/language arts, which is an unrealistic target for a number of reasons. Each state was required to set benchmarks for AYP in each year leading up to 2013-2014, which, in essence, creates moving targets for schools. Some states have even 'backloaded' their benchmarks, creating incredibly steep goals as 2014 approaches (Kober et al., 2010). The benchmarks for the state in which this research takes place can be seen below in Table 1. With slow gains required in the early years of NCLB, this state could be considered to be consistent with Kober et al.'s definition of backloading. This criticism is especially relevant to the context of this study, because as we approach 2014, teachers are feeling increased pressure for all students in their classroom to achieve at a high level on the state standardized tests in math and reading, resulting in math and reading being the main priorities throughout the school day.

The CEP refers to AYP as a 'status' model rather than a 'growth' model, in which,

With limited exceptions, schools and districts are not credited for gains made by

students below or above the proficient level, and percentages proficient may

fluctuate for reasons that have more to do with differences among cohorts of

students rather than with changes in learning. (Kober et al., 2010, p. 12)

Furthermore, schools that do not meet one AYP goal are treated exactly the same as those that do not meet several goals (Kober et al., 2010), which can be demoralizing to schools with tough populations that are making gains, such as RPECS. In 2009, the CEP asked administrators,

Table 1				
State Benchmarks for Math and Reading Scores on State Standardized Test				
2003	50.0%	60.0%		
2004	50.0%	60.0%		
2005	58.3%	66.7%		
2006	58.3%	66.7%		
2007	58.3%	66.7%		
2008	59.5%	73.3%		
2009	59.5%	73.3%		
2010	67.6%	73.3%		
2011	75.7%	80.0%		
2012	83.8%	86.7%		
2013	91.9%	93.3%		
2014	100.0%	100.0%		

teachers, parents, and students, "If you met President Obama in an elevator and had 30 seconds to talk to him about the No Child Left Behind Act (NCLB), what would you say?" In response to the punitive measures enacted when students and schools do not meet AYP, teachers said that they would like to see more emphasis placed on the gains students are making, no matter how small. Teachers feel as though their progress is negated when they do not meet AYP. As one teacher stated, "[We are] not making products... [We are] making citizens" (Jennings, 2009, p. 2).

A final criticism relating to the goals of NCLB pertains to the mandate that all teachers and paraprofessionals be 'highly qualified.' The term 'highly qualified' is defined by NCLB as teachers who are licensed by the state to teach and have also shown competence in the subject matter that they teach, presumably measured by a test (Futrell, 2010). Unfortunately, the quality of a teacher, as determined by these measures demonstrates only one piece of a very complicated puzzle. The CEP stated, "In general, the highly qualified requirements have not improved the quality of instruction to the extent hoped for" (Kober et al., 2010, p. 18). And while there have been some inconclusive studies conducted attempting to link teacher effectiveness to test scores, the CEP encouraged that the reauthorization of ESEA should look into alternative measures of establishing teacher quality and should invest in professional development for in-service teachers, recruitment and mentoring programs, and data systems that better link teacher and student performance (Kober et al., 2010).

NCLB has come under fire not only for its basic goals, but also for the lack of funding and capacity to achieve these goals (Kober, et al., 2010). Between 2001 and 2004, President Bush increased federal education appropriations from \$29.4 billion to \$55.7 billion. However, this is a drop in the bucket compared to what is actually needed to fund NCLB initiatives on a regular basis. In CEP's letter to President Obama they argued,

Several teachers said they require proper resources and support to help their students achieve at the level necessary to be successful...Given the intense needs

of students and the pressure to produce adequate test scores, many teachers felt that if they had sufficient and proper resources they would be able to help their students achieve more. (Jennings, 2009, p. 1)

Furthermore, there have been schools that did not meet AYP, and thus qualified for assistance through NCLB, but were then denied funding as soon as they met AYP and slipped back into needing improvement due to this lack of funding (Kober et al., 2010). While it is difficult, to say the least, to meet all of the objectives set out by NCLB, to meet these objectives with a serious lack of funding is nearly impossible. Unfortunately, teachers bear the brunt of the backlash when these failures become public (Goldstein, 2010).

Whether one falls on the side of supporting NCLB because one believes teachers should be held accountable for their students' achievement (Jennings, 2009), or one believes NCLB is, as Fullan (2009) suggests, "one of the weakest system reform strategies that one can imagine...[with u]nattainable goals, little investment in capacity building, narrow and overloaded testing, [and] ridiculously short timelines" (p. 110), it is a reality for administrators, teachers, and students who spend each day in schools. The consequences of NCLB, whether intended or not, have been a narrowing of the curriculum and increased pressure on schools to turn out high-achieving students, regardless of students' backgrounds or personal issues. The public, aided by the media, now believe,

Standardized tests are the *sine qua non* of assessing school quality; our public schools are failed and cynical institutions; teachers are self-interested unionists; education faculty are woolly apologists for the status quo; explanations of school problems – including the impact of poverty on children – are only "excuses"; there is no correlation between school quality and school funding; the punitive

imposition of high stakes tests and centralized standards will "shape up" malingering students and teachers; re- search in education should exclusively follow certain quantitative models; voucher advocates are the true sponsors of minority advancement; etc. (Shaker & Heilman, 2004, p. 1456)

Teachers across the United States feel the weight of the world on their shoulders and the teachers in this study are no different. Each piece of the NCLB legislation has left a mark on these teachers' classrooms and impacts how they think about education in general. NCLB has influenced what teachers believe they can change and what they must accept. While NCLB will soon be replaced by RTTT (many measures in RTTT were implemented beginning in 2010 by the state in which this study takes place), it is a major historical piece of the context that betters allows us to understand the present state of education in the United States overall and at RPECS specifically.

Race To The Top. Keeping in mind that the concept of historicity in a CHAT framework not only includes the past, but also the future, it is important to be cognizant of school reform legislation that is on the horizon. While teachers at RPECS are living relatively firmly in an NCLB-influenced world, they are aware of future reforms that may require them to change the ways in which they teach. Therefore, it is important to examine the newest national school reform initiative, Race To The Top (RTTT).

In February of 2009, Secretary of Education Arne Duncan was given \$5 billion in discretionary funding. Out of that pool, Duncan and President Obama announced on July 24th of the same year the aggressive guidelines for states to compete for \$4.35 billion in the RTTT initiative (Cruz, 2009, Pennycook, 2011). In order to receive RTTT funding, states had to create plans that would align with the goals of:

- Removing barriers for the expansion of public charter schools
- Agreeing to adopt the national common core standards
- Creating a plan to turn around the worst schools
- Improving data systems

• Removing legal barriers to linking student performance and teacher pay (Cruz, 2009).

The goals salient to the context in which this research takes place will be discussed below.

Between 2002 and 2010, the number of charter schools in the United States more than doubled, (Debray & Houck, 2011) and as of January 2013, there were over 6,000 charter schools in operation (National Alliance for Public Charter Schools [NAPCS], 2013). Additionally, the number of students attending these charter schools tripled between 2000 and 2008, (Hess & Petrilli, 2009) and as of January 2013, there are now more than 2.3 million students enrolled in American charter schools (NAPCS, 2013). In particular, the state in which this research takes place has 109 charter schools in operation enrolling over 60,000 students as of January 2013 (NAPCS, 2013). What is truly interesting, however, is that while these numbers have skyrocketed and the proliferation of public charters schools is encouraged by the RTTT initiative, questions still remain concerning the links between charter schools and student achievement (Debray & Houck, 2011). What is known about charter schools, however, is that charter schools are typically exempt from union rules and other regulations that may interfere with national school reform efforts (Cruz, 2009). This point is relevant to teachers in public school classrooms because the message is that one way or another, teachers will have to comply with national school reforms; if teachers do not successfully comply with the assistance of protective teachers' unions and regulations, these protective measures will be taken away.

A second goal states were 'encouraged' to meet in order to receive RTTT funding was to adopt the national Common Core Standards. The push for Common Core Standards came from the National Governors Association and the Council of Chief State School Officers. Their goal was to produce standards in reading/language arts as well as in math that would prepare students for college or a career after high school. Thus far, 48 states have indicated they would adopt the Standards, and it is these states that are then given priority in RTTT funding (Debray & Houck, 2011). The state in which this research takes place has adopted both the math and the reading/English language arts standards and is part of the effort to create the Next Generation Science Standards (NGSS; Achieve, Inc., 2013). Incidentally, countries that education policymakers admire, such as Singapore and Japan, have a standards system similar to the national Common Core Standards (Toch, 2011).

Perhaps the biggest issue within RTTT is teachers being held accountable for student achievement in a much more visible way (Cruz, 2009). What is interesting about connecting teacher and student performance is that while there may be a degree of correlation between teacher effectiveness and student achievement, the research is largely inconclusive (Kober et al., 2010). Perhaps because of this, performance pay is strongly opposed by teachers' unions and special interest groups (Debray & Houck, 2011) – which provides more impetus for the government to create charter schools. But although performance pay and thus, RTTT, is not popular with teachers' unions, it is fairly noncontroversial for the public as well as politicians from both parties (Debray & Houck, 2011).

Those who oppose RTTT see the initiative as focusing on the 'game' rather than fundamental change in education. Debray and Houck (2011) believed that RTTT allows the Department of Education to focus on "rewarding innovation rather than remediating or

restructuring current educational efforts" (p. 322). Outspoken educational policymaker Diane Ravitch stated that the purpose of RTTT is to "lure or bribe or implore or compel states and school districts to do things that we don't actually know are going to make things better" (Cruz, 2009, para. 15). Moreover, Ravitch warned, "On their present course, [Duncan and President Obama] will end up demoralizing teachers, closing schools that are struggling to improve, dismantling the teaching profession, destabilizing communities, and harming public education" (Ravitch, 2010, para.11). While 'demoralizing' may be a strong word, it could be argued that school reform initiatives such as RTTT are making the daily action of teaching much more complex.

National context summary. The national context of school reforms, past, present, and future greatly impact teachers who are in public school classrooms. They are being asked to comply with reforms they have no hand in creating. Furthermore, in some cases, teachers are being asked to do things in their classrooms that they believe are counterproductive to student learning (Rose, 2010). The CEP stated that "When the federal government enacts short sighted policies without a clear, strong basis in research, it risks misdirecting its tremendous influence and resources and creating problems down the road for millions of children" (Kober et al., 2010, p. 7). In addition to many governmental school reforms being 'short sighted,' they typically do not take into account the local context, which can exert a considerable influence on the success or failure of school reform efforts (Kober et al., 2010; Hatch, 2009). Moreover, even though teachers attempt to work within or around the school reforms in order for their students to succeed, they are often called lazy, uncaring, or not as intelligent as other professionals (Goldstein, 2010). As Pennycook (2011) summed up, "teachers increasingly become pawns in a dubious statistical process that shames and blames indiscriminately" (p. 128). National school
reform is a daily reality for teachers in classroom, and is a large part of the context in which they work.

School Reform Enacted at the State Level

Continuing to describe the historicity and multivoicedness of the RPECS context, it is important to understand the educational milieu at the state level. This research was conducted in a southeastern state in the United States. Recently, the state had elected a new governor whose commitment to education can be summarized in the following statement on his "Issues" website: "We must increase rigor and ensure that our requirements truly prepare students to compete nationally and internationally."² To those ends, the state has adopted the Common Core Standards in math and reading/English language arts beginning in the 2012-2013 school year, will use the Common Core Assessments which will begin in 2014-2015, and won \$400 million in RTTT funds in August 2010.

As a result of receiving the RTTT funding, policymakers in this state have made plans concerning education that will affect teachers around the state. On the state's website concerning the RTTT grant, they outline how they will use the money by

...strengthening traditional and alternative preparation programs for teachers and leaders, supporting teachers more effectively in the classroom, evaluating teachers and leaders with consistent and objective criteria, rewarding great teachers and leaders with performance-based salary increases, and more effectively using data to inform decision-making.

In particular, the state is putting a great deal of money towards two programs, UTeach and the Innovation Fund. UTeach is a program that encourages undergraduate math and science majors

² Information regarding the state context in this dissertation was taken from state/gubernatorial websites. However, to ensure anonymity, these references will not be cited.

to go into secondary teaching. The Innovation Fund is money that can go to school districts, charter schools, nonprofit business, and institutions of higher education that create 'high impact' programs that will improve student achievement. Among other things, the Innovation Fund is also being used to further STEM instruction. In addition to these programs, school districts that have partnered in the RTTT grant will serve as 'innovation incubators' so that reform strategies developed in those districts can be scaled up for the rest of the state.

While RTTT promises exciting new things for the future of education in this state, we must also take into account the state's current educational context, which includes a very prominent standardized test. The state standardized test, as in many states, creates such a high-pressure situation that there was recently a cheating scandal involving several teachers and administrators within a school district. In 2009 in a major city in the state, 38 principals and over 100 teachers in 56 schools were found to be involved in cheating on the state test and the cheating had been going on for several years. The state website asserts that there were a number of factors that led to the cheating, but the major impetus to cheat was "the pressure to meet targets in the data-driven environment."

This high-pressure situation in which school reform and testing are at the forefront of educational conversations is further complicated by the economy in the state. The state's economic climate is one in which the unemployment rate is hovering between 9% and 10%. It is of the utmost importance for teachers to do an exemplary job and complain as little as possible in order to continue their employment. During 2011, the average unemployment rate in this state was approximately 10% and teachers were either given furlough days in which they were not paid or simply laid off in several school districts around the state. In 2010, a major state

newspaper reported that 3,500 of the state's 118,000 teachers would not be returning for the 2010-2011 school year due to economic cut-backs.

State context summary. Certainly the state context is a product of the national context in terms of educational reform and initiatives. The pressure to perform well on standardized tests comes from the NCLB, but is compounded by the difficult economic climate within the state. Additionally, teachers in classrooms are looking toward an uncertain future with the adoption of the Common Core State Standards as well as the RTTT grant award. As elementary teachers in this southeastern state enter their classrooms each day, they are fully aware of the enormous task they have undertaken and the dire consequences for themselves and their schools if they fail. Moreover, teachers in general are aware that national and state educational policies increasingly control the curriculum, instruction, and assessment in their classrooms – tasks that teachers themselves used to have more control over (Shaver et al., 2007). Consequently, more now than ever, no teacher teaches in a vacuum; classroom instruction is now a product of the environment in which it takes place. Therefore, it is of the utmost importance to examine precisely how this context impacts instruction.

Elementary Science and School Reform: A Productive Intersection?

As Southerland, Smith, Sowell, and Kittleson (2007) noted, "For decades, there have been a number of calls to reform science teaching and learning. Typically, these calls have been in response to a real or rhetorically expedient crisis invoked by policy makers," (p. 47). Certainly many Americans are familiar with the rush to improve science education following the launch of Sputnik in 1957 as well as the push for a massive educational overhaul after the 1983 release of A *Nation at Risk: The Imperative for Educational Reform* (National Commission on Excellence [NCEE], 1983). However, as of late, there is a significant difference in 'science education reform' and school reform in general. The *National Science Education Standards* (NSES; NRC, 1996, 2000) and the more recent *A Framework for K-12 Science Education* (Framework; NRC, 2012) both suggest ways in which to teach and organize the science curriculum to ensure maximum learning, with the emphasis on science as inquiry. While these concepts may be officially espoused in national school reform mandates (i.e. NCLB and RTTT), as will be seen, these visions of science are often seen as incompatible with state standards and accountability measures (Southerland et al., 2007). While school reform initiatives are inherently designed to improve teaching and learning, the everyday enactments of the reforms may not live up to the original visions of the documents. Moreover, pertaining specifically to science at the elementary level, we must be aware that there are trade-offs involved in reform initiatives that while beneficial to math or reading instruction may be detrimental to science instruction.

The 2002 NCLB legislation made reading and math priorities due to testing, with science testing in grades 3-5 to begin five years later, in the 2007-2008 school year. Although many science proponents were initially dismayed by the lack of emphasis on science, they were hopeful that the 2007-2008 school year would bring science back into the spotlight (Shaver et al., 2007; Marx & Harris, 2006). However, it is important to note that while science was required to be tested in the 2007-2008 school year, it was not included in AYP calculations (Marx & Harris, 2006). This means that while schools had to test elementary students in science, there were no penalties or rewards associated with these scores – in effect, it was a mandate 'without teeth.' For the state in which this research takes place, science scores will not be included in the state's AYP reports until the 2012-2013 school year, with the 2011-2012 school year being a 'hold harmless' year in terms of science scores. This was a voluntary inclusion on the state's part for RTTT purposes, and the state explained this choice as follows on their RTTT application:

The rationale for this strategy [the inclusion of science scores in AYP] is twofold: First, student interest in and preparation for science in high school must begin at the elementary level. Unfortunately, teachers and principals often deemphasize science, partly because of the strong focus on reading and mathematics, where distinct accountability consequences are in place, and partly because many elementary and middle school teachers lack strong content knowledge in the sciences. Second, since what is measured matters, requiring science as a second AYP indicator will put an instructional focus on teaching and learning the subject.

The key point made by this state is, "what is measured matters." As will be seen, this point has incredible implications for elementary science in terms of the time allocated to science and the science curriculum.

In 2000, Horizon Research conducted a survey of K-5 teachers and found that they spent 25 minutes on science instruction each day, as compared to 114 minutes on reading/language arts and 53 minutes on math (Fulp, 2002), demonstrating the lack of emphasis on science at the elementary level. Given its low status, science was pushed even further to the side after NCLB, as what is on standardized tests is taught while what is not is omitted from the curriculum, or at least given short shrift. As a result, many districts and schools have reduced instructional time for science, social studies, the arts, and even recess to meet NCLB requirements (Kober et al., 2010, Griffith & Scharmann, 2008). Several researchers have examined this issue, and their reports about elementary science instructional time since the dawn of NCLB are alarming.

Observing 780 third grade classrooms, the National Institute of Child Health and Human Development Early Child Care Research Network (2005) noted that a mere 5.3% of the observed

time intervals were spent in science instruction as opposed to 47.7% in English language arts and 24.3% in math. A possible explanation for the meager amount of time spent on science, the CEP found that in 2007, 28% of districts had reduced instructional time for science since NCLB by 75 minutes per week on average. Compare this with 58% of districts increasing English language arts instructional time by 141 minutes per week and 45% of districts increasing math instructional time by 89 minutes per week since NCLB. For those districts reporting an increase in math/English language arts instructional time was cut by 33% (McMurrer, 2008). Similarly, Griffith and Scharmann (2008) surveyed 164 K-6 teachers across the country and found that 59.1% had decreased the amount of instructional time for science since the implementation of NCLB. Of those teachers, 71.8% had reduced science instructional time by 31 to 90 minutes per week. With decreased time available for elementary science, 53.6% of teachers surveyed spend 90 minutes or less per week on science.

This reduction in science instructional time seems to be a slippery slope, as some schools may omit science altogether from their curriculum for some or all of their students. For example, Griffith and Scharmann (2008) found that students who are struggling in math or reading may receive double periods of these subjects while missing other subjects, such as science. Moreover, in schools that have low test scores and have been targeted for improvement, little or no time is spent on science instruction schoolwide (Sandholtz & Ringstaff, 2011). Lee and Luykx (2005) even found that some elementary principals – especially those in schools that are threatened by state takeover as punishment for poor performance on state tests – explicitly tell teachers to teach only subjects included on the statewide tests during the two or three months prior to the test. Exemplifying the (lack of) importance of science instructional time, a Washington state teacher

observed, "If I said that I didn't teach reading, I would be fired. If I said I didn't teach science, they would say, 'Well, try and work it in more,'" (Carroll, Castori, Stokes, Hirabayashi, Lopez, Mitchell & Regan, 2009, p. 26)

Echoing these findings, in 2006, the president of the National Science Teachers Association (NSTA) stated,

Science is not being reformed in our elementary schools because some teachers are directed to omit it. I've heard from elementary teachers who say that their administrators have told them to drop science from the curriculum because there is simply no time for it: They are to concentrate on reading and math. NCLB legislation requires testing in reading and mathematics, and administrators are held accountable for those test scores. This mandate has squeezed science out of many elementary schools, especially elementary schools with low-income and minority students. (Froschauer, 2006, para. 5)

Certainly in this atmosphere of extreme accountability, teachers feel as though their jobs depend on their students performing well on standardized tests. Consequently, even if teachers are not directed to omit science by their superiors as Froschauer indicates, teachers may feel as though they have no other choice than to decrease science instructional time or cut it out completely (Marx & Harris, 2006; Griffith & Scharmann, 2008).

On the surface, it seems that decreased time for science instruction simply reduces students' exposure to science topics and practices. However, there are deeper implications regarding the quality of science instruction in the elementary classroom. Reform documents extol the virtues of inquiry-based pedagogy (e.g. the NSES) but this type of instruction takes a great deal of time to plan and enact in the classroom, butting up against directives that reduce

time allotted for science. Sandholtz and Ringstaff (2011) found that 44% of their participants reported not enough time to plan for hands-on science, as this type of instruction requires more preparation than using textbooks. And even if elementary teachers can find time to plan reform-oriented lessons, implementation of these lessons may take more time than they have available. Marzano (2003) observed the overwhelming curriculum 'coverage' required in such a limited amount of time: "Can the 200 standards and 3,093 benchmarks be taught in the actual time available for instruction? The answer is a resounding no!" (p. 25). Thus, teachers may resort to textbook-based instruction simply for time's sake (Southerland et al., 2007). Often required to have students practice for testing, teachers quickly realize there is not enough time for experiments and inquiry, especially since all standards must be covered in time for testing in March or April rather than the end of the school year (Shaver et al., 2007).

The push for coverage from the textbook has disastrous effects, as this type of instruction strips students of their ability to act on their natural curiosity through inquiry (Marx & Harris, 2006). Teaching science as inquiry in the NCLB/RTTT era of accountability, teachers are pulled in two very different directions, as Wallace (2012) clearly described:

To teach science as inquiry, the teacher must carry out the dual and contrasting purposes of (a) promoting independent thinking and autonomy and (b) training all children to think the same way and recall the same factually based relationships on examinations. (p. 299)

Wallace's observation illustrates the clash of reforms – science as described by the NSES versus the call for high achievement on standardized tests as mandated by NCLB and RTTT – and how elementary teachers are often put in an impossible situation concerning instructional strategies for science. Another potentially serious consequence of this clash is that science as inquiry will

become something only for elite, upper-class schools, as struggling poor and minority schools are required to devote more time to test preparation rather than the time-intensive reasoning and investigation found in inquiry (Marx & Harris, 2006). The apparent ideological conflicts between reform-oriented science and national school reform lead the science education community to be concerned that the need for short-term success on standardized tests is overshadowing the need for long-term success in science. In other words, teachers are being asked to comply with reforms rather than to meet the needs of their students (Klieger & Yakobovitch, 2010).

Finally, struggling to meet the reform mandates in all subjects, teachers may strictly adhere to the 'what is measured matters' credo while also observing the inverse: 'what is *not* measured does *not* matter'. This narrowing of the curriculum results in science that is "fractured, unconnected to context, and out of balance" (Goldston, 2005, p. 186). Rather than presenting science as a coherent discipline, teachers are pressed to transmit isolated facts and teach to the test, as the standardized test becomes the *de facto* curriculum, especially in failing schools (Settlage & Meadows, 2002). Sadly enough, as most standardized tests emphasize low-level knowledge and basic skills covering a huge amount of content, higher-order thinking and deep understanding of science may be completely disregarded in elementary classrooms (Shaver et al., 2007; Southerland et al., 2007). Quite simply, NCLB has forced teachers to focus on every tiny detail of science, leading to the 'mile wide and inch deep' elementary science curriculum found nationwide (Southerland et al., 2007).

Summary

As long as there have been schools, surely, there has been some form of school reform. While these reforms are designed to improve student learning, some reforms can be quite detrimental to the teaching and learning that takes place in the elementary classroom, particularly

in science. Cognizant of the fact that these policies make up elementary teachers' day-to-day reality concerning science instruction, it is a worthy undertaking to examine the nuanced ways in which context can impact instruction. Clearly, if school reform and/or science education reform is to be successful, more attention must be paid to the interactions of factors within contexts and their impacts on science instruction. Moreover, if we are to improve science education, it must begin at the beginning. It must begin at the elementary level.

CHAPTER 3

METHODS

Introduction

This chapter begins with a description of the conceptual and theoretical frameworks that form the foundation of this research. From there, I describe the research methodology, participant selection, research context and data analysis. Finally, I describe my role in conducting this research as well as possible subjectivities I hold.

Conceptual Framework

This study is the investigation of how *context* impacts science instruction in elementary classrooms. Understanding context is crucial for understanding teachers' instructional decisions, as "context has a potentially powerful influence on teachers' beliefs about both content and pedagogy" (Smith, 2002, p. 5). However, the notion of context can be elusive, as Jones (1997) explained: "Although most people have an intuitive notion of what context is, they cannot clearly define it...Context is said to have something to do with environment, something to do with conditions, something to do with the actors in a given situation" (p. 131). Nevertheless, many people do not think beyond the physical notion of context, in line with Nyan's (2011) statement that, "At its most basic, context can be looked upon as a non focal element which is, in some way, necessary to the occurrence of a focal element" (p. 205). In this way, context is simply seen as the 'background' or 'setting' for a particular action, such as teaching. I argue that context is much more than chairs and tables, bricks and mortar. As demonstrated in the literature review and by the basic tenets of CHAT, context includes physical space, a sense of historicity, and the many voices vying for attention within an environment.

Unfortunately, when context is viewed as something beyond a mere physical setting, scholars have noted the complexity involved in capturing this notion: "The heterogeneous nature of context…has made it almost impossible for the scientific community to agree upon a commonly shared definition or theoretical perspective, and frequently, only a minute aspect of context is described, modeled, or formalized" (Fetzer & Oishi, 2011, p. 2). In education, however, inroads have been made to consider the context of teaching in its entirety. In 1992, Ford extended Bandura's concept of self-efficacy to take into account context, resulting in a construct Ford termed "context beliefs." Specifically, context beliefs were defined as

...expectancies about whether the environment will be responsive to one's goal attainment efforts ("Does my context afford the *opportunity* to try to achieve my goal? Will my context make it easier or harder for me to attain my goal? Can I trust this context to support me or cooperate with me in what I try to do, or will I be ignored/rejected/attacked?"). (Ford, 1992, p. 45, emphasis in original)

Ford went on to state that in education, context can be thought of as encompassing the designed environment (buildings, equipment, etc.), the human environment (students, faculty, etc.), and the sociocultural environment (policies, norms, etc.). Ramey-Gassert, Shroyer, and Staver (1996) continued Ford's broader notion of context when they used the Science Teacher Efficacy Beliefs Instrument (STEBI) with a group of elementary teachers and created three categories for influencing factors: antecedent (prior schooling, etc.), internal (attitudes towards science, etc.), and external (workplace environment, etc.).

Building upon the idea that teachers' science instructional behaviors may depend upon beliefs concerning the context, Lumpe, Haney, and Czerniak (2000) created the Context Beliefs about Teaching Science (CBATS) instrument (see Appendix A for the CBATS). The CBATS

contains 26 items that are responded to via two different scales. The first scale asks teachers how much they believe the factor would enable them to be effective science teachers while the second scale asks teachers how likely they believe it is that the factor will become available to them. What is interesting about the CBATS and quite relevant to this study is that in line with Ford (1992) and Ramey-Gassert et al. (1996), the contextual factors on the CBATS go beyond the physical setting and include such components as people in the community, time, policies, and support. It should be noted however, that while this instrument was informative as I pondered the data collection methods for this study, I did not use the CBATS with my participants as I wanted teachers to organically describe what impacted their instruction rather than respond to my predetermined categories.

Smith and Southerland (2007) confirmed that "various aspects of the teaching context impact teachers' thinking about instruction" (p. 400). This statement is at the crux of the research at hand. Beyond the self-efficacy beliefs of teachers described by Lumpe et al. (2000), basic decisions about what to teach and how to teach it are influenced by the context within which the teacher exists. Consequently, it is important to take a broader view of the notion of context that includes much more than the physical setting. Consistent with Ford's (1992) notions of components of educational context, Jones (1997) noted that the context can include "the conditions of the classroom; the educational emphases of the school; the political, social and educational relationship between the school and the community; the financial resources available; the educational policies that govern teaching, and so on" (p. 132). Additionally, Smith and Southerland (2007) pointed out that context can include "the methodology a teacher utilizes, his or her instructional goals, and his or her beliefs and knowledge about subject matter and its relationship to what is appropriate or inappropriate to do with students" (p. 400).

Context can be thought of as two intertwined categories: externally imposed and internally constructed (Smith and Southerland, 2007). Under the umbrella of 'externally constructed' comes what is perhaps typical when one thinks about context: policies, space, time, power divisions. Brickhouse and Bodner (1992) divided external contextual factors into personal, bureaucratic, and technical control. Personal control consists of the influence of supervisors; bureaucratic control is concerned with regulations and social hierarchies; technical control includes much more basic items such as time for classes, physical resources, and building design. Within the category of internally constructed portions of the context come teachers' goals and beliefs (Smith & Southerland, 2007). Goals are what teachers want to achieve; beliefs are what teachers personally believe about teaching, learning, and science. Jones (1997) noted that there is an interaction between the internal and external realms of context, a give and take in which the external imposed context can impact the internally constructed context, and vice versa.

Taking a broader view of context allows me to take into account much more than the physical setting when exploring how teachers go about science instruction. It has been noted that in regards to the success or failure of reform initiatives, "Until recently, the influence of particular institutional contexts and the role of individual classroom teachers…have been disregarded (Smith & Southerland, 2007, p. 397). Similarly, Sarason (1990) argued that, "...the failure of educational reform derives from a most superficial conception of how complicated settings are organized: the structure, their dynamics, their power relationships, and their underlying values and axioms" (p. 5). Sarason's statement implied that the interplay of the elements such as rules, community members, and the division of labor are important to consider when examining the context in which educational reform – or simply day-to-day teaching – takes

place. Moreover, Nyan (2011) highlighted some of the CHAT tenets such as multivoicedness and historicity as being important to the notion of context as well:

As a construct, context begins by being largely based on the external environment. However, this situation is gradually reversed as experience increases on the individual level, and then is passed on to later generations. Once learning has taken place, past experience of prior environments is brought to bear, and context construction becomes more a matter of categorizing the current environment. (p. 219-220)

It is therefore this CHAT-inspired notion of context used in this study that makes the concept of context more robust than is typically found in educational research. Utilizing this broader view of context, I am able to better capture the complexity of science instruction at the elementary level such that it may be helpful to those outside schools.

Theoretical Framework

"Contexts are neither containers nor situationally created experiential spaces. Contexts are activity systems" (Engeström, 1993, p. 67). To observe science teaching within context then, and to accurately capture the complexity within the art of teaching, one must look beyond the teacher to the entire system. Thus, to study teachers as a component within a larger context, I have chosen to use Cultural Historical Activity Theory (CHAT) to frame this research. Scholars have documented that CHAT can work particularly well in settings in which the components of the context are well-defined, such as in health care, education, and work settings (Bakhurst, 2009). For example, in education, it is quite clear who the subject might be (a teacher), what a rule in that context might be (students must score well on tests), and what tools are available to that subject (textbooks, computers, science materials, etc.). Much more relevant to this study

however, is that it has been noted that CHAT "...manifests its applicability to classroom research. Although the complexity of CHAT may appear challenging, applying it to relationships between various constructs and components can reveal embedded organizational and contextual influences" (Nussbaumer, 2012, p. 45). Further, Roth, Lee, and Hsu (2009) stated that CHAT is useful for making visible normally invisible structures, processes, relations, and configurations; investigating issues concerning a larger system or across systems; and rethinking and empowering science learning (p. 145). As this is a study that is investigating how the context – something that typically goes without examination – impacts elementary science instruction, according to these points, CHAT is a beneficial framework to use.

CHAT has roots in Marxism, as Marx introduced the concept of activity as being more suitable to describe human behavior and understand change rather than mechanical materialism and idealism (Engeström & Miettinen, 1999). In the 1920s, Vygostky created his simple triangular model of human activity, which included a subject (perhaps a little girl), an object (picking an apple from a tree), and a mediating tool or artifact (a ladder to climb up the apple tree). This heuristic, which can be seen in Figure 1, is often referred to as the first generation of CHAT (Bakhurst, 2009).



Figure 1. A heuristic for first generation CHAT (Engeström, 2001).

The second generation of CHAT was begun in the late 1970s by Vygotsky's student, Leont'ev, who differentiated between activity, actions, and operations. In an activity system, Leont'ev defined a hierarchy of activity, with activity being the top level, actions being the middle level, and operations at the bottom level. He believed activities to be motivated by objects, which are then molded into outcomes; the objects of activities are realized through group or individual actions, which are short-lived, have a defined beginning and end, and are motivated by goals; operations are carried out automatically in response to the environmental conditions and help subjects achieve the goals of actions (Engeström & Miettinen, 1999). This differentiation allows researchers to examine activity at different levels. For example, attending college is an activity driven by the object of becoming educated and perhaps obtaining a job. To those ends, a student will perform the actions of writing papers, which are driven by the goals of completing assignments for specific courses. The operation of creating the paper – either by typing or handwriting – is driven by the conditions and tools available, such as the amount of time available, whether or not there is access to a computer, etc.

In 1986, Engeström extended Leont'ev's ideas into the commonly-accepted second generation CHAT triangle (seen in Figure 2), which now includes not only the subject, object, and mediating tools, but also rules, the community, division of labor, and the outcome of the activity. Engeström noted that development within a system is a result of the contradictions between and within these elements. These elements will be discussed in depth below. The most recent iteration of CHAT – the third generation, also crafted by Engeström – involves multiple systems interacting (Bakhurst, 2009) and can be seen in Figure 3.



Figure 2. A heuristic for second generation CHAT (Engeström, 2001).



Figure 3. A heuristic for third generation CHAT (Engeström, 2001).

This study will use a second generation CHAT model with individual teachers as the subjects, which is a common approach when using CHAT in classroom-based research. In fact, Nussbaumer (2012) performed a review of articles that focused on classroom research while using the CHAT framework and found that of twenty-one articles, fifteen used the second generation model. Moreover, fourteen out of the twenty-one articles focused on individuals as

the subject rather than on collective groups. While I will be making cross-case comparisons (i.e. between activity systems), I believe it is more fruitful to look at second generation models rather than third generation models, as I am examining the peculiarities of each case. Engeström and Miettinen (1999) have noted that 'local activity' such as the activity happening in each one of my teachers' systems, has historically formed mediating artifacts in common with societies at large. Therefore, in investigating the science instruction on a smaller scale, I will be able to make inferences about science instruction within RPECS as well as other elementary settings.

Looking at the second generation CHAT model, it is important to define each of the elements of this system.

- Subject → The person or group of people whose activity is being examined. The subject's goals and beliefs are part and parcel of the subject
- Object → The motive for the action; the object is not a 'thing' but rather a goal or purpose, as used in the phrase 'object of the game'
- Tools/artifacts (terms used interchangeably) → The subject may use physical tools, such as an AIMS resource book, or non-physical tools, such as discussing science plans with a collaborating teacher in order to meet the object and produce outcomes
- Community → Participants in the activity system, particularly those who have a stake in the object/outcome
- Division of labor → With Marxist roots, this originally dealt with the division of power and status. However, this term has been expanded to examine the different roles people play within the system
- Rules → Both explicit and implicit, this includes traditions, norms, standards, and beliefs within the system (Engeström, 1987)

Certainly this is a hefty undertaking for any researcher to study each of these components within an activity system. In fact, Arnseth (2008) stated that it is "impossible to cover all of the elements [of an activity system] equally well" (p. 293). However, this is why it is imperative to explore the relationships between the different elements and view the system as a whole rather than examining one element at a time.

While the basic tenets of CHAT were outlined in Chapter Two, they bear repeating in this section. Engeström (2001) listed the five tenets of CHAT as:

- Activity system is unit of analysis
- Multi-voicedness within a system
- Activity systems evolve over time and can only be understood against their own history
- Contradictions are a source of change
- There is the possibility of expansive transformations as a result of contradictions over time

Once again, this study will look at teachers' entire contexts when analyzing findings, as no one element will make sense without looking at the interactions throughout the whole system. This holistic approach allowed me to take into account the multiple perspectives in as well as the historicity of the context. Contradictions (or tensions) within the teachers' contexts are of particular interest in this research, as focusing on these holds the most promise for revealing 'invisible structures' or unseen issues, as will be described below.

When studying an activity system, there are four different types of contradictions that may occur:

- Primary contradictions → Contradictions within one element of the system.
 Ex. One rule states that students must pass reading and math standardized tests as all costs (often requiring extra instructional time) while another rule states that science must be taught for 50 minutes each day.
- Secondary contradictions → Contradictions between two elements of the system.

Ex. A rule states that collaborative teachers must plan all science lessons and enter them into the district website while the division of labor does not bear this out and classroom teachers end up writing the lessons.

• Tertiary contradictions → Contradictions between an activity as it currently exists and possible forms that are more advanced.

Ex. Science instruction in a classroom is currently book-based and 'boring', but a teacher has a vision for science in her classroom that is more advanced, hands-on, and reform-oriented.

• Quaternary contradictions → Contradictions between activity systems.

Ex. A teacher is being asked to teach science in a reform-oriented manner, but the district system does not provide scaffolds or supports for teachers to do so (Roth, Lee, Hsu, 2009).

In this particular study, primary, secondary, and tertiary contradictions exist. Quaternary contradictions will not be examined, as I am not utilizing the third generation CHAT model required to document these types of contradictions.

Again, these tensions are what cause the expansion or change of the system over time. Bakhurst (2009) stated, "The results of our activity stare back at us with meaning and this creates new needs and desires, engendering further activity that further transforms the world, which then confronts us with new demands and opportunities" (p. 203). How contradictions result in expansion of a system is similar to Kuhn's (1962) idea of normal versus revolutionary science where 'normal' science persists at equilibrium until new concepts and theories can no longer be assimilated into the current scientific beliefs and there is a burst of 'revolutionary' science. Likewise, contradictions can be ignored, pushed to the side, or accommodated for a while until the system can no longer bear these contradictions, resulting in a new reality of how the system functions. In this study, contradictions are examined for their potential for expansive learning, as these events can tell us a great deal about what may and may not be productive in elementary science settings.

Cognizant of the various tenets and components of CHAT, it is important to see how this theoretical framework can align with the concept of context. As demonstrated in Table 2, each element of the CHAT model aligns with an element of context. Thus, when describing the tools within a teacher's activity system, I am including the books and materials available to teachers as well as the people whom the teachers look to as resources, which are all items that fall under technical control. Rules, whether explicit or implicit, demonstrate the bureaucratic control within a system. The community working alongside the teachers – including supervisors – makes up part of the personal control component. The division of labor will include portions from the bureaucratic as well as the personal categories of context as the division of labor is concerned with the hierarchies of power as well as roles that people may play within a system. Finally, the subject is the holder of their own goals and beliefs.

Table 2 Alignment of CHAT Components With Contextual Elements						
CHAT Model	Contextual Element					
Component						
Tools	Technical Control	Externally Imposed				
Rules	Bureaucratic Control					
Community	Personal Control					
Division of Labor	Personal Control					
	Bureaucratic Control					
Subject	Goals	Internally Constructed				
	Beliefs					

It is because the alignment between contextual elements and the components of CHAT is so tight that CHAT once again is an incredibly appropriate and fruitful framework for this research. As a researcher, it is my duty to try to accurately capture the activity I am studying – not solely because I wish to be a researcher of integrity, but also because what I will share with the public has consequences. As stated by Lee (2011), "researchers…yield enormous power; they either are part of the solution or help to preserve the status quo" (p. 406). I believe that in conjunction with a broader notion of context, CHAT allows me to be part of the solution by giving teachers a voice and sharing with others the intricacies of teaching elementary science.

Setting and Participant Descriptions

As understanding the context in which this study took place is integral to the study as a whole, the local/school district context as well as the school context will be described in depth. Additionally, I will briefly describe the participants as well as their respective science curricula.

Local/school district context. The city of Sycamore, in which the school district is located, would be described by any outsider as a typical college town. Sycamore University³

³ All statistics concerning Sycamore University and the city of Sycamore itself are from either the University's website, state census statistics, or national census statistics. However, to ensure anonymity, these references will not be cited.

(SU) had a 2010 enrollment of approximately 35,000 students while the city itself had a population of approximately 115,000 in 2010. Therefore, SU is a huge presence in the town as well as the largest employer. SU employs approximately 10,000 people, with around 6,500 of those being faculty or professionals. The average salary for an assistant professor in 2010 was \$71,900 – other professional faculty and professor salaries are commensurate or higher. The remaining 3,500 employees of the university average a salary of around \$30,000 per year. Many of the higher-paid employees of the university tend to live outside the city in the affluent neighboring counties. While this may seem like information unrelated to the research context at hand, the income disparity within Sycamore University is quite astounding and often times is most evident when looking at the schools within Sycamore.

Sycamore is home to middle- and low-income citizens, with a total of 13 neighborhoods listed under the local housing authority and an average per capita income of around \$20,000. The 2010 Census listed a third of Sycamore's citizens (of all ages) as living in poverty. The citizens of Sycamore are 26.6% African American, 10.5% Hispanic, and 61.8% white.

The Sycamore School District (SSD) has 21 schools and has not met Adequate Yearly Progress (AYP) as a system for the past two years (although some schools within the district have individually made AYP). The demographics of the students in the schools are 52% black, 22% Hispanic, and 29% white⁴. The district has handed down several mandates to its schools, including a district pacing guide for each subject, monthly district walk-through evaluations, weekly data team meetings along with a complex set of forms to document the content of the meetings, turning in weekly lesson plans online, weekly grade level curriculum meetings, personal goal-setting, and attending a number of required professional learning days.

⁴ All statistics concerning SSD and RPECS are from the 2010-2011 school year and found on the district's website. However, to ensure anonymity, these websites will not be cited.

SU faculty from both inside the College of Education (COE) and across the university have a history of working with the SSD. Beginning around 2000, personnel from the COE worked with SSD, resulting in two elementary schools to enter into a partnership with SU. This first iteration of a school-university partnership evolved over time, which led educators from both SU and SSD to explore different kinds of school-university partnerships, resulting in the most recent iteration: a professional development school (PDS) district-wide partnership. What this partnership looks like varies from school to school, with some schools considered to be fullfledged PDSs while others simply have access to SU resources.

School context. The particular school in which this research was conducted was Rosa Parks Elementary Charter School (RPECS). The demographics of the school are different from those of the district, both in terms of ethnicity (24% black, 68% Hispanic, and 6% white) and in prevalence of free and reduced-price lunches (99% in the school versus 79% overall in the district), leading RPECS to be a Title I school. RPECS also differs from the district in that it *has* met AYP for the past two years. When the district built RPECS in 2009, it was from the groundup, both physically and metaphorically. The principal, Serena, was handpicked by the superintendent, and in turn, Serena was allowed to handpick her staff. Many of the faculty members at RPECS are young teachers, and there is a larger male presence in the school than is typically found at the elementary level (10 men out of 46 teachers).

RPECS is a local education agency (LEA) start-up charter school. The state Department of Education website defines this as "a new school started by the LEA as a charter school. The new school operates under the terms of a charter between the charter petitioner, local board of education, and the State Board of Education." In general, charter schools can request waivers from state and local laws and regulations and in return, the charter school will be held

accountable for the state performance-based objectives. However, the only waiver granted to RPECS was concerning teacher certification (one of the teachers was not a certified teacher), and for all intents and purposes, RPECS functions as a typical public school. As mandated by the district, RPECS's charter includes two schoolwide initiatives: a schoolwide enrichment model (SEM) and a foreign language component.

The SEM has required all teachers within RPECS to obtain their gifted certification, and gifted strategies are used with all students in the school. The SEM initiative also allows for students to take part in different types of enrichment activities, including once-a-week enrichment clusters. The foreign language component of the charter, on the other hand, requires much more on the part of the teachers. Due to its large Hispanic population, the district applied for a U.S. Department of Education Spanish Foreign Language Assistance Program (FLAP) grant at the end of the 2010-2011 school year with the goal of moving RPECS towards being a bilingual (Spanish/English) school; this grant provided the funding for the previously unfunded foreign language component of the charter. In the spring of 2011, this grant was implemented in K-2 classrooms during science and social studies instruction. The format of the lesson for grades K-2 was such that three-quarters of the instruction was to take place in Spanish while one quarter of the instruction would take place in English. Two Spanish teachers were hired to assist classroom teachers. In the fall of 2011, the FLAP grant went schoolwide, with grades 3-5 joining in the implementation. However, their lessons were to be one quarter in Spanish and threequarters in English in these upper grades as the students had not had the exposure to the language and the academic concepts were a bit more difficult. Two more Spanish teachers were hired in the fall of 2011 to assist with the instruction.

In addition to being a charter school, RPECS holds a special place within the district because it was the first PDS within the district. A PDS "allow[s] school and university educators to engage jointly in research and rethinking of practice, thus creating an opportunity for the profession to expand its knowledge base by putting research into practice – and practice into research" (Darling-Hammond, 1994, p. 1). The root of the concept for PDSs originates with the teaching hospital model in which yearlong residencies are conducted under the watchful eye of expert doctors (Heller, 2004). Specifically, the relationship between RPECS and SU involves some SU courses being taught on site at RPECS, such as an elementary methods course and a language/literacy course. Additionally, SU has partnered with RPECS so that many student teachers and interns are placed within the school, as are many university volunteers. The result of this partnership is visible – it is typical to find a much lower adult to student ratio in many of the classrooms. Quite a few classrooms have both a student teacher and an intern in addition to the classroom teacher and may have regular volunteers as well. The PDS partnership also gives the school access to more resources in terms of science materials, assistance with lessons planning, and professional development.

Participant Information. In August of 2011, I began attending meetings at RPECS with the professor-in-residence, Jack. This allowed me to make myself known and begin to build rapport with the teachers of RPECS. I decided I wanted to focus on teachers who would have student teachers during the spring semester of 2012. After discussing this decision with Jack, I met with each grade level team at the end of August, gave them a general idea of my dissertation research, and asked for those who were interested in participating to contact me and we would discuss details as well as sign consent forms. As a result of these mini-presentations, I had six teachers volunteer. I then met with the classroom teachers as well as their Block Three interns

(students who would then become their student teachers in the spring of 2012) to finalize the details. Consent was granted by all participants by mid-September. Out of those original six classrooms, three participants completed the entire study. These participants are briefly described in Table 3; more in-depth descriptions can be found in below.

Table 3							
Brief Description of Participants							
	Erin	Carole	Heather				
Grade Level	5	4	2				
Years Teaching	3	23	7				
Student Teacher	Gwen	Jackie	Adrienne				

Erin and Gwen. Erin is a fifth grade teacher in her late 20s and has been at RPECS for three years, but this is her second year as a fifth grade teacher. She was a resource teacher her first year at RPECS. Her student teacher is Gwen. Gwen is a quiet, organized student teacher who is uncomfortable teaching science. She does not consider herself a science person, nor does she seek out scientific activities, although her family is "science-y". Gwen's teaching style could be considered 'traditional' in that she is more comfortable with book reading and lecture than hands-on activities. Given her teaching preferences, a major concern of Gwen's is that she will make science boring or teach incorrect concepts. Erin and Gwen have a good working relationship, although Erin wonders if Gwen is receiving adequate support, due to her largely hands-off style in mentoring.

Carole and Jackie. Carole, a fourth grade teacher in her early 50s, has taught fourth grade for each of the three years she has been at RPECS. Carole has taught for a total of 23 years, although not consecutively, as she took time off to be with her daughters when they were young. Jackie, her student teacher, is a friendly, creative student teacher who is adored by Carole for all the talents she brings to the classroom. Jackie loved science growing up and truly enjoys

teaching science so she can watch kids have 'light bulb' moments during investigations. Jackie's only fear about teaching science is that she is such a hands-on learner that she may not reach students who learn in other ways. Carole and Jackie have a professional, yet mother-daughter type of relationship; it is evident that they care a great deal about each other's successes in the classroom.

Heather and Adrienne. Heather, a second grade teacher in her mid-30s, has taught second grade for each of the three years she has been at RPECS, and has taught for seven years total. Adrienne, her student teacher, is business-like, down-to-earth, and an honors student at the university. Although Adrienne does not claim science to be her strength because she never enjoyed the memorization portion of her past science courses, she enjoys connecting science to her life and tries to make this connection for students while also engaging them in the nature of science. Heather and Adrienne have a professional, efficient relationship, which works for both of them as they are highly organized and focused individuals.

Participant Science Curricula

The science curriculum in RPECS is spiraled in each grade level. That is, each teacher in each grade level teaches portions of earth, life, and physical science that build upon portions taught in previous grades. Themes in the curriculum for kindergarten through fifth grade include energy, states of matter, water, objects in the sky, and living things. Each of these themes is generally seen at each grade level, although certain concepts may 'skip' a grade level or two before students see them again. For example, students may learn about the moon in second grade and then revisit the topic in more depth in fourth grade. In addition to this content, teachers are also responsible for teaching Habits of Mind and Characteristics of Science standards that are designed to teach students about the nature of science as well as how to operate as a scientist.

A summary of the science content standards for each teacher in this study can be found in Table 4. For the specific standards and sub-standards, including the Habits of Mind and Characteristics of Science, see Appendix B.

Table 4							
Summary of Science Curriculum for Participants							
	Erin	Carole	Heather				
	Grade 5	Grade 4	Grade 2				
Content Topics	Constructive/	Stars	Stars				
	Deconstructive	Day/Night	Day/Night				
	Forces	Seasons	Seasons				
	Landforms	Solar System	Moon Phases				
	Physical/	Weather	Properties of Matter				
	Chemical Changes	Light	Sources of Energy				
	Electricity	Sound	Pushes/Pulls				
	Magnetism	Force	Life Cycles				
	Classification	Simple Machines					
	Heredity	Ecosystems					
	Cells						
	Microorganisms						

Research Design/Data Collection

For this study, I selected qualitative research methods because they allow researchers to construct a "*complex*, detailed understanding of the issue" (Creswell, 2007, p. 40, emphasis in original). Additionally, researchers use qualitative research methods when current theories are insufficient because they do not "adequately capture the complexity of the problem we are examining" (p. 40).

This research is an ethnographic case study. Merriam (1998) suggested that a study focusing on school culture should use this format. Ethnography is traditionally employed to analyze a specific culture from the viewpoints of its members and utilizes both participant observation and interviewing (Hatch, 2002). Case studies allow researchers to examine the everyday events of a culture in context (Yin, 2009). There are three case studies within this

research study – one for each participant. Yin (2009) believed the logic behind multiple case studies is the same logic as conducting multiple trials in an experiment: replication. This idea feeds into the quality of research because, "The evidence from multiple cases is often considered more compelling, and the overall study is therefore regarded as being more robust" (Yin, 2009, p. 53). Yin further described the difference between literal replication and theoretical replication in case studies; it was my intention to use multiple case studies for purposes of literal replication in that I anticipated different cases to demonstrate similar phenomena.

In case study methodology, it is important to bound the case to look at the unit of study (Hays, 2004). Each 'case' in this study is bounded to a classroom teacher. It has been recommended that in a multiple case study, there are four or five cases to research (Creswell, 2007). In this study, I began with six cases in the fall of 2011 and narrowed down to three in the spring of 2012. Of the three participants who did not finish the study, one participant chose to opt out due to personal issue, another participant became over-committed in other areas of her teaching career and did not have time to meet for interviews, and a third participant was a kindergarten teacher with science instruction so incredibly different from the three remaining participants, it was determined it would be best to work with this data in a separate project.

One of the strengths of a case study research design is the opportunity to use multiple data sources (Yin, 2009; Hays, 2004). In this case study, I utilized participant observation and a variety of semi-structured interviews in order to collect data. These methods are described in further detail below.

Participant observation. Several authors have lauded observations as one of the most important data sources in a research study (e.g. Yin, 2009; Hays, 2004; Patton, 2002). Throughout this study, I collected observations through participant observation. According to

Yin (2009), participant observation can be defined as "assum[ing] a variety of roles within a case study situation and...actually participat[ing] in the events being studied" (p. 111). Yin noted that participant observation can provide opportunities for the researcher to gain access to events and groups, and to perceive reality from the view of the 'insider'. This technique is usually found in anthropological studies, but obviously can be applied in this scenario. True to the definition of a participant observer, there were times when I assumed different roles while observing: teacher, confidante, 'science expert' (so named by Carole, who was one of the participants), and tutor.

These observations focused on science lessons taught by either the classroom teacher or the student teacher. While lessons were taught, I generally positioned myself in the back of the classroom, attempting to be as unobtrusive as possible. However, while I anticipated sitting silently, there were many times that the classroom teacher or student teacher looked to me for assistance with science content. There were also many opportunities for informal conversations in the halls, during lunch, or between subjects with both the mentor teachers and student teachers. These were times for me to hear informally about contextual components, thoughts about science instruction, or just to be someone who could listen to the frustrations of the day. Due to student teachers/collaborative teachers leading the lessons and/or social studies being taught during the science time slot, throughout my time at RPECS I observed Erin lead science instruction 9 times, Carole lead science instruction 3 times, and Heather lead science instruction 7 times.

Semi-structured interviews. "Qualitative interviews are used when researchers want to gain in-depth knowledge from participants about particular phenomena, experiences, or sets of experiences" (deMarrais, 2004, p. 52). I conducted semi-structured interviews (Roulston, 2010) with the classroom teachers three times throughout the year for approximately one hour each

time. The first interview provided me an overview of how each participant came to be teaching at RPECS and their general feelings toward science. After reading through all three transcripts from the first interview, the second interview protocol focused on those components that came up regarding science instruction, but required further explanation. The final interview included a card sort concerning the contextual components (Saunders & Thornhill, 2011) as well as questions concerning the student teachers, mostly in response to a vignette written about the student teacher's science instruction (Schoenberg & Ravdal, 2000).

The card sort as a research method has a number of advantages, including simplicity in administration and understanding for the participant. Saunders and Thornhill (2011) have noted that this method is particularly fruitful when used in conjunction with interviews because it, "offers an opportunity to explore and understand participants' reasons for their categorizations, helping make sense of the data collected" (p. 334). In order to use this method with my participants, I first found 15 contextual components that the participants had mentioned in the two previous interviews as impacting their science instruction (See Appendix C for these 15 components and more details concerning this interview). Each of these components was written on an index card and the participants were asked to put the cards in order from the item that most impacted their decisions about science instruction to the item that least impacted their decisions about science instruction. After the participants were satisfied with their ordering, I then asked them to explain their reasoning.

Concerning the use of vignettes, it has been shown to be beneficial to qualitative researchers because the research can craft the vignette to address specific topics, it is generally enjoyable for the participant, and it provides an element of depersonalization that allows the participant to go beyond their own experiences (Schoenberg & Ravdal, 2000). In order to use

this method with my participants, I studied each participant's student teacher's science instruction. From observational notes, I then created a vignette based on the most commonly used teaching methods employed by the student teacher (see Appendix C for the vignettes and more details concerning the interview). This meant that while I had observed everything that was written in a vignette, not all teaching strategies occurred in the same lesson and the vignettes provided a more holistic view of the student teacher's science instruction. I informed the participants that I would be reading a story to them about a science lesson and after reading, I would ask them to reflect on various aspects of the lesson.

In addition to interviewing the participants, I also interviewed their student teachers. Interviewing the student teachers in each classroom allowed me to triangulate data from the classroom teacher, as well as allow them to report on their views concerning the context of RPECS and its impact on science instruction. The first interview was approximately 30 minutes in length and provided me with basic information about each student teacher as well as how their feelings concerning science instruction. They also responded to the vignettes written about their teaching, and although they suspected as it was read to them, the student teachers were not explicitly told the vignette was about them until after it was read in its entirety. The second student teacher interview was approximately 12 minutes in length and focused more on their experiences with their mentor teachers in the realm of science instruction.

Finally, in order to glean a bit more background information about RPECS as well as the PDS partnership, I interviewed the professor-in-residence, Jack, the instructional coach, Evelyn, and RPECS's principal, Serena. Jack's interview was quite lengthy, at approximately 100 minutes in length, Serena was able to share 30 minutes of her time, and Evelyn spoke with me

for approximately 20 minutes. Each of these protocols as well as the vignettes can be found in Appendix C. A timeline for all data collection methods can be found in Table 5.

Table 5							
Timeline for Data Collection During the 2011-2012 School Year							
October	November	December	January	February	March	April	
	Classroom		Classroom		Classroom		
	teacher		teacher		teacher		
	interviews		interviews		interviews		
					Student	Student	
					teacher	teacher	
					interviews	interviews	
			Interview			Interviews	
			with Jack			with	
						Serena	
						and	
						Evelyn	
Participant observation \rightarrow Ongoing							

Data Analysis

To begin analyzing this data, I referred back to basic elements of CHAT (tools, rules, community, and division of labor) as well as focused on the beliefs and goals of the subject. I then read through each transcript and observation field note and highlighted elements with a different colored highlighter and made notes on a corresponding colored sticky-note. Each participant had her own envelope of piles of colored sticky notes. Based on the observation field notes, I also made a list of each science lesson I observed that was taught by the teacher and each lesson that was taught by the student teacher and summarized the instructional practices employed in these lessons. Once this initial analysis had been made, I applied the five basic tenets of CHAT as described by Engeström (2001) to the data.

Looking at these tenets, I turned them into questions I could ask of my data. These questions are as follows:

- 1. What is happening with the entire system?
- 2. What are the multiple voices/viewpoints in this system?
- 3. What is the history of this activity system? What has happened to bring us to this point?
- 4. What are the contradictions/tensions within this system?
- 5. What transformations are taking place?

As utilizing a CHAT framework implies that one is examining the entire system, I discarded the first question above to avoid redundancy. Using these remaining four questions as overarching topics, I then created sub-questions pertaining to my study under each of these that would allow me to delve more deeply into the data. These questions were applied to the sticky-notes in each participant's envelope of data. Specifically, I spread out all of the sticky notes for a participant, and asked myself these questions as I looked over the data, attempting to find key instances and events. As readers will soon see, there is a great deal of overlap between question categories, just as components in a system overlap.

1. What are the multiple voices/viewpoints in this system?

- a. Are there moments when the teacher has different viewpoints? Can she see multiple sides of an issue?
- b. Do the teacher's instructional practices show evidence of multiple views?
- c. Are there viewpoints of others mentioned by the teacher (administration, district, etc.)?
- d. How is history/context influencing the viewpoints?
- 2. What is the history of this activity system? What has happened to bring us to this point?
- a. What is the history of this policy?
- b. What is the history of this school?
- c. What is the history of this teacher?
- d. What is the history of this relationship?
- e. What is the history of this district?
- f. In what way are these histories evident?

3. What are the contradictions/tensions within this system?

- a. Are there places where policies are contradictory? If so, what does this look like?
- b. Are there places where the teachers' beliefs are contradictory? If so, what does this look like?
- c. Are there places where the teachers' beliefs contradict other components of the context (policies, rules, people, etc.)? If so, what does this look like?
- d. Are there places where the implicit rules/norms are contradictory? If so, what does this look like?
- e. Are there places where the implicit rules/norms contradict other components of the context (policies, rules, people, etc.)? If so, what does this look like?
- f. Are there places where the instructional practices contradict other components of the context (policies, rules, people, beliefs, etc.)? If so, what does this look like?

4. What transformations are taking place?

a. Are teachers questioning the established norms? If so, what does this look like?

- b. Are teachers completing actions that are contrary to the established norms? If so, what does this look like?
- c. Are others in the system questioning the established norms? If so, what does this look like?
- d. Are others completing actions that are contrary to the established norms? If so, what does this look like?
- e. Are there consequences being seen for pushing back on the norms? If so, what does this look like?

Finally, I aligned each of these sub-questions with my research questions so that using the tenets of CHAT informed how I examined the data to answer each of my research questions:

1. How do elementary teachers' perceptions of the context in which they work

impact their science instructional practices?

Intermediate step \rightarrow Examine instructional practices

- Are there places where the instructional practices contradict other components of the context (policies, rules, people, beliefs, etc.)? If so, what does this look like?
- Are teachers completing actions that are contrary to the established norms? If so, what does this look like?
- Do the teacher's instructional practices show evidence of multiple views?
- What is the history of this teacher? How is this history evident?

Intermediate step \rightarrow In what ways are components of the context characterized by the teachers?

• Are there moments when the teacher has different viewpoints? Can she see multiple sides of an issue?

- Are there viewpoints of others mentioned by the teacher (administration, district, etc.)?
- What is the history of this policy? How is this history evident?
- What is the history of this school? How is this history evident?
- What is the history of this teacher? How is this history evident?
- What is the history of this relationship? How is this history evident?
- What is the history of this district? How is this history evident?
- Are there places where policies are contradictory? If so, what does this look like?
- Are there places where the teachers' beliefs contradict other components of the context (policies, rules, people, etc.)? If so, what does this look like?
- Are there places where the implicit rules/norms are contradictory? If so, what does this look like?
- Are there places where the implicit rules/norms contradict other components of the context (policies, rules, people, etc.)? If so, what does this look like?
- Are teachers questioning the established norms? If so, what does this look like?
- Are teachers completing actions that are contrary to the established norms? If so, what does this look like?
- Are others in the system questioning the established norms? If so, what does this look like?
- Are others completing actions that are contrary to the established norms? If so, what does this look like?

Intermediate step \rightarrow In what ways do the teachers' instructional practices in science reflect contextual influences?

- Do the teacher's instructional practices show evidence of multiple views?
- Are there moments when the teacher has different viewpoints? Can she see multiple sides of an issue?
- What is the history of this teacher? How is this history evident?
- Are there places where the teachers' beliefs contradict other components of the context (policies, rules, people, etc.)? If so, what does this look like?
- Are there places where the instructional practices contradict other components of the context (policies, rules, people, beliefs, etc.)? If so, what does this look like?
- Are teachers completing actions that are contrary to the established norms? If so, what does this look like?

2. In what ways do contradictions present in the context result in tension or growth? Intermediate step \rightarrow What types of contradictions are present in the context?

- Are there moments when the teacher has different viewpoints? Can she see multiple sides of an issue?
- Do the teacher's instructional practices show evidence of multiple views?
- What is the history of this teacher? How is this history evident?
- Are there places where the teachers' beliefs contradict other components of the context (policies, rules, people, etc.)? If so, what does this look like?
- Are there places where the instructional practices contradict other components of the context (policies, rules, people, beliefs, etc.)? If so, what does this look like?

Intermediate step \rightarrow Are these contradictions resulting in more tension or growth?

• Are teachers questioning the established norms? If so, what does this look like?

• Are teachers completing actions that are contrary to the established norms? If so,

what does this look like?

Using a short transcript excerpt from an interview conducted with Erin (Figure 4; Interview

030612, Lines 18-49), the analysis process will be illustrated in Figure 5. Note that Erin had just

completed the card sort that was described earlier.

18 I: So tell me about why you put stuff in the order that you did.

20 R: OK. Instructional time, I mean I think that is, we're constantly having conversations, particularly this 21 time of year, "OK well this day is shorter because of this, so we're not going to be able to get as far," or I mean Gwen and I, we're talking the other day about, we're just going to have to steam-roll math and 22 finish our current unit on Friday because Spring Break is next week and y'know, I mean just factor in 23 24 things like that. It's what, for me, drives – that's the initial start. This year, I've really, really, really 25 enjoyed having a designated time, we have a clean break of specials and then we come back and do the 26 rest of the stuff, so it's really allowed us to actually protect the science and social studies content block. I 27 mean, truly. And we can actually, I mean aside from this card down here - the FLAP grant - [laughter] if 28 this hadn't been an issue, I would have started at 7:45 every day, but I had to accommodate somebody 29 else and that really threw a wrench in my beautiful plans last summer to be like, "Yeah!"

30

19

31 I: But now he's not in here for the rest of the year, right? 32

R: I don't really know because nobody communicates – they don't even know – it's not his fault. They're
doing the LinguaFolio smish-smash and so I don't know how long that will take. At this point in the year,
I'm not really going to be very nice I don't think, and not like him directly, but it's kinda just based on
conversations that we've had as a grade level with our administration, they can be used as the lead of a
small group kind of thing, but at this point, we're going to try to get as much in as we can...

- 38
- **39** I: So it's more about this instructional time.

40 41 R: Yeah. It's not about accommodating every possible thing that we can. So I mean, if I only had, 42 looking ahead to next year with the reading – whatever that reading grant is – it might allow us to actually 43 do science and social studies every day because we can use some of that allotted time to read in the content area. So I mean, or just doing a circular review. If we're doing science, then during that time, we 44 45 read social studies to reinforce the previous unit. If we're doing social studies, we read about science to 46 reinforce the previous unit. So it'll be interesting to see what that looks like. But ultimately, it's all about 47 time. We're out of time. We're literally out of time. At this point in the year. Resources, if you had not 48 been in here, I would have never known about those AIMS books, that's what we're using on Thursday. 49 I'm going to kinda wing it.

Figure 4. Sample transcript.

Step 1: Pick out CHAT elements

Tools:

- Instructional time (Line 20)
- Gwen (Line 22)
- It's what, for me, drives that's the initial start. (Line 24)
- But it's kinda just based on conversations that we've had as a grade level with our administration, they can be used as the lead of a small group kind of thing (Lines 35-37)
- But ultimately, it's all about time. We're out of time. We're literally out of time. At this point in the year. (Lines 46-47)
- Resources, if you had not been in here, I would have never known about those AIMS books (Lines 47-48)

Division of Labor:

- So it's really allowed us to actually protect the science and social studies content block. (Line 26)
- I had to accommodate somebody else and that really threw a wrench in my beautiful plans (Lines 28-29)
- I don't really know because nobody communicates they don't even know it's not his fault (Line 33)
- They can be used as the lead of a small group kind of thing (Lines 36-37)

Rules:

- I had to accommodate somebody else (Lines 28-29)
- They're doing the LinguaFolio (Lines 33-34)
- We're going to try to get as much in as we can... (Line 37)
- Allotted time to read in the content area (Lines 43-44)

Community

- Gwen (Line 22)
- I had to accommodate somebody else (Lines 28-29)
- Just based on conversations that we've had as a grade level with our administration (Lines 35-36)
- If you had not been in here (Lines 47-48)

Beliefs

• It's not about accommodating every possible thing that we can (Line 41)

Goals

- We're just going to have to steam-roll math and finish our current unit on Friday because Spring Break is next week (Lines 22-23)
- It's really allowed us to actually protect the science and social studies content block (Line 26)
- I'm not really going to be very nice I don't think, and not like him directly, but it's kinda just based on conversations that we've had as a grade level with our administration, they can be used as the lead of a small group kind of thing, but at this point, we're going to try to get as much in as we can... (Lines 35-37)
- So I mean, if I only had, looking ahead to next year with the reading whatever that

reading grant is – it might allow us to actually do science and social studies every day because we can use some of that allotted time to read in the content area. So I mean, or just doing a circular review. If we're doing science, then during that time, we read social studies to reinforce the previous unit. If we're doing social studies, we read about science to reinforce the previous unit. (Lines 41-46)

Step 2: Use these elements to answer analysis questions (for the sake of space, only one

analysis question will be listed)

1a. In what ways are components of the context characterized by the teachers?

- Are there places where the teacher's beliefs contradict other components of the context (policies, rules, people, etc.)? If so, what does this look like?
 - Erin believes that it is "not about accommodating everything possible that we can." However, she was asked to accommodate the FLAP collaborative teacher for the majority of the year (before the administration said it was fine to allow FLAP teachers to serve as leaders of small groups) on top of her typical responsibilities, which has caused her to run short on time. Erin truly feels that the FLAP grant threw a 'wrench' in her plans for social studies and science and that she has lost time due to waiting on her collaborative teacher.

Figure 5. Example of data analysis process.

Using the aforementioned data analysis process, I wrote short (one to three sentence) paragraphs answering each one of the data analysis questions for each participant. I then worked with these paragraphs so that I could tell a cohesive story for each participant. Grouping these paragraphs under the headings *Personal Background, Participant and Science, Participant's Impressions of the External Context,* and *Participant's Instructional Practices,* I crafted a case study for each participant, making sure to include references to the data as much as possible.

Once the case studies were written, I went back to the data to conduct a cross-case analysis. In particular, I was interested in patterns across all three cases that might explain the teachers' similarities or differences in instructional decisions. For example, I noticed that the three items most often discussed as impacting instructional decisions were the FLAP grant, accountability measures, and physical resources. However, to avoid reducing this information down to simple conclusions, I applied teachers' internal contexts – their past experiences, personal beliefs, goals, etc. – to their behaviors to enrich these findings and trouble the notion that *all* elementary teachers believe a certain thing or act a certain way given a specific context.

Quality

When thinking about quality in regard to my study, I relied upon Lincoln and Guba's (Schwandt, Lincoln & Guba, 2007) perspective on the 'trustworthiness' of a study. They defined trustworthiness as pertaining to the "truth value, applicability, consistency and neutrality" of a study (Schwandt, Lincoln & Guba, 2007, p. 18). To achieve trustworthiness, researchers must be concerned with credibility, transferability, dependability, and confirmability. Under the umbrella of credibility, Lincoln and Guba (2007) suggested a number of measures be taken to ensure quality, including prolonged engagement in the research, methodological triangulation, and member checks. Each of these were measures I took to ensure the quality of my study. First, I worked with my participants for seven months and used a variety of data collection techniques in order to gather data. Lincoln and Guba (2007) defined member checks as "soliciting reactions of respondents to the investigator's reconstruction of what he or she has been told or otherwise found out" (p. 19). As the latter teacher interviews built on the previous interview or observations in terms of content (such as the utilization of the card sort or reading the vignettes) the second and third interviews served as member checks.

Concerning transferability, dependability, and confirmability, Lincoln and Guba (2007) suggested providing the readers with thick description as well as creating an audit trail. Merriam (1995) stated, "The general lies within the particular," (p. 58) meaning there may be findings that

are 'universal' or can be generalized to other similar situations. In order to accurately portray the 'particular' it was imperative to collect data in such a way that I was be able to write using as much detail as possible. Lincoln and Guba (2007) supported this notion by stating, "[N]arrative [should be] developed about the context so that judgments about the degree of fit or similarity may be made by others who may wish to apply all or part of the findings elsewhere" (p. 19). I took copious field notes during each observation and wrote notes about each interview after it happened in order to describe my 'gut feelings' about things that were said or even left unsaid. Finally, I used my researcher's journal to serve as an audit trail throughout my data analysis, both for myself and for others who may inquire. I believe each of these measures taken ensure my study is of the utmost quality.

Subjectivity Statement

With regards to researcher subjectivity, Ruona (2005) stated,

It is vitally important for the researcher to acknowledge that the words we study in our analyses are influenced by ourselves. In qualitative research, it is impossible for the researcher to stand apart from the participant. Our personal histories...characteristics, beliefs and biases influence every stage of the process.

It follows, then that I should reveal relevant portions of myself to the reader in order to present the findings from this study with the utmost honesty and integrity.

All of this affects what we hear, observe, and deems as important. (p. 235)

To begin, I was a teacher for eight years – six years as a middle school science teacher and two years as a fourth grade teacher. As a fourth grade teacher, I was in charge of teaching all subjects (with the exception of art, music, and physical education) and was kept to a strict district-level pacing guide to ensure my students' progress. While I had many joys during my stint as a fourth grade teacher, at the end of my teaching career I found myself feeling as though I was a 'Jill' of all trades, master of none, and I felt as though my professional opinion concerning the education of my students was not valued. These feelings ultimately caused me to leave teaching for graduate school in the hope that I could 'fix' the system.

Before teaching at the elementary level, I taught middle school science for five years in an urban school district. During this time, I taught using a spiraled curriculum and thus taught bits of earth, physical, and life science. The administration in this school allowed the teachers professional freedom in terms of the order and manner in which they taught content; as long as the content was taught well, the administration was 'hands-off.' It was during these five years that I blossomed as a middle school science teacher and crafted my science teacher identity. I felt successful, innovative, and was excited to be at school each day.

But perhaps the most profound facet of my teaching career is that I never thought I would become a science teacher. Through a series of twists of fate, my very first teaching position was a middle school science position and I fell in love with teaching science. Nevertheless, because I did not plan on becoming a science teacher, I lacked science content knowledge. I did not major or 'concentrate' in science during my undergraduate education. As a result, I often felt very much unprepared for my lessons and relied heavily on the textbook – a typical behavior of those who do not really understand the content they are teaching. It was only after pursuing a master's degree in science education that I began to feel much more comfortable with my science content knowledge.

These experiences caused me to form deeply held beliefs about education and science. The most basic belief is that it is more difficult to teach elementary grades than middle school

grades. Elementary teachers are asked to be experts in many subjects and for most people that is simply a ludicrous expectation. Therefore, to ask elementary teachers to become experts in science is unreasonable. However, I do believe it is fully realistic to ask elementary teachers to have a fundamental understanding of major scientific concepts encountered in the elementary curriculum as well as the typical misconceptions that students hold about these concepts. I believe that elementary teachers should and can hold a sophisticated view of the nature of science that can carry over into any science content area. Thus, an elementary teacher is not simply teaching a series of disconnected facts, but rather connected facts within the larger view of what science is, how it works, and how those facts were discovered.

It is obvious to me that these experiences and beliefs led me to conduct the research at hand. Why did I feel professional and successful in one setting and not in the other? How do elementary teachers with more staying power than me manage to teach all subjects well? It seemed to me that elementary instruction requires a delicate balancing act of many content areas, many responsibilities, and many demands. I wanted to discover how elementary teachers made decisions about balancing everything as well as how they felt about the numerous obligations elementary teachers are expected to meet.

There have been moments in which my beliefs and experiences influenced how I viewed my study. Because I believe elementary grades are more difficult to teach than other grades, it is easy for me to sympathize with teachers who rely heavily on the textbook or use 'activities that work' (Appleton, 2002). On the other hand, it is also possible that I expected much more sophistication than necessary from elementary teachers when it comes to science concepts because science is 'my thing' and I believe it is incredibly important to convey the nuances of

sophisticated scientific concepts to students. These two possibilities are at odds, which leads me to believe that overall, the effects of my beliefs in this area balanced each other out.

And while my personal history is important to consider, my experiences during the data collection period of this study are significant as well. Including the time used to establish rapport, I spent nine months at RPECS. During these nine months, I spent from two to four days a week working in my make-shift office or moving from classroom to classroom conducting observations. A few days prior to the beginning of the school year, I helped organize their new science lab space and materials, working closely with Serena in order to provide what she expected the teachers would need. During the months of February and March, Serena asked an SU professor and me to provide science professional development to grades 3-5. Before leaving for winter break, I brought in a variety of Christmas cookies for the RPECS faculty and staff and toward the end of my data collection time at RPECS, I bought breakfast for everyone as a thank-you. As a result of my constant and familial presence at RPECES, my role as a researcher became complicated.

Adler and Adler (1987) described different roles for qualitative researchers, depending on the amount of interaction and commitment to core activities. Using their schema, I became a 'peripheral member', as I interacted "...closely, significantly, and frequently enough to acquire recognition by members as insiders," while at the same time "...refrain[ed] from participating in activities that stand at the core of group membership and identification" (p. 36). Clearly, I could not waltz into a classroom and be the teacher, or begin to take on the responsibilities of a principal. However, I spent enough time with not just my participants, but many others within RPECS that I was told by the principal I was part of their family. Moreover, there were several times when participants shared their feelings about science and elementary instruction with me

and I felt a burst of, "I think that way too!" or an empathic, "I totally understand." But while these moments position me as an 'insider' of sorts, I could not claim complete insider status, just as I was not a 'full member' under the Adler and Adler (1987) schema.

Reflecting upon my research journey, there were many times when I felt elated to be one of 'them' and felt truly accepted by my participants. On the other hand, there were just as many times that I felt isolated from my participants and RPECS. At a very basic level, I was required to wear an SU badge each day for security measures, which served as a visual reminder to others that I was a different 'species,' so to speak. At a more intuitive level, there were small comments here and there made by participants and RPECS faculty that 'othered' me. As I was conducting research for my doctoral dissertation, many teachers joked that I was somehow smarter than them, and treated me at times as a professor who was 'above' them – sometimes even slipping up and calling me 'Doctor' rather than 'Miss Wenner' or 'Julianne.' There were also times during interviews – particularly with Heather and Carole – when I got the feeling they were sugar-coating their responses because I was not one of them and they did not want anything to reflect poorly on teachers in general or RPECS as a school.

Consequently, I cannot claim to have been an outsider nor an insider in this research. As Dwyer and Buckle (2009) termed my position, I was in the "space between." I take comfort in the fact that this is a legitimate space for researchers to occupy: "We may be closer to the insider position or closer to the outsider position, but because our perspective is shaped by our position as a researcher...we cannot fully occupy one or the other of those positions" (p. 61). Being a part of the RPECS family for nine months yet never quite achieving full membership provided me with moments in which I 'went native' and moments in which I was incredibly objective. Once again, in the grand scheme of my research, I believe these two reactions balanced each other out

as I interacted with my participants, listened to their responses, and analyzed the data I collected. The following quotation perfectly summarizes my subjectivities in this study as well as the vigilance I had in ensuring an accurate representation of the study's findings:

As qualitative researchers we are not separate from the study, with limited contact with our participants. Instead, we are firmly in all aspects of the research process and essential to it. The stories of participants are immediate and real to us; individual voices are not lost in a pool of numbers. We carry these individuals with us as we work with the transcripts. The words, representing experiences, are clear and lasting. We cannot retreat to a distant "researcher" role... The intimacy of qualitative research no longer allows us to remain true outsiders to the experience under study and, because of our role as researchers, it does not qualify us as complete insiders. We now occupy the space between, with the costs and benefits this status affords. (Dwyer & Buckle, 2009, p. 61).

CHAPTER 4

FINDINGS

Overview of Findings

In this chapter, the description of the findings is divided into two sections. In the first section, the findings will focus on RPECS as a whole and then each individual teacher. In the second section, the four major findings will be depicted through a cross-case analysis.

Introduction to Rosa Parks Elementary Charter School

"Take that road out of downtown, and drive forever." That's what I often tell student teachers who are placed at Rosa Parks Elementary Charter School ('RPECS'). As you drive out of downtown Sycamore towards RPECS, cute college apartment complexes and artsy restaurants give way to the Department of Labor, a dilapidated discount off-brand grocery store, and a strip mall filled with signage strictly in Spanish. Just when you feel as though you somehow missed the school, neighborhoods full of well-kept trailers pop up next to large, empty wooded lots. Nestled on three sides by scrubby woods and fields is the beautifully-new RPECS building.

If you arrive early enough, you'll hear a rooster crowing in the neighborhood just east of the school as buses pull into the large side parking lot. Walking into the school in the morning, parents greet each other and their small children in Spanish, while little boys who come up to my waist hold the doors open for ladies entering the school. Entering the back part of the office, there are often shouts of laughter coming from either the principal or assistant principal's office as Phoebe and Serena chat with one another or other teachers, keeping a sense of humor about all that is going on. Once the school day is in full swing, Phoebe's office has two students seated at desks reading a book, and the secretary has a student working through a math worksheet on her lap or by her feet as she answers the phone in Spanish. The school counselor can be found crouched in the hallway asking a child how their day is going while another student and teacher walk past on their way to tell Serena about the good behavior the student has displayed – this accomplishment will be shared with the school later on during the afternoon announcements. Orange, navy, white, and khaki-clad students march down the hallways in semi-straight lines, the little ones 'catching a bubble' in their mouths and 'making duck tails' with their hands so that they are silent and keep their hands to themselves. Posters line the hallway, advertising enrichment cluster projects, labeling items in Spanish (clock = reloj), or explaining RPECS's mission statement.

There are three hallways that split off of the main hallway and lead to the classrooms. Each wall boasts of students' work, different projects marked with the standards they address. In recessed parts of the hallways, student teachers or intervention teachers are working with small groups of students on their writing or spelling. When peeking into the classrooms, it is rare to see a teacher by himself or herself – you may see not only the homeroom teacher, but also a Sycamore University (SU) intern, an SU student teacher, a collaborative teacher, or a volunteer grandparent. The rooms are neat and orderly, but with a cozy feel. Supplies are in wicker baskets, teachers' family pictures are on display, lamps add soft lighting, and some teachers play classical music as students work. As you walk down the halls, teachers and students alike greet you and welcome you to the school. Many outside visitors have commented on the warm atmosphere at RPECS and it is known in SU that faculty members and students are welcome to be a part of the RPECS family.

Description of School Context

The vignette above portrays my perceptions of RPECS on a typical day. However, the context of RPECS includes much more than what is found in this simple story. As this is a study that documents the complexity of science instruction within an elementary school, the participants' stories cannot be viewed in isolation. Therefore, I preface the participants' case studies with a broad description of the school context in order to better inform the particulars of each case.

RPECS overall, gives off a happy, positive feeling the moment you step foot into the lobby. Since opening, teacher turnover has been extremely low, perhaps as a result of Serena's leadership style. She insists that she does not lead by fear, but tries to instill a sense of shared vision and shared ownership within her staff. In this way, "The teachers aren't doing [what they are supposed to do] for me. They're doing it because they believe in the work," (Serena, interview 053112, Lines 50-51). In general, the climate in the school is very constructive and there is a high level of dedication to the students. While RPECS has been identified as one of the poorest schools in the district, several teachers as well as the principal have children who attend the school. As articulated by Serena, RPECS seeks to go beyond merely passing tests in terms of education:

My [vision for RPECS] is to help create a successful learning environment for our students where they are able to really meet and exceed academic expectations while also providing a loving, caring, supportive school family for them. And I think in meeting and exceeding those academic expectations, it also encompasses teaching them just to be good people, good citizens, good lifelong learners...truly creating a desire for knowledge in them...just teaching them the importance of

being good individuals, because really if you're not, the academic knowledge will only take you so far. And so, really working to create the whole person, I think, is

The supportive administration, friendly faculty, and commitment to student success gives one a sense that if great things can happen in education, they will happen at RPECS. Serena boldly shared with me,

[my goal for RPECS] (Serena, interview 053112, Lines 10-18)

I don't want excuses for why our kids can't do it. I don't want to hear it. I want you to come to me and say, "You know what? They're struggling. I want to do this out-of-the-box – can I have permission to do it?"...That's the way our teachers work...And it's working. (Serena, interview 053112, Lines 85-89)

High expectations for helping students become successful seem to be a secret to victory at RPECS. At the same time, however, individual teachers shared with me that they are quite stressed out and would be open to moving to a different school that would be less demanding.

RPECS as it is today is certainly a product of its history, and the history involving its charter is quite interesting. The idea to become a charter school came from the partnership between SSD's COE and SU. Both organizations had decided they wanted to open a PDS and worked on an educational plan for the partnership together prior to the opening of RPECS. Before RPECS opened, SSD hired Serena, an assistant principal, Phoebe, and appointed an SU professor, Jack, to be a liaison between SU and RPECS. It was during this planning stage that SSD decided RPECS would be a charter, which would include the SEM and a foreign language component, and according to Jack and Serena, these points were not discussed with either the SU members of the planning committee or Serena (Jack, interview 011112; Serena, interview 053112). Once Serena was brought on board with the plan, she suggested that RPECS have a

performing arts component to its charter, and while this is now officially part of the charter, there is little evidence of this within the walls of RPECS (Serena, interview 053112).

It is important to note that the Serena and Phoebe have struggled with the foreign language component, because it did not grow organically out of the school's need, but rather out of the district's desires (Jack, interview 011112). The original design of the grant was to work with K-2 for a few years to build vocabulary and knowledge, and then 'roll up' the Spanish instruction one grade at a time (third grade the first roll-up year, then fourth grade the second year, etc.). Serena stated that the reason for 'pushing into' the regular school day was because the district had written time requirements into the grant and teachers could only put so much into morning meetings and announcements (Serena, interview 053112). Science and social studies were 'officially' targeted because there were the fewest number of 'pull-outs' in these subjects (students being pulled out for IEP instruction, ESOL instruction, etc.), so the most students would be able to participate, and because research has shown that when students learn content in their native language, they retain it much better. However, Serena shared that 'truth be told,' science and social studies were targeted because they did not 'count' for AYP and she did not feel as though she could interfere with math and reading (Serena, interview 053112).

Once the kinks were worked out, the K-2 teachers generally seemed to accommodate this grant however they could. Grant meetings were held once a month throughout the school year with Phoebe presiding. Phoebe tried her best to balance the expectations of the grant with the needs of the students and teachers and constantly fought an uphill battle, especially with the 3-5 teachers, tweaking this model and working with teachers in order to find compromise. This school year has been difficult for teachers due to the Spanish language implementation, working with new Spanish teachers, and still trying to meet all of the district and state requirements.

Summing up the school feelings towards the FLAP grant as well as all the reform initiatives happening within RPECS, Serena stated,

I am not anti- anything except anti- what's not good for kids. And I have a very difficult time swallowing a pill that's disguised to me as being good for kids when I sit there and watch and see and know that it's not. Because these are my babies. All of them. And I just know that the conversations at my house are not just happening at my house. [So] you want programs to be meaningful. (Serena, interview 053112, Lines 245-250).

Consequently, Serena is hopeful that future initiatives implemented at RPECS will be more meaningful and need-driven.

Regarding science at RPECS, both Serena and the instructional coach, Evelyn, expressed to me that their vision for science education in the school includes hands-on activities, asking questions, high student engagement, posing 'what if' scenarios, students creating their own experiments, interactive lessons, and the application of knowledge to new situations. There is a time for whole group, direct instruction in science, but they both stressed that this should be coupled with small-group, high-interest activities (Serena, interview 053112; Evelyn, interview 050712). Serena and Evelyn independently agreed that their vision for science at RPECS and reality are still inconsistent at this point in time, although progress is being made. Evelyn noted that at times, teachers see students being excited about science as an 'inconvenience' perhaps because they are uncomfortable with not knowing everything or perhaps because there is such a focus on testing in math and reading. Nevertheless, she pointed out that while teachers are often struggle with a lack of time, they are very enthusiastic about the science professional learning that has been supported by SU (Evelyn, interview 050712). Serena suggested that while some

Type III projects (projects implemented through the SEM are deemed Type I, Type II, or Type III, based on the amount of initiative the students take; Type III indicates independent projects) are science based, there should be more opportunities for students to do long-term science-based projects to build excitement about science. She admits that in the past with NCLB measures, science had been pushed to the side, but now that RTTT and the new state AYP measures are coming into play, science must be treated as being on the same level as reading and math. Serena is aware that this new idea of science being 'equal' will require a shift in teachers' thinking:

So now you've got to...shift people's mentality that when there are standards that haven't been met in reading, you don't automatically go pull from that science and social studies block. When there's something you need to get caught up in, you don't say, "Well, I'll pick up on science next week." But that has been the mode of operation for years, so you're going to have to undo a lot. It is hard. And it's not that science and social studies were not important, but unfortunately in this world of accountability, people teach to that which is reported. (Serena, interview 053112, Lines 106-115)

While Serena understands this will be a large task, she believes that the resources for success are available to them and believes that science instruction at RPECS will ultimately meet her vision.

Introduction to Case Studies

The previous section serves to describe the broad context of RPECS. This allows readers to better understand the larger environment in which each teacher teaches science, from the national school reform context that has trickled down to RPECS to how Serena chooses to work with the embattled FLAP grant. However, each teacher's story is unique due to their own personal experiences as well as how they perceive this external content. It is these differences

between teachers that serve to educate us on how context truly does impact elementary science instruction.

Each case is broken up into six major sections: personal background, the participant and science, the participant's perceptions of the external context, the participant's instructional practices, a summary, and the participant's context described in terms of CHAT. The personal background section is to provide readers with a sense of the participant's personal and educational background and how they came to work at RPECS. I then describe the participant's views toward science, including their own personal attitudes as well as their expectations for students, in the next section. In the third section, I illustrate the complex views the participant has concerning the external context in which they work – both positive and negative – and provide the reader a glimpse into what the participant sees on a daily basis. The instructional practices section explains how the participant (and often their student and collaborative teachers) go about teaching science, including the some of the motivations for these practices. The summary leaves an impression of the participant that sums up who they are in relation to science instruction and teaching in general. Finally, I end each case study with a description of the participant's activity system in terms of a CHAT framework.

These case studies represent my efforts towards capturing the complexity of the context for these teachers. There are many competing agendas involved in schooling and several reasons aside from weak content knowledge and lack of time that may explain the current state of elementary science education. Following these case studies, I will take my analysis of this context deeper as I answer my research questions and piece together this incredibly complex puzzle that is elementary teaching.

Heather's Case Study

Heather is a solemn woman in her mid-30s, with her dark, shoulder-length hair streaked with a few strands of white. In her seventh year of teaching, she exudes an attitude of 'no-nonsense,' clad in her long, comfortable skirts and Croc shoes – an attitude that is apparent in her second grade classroom. Her students are expected to follow rules and directions and are often reminded what they should and should not be doing. Once a business major who, as a child, preferred the "office supply section and looked at the pens and the papers instead of the toys" (Heather, I1, Lines 85-86), her penchant for organization carries through everything she does.

Personal background. While Heather always wanted to own a restaurant and began her undergraduate career majoring in business so that she could manage the business side of a restaurant, she has both an undergraduate degree as well as a master's degree in Early Childhood Education. But how she came to major in education was a bit of random chance. Heather began her undergraduate degree in business at a small, public university and, as she bluntly stated,

I hated it. I hated accounting. I hated economics. I hated business law. I hated all of it. I hated it. I was failing out of school. I'd moved back home with my parents and I didn't go to class and I'd show up for tests and I didn't do very good...And so I said, "Why am I wasting my money?" (Heather, I1, Lines 51-54).

Consequently, she took a semester off, reflected on her options, and enrolled in a smaller private college. At this new college, she had to declare a major and so, "One day I was like, 'I think I might like to be a teacher" (Heather, I1, Lines 61-62). Heather was initially worried about this new major, as she had never baby-sat growing up, did not have brothers or sisters, and "...didn't know a thing about a child," (Heather, I1, Line 70). To forget her worry, Heather focused instead on the organizational aspect of teaching, excitedly thinking, "I get to use fun colored pens and I

get to have folders and I get to organize things!" (Heather, I1, Lines 77-78). However, her inexperience with children was very obvious on her first day as a first grade teacher:

...the other teachers had told me to bring snacks because the kids would be hungry the first few days and I still do that now, buy animal crackers and give them to the kids. And I didn't know how much to give them. I was like, "How much does a 6 year old eat? I don't know how much to give you." I had to run next door and say, "How many crackers do I give a child?" (Heather, I1, Lines 71-74).

Heather thus encountered a steep learning curve as she began her career as a teacher.

For the first three years of her teaching career, Heather taught first grade in a town with a predominantly Hispanic population, and she reflected upon these years with fondness. While she was teaching a statistically difficult population full of English for Speakers of Other Languages (ESOL) students and with a high percentage of students receiving free and reduced-price lunch, she judged herself as being very successful as a teacher while at that school. In fact, when interviewed for her job at RPECS, which has a similar population to Heather's first school, she proudly shared her standardized tests scores with Serena and Phoebe, demonstrating her students' high levels of achievement on the state test. After Heather's first three years of teaching in the neighboring town, she moved into the SSD, to an elementary school she loathed. She summed up her time there by saying,

...it's not the school's fault. It's not anybody's fault. I just did not like it. It was a new district, a new grade level, a trailer that was new and it had no awning, there was no sidewalk. I had to throw all my shoes away at the end of the year because

they were all coated in mud. The kids and I got soaking wet every time we went to the bathroom, the cafeteria, everywhere. (Heather, I1, Lines 149-153).

After spending a year at this school, Heather applied for a transfer within the district to RPECS, which was about to begin its first year. The one thing that truly drew her to RPECS was the Hispanic population. So much so, in fact, that she cried in her interview with Phoebe and Serena. When I asked Heather to tell me more about this, she began crying during our interview as she told me how much she loved her "Hispanic babies" (Heather, I1, Line 164):

They [Hispanic students] care. That's it. Their parents care. They care. They try. They help each other. They don't argue. They don't fight. They help each other. They don't say bad words. You don't have to track down their parents. And this is just in general. It's not the same... You don't have to track down their parents five times. I'll find things on my computer sometimes about the year I was at [the other SSD school] and it's like, "Fourth and final attempt, please come in for conferences..." I don't know. I really liked it there [her first school] and I guess it was what I always knew. That's where I started teaching. That was my first year. (Heather, II, Lines 174-179)

In her classroom of 22 students, 20 of whom are Hispanic (Heather, Obs. 101011), Heather is now much happier than her first year in the SSD.

Perhaps a vestige from her business-major days, Heather is a consistent rule-follower. She became concerned if her lesson plans were not filled out as they should be and expected order and behavior in her classroom. The most interesting result of this quality is that when questioned about how children learn best, she commented, "…it seems weird because it kinda doesn't matter what I believe. I have to teach what I'm told to teach about science. Like I don't

get to just pick whatever" (Heather, I3, Lines 327-328). While Heather's instructional practices surely seem to be indicators of her beliefs about what and how students should learn, this statement demonstrated that her emphasis is on getting through the standards in a timely manner, rather than catering to her students' learning needs.

Heather and science. Although the population in her classroom made Heather very happy, science did not. Her science preparation during her undergraduate career was not memorable in the least, except for two events, the first of which was her 'welcome' into education. One of her first courses as an education major was her science methods class and Heather recalls that on the first day, everyone began using the acronym for the standards and she had no idea what they were talking about, seeing as she had just decided to become a teacher. The second memorable event connected to her science preparation was an assignment to make science centers and hers was entitled "Make Those Pennies Sparkle!" She had to use different liquids to see which one would make a penny shine. While she could not recall any other science courses in college, Heather clearly remembers the result from this science center as if it were yesterday: "…the vinegar cleaned the penny and the Coca-Cola actually cleaned the penny. And then orange juice didn't" (Heather, II, Lines 34-35). As Heather explained to me in our interviews, her science background is "nonexistent" as far as she is concerned (Heather, II, Line 218).

Heather insists that she does 'some' science-related things outside of school, but it is probably "because of my husband and child" (Heather, I1, Line 223). Her two-year-old son loves looking at birds and trees and helping his father water the garden in the summer. Before she was married, Heather liked having aquariums and having little plants in her home, which she considered science-related, but she doesn't have time for those activities now. If she comes home

and her husband has a Discovery Channel show on about animals or plants, she may sit down to watch it, but as with any other science hobby, "I don't seek it out" (Heather, II, Line 239). However, Heather did point out that she bakes cookies with her mother every year and likes to shop and asked if those could be science-related.

While Heather did not care for many science topics, she did admit that she liked life science, such as the life cycles unit she teaches at the end of the year. And "[m]atter's pretty good. States of matter and changes in matter...It's fun... [because w] e do a lot of food experiments" (Heather, I1, Lines 315-316). And "[t]he stars are OK" (Heather, I1, Line 326). So while Heather claimed to not really like science at all, she seemed to be able to find pieces of the science curriculum that she did not mind, or even enjoyed, teaching.

Doing experiments and activities that can make science fun for her students is one of Heather's major goals for science. In her mind,

I want them to understand what it is [the science concept] and I think they'll understand it more if it's like fun. If it's just reading it, then they're just probably not going to understand it. They need to...really visualize it, really see how it's happening. (Heather, I2, Lines 309-312).

Fun is definitely a means to an end, a way for students to know the standards they are supposed to learn in second grade. In terms of thinking about science as what science educators would term 'reform-oriented science,' fun was the main focus for Heather. As demonstrated in the above quotation, hands-on science is used in Heather's classroom to aid students in 'seeing how things happen' – especially if the science concepts are hard to see, such as astronomical topics: "You can't go up there and see the Sun and the moon. You can't see the planets and all that happening" (Heather, I2, Lines 316-317).

This view of hands-on activities seemed to go hand in hand with her view of the importance of science overall. When asked why it's important for students to learn science, Heather stumbled quite a bit in with her answer. She reminded students all the time why math and reading are important, but could not think of a time when she told students why it was important to know a particular science concept. Haltingly, Heather responded:

I think it's [science] important, but I'm really trying to figure out why...When do I talk about when we need to use science? I don't think that I do that...This makes me sound like I don't think it's important. That's not true...I guess it's just something you need to know. If you didn't know anything about matter, you might just be like, wouldn't know anything. I don't know. It makes you smarter. It makes you understand the world around you and how things work and just in general. I just can't imagine if you had learned all these other things and you hadn't learned science that you could be at the level of education. Like if you just kept learning everything else and you didn't ever learn science, if just doesn't seem like you could learn everything else as well. You wouldn't be as welleducated all around... I just think it would be really strange if you just didn't, you had no idea why it's night and day and you were like in sixth grade. If you had no idea. Or an adult. No idea why it gets dark and light every day at this time. I don't know. It's [not learning science] one of those things I can't imagine. (Heather, I2, Lines 263-287)

Thus, Heather believed that understanding science makes a person more intelligent and more well-rounded, although this was not something that she thought about a great deal, nor something she communicated to her students. According to her statements, science is a collection of facts

that should be understood, and hands-on activities may be used in order to teach those facts and have fun.

One of the most interesting findings concerning Heather and science was her impression of herself and her confidence. On a few occasions, she said to me, "You think I'm a terrible science teacher" (Heather, II, Line 680) or "I'm a terrible science teacher" (Heather, I3, Lines 366-367). While Heather could clearly articulate exactly how she wanted to teach science and why, she still admitted, "I don't think I'm very confident in teaching science" (Heather, I3, Line 430). However, she was quick to say that her lack of confidence does not affect her instruction: "I'm not making them read from the book because I'm not confident in teaching science. I think it's important" (Heather, I3, Lines 431-432). As will be seen in the description of her instructional practices, Heather believed that even though it is "probably not really science" (Heather, I1, Line 395), reading the science book has a prominent place in her instruction.

Heather's perceptions of the external context. Because science was not something for which Heather has a natural proclivity, science instructional resources were very important. As she said, "If you don't have good resources, then you're not going to have anything good going" (Heather, I3, Lines 517-518). She said that at RPECS, "there's not a lot of resources for our science and social studies. Not as much as math and [reading]" (Heather, I1, Lines 337-338). On the other hand, Heather did admit that maybe there are more resources than she gives the school credit for, but said, "I want it to be right here. I want it to be available" (Heather, I3, Lines 503-504). Heather depended on the Harcourt textbook and workbook a great deal and felt that to be a smart move, as the book is based directly on the state standards and focused on reading comprehension skills. The textbook includes quite a few 'experiments' that are also on an accompanying DVD, which Heather used in two different ways: "...you can use it, like show it,

the kids do it, and then you pause it and then you show it again so they can...or you can just show it if you don't have time to do the actual experiment" (Heather, I1, Lines 391-394). She did point out to me, however, that she sometimes questioned the book's interpretations of the standards. Regarding a standard that stated, "Relate the length of day and night to the change in the seasons," the book walked students through how a tree changes throughout the seasons due to the change in the length of the day. In Heather's mind, this was not a clear connection between day and night and seasons, although when I asked her what she would focus on instead, she replied simply, "I don't know! Thank goodness I have it [the textbook]!" (Heather, I1, Line 357).

Heather's viewed her student teacher, Adrienne, as a valuable science resource. Heather joked that, "We need somebody who likes science!" (Heather, 13, Lines 48-49) and Adrienne reported that Heather told her, "The first thing that you can take over [teaching] is science because I don't like teaching science" (Adrienne, I2, Lines 74-75). Especially for her least-loved unit – the unit on pushes and pulls – Heather was impressed with the ideas Adrienne had for lessons, such as running Matchbox cars up and down books. When reflecting upon Adrienne's lessons, Heather was hesitant to embrace them fully without a large textbook component due to her affinity for teaching reading comprehension, but admitted that Adrienne's hands-on lessons allowed students to see "how it is in real life, how it relates, how, 'OK. We're talking about heat energy...but now that you can see how that relates to your world...it's not just this concept we talk about at school. It really exists" (Heather, I3, Lines 264-267). For Heather, talking about students seeing science relating to 'real life' may be the key reason for students to learn science, although she did not explicitly discuss this with me. Regardless, Adrienne seemed hopeful that Heather will be able to incorporate more science lessons such as these into her repertoire:

I think she [Heather] likes that I do the creative activities and I'd like to think that she's gotten some ideas for things to do... [M]aybe she'll do more hands-on activities because...she does do more book things than I would like to do and so I'm hoping that she's seen that it's not that hard to incorporate hands-on things in science. (Adrienne, I1, Lines 420-427)

Additionally, Adrienne said that while she was hopeful that Heather would include hands-on activities in her lessons, she knew that Heather was "afraid to do it with the whole class, so hopefully she has seen that you can do it with the whole class" (Adrienne, I2, Lines 117-118).

Heather also saw the science lab as a resource, as it not only "encourages me to do more experiments because it's set up and the things are there" but also because it got the students excited – it's a "change of scenery" from the classroom, so to speak (Heather, I2, Lines 12-15). The key to making the science lab a truly beneficial resource, however, were the additional people in the lab to work with small groups. For example, on Thursdays and Fridays when Block 3 students were on the RPECS campus, Heather had four adults in the room: herself, her Block 3 teacher, her student teacher, and her FLAP teacher. Heather pointed out, "…we can do more group things because we have more people in the room that can take a group. If it was just me…I can't lead an experiment with each group or lead them at anything" (Heather, I2, Lines 17-19). She felt the PDS partnership with SU was beneficial because "I can get new ideas and I can do more…stuff with the kids" (Heather, I3, Lines 9-11). However, Heather did recall a time when she had so many extra people (a Block 3 student, student teacher, and other volunteers) in her room that she felt like "the puppet-master and I never did anything anymore…It was just too

much" (Heather, I3, Lines 33-34). So while Heather appreciated the extra hands in instruction, there was a limit to what she can manage while keeping her sanity.

When reflecting on planning for science, the word 'time' came up a great deal because the time she had to plan and implement science impacted what she plans. For example, SSD used to subscribe to a website that contained a large collection of educational videos that were intuitively organized, but SSD had cut that subscription and switched to a similar website that was not easy to navigate. Heather lamented, "the time to search this new website and find new videos and then you have to watch it and I just don't have time to do that," even though she felt that videos were good for "presenting the information in a new way" (Heather, I1, Lines 498-500). In the same vein, she felt that the county pacing guide and its accompanying activities (collectively referred to by teachers as "Titan") could be more helpful: "...they do have some cool things sometimes, but who has time to look at it all?" (Heather, I2, Lines 424-425). Time to actually teach science was another constraint Heather saw impacting how she taught science. As previously mentioned, Heather did like teaching the life cycle unit at the end of the year, but this was partially because "there's time to do more things with [the unit]" (Heather, I1, Line 309).

The biggest constraint related to time came up when Heather was discussing the FLAP grant. During our first interview, Heather was visibly frustrated with the FLAP grant because, "I feel like I have less time this year to do things because I'm teaching it in Spanish too." (Heather, I1, Lines 453-454). She felt that as a result of this loss in instructional time, she was teaching science concepts with less depth than normal. When I probed further, Heather could not put her finger on exactly what she would be doing differently if the FLAP collaborator was not in her room four days a week, but she was adamant that she was losing instructional time, which was

resulting in her falling behind the pacing guide and thus, she is teaching science quickly and at a surface level.

Heather's attitude towards the FLAP grant changed as she became more comfortable with the routine and her collaborator, Lisa. During our second interview, she contradicted her initial feelings towards the FLAP grant by listing its advantages:

I guess in some ways, other people could say that it [the FLAP grant] takes away from some of it [science] because if you have to learn all this in science but then part of it is actually learning Spanish, it's taking away from some of the time that you have to teach the science because you're also learning Spanish. But I think that it can enhance it in a way...it's more exciting for them, like [an African] American student in her class] doesn't speak Spanish, she gets like really excited sometimes about knowing the Spanish words and I don't know that she would be that excited about it if it wasn't – about the science or whatever we're learning – if it wasn't in Spanish...also I would think that some of the Spanish speakers, especially the ones who, like are really good at Spanish, but they struggle in other areas, this is like really exciting, so they're like, "Oooh!" Like [a Spanishspeaking] child, when he first came here from Mexico, he spoke no English, he had no idea what was going on at all, was probably like the highlight of his day because he was like, "Oh!" and he could answer the questions... I guess I could see where maybe different aspects of the content maybe there's less time or it takes longer but that you can get deeper with the parts that you do...Because it just makes it a little more exciting and maybe get to kinda offshoots that you wouldn't have gotten to if you were just teaching it in English...And it would

probably be a lot more boring if it was just me. If it was just me and I was just teaching it in English, it would just be less exciting than me and Lisa teaching it in English and in Spanish, especially for kids who are Spanish speakers. (Heather,

I2, Lines 475-511)

In this second interview, Heather said that she understands how people could feel that the FLAP grant takes time away from instruction, as she felt at the beginning of the year, but there are several advantages for her students. And, in fact, the FLAP grant allows for *greater* depth in science instruction. While the FLAP grant and Lisa, her FLAP grant collaborator, were 'bonuses' to Heather's science instruction in the classroom, Heather also appreciated planning with Lisa because,

I think the science...standards...are so vague that you can look at them and I might see something, somebody might see something else...having another person coming in, they kinda see it in a different way so they can add to the learning experience. (Heather, I2, Lines 30-35)

Additionally, Heather viewed Lisa as having more time to plan and find resources – time that Heather herself did not have. Consequently, she believed Lisa provided strong lessons, which was reflected in the instructional time she gave to Lisa.

While this about-face concerning the FLAP grant may seem to have come out of the blue, it is easy to understand Heather's change in attitude when the events of the year are taken into account. Prior to this year, the FLAP grant had been implemented with kindergarten and first grade, so her second grade students were acclimated to the arrangement, but Heather was brand new to the FLAP grant and admitted, "the kids are better at it than I am" (Heather, I1, Lines 661-662). Additionally, the other three second grade teachers all had FLAP collaborators

at the beginning of the year. Because Lisa was not hired until later in the school year, Heather was left out while the second grade and FLAP teachers collaborated on science and social studies at the beginning of the year. She remembered thinking, "I don't even have another person to do any of these ideas with. So I was very frustrated. I was like, "I'm not coming to these meetings." I was like, "I'm sorry, but I don't even have a [FLAP] person" (Heather, I2, Lines 174-176). Once RPECS hired Lisa, there were still planning difficulties that needed to be resolved concerning who wrote and posted the lessons for the district – was it the classroom teacher's responsibility or the responsibility of the FLAP teacher? So while Heather seemed to have made her peace with the FLAP grant and even enjoyed it, she reflected that,

... it's [the FLAP grant] not very well organized. It's just like it wasn't thought through how to implement it well enough...the FLAP teachers don't know what they're supposed to be doing and I don't really know whose – I don't want to say 'fault' – but where that's coming from. (Heather, I2, Lines 152-159)

Being the highly organized person that Heather is, it is completely understandable that she would have problems with a grant she feels is not well organized or implemented. Despite the fact that Heather eventually saw the advantages of the FLAP grant, it was not an easy transition and definitely impacted her science instruction along the journey.

Heather's instructional practices. Heather's feelings about science instruction within the classroom were consistent with what one might expect of a teacher who does not 'seek out' engagement with science activities. She said of her instruction,

... if anybody was coming in to see me teach and I had to list the things I would want you to see me teach, science would be at the very bottom. The absolute

bottom of things I would want you see me teach... [because] I don't really like it.

(Heather, I1, Lines 295-301)

While the topics she enjoyed teaching tended to be those that can be taught using a great deal of hands-on activities (as illustrated by the matter unit referred to above), it should be noted that a physical science unit that could be taught in a similar fashion was, in fact, her least favorite unit: "the forces and the pushes and pulls [unit] is the worst" (Heather, I1, Lines 327-328).

Perhaps because of her issues with teaching science, there were a few disconnects between her preferences and her instruction. Heather did believe that students having fun helped them learn science, but in the next breath she would state that students needed to be able to read for information and complete worksheets in order to prepare for standardized tests. For example, when reflecting on Adrienne's interactive teaching strategies, Heather recalled saying to her,

OK. What day are they sitting down and not talking and not working with anybody else and filling out a worksheet? Because when they have to take the test, the test is not hands-on. There are no manipulatives. There are no groups...you can't learn this way [hands-on, interactive] and then it just automatically transfer over [to the standardized test] like that. (Heather, I3, Lines 136-141)

Although Heather appreciated lessons in which Adrienne had students interact with materials in conjunction with reading from the book (Obs. 030212, 030512, 030612, 030712, 032012, 040312, 040412), she was still concerned that students needed to read and complete more worksheets more so that they would perform well on the state test; Heather emphasized that it was her duty to balance these two things so that students were getting an equal amount of each type of instruction. As she said to her second graders, "Everything in life is not fun" (Heather, I3,
Line 462). Another non-sequitur between what Heather believed was good for her students and what she actually did during her instruction concerned the usage of people in her classroom. While she touted having many people in the room as an advantage, I did not see Heather as a lead teacher split her students into smaller groups in order to use those additional people as instructional leaders.

Even though I observed Heather's science instructional time prior to Adrienne taking over for student teaching, the FLAP grant was in full force and Lisa taught the majority of the science lessons. In fact, Adrienne stated that, "I haven't seen her [Heather] teach science much" (Adrienne, I2, Line 4). When she did teach, at the beginning of the lesson Heather would introduce the topic, then Lisa would teach the 'meat' of the topic, and finally Heather would conclude the topic at the end of 50 minutes (e.g. Heather, Obs. 112111, 120511, 120611). On four other occasions while Lisa was absent, Heather was the lead teacher. Although she spoke a great deal in her interviews about wanting to do activities that were fun for the students, these activities were rarely seen. Adrienne, too, observed the lack of hands-on activities: "I think it was kinda like they [the students] would go to the science lab once a week and then do something fun" (Adrienne, I2, Lines 26-27). In one of these 'fun' lessons, Heather filled up a jar with water to place in the window so students created their own constellation using black construction paper and white crayon (Heather, Obs. 111611).

In lieu of hands-on activities, lessons led by Heather were dominated by use of the textbook (e.g. Obs. 101011, 112911, 041212). Heather enjoyed the textbook, as it aided her in teaching reading comprehension, which, she said, "That's what second grade is all about" (Heather, I1, Line 399):

...it [the textbook] just gives them a really good chance to read some informational, I mean that is such a big thing...this is just such a great way to practice that as a reading skills, so that's why I love these little books. And they're so – it's not even like – there's no implying. It's like straight there. "A pull moves something towards you. A push moves something away from you. What is the difference between a push and a pull?" I mean, it's like very straightforward. And that's what I like about it, because it helps them...It's just straightforward comprehension. (Heather, I1, Lines 396-410).

In this way, the science textbook became not only an important resource for science instruction, but also for reading instruction. However, students struggled during the lessons in which Heather focused on the textbook. When asking questions of her students, she had certain responses that she liked, and while the students seemed eager to please, it was often a long, frustrating dance to get the 'correct' answers.

In closing... Heather seemed to be a study in extremes. She cried about how much she loved her 'Hispanic babies' but was stern in her classroom management. She loved hands-on instruction in theory, but taught almost exclusively from the textbook. But perhaps this was a result of beginning her professional career as a business major; there is a great deal of black and white in the business world as opposed to the several shades of gray in the world of seven- and eight-year-olds.

Heather thought she was a 'terrible' science teacher. Perhaps she had this perception of herself because her goals for her students centered on reading and test-taking rather than science. Heather wanted her students to be able to read for this purpose so they may be successful in school – a system that is full of standards and standardized tests. No teacher looks at her students

and says, "I know the right way to teach, but I will deliberately teach my students the 'wrong' way." Heather did not seem to have the knowledge of science and rigorous science pedagogy to do much better than she was doing. And in an accountability-driven system, what she was doing was enough – why should she change?

Heather's system in terms of CHAT. In order to better understand the interactions between context and Heather's instructional practices, it is helpful to use a CHAT lens to view her teaching context. Figure 6 illustrates the major components of Heather's activity system.



Figure 6. Heather's activity system.

Through an examination of Heather's activity system, how interactions between various components resulted in Heather's instructional practices becomes apparent. For example, she

believed students should really focus on reading comprehension (subject/belief) and complied with the rule that teachers must follow Titan and the textbook. This interaction resulted in Heather keeping the fast pace of Titan through having students read from the textbook on a nearly daily basis. Another interaction that reinforces Heather's instruction is between her beliefs and the division of labor. Heather did not enjoy science, nor did she believe she was very good at teaching science; at the same time, Lisa and Adrienne both took on the role as primary science instructor, either due to the FLAP grant or SU student teaching requirements. This interaction allowed for Heather to 'opt out' of teaching science to a certain extent, and made 'hands-on' instruction the purview of others – Heather could then focus on the reading comprehension she believed was important and felt comfortable with. Other interactions and interactions that result in contradictions will be discussed further in the cross-case analysis that follows these case studies.

Carole's Case Study

Carole is a 4th grade teacher who is in her early 50s. She spoke quietly and calmly to her students as she breezed in between the desks in her classroom. In her 23rd year of teaching (although she began teaching 30 years ago and took time off here and there with her children), Carole emanated serenity and a sincere interest in whomever she was speaking with, whether a child or an adult.

She was passionate about teaching and believed that what she did every day was important in the lives of children. After knowing Carole for a very short time, I observed her during a meeting in which she was fired up about a news story that portrayed teaching and elementary teachers in particular in a negative light. The story clearly bothered her because it had attacked who she was as a person. Later, Carole commented to me,

I feel like teaching is the one occupation, one profession where we're really not treated professionally by many people...I feel like...everyone should have the experience of being in a school to see what teachers actually do because it's an incredible job. Very rewarding, though. I do it for the rewards. I can't imagine not having the rewards or enjoying that part of it because I don't know how you could stay. (Carole I1, Lines 386-396)

It was apparent in Carole's demeanor and actions that every day in the classroom was a chance to make a difference, no matter how difficult the task may have been.

Personal background. Carole did not speak much about her schooling experiences due to the length of time that had elapsed since her schooling. Instead, Carole focused descriptions of her personal background in the present, beginning with her being hired at RPECS. Carole had been a part of RPECS since its opening in 2009. She had moved to the area with her husband, but was not teaching at the time when she got a call from a friend who is now a second grade teacher at RPECS. This friend said to Carole, "You need to go meet Serena and Phoebe," because they were "awesome administrators to work under" (Carole, I1, Line 46) and as Carole remembers it,

So I called them and like that day they said, "Do you want to come in today? Can you come in today?" I'm like, "OK. Sure." So I met them at the board office when they were housed out of the board office and then the next day Phoebe called and offered me a job. So it was crazy. So all the sudden I had gone from not teaching to getting a job...in like a week. (Carole, I1, Lines 36-41)

Carole recalled sharing with Serena and Phoebe that she had not been in public schools for a while, but they were undeterred, saying, "Well, that [her comfort level with public schools] will come" (Carole, I1, Line 56).

Working at RPECS seemed to feed Carole's predilection for continued professional learning: "I feel that as a teacher, for me, this is my 23rd year and I've learned more in the last 3 years [at RPECS] than I learned in the 23 I've taught because there's so much coming down here..." (Carole, I3, Lines 245-246). Carole often referred to learning from the courses she was taking for her gifted certification (a requirement of RPECS) at SU, from her student teachers, and even from a dyslexia specialist she had been in touch with due to her daughter's struggles with dyslexia. And, during our time together she was quite curious about my research; she thought it was fascinating and always wanted to know what others were saying in response to the questions I asked.

Carole and science. Because Carole entered teaching 30 years ago, the details concerning her science preparation were fuzzy, as evidenced by her response when I asked about science methods courses:

Sad to say, if so, I don't remember taking that, but I'm not sure that I did. I did go through SU, but I don't remember science methods class. That doesn't mean I didn't take it. I mean I'm sure I took something related to that, but... (Carole, I1, Lines 18-20).

While she did not remember taking science courses during her teacher education training, Carole did vividly remember her lackluster experiences with science growing up. She stated,

I just think I never had tremendous experiences as a student with science...I didn't dislike it but it just wasn't my favorite subject...It was so much, like you would walk in the door, and pretty much you had all your lessons on the board for the day per subject and it would be like read, answer questions, read, answer questions, read. And I was cut out for that because I was fine checking off my list,

but that was not science, nor was it anything else. (Carole, 11, Lines 68-76). As a result of these (non) experiences in science, she felt she worked "extra hard" to create lessons that were interesting because "I don't want them to dislike it because I feel like most kids love science" (Carole, I1, Lines 126-129). Carole was adamant that students need to learn science not only because it "is the world around them" but also because science "nurtures their creative side and allows them to explore... [science] just stretch[es] the brain" (Carole, I2, Lines 126-128). Often, Carole highlighted the creative aspect of science, such as during a lesson on simple machines when she stated, "People used their minds and creativity to make work easier" (Carole, Obs. 040312). Being an artistic person, Carole believed that science encourages students to think imaginatively while making predictions about scientific concepts or 'connections' between the science content and their lives (Carole, Obs. 101411). Based on these characterizations of science, Carole's thoughts on science could be considered consistent with science reform documents. However, as will be seen, Carole's science instruction was relatively far from being 'reform-oriented.'

Keeping all this in mind, Carole still admitted that science was "the least comfortable subject I teach" (Carole, I2, Lines 133-134) even though she was trying to become more comfortable with it. Jackie even stated that Carole "enjoys science but it's not her favorite to teach" (Jackie, I2, Line 49). While she shared with me that working with Jackie has helped bring her confidence from 'low' to 'middle' because, "Jackie's been a good influence on me…she just does simple cool things, like this is easy, this is not anything I should be scared of," (Carole, I3,

Lines 55-57), it became apparent to me that Carole did not plan nor teach much science on her own. I observed Carole's science instruction twelve times during the school year and out of those twelve instances, Carole was the lead teacher of the lesson three times (Carole, Obs. 101411. 011212, 040312). During each of those three lessons, her FLAP grant collaborator, David, taught approximately half of the lesson. The other nine lessons were led by either student teachers (Adair during the fall semester and Jackie during the spring semester) or the gifted collaborative teacher, Dorothy. Moreover, of the three lessons Carole led, two of those had been planned by Dorothy (Carole, Obs. 011212, 040312). Interestingly enough, Erin – the 5th grade participant in this study – used to be the intervention collaborator with Carole when RPECS first opened and shared with me that Carole was still using lessons that Erin planned for her two years ago.

Knowing that Carole did not plan or teach much science throughout the year may cause alarm, but Carole often had problems sharing the correct science content knowledge with her students. Of the three lessons Carole led, she taught incorrect science concepts to the class during two of those lessons. In the course of her January 12th lesson, students were learning about the phases of the moon and at the end of the class, students were to draw their favorite phase and label it. Carole then took those drawings and put them in the wrong order on the board asking students for what came next, and told them they were incorrect when in fact they were telling her the correct phases. One day, students were being introduced to simple machines via a SmartBoard lesson created by Dorothy and taught by Carole. When the lesson came to describe a wedge, Carole described a wedge correctly, but then began sharing with the class that she used a wedge everyday as she rolled her heavy cart of books and papers up a ramp (an inclined plane) into the school. Carole went on to give several examples of ramps, all of which she called wedges. Interestingly enough, at the end of this lesson, David mentioned to me that he had

caught her mistake and would help correct it the next day. Finally, on a day when Dorothy was leading the class, students went on a scavenger hunt around the room for simple machines. One group found a globe that spun and called it a wheel and axle. At the end of the lesson, Carole called this group up to the front of the room to share, as she thought this to be a wonderful observation. After the students shared that observation, she took a moment to ask what happens when the earth spins on its axis (night and day) and what happens when it moves around the Sun (a year). Carole then flipped the globe upside down so that the northern hemisphere was on the bottom and told the class that was how our seasons happen (Carole, Obs. 040512).

Jackie was hesitant to share her thoughts on Carole's content knowledge as she respected Carole a great deal, but said, "...she's [Carole] getting there in her thinking, but sometimes she confuses...some of the definitions of terms" (Jackie, I2, Lines 23-24). Then, Jackie expanded on how it played out in the classroom when Carole is unsure of the content:

It is, it's awkward [when Carole relays incorrect science content to the students]. A lot of times, usually if she's unsure about it, she'll kinda look to me in the back for clarification and she's fine if I step in...but when she hasn't...I try to clarify it for the students on at least an individual basis, if not to the group. But I think...it's in the moment. I don't think she actually doesn't know what it is, but it's just in the moment, tongue-tied or something like that. (Jackie, I2, Lines 86-91).

Jackie was very protective of Carole and tried to do 'damage control' with the students quietly so as not to embarrass Carole, but did realize that Carole had problems with the content, even if it was "in the moment."

Carole's perceptions of the external context. Carole was an incredibly positive person, and so consistent with her personality, she characterized the context within which she taught science as very positive. A large component of science instruction this year, Carole saw the FLAP grant and, in particular, her cooperating teacher David, to be wonderful additions to her instruction. She mentioned several times that David was not only a Spanish language resource, but also a science resource, because he "can bring in a lot of background knowledge that maybe I don't even have because he is such a science figure" (Carole, I2, Lines 299-300). David was, after all, a science professor in Central America before moving to the United States. Indeed, he often contributed valuable science content to the lesson (e.g. Carole, Obs. 101411, 101811, 040412), as on April 5th when he ran to the custodian's office and came back with several tools he could use to demonstrate simple machines. Moreover, the PowerPoint presentations David created for Carole's class were always full of scientific information that, at times, went above and beyond what 4th graders needed to know (e.g. Carole, Obs. 101411, 011212).

Carole could not find enough wonderful things to say about the FLAP grant and David. Of David, she raved, "I feel like he's always willing, he goes over and beyond preparing...I can't even imagine how much time that he puts into his planning" (Carole, I2, Lines 232-233). The only issue with working with David and the FLAP grant was that David was frequently pulled out of the classroom for testing (part of the accountability measures of the grant) and could not be counted to be present for class for days at a time. And while she was a bit puzzled as to why RPECS might choose Spanish as an immersion language for a school that was nearly 70% Hispanic, she believed that "if students are exposed to several languages…it helps them become fluent and more intelligent" (Carole, I2, Lines 264-265). Both she and her student teacher,

Jackie, saw the FLAP grant as an "additive" rather than something detracting from science (Carole, I2, Lines 333-335).

Carole openly shared how much she "lean[s] on those around me" (Carole, II, Line 167) for assistance and insight in science, so David was just one resource. When asked what the advantages of being a teacher at RPECS were, Carole immediately cited the major advantage as the number of people she could turn to for support: "…we have oodles of resources as far as lots of teachers, the collab[orative teachers are] awesome….It's been great having the student teachers in, the Block 3's" (Carole, I2, Lines 60-63). Dorothy, Carole's gifted collaborator, was supposed to be in Carole's room most days during science, so Dorothy planned quite a few lessons/units for Carole. Speaking of Dorothy, Carole stated that she is a "science/math person…so I'll lean on her to help me" (Carole, I1, Line 168). Carole also viewed the student teachers taught nearly all of the science this year because it was the first subject/block they picked up and the last one they taught to satisfy their student teaching requirements. Consequently, Adair and Jackie also planned many of the science lessons/units.

Carole's fourth grade team had not been as helpful in science, but she believed this was because "there's so many demands put on us right now for scores and results, I think everybody's doing what they feel like works best for them" (Carole, I2, Lines 221-222). Carole was willing and able to put in longer hours than her colleagues because they were young and trying to raise families, so she was lucky that her daughters were older and her husband worked many hours. Carole said that by planning individually, she was not burned out now, but was taking it one year at a time (Carole, I2, Interview Notes).

Carole believed the administration was very supportive and treated her and the other teachers in the school as professionals. But Carole's circle of support also extended outside of the school. In terms of science, she had taken her class to a local park to learn about weather, and invited Type I (from the Renzulli scheme; this means someone who is an expert in their field) visitors to share information. Beyond science, Carole also felt supported by the district as a whole, based on a recent interaction with the superintendent. She had been in touch with a dyslexia expert due to her daughter's struggles with dyslexia and thought that these strategies could be helpful with students that are termed 'far to go' (this term refers to students who have 'far to go' before meeting state standards on the standardized test). She had been bothered by a faculty meeting in which she felt she was being asked to focus on 'bubble' students (so termed because they are within a tight bubble of meeting the state standards) rather than the 'far to go' students. Carole felt so bothered by this and believes the dyslexia strategies to be helpful that she wrote an email to the superintendent, who in turn said, "I'm listening and I'm going to send this on," (Carole, I2, Line 77) and set up a meeting with a Special Education representative from the district. Carole felt this was indicative of the support that the district provided to teachers: "I was very encouraged that I do think our administration listens and I think they're very open" (Carole, I2, Lines 80-81).

Concerning the material resources rather than the human resources at RPECS, Carole felt supported by the number of resources provided by the school, such as the textbook, science lab materials, and professional development. She stated, "I feel like...anything that we're needing...we have a lot of support," (Carole, I2, Lines 61-62). In fact, there was so much professional development that Carole reported, "it's hard to implement all of it and figure out how you're going to implement all of it" (Carole, I2, Line 68). Conversely, in talking with

Jackie, she believed that Carole did not have enough resources at her disposal: "...she might enjoy science, but it might be just difficult for her to teach...maybe if she had more resources and more ideas that she knew of, than maybe she would enjoy it better" (Jackie, I2, Lines 103-109).

Carole's instructional practices. In order to present quality instruction to her students, Carole's goals were to present information in a number of ways so that students could "learn the best that they can, the best way that they can" (Carole, I1, Line 371). She also tried to utilize the many people who worked with her in her room to the best of her ability. Carole said of these collaborators, "...more is better. I just think, if there are going to be ten people in here, let's put them to work. Let's see what we can get out of it. Let's see the end product" (Carole, I2, Lines 343-345), and that she wanted "...as many people as can come in as would like to come in here because it's just more hands in here to get the job done" (Carole, I3, Lines 192-193). Another strategy Carole employed to teach science was working toward the goal of having student-led activities, with a minimal emphasis on the book (Carole, I1, I3). Because reading straight from a book and answering questions "meant nothing" (Carole, I3, Line 372) to Carole as a child, she wanted students to differentiate her instruction such that all students could find a way to connect to science.

Carole wanted science to be fun and hands-on for her students because "I think that the students like it," (Carole, II, Line 314), but understood that students may not have the same kind of 'fun' instruction in middle school, which was worrisome:

I think these kids are so fortunate to have all these experiences and I like [handson learning] because they like it, it keeps them interested, it makes the time fly, they learn, they love school. [But] I worry a little bit about them moving into

middle school from all of this because I feel like sometimes when I need them just to sit and focus for a while, they struggle. Or, "I need you to turn to page 262." "What page?" Y'know, it's just like they're just so used to everything being in a group... (Carole, I1, Lines 327-332)

While this worried Carole, this did not warrant her changing her instruction to purely book-work. Her ultimate goal in science instruction – and in all instruction – was to make her classroom more student-centered. "I'd like for it to be more differentiated in the classroom and let it be student-generated, the ideas be from them versus such a teacher choice" (Carole, I1, Lines 257-258). However, Carole was having difficulty implementing this type of instruction in science due to resources and time. Furthermore, she fully recognized the pacing guide as driving instruction, which may serve as another obstacle to student-centered instruction, particularly since the fifty minutes allotted for science each day were shared with social studies as they alternated units.

Concerning her science instruction, it was interesting to note that while Carole talked of her love for hands-on instruction in several of our conversations because it "keeps the kids interested... [and] they learn from those experiences more than reading and answering questions about topics" (Carole, I1, Lines 333-334), she did not conduct what many would consider to be hands-on science lessons. So, like Heather, she saw hands-on lessons as being a way to keep students interested in learning because the lessons would be fun (rather than the hands-on lessons to be inquiry-oriented and scientifically grounded), yet did not implement lessons such as these. Each of the three lessons Carole led were based on SmartBoard/PowerPoint presentations and contained some sort of graphic organizer or worksheet for students to fill out. It was in fact Carole's student teacher, Jackie, who created the hands-on lessons and implemented them with the class (Carole, Obs. 011912, 032012, 032312). Indeed, of the 12 lessons I observed, these

were the only lessons that were hands-on. It was possible, however, that the lessons Carole taught were not reflective of her personal goals and styles simply because she did not plan two out of the three lessons (and I suspect the third lesson was planned by Adair, as it was during her unit and she was absent that day). Perhaps these lessons reflected Adair and Dorothy's values rather than Carole's. In reflecting upon what she hoped Carole learned from her, Jackie stated, "I hope that she learns that there is that balance and to just try more hands-on or more student exploratory activities...I hope she learns that those are good for students to go through" (Jackie, I2, Lines 142-145)

However, Carole did have other strategies she used with her students in order to facilitate science learning. When presented with the vignette of Jackie's teaching, Carole commented that she liked Jackie's use of "real-world connections" and "bridge-builders" (Carole, I3, Lines 345-346), probably because it was something she did herself. In one lesson on weather, she connected the Spanish words to English words through the use of cognates and then allowed students to share what they knew about weather (Carole, Obs. 101411). In another lesson on simple machines, Carole connected the concept of a pulley to a well they had seen when they visited a colonial plantation and then invited a student to share how fixing a flat tire can use a lever (Carole, Obs. 040312). Carole also used several 'teacher moves' commonly found in science to encourage discussion and critical thinking. In one lesson, she asked students to make predictions about what a weather symbol stood for and when there were no hands raised, she said, "I get concerned when I see frustrated faces while we're making predictions. We're just guessing. Nobody will get in trouble if they have the wrong answer" (Carole, Obs. 101411). At the end of the class, while reviewing the same symbols, she asked the class whether or not they agreed with students' responses. To end another lesson, Carole told students they were going do something

college students do and respond to statements about simple machines she had on large pieces of paper around the room. Students could write other questions or make connections things they knew (Carole, Obs. 040512). So while Carole did not conduct as many hands-on lessons as she aspired to, she did implement strategies that encouraged students to think on a deeper level.

One thing that stood out in Carole's instruction was her efforts to engage students on a personal level. In her weather lesson, she spoke of her friend who was a meteorologist and then allowed students to tell stories about their experiences with weather (Carole, Obs. 101411). During her simple machine lesson, she allowed students to give example of simple machines they have seen (Carole, Obs. 040312). And during her lesson on the moon phases, she gave each student a post-it note and had them draw and label a phase of the moon and put it in order up on the board (Carole, Obs. 011212). While students were typically quiet and passive during David's portion of the lesson, Carole attempted to engage students in discussion and activity during her portion. Jackie relayed to me how she admires Carole's patience in allowing students to talk about then finding the connection the material: "She [Carole] definitely listens to their stories and I think I've learned that through her...'OK. Let's make a connection somehow'' (Jackie, I2, Lines 6-7).

In closing... Carole was a nurturing, caring, and professional teacher. Students loved her and worked for her because when she spoke with them, Carole had a way of making them feel as though they were the keepers of important knowledge they could share. Even with 23 years of teaching under her belt, Carole had never stopped striving to improve her craft: "I'm open to learning new things. I'm aware that kids are so different now than when I first started teaching in 1982 and therefore, the education should be different for them" (Carole, I1, Lines 363-365). And

while science was not her strongest subject, she had found ways to work around her weaknesses by collaborating with others and using teaching strategies that transcended content borders.

During an observation in November, one of Carole's students wandered to the table at which I was sitting in the back of the room and eyed me both shyly and inquisitively. He saw my digital voice recorders from the morning's interviews and picked them up, turning them over in his hand as I continued to type observations of the lesson. Touching the screen of my laptop, he asked why I was typing. I replied that Carole was such an amazing teacher that I wanted to write down what she was doing so I could figure out what makes her so amazing. Solemnly, he nodded, and said, "Yeah, she's good," before walking back to his seat, the corners of his mouth turned up in a small, satisfied smile.

Carole's system in terms of CHAT. In order to better understand the interactions between context and Carole's instructional practices, it is helpful to use a CHAT lens to view her teaching context. Figure 7 illustrates the major components of Carole's activity system.



Object: Science

instruction



Rules: you are accountable to the district; district wants small group/hands-on instruction; must incorporate FLAP into science; must teach many subjects and integrate enrichment strategies; must prepare for state test; Titan drives instruction

Community: administration treats teachers professionally; several science collaborators; variety of abilities in her classroom **Division of Labor:** student teachers and collaborating teachers as science planners; David as great science resource; district as dictator of preferred science activities; Carole as math/ reading expert; Carole as mentor; Carole as helping out with logistics with others' lessons; Carole as learner

Outcome:

(lecture- or

book-based)

Carole's

science

instruction

Figure 7. Carole's activity system.

Through an examination of Carole's activity system, it is easy to see how interactions between various components result in her current instructional practices. For example, she does not feel comfortable planning science and has several people available to plan science for her, resulting in Carole being relatively detached from science instruction in her classroom. Another interaction that reinforces Carole's instruction is between her role/belief that she is a learner, and working with the many collaborators at RPECS. Positioning herself as a learner and taking into consideration her lack of positive experiences with science, Carole does not assert herself with her collaborators in terms of science and assumes that whatever they plan is the best for her

students. Other interactions and interactions that result in contradictions will be discussed further in the cross-case analysis that follows these case studies.

Erin's Case Study

Erin was a 5th grade teacher who was in her late 20s. In her third year of teaching, Erin had two distinct personalities in her classroom: about half of the time she joked around with the students, sitting on the desk while she read, using what was popular and fun to get her point across; the other half of the time, she was serious, a self-described 'old school' teacher, with high expectations for her students' academics and behavior. She believed one of her strengths was the ability to balance these two different personalities, and stated, "I feel like I'm really good about keeping things in an orderly manner but not so rigid that the kids feel like they can't get out of their seats," but also admitted that due to her three short years of experience, "I don't know if I have a 'I'm really good at this yet' feeling about some things" (Erin, I3, Lines 306-309).

Personal background. Being a teacher was not something that Erin always dreamed of. She was a Recreation and Leisure Studies major at SU, with a focus on recreational therapy, finishing her degree as an instructor at a psychiatric facility for minors in Texas. But after graduation, she decided not to take the certification exam to become a licensed therapist because, "there [was] no room for growth. Like you either do it and you do it or you go back to school and you write a book kind of thing" (Erin I1, lines 30-31). After making that decision, she took a sales job in a neighboring state for six months before coming back home and considering teaching. However, she thought at the time that teaching was a 'cop-out career'. As she put it, "Oh, everybody becomes a teacher" (Erin, I1, lines 34-35). When Erin finally did decide to pursue a career in teaching, she looked into Master of Arts in Teaching (MAT) programs and found one at a newly-opened community college. Within one month, she asked her grandmother

for financial assistance with tuition, took the GRE, applied for the program and was accepted, moved, and enrolled in courses.

While working on her MAT degree, Erin worked as a paraprofessional (parapro) at a local middle school media center. Because of her work at the middle school level, she was drawn to upper elementary grades, but did not want to teach middle school because she felt that she did not have the content knowledge to specialize in one content area at the middle grades level. When asked later what subject she would have chosen if she had chosen to teach middle grades, she said that she would have specialized in social studies, with science being a close second. Erin explained this by saying,

I like stories...I can look at social studies content and see how to lend it to writing or reading. And I can kinda see that for science. I just don't know the content as well. Like I'm still gaining my own confidence within the content (Erin, I1, Lines 167-170).

Overall, Erin did not see her MAT program as being terribly rigorous, something about which she spoke at length. While she made a point of saying she enjoyed her professors and she had since heard that the program had changed, she said,

...the accountability aspect of [the MAT program], it was not as rigid as I think other programs are so there was much more wiggle room to take liberties where you needed to in order to get the project done...it was not as professional as I think they thought it was. (Erin, I1, Lines 93-97).

Because of this lack of rigor and because there were few classes which Erin felt were 'real life', she really enjoyed her time in the middle school as a parapro. In fact, she said that had she not been working at a school while completing the MAT program, "I would have been like, 'Why

am I taking these damn classes? Like this is a joke'" (Erin, I1, Lines 113-117). After receiving her MAT, Erin applied with the SSD, but had not yet been called to interview when she took a job with Head Start. However, no sooner did she take a job with Head Start than Serena, the RPECS principal, called her up for an interview and offered her a job. Erin took an Early Intervention Program (EIP) teacher position at RPECS for a year and was moved to fifth grade the following year, making this her second year as a fifth grade teacher.

Erin's tendency towards rigor and high standards for herself and others was a constant theme that resounded throughout all of our conversations. Regarding herself, she summarized her work ethic succinctly: "I have never in my life…been OK with not doing my best or going above and beyond" (Erin, I1, Lines 423-424). When feeling overwhelmed with all that needed to be done, Erin was often frustrated because she knew that for her own mental well-being, she should have stopped with 'good enough,' but found herself saying, "You lazy piece of crap. You know that nobody else is going to do it so you need to" (Erin, I1, Lines 432-433). Very tongue-incheek, Erin called herself the "hopeless romantic of education" because she often thought, "We can do it all and we can do it all great" (Erin, I1, Line 418).

This inclination toward rigor was also reflected in Erin's teaching style and expectations for her students. First and foremost, Erin often referred to herself as "old school" or "traditional" (Erin, I1, Line 221) because she believed that students should have basic life skills, such as writing a letter or balancing a checkbook and that technology had "excused" younger generations of students from these skills (Erin, I1, Line 223). Knowing that there may have been times when she should have embraced 'newer' ways of teaching, she insightfully stated,

...you have teachers who had successful experiences in school and are being asked to now teach it completely differently than how they learned. And so I

don't think I'm opposed to trying new things or trying things in different ways, but there are moments...that the old school way, for lack of a more professional term, was fine. (Erin, I3, Lines 137-141)

Continuing her 'old school' outlook, Erin also remembered fondly that when she was a fifth grader, she had more "stamina" when it came to sitting still, writing, and taking notes than the students she was then teaching and that she was better able to think for herself. To these ends, Erin often had her students take notes and told her students to 'use their resources' or asked which resources they could use to answer certain questions (e.g. Erin, Obs. 110811, 112111, 022212). Erin was also adamant that it was her job to teach these life skills so that all of her students – not just those on a college track – could be successful in the real world:

I think it's an academic injustice if I just teach only content. Like I personally feel that, at some point, teachers have to put their foot down and say, "No. These kids need to know how to write their name correctly with capital letters in the right spot," and things like that. (Erin, I1, Lines 199-202).

Consequently, Erin placed a great deal of pressure on herself because simply teaching the standards was not enough for her. She believed "... it's part of my responsibility as a fifth grade teacher to prepare them for next year and for high school because they're not going to have their hand held" (Erin, I1, Lines 552-554). She was not just preparing her students for more schooling, however, but for real life and independence.

All in all, Erin believed she was doing the best she could, pushing herself to go above and beyond in science when she could, while also taking into account the many layers of requirements and components involved with teaching at RPECS. At times, she felt as though she was becoming one of those people who said, "Well, if it doesn't get done, it doesn't get done,"

which she absolutely hated (Erin, I1, Lines 428-429). However, she had hope that she would grow as she continued to teach. "I'm still learning how to stand up for not only myself and what I think as a professional and as [the students'] teacher, they need versus what I'm being told that I have to do" (Erin, I2, Lines 102-103). It was this attitude of learning and growth that kept Erin striving for more for her students when it came to science, and she knew she still had much to discover: "I think teaching is a very humbling experience because I think if you're halfway in it, you realize that you never are going to know everything and…no matter how old you are, going to need to ask for help" (Erin, I2, Lines 238-240).

Erin and science. Her science preparation in the MAT program was memorable, but perhaps not the most rigorous. Erin's science methods instructor had students work from a middle-school-level review book that covered all science topics and included a 'blurb' of information at the top of each page and some sort of learning check at the bottom. Erin loved this book and pulled it off her shelf when she was telling me about the course. The instructor also required students to create note cards for each experiment shown in class. These note cards could then be filed with different science units "to remind you the next year after a whole year had gone by and like the steps of what to do and things like that" (Erin, I1, Lines 142-144). Finally, students were required to create a box full of supplies, such as candles and balloons, which could be used in 'grocery store' science experiments. Erin saw this methods course as being beneficial: "I did really enjoy that class because…there [were] no silly tests, it was all very practical" (Erin, I1, Lines 144-145).

When asked how she felt about science and teaching science, Erin revealed her "dirty little confession" (Erin I1, Line 306) when she told me that the fifth grade wants to departmentalize next year, and she wants to teach science and social studies. In fact, at the time,

the period allocated for science and social studies in her room (from 7:55-8:45) was her favorite part of the day. However, the desire to departmentalize fifth grade was not just because Erin liked social studies and science, but rather a much deeper reason:

I just want to feel like I'm good at something. And the three of us [fifth grade teachers], in lots of roundabout ways have had many conversations about how none of us feel that we're actually doing anything well. We feel like we come to school and we check things off a list and we're kinda teaching. And I think all of us, even though we have very, very different personalities and we have very

different strengths, need to have that satisfaction. (Erin II, Lines 318-323). Erin truly felt that being the typical elementary generalist, "... keeping all those balls up in the air and actually being successful at all of them, it feels like something that's always going to be out of reach" (Erin II, Lines 328-330). She argued that being able to specialize in science and social studies would allow her to understand the content at a deeper level, find more resources, and "delve into some really cool things" (Erin, II, Line 46) that she simply did not have time to do when preparing for all subjects simultaneously. Giving the example of Takis (very spicy chips that all her Hispanic students seem to love), Erin talked about how she could use Takis to teach science, if only she were given the freedom and time to do so. Lessons such as this would then allow her to grow her students' interest in science, as at the time she was concerned that the United States was not producing students who have a "strong desire to investigate something from a scientific angle" because we were not giving them time to explore things about which they were curious. Erin truly felt that given the opportunity, she could be very good at this.

And to Erin, cultivating an interest in science was important because science is "in everything" and it "makes kids more curious and makes them critical of the world and makes

them critical of what they should and shouldn't be doing," which are qualities she felt her students needed (Erin, I2, Lines 108-113). To these ends, she wished she had more time to make her lessons more hands-on and interactive so that students could be more interested in science. Again, like her colleagues Heather and Carole, hands-on activities were seen as a means to an end, a way to keep students interested by having fun. Reform-oriented science did not seem to be something Erin considered or saw as a possibility for her class. Ultimately, due to the constraints she felt concerning science instruction, her goal in science for her students was that,

I want the kids to at least remember enough so that when they hear it again, it at least jogs their memory... 'I know I've heard this word before. I know what a cell wall is. Can't remember if both plants and animals have it, but I know it's important.' (Erin, I2, Lines 185-193).

Erin admitted this was a "bottom of the barrel goal" (Erin, I2, Line 186), and said wryly, "I'm professional enough to know that that's what I should be doing, but execution-wise, I would probably give myself a three or four. Probably a three if I'm being honest" (Erin, I2, Lines 211-212). Concerning her confidence in her science instructional abilities, Erin was probably more confident than most elementary teachers, but admitted, "I'm still at a point…where I have to review the information myself…I still have to ask questions and I don't necessarily always understand the answer the first time" (Erin, I3, Lines 107-110).

Erin's perceptions of the external context. In reflecting upon the external context, Erin saw many more barriers than supports. One of these perceived barriers came in the form of the resources available to Erin while planning for science. The most readily accessible resource was the county pacing guide and its accompanying activities, which the teachers referred to collectively as Titan. However, Erin did not believe Titan to be a useful resource. She asserted,

"the district thinks it's like the Bible" (Erin II, Line 443), but it was not always updated, could contain incorrect content information, often had flaws in the county-wide assessments, or was otherwise "filled with junk" (Erin I2, Line 306). She was frustrated with Titan because she believed the district was throwing things into Titan in a slapdash manner while teachers were expected to do things perfectly: "Really? Really? You're going to ride my ass about X, Y, and Z and you can't even get a Word document correct?" (Erin, I1, Lines 450-451). Erin did believe that Titan was a good starting point, especially for new teachers or teachers new to the grade level, but thought it could be improved upon if the errors were corrected and the activities were chosen more deliberately. Due to her feelings about the quality of Titan, Erin relied heavily on the textbook as well as her husband, who was a fifth grade teacher in a neighboring district, for science instructional strategies and activities. And while Erin did not indicate that her student teacher, Gwen, was a resource in terms of science content, she did admit that watching Gwen teach science made her "more conscientious and aware of my own habits and approaches to things like how I speak to the kids [and] how I provide my instruction" (Erin, I3, Lines 393-394).

Erin also listed the newly-created science lab and SU (due to the PDS partnership) as other resources she turns to for science. However, these were resources that Erin felt could hold great promise but, for various reasons, were not actually as useful as they could be. Erin referred to the lab as having "potential to be a big advantage" but that finding the time to actually utilize it was difficult (Erin, I2, Line 60). Further, as will be described below, Erin believed there to be so many other issues with her particular class that it would be a better use of her energy to work with those issues rather than to plan activities in the lab. Concerning the SU partnership, she said,

...we have people organizing and facilitating the science centers⁵ with the SU students, which I think is a wonderful thing and I think that schools that don't have that option are missing out because it does provide a different angle, it provides the kids with different types of interactions, so in that regard, that extra of having SU present in the building I think is a positive thing (Erin I2, Lines 24-28).

But Erin saw SU's science centers as merely a drop in the bucket. What she really wished for was more science professional development in conjunction with SU, and saw the PDS partnership with SU as an underused resource in that respect: "If we've SU at our fingertips, if we have those resources, why not let them come in...Let them [SU graduate students and professors] do what I'm assuming y'all are asking [RPECS] to do" (Erin, I2, Lines 624-627).

When it came to the everyday implementation of quality science instruction, Erin saw quite a few obstacles. The FLAP grant, lack of time, and the particular needs of her class that year were very high on her list of items that were keeping her from teaching science as she wished she could. Without hesitation, Erin blasted the FLAP grant, stating, "I think that the FLAP grant distracts from science instruction. I think that it has shifted our priorities to accommodating a grant that was not well thought-out, and it's taking the focus off of instruction" (Erin, I2, Lines 10-11). A major part of this frustration was not just the grant itself, but her collaborating teacher, in particular. Erin lamented that David, the same FLAP collaborator who worked with Carole, lectured the students in Spanish, and when he did speak English to the students, his accent was very thick and difficult to understand. Erin had attempted to give David teaching tips to liven up the presentation of material, but he had not taken those suggestions.

⁵ A component of the SU-RPECS PDS partnership includes SU pre-service elementary teachers teach small 45minute science centers at RPECS three times per semester, allowing each grade level at RPECS to have a science center experience with SU students once a year.

Consequently, she had washed her hands of the situation, saying, "...it's not the right way to approach it, but I might have a brain aneurysm if I let that consume me" (Erin, I2, Line 369) and that,

I basically cut off the last 10 to 15 minutes of my day so that my collaborator can have that time to do a closing...I feel like the kids are losing 10 to 15 minutes of their life because they sit there, half of them can't understand the instructor, the other half just don't care because now they're just being lectured to...the easiest way for me, and I've kinda adopted this attitude, "Well I'm the classroom teacher, I have more pressures than you do, so I'm going to do things my way." And I can say that. I'll own it. I'm going to plan my lesson, here's what we're working on, here's the vocabulary, here are the standards, you can have 10 minutes at the end of every class on most days. Wednesdays are my favorite day because [David's] not in here. I get so much done. (Erin, I2, Lines 348-363)

Obviously, Erin saw the FLAP grant as a large obstacle to quality science instruction and a daily source of exasperation. She felt that she was constantly slipping behind the pacing guide due to lost time and, "I am eventually looking forward to a point in my life when I don't have to do this [the FLAP grant] collaboration" (Erin, I2, Lines 494-495). And while Erin seemed to have been granted her wish concerning the disappearance of the FLAP grant, the issue of time still remains.

If anyone asks teachers what they need more of, 'time' is often the answer, and this was no different for Erin. She felt at a loss for time to find resources, time to talk and work with others, and time to teach science to her satisfaction in her classroom. When thinking about her science instruction, Erin flatly said, "...ultimately, it's all about time. We're out of time. We're literally out of time [for science]" (Erin, I3, Lines 46-47). During one of our interviews, Erin

brought up the fact that she had just discovered the collection of Activities Integrating Math and Science (AIMS) books in the library and she was absolutely delighted by the variety of activities as well as the accompanying worksheets that were in these books. However, "…because I'm juggling reading, which is a big issue, writing... Something's got to give and often times it's science and social studies, unfortunately" (Erin I1, Lines 383-385). Too often, Erin found that she did not have the time to devote to science and social studies or to find resources such as AIMS books and the like, but "This is what I would rather be doing than fishing for resources...Like I wish I had time to look at resources like this and bring it back to the classroom" (Erin I1, Lines 381-383). Moreover, Erin felt she had to make some hard decisions regarding her planning in order to help her students with life skills and please the district:

...do we go to the science lab and put the energy towards planning a lesson in there and some activities in there or do we find resources that can help support the big umbrella issues that we're trying to address such as reading?...Like do we put our energy towards that stuff [science], which is arguably just as, if not more, important, or do we put our energy towards what the district is looking at us with a microscope with, which is why aren't these reading scores higher? (Erin, I2, Lines 64-69).

Additionally, she did not have time to plan or talk with her colleagues about science. There was an English for Speakers of Other Languages (ESOL) collaborator with whom she would like to try to 'extend the tentacles' of ESOL reading strategies into science, but "We just don't have time to talk about it or get it ready" (Erin, I1, Lines 531-532). Concerning her own fifth grade team, they met three days per week during their planning period but,

...our focus is still primarily math and reading, even though science is now in this whole AYP [Adequate Yearly Progress] mix, we should be looking at it, but again, there's just no time because of all the other stuff, of all the paperwork, of RTI, of things like that. (Erin, I2, Lines 20-23)

The general feeling was that reading and math need to take center stage, and that the district expected them to complete so much unnecessary documentation on these two subjects such that there was no time for anything else. Erin mused, "I think teachers could easily spend more time documenting and being accountable for their job than they actually do their job" (Erin, I2, Lines 233-234). She was frustrated with what she saw as busy-work taking away her already precious time and said she had times when she wanted to ask, "Can I just teach? Would you all just leave me alone and let me teach?" (Erin, I2, Lines 236-237).

Another issue concerning time was the ambitious county pacing guide. Harking back once again to her own elementary days, Erin remembered that students used to learn science and social studies every day. But SSD had implemented 'extended learning time' (ELT) into the schedule each day, with the aim of remediating students on an ongoing basis. ELT took the place of a (45 minute) class, which meant that social studies and science could not be taught every day, but rather teachers must alternate between teaching a unit of social studies and a unit of science for approximately four weeks at a time. However, even with this obvious loss of time, the pacing guide had not decreased the amount of content to be taught. Erin pointed out,

...if you take a little [time] here, then you have to take away a little bit there...And we express that to them [SSD] at the beginning of the year. There is more content than there is time, even if we didn't have to worry about [the standardized test], there is not enough time from August whatever to May 16th or whenever we get out to cover everything on the pacing guide. Period. So if you can find somebody who does it successfully, please let us know. But they [SSD] don't register that. (Erin, I1, Lines 468-478)

Moreover, Erin believed that the students needed more instruction concerning the scientific method, which was not in the pacing guide. She and her colleagues 'snuck' that topic in at the beginning of the year, but did not get to teach it long enough:

...we as teachers felt the pressure to...stop at some point and move on to the normal content... [but] we didn't do it as thoroughly as we should have...they [the students] just needed more time to build up to that and I felt as a teacher, for whatever reason, that I didn't have the time to take to actually let them do that as long as they should have been able to do that. (Erin I1, Lines 287-296)

The compression of the curriculum resulted in Erin not teaching science to the depth she believed the students needed or deserved, but she was compelled to move on and get through the pacing guide.

To compound this issue of not having enough time, Erin shared with me several times that her class was much less academically capable than the previous year's class. For example, many of her students could not even spell their names correctly. Due to issues such as that, she could not move through the curriculum as she did in years past because "my group last year would have taken 10 minutes, it would take 30 with this group" (Erin, I1, Lines 496-497). Vocabulary was also a constant struggle for her students and while Erin has strategies in mind to address vocabulary issues in science, she did not feel she had the time to do so because these strategies would take 15 to 20 minutes of each class. Her students' academic issues complicated by the lack of time also guided Erin to fewer inquiry-based lessons, as her students struggled

with what she called the 'confidence' to ask questions and try to answer without the fear of being wrong. She was disappointed in herself for not teaching as she felt she should be and worried about selling her students short, but at the same time,

Why the hell am I going to waste time on this [an inquiry lesson] if I'm going to sit there for 10 minutes and they're still staring at me blankly? Because then it just goes back to the whole, I don't have enough time to waste on this. It's a total domino effect, like if one falls, they all fall. (Erin, I2, Lines 208-210).

Erin knew that she needed to meet her students where they were in terms of academic ability, but she felt pulled in opposite directions when she considered her constant battle with time for science instruction.

The matter of time was brought up in my conversations with Erin in one more very surprising way, in regard to the concept of 'fluff.' Erin defined fluff as an "element of a dog and pony show on the off-chance somebody walks in" that must be included in her lesson plans (Erin, I1, Lines 505-506). For example, because of a scheduled district walk-through, Erin had students write information from flip-books they had made onto white boards. These white boards were then rotated through the classroom. Erin believed a lesson such as this would appear much more interactive and would play to what the district wanted. However, she would have much rather had a "cut and dry, we're going to take notes, we're going to create a resource and then let's have some creative activities, exploration activities" kind of day (Erin, I1, Lines 517-519). This, she insisted, was how you get students to create resources and then use their resources, but it did not 'look good' to the district. Erin also included enrichment strategies in her lessons that did not always "align with their [the students'] academic needs" so she could satisfy the 'fluff' requirement because, "I had to put it in my damn lesson plans and highlight them on the off-

chance, the fucking off-chance, that somebody checked them" (Erin, I3, Lines 651-655). Another aspect of 'fluff' was ensuring that lessons had some sort of product that could be displayed on the wall in case the district or administration walked through. Erin said that she made the flipbooks in part because she did not want the superintendent to come through and then say to the principal, "Why didn't that 5th grade teacher have student work posted?" (Erin, I1, Line 577). The inclusion of products for products' sake as well as the 'dog and pony show' lesson elements were things that Erin felt were necessary in order to satisfy the district and school's 'fluff' requirement, but these all took up more science instructional time than Erin felt she actually had to give.

Erin's instructional practices. Because Erin was very vocal about the context in which she taught science, it was interesting to see how this played out in her instructional practices. I observed science instructional time in Erin's room 17 times and out of those, Erin was the lead teacher 9 times (Erin, Obs. 110811, 111611, 112911, 113011, 120611, 112111, 030712, 030812, 032012) – the other lessons were taught by her student teacher, Gwen. Gwen was supposed to teach the final unit of science for the year, a unit on landforms, but Erin took science back over simply because she had never gotten that far in the pacing guide and wanted to try her hand at teaching landforms.

Although Erin complained during interviews that she had to give up 10-15 minutes at the end of each science lesson for David, her FLAP collaborator, I did not see any instances of this. However, in her final interview, Erin mentioned that she started her science instruction 10 minutes *later* than she wanted because she had to wait until David arrived. She went on to say,

If the FLAP grant hadn't been present this year, I think that we would have hit the ground running because I would have started earlier, I would have given myself

more time to have really complete lessons versus having to split them up over 2 days because I have to account for somebody else...because of that I have had to take short-cuts and possibly not have completed as many exploratory activities or demonstrations. (Erin, I3, Lines 318-323).

While it is difficult to say what would have happened if the FLAP grant were not a part of Erin's instruction, when David was present, he either took small groups in the hallway (Erin Obs. 110811, 120611) or spoke with Spanish-speaking students to assist them with their work (Erin Obs. 112111, 112911), so it did not seem as though Erin was making many accommodations for David and FLAP. And although David indeed did not arrive until approximately 8:00 rather than the 7:45 start time Erin wished for, not once during a science lesson did I see David 'take' time to do his own lecture.

As a lead teacher, one thing that was striking about Erin's instruction was that she tried to ask students questions that would make them think about the topic at hand. Her questions seemed to range from Knowledge to Evaluation levels of Bloom's Taxonomy, from "How are characteristics or traits inherited?" (Obs. 112911) to "What do we have in common with a whale?" (Obs. 110811) to "Why is it important to compare and contrast drawings to real pictures?" (Obs. 030712). At times, the questions were not posed by Erin, but by her students, as was the case of November 16th. As they began to read about invertebrates, a student asked why a worm is an invertebrate and a snake is a vertebrate – they're so similar. Another student began talking about the way those two organisms moved and Erin told them they should think about that as they read and if their question was not answered, they could research it later. This is one example of how Erin encouraged students to think and discuss.

True to her goals of teaching students 'life skills' such as being able to take notes on their own and write what they found in a book, there were several occasions when students in Erin's class completed a 'note-taker' or answered questions from the book (Erin Obs. 110811, 112111, 120611, 032012). Erin did include some activities that went beyond pencil and paper or textbook reading, such as showing pictures or videos on the SmartBoard (Erin Obs. 110811, 113011, 030712, 030812, 032012), cutting out and classifying animals on a T-chart labeled 'vertebrate' and 'invertebrate' (Erin Obs. 111611), matching pictures with their geologic terms (Erin Obs. 030712), and cutting out and placing together the continents in order to create Pangaea (Erin Obs. 030812). Gwen confirmed this, observing, "...when she was up there, it wasn't reading the textbook. They might read the textbook a little on their own...but when she was up there, it was pictures and activities and stuff" (Gwen, I2, Lines 26-28). Concerning hands-on, interactive activities that Erin often spoke of wanting to do, I did not observe any of these, although the geology lessons came close. There were a few times when Erin read the textbook out loud together with the students and she was very good at stopping and checking for comprehension or asking questions such as those listed above to provoke deeper thought about the subject (Erin Obs. 111611, 112911). Gwen was especially impressed by this as she observed Erin, saying, "Oh, they [students] can get engaged even using the book! It's not always drudgery!" (Gwen, I2, Lines 59-60). Erin seemed to feel torn between hands-on activities and book- or lecture-based activities and but perhaps erred on the side of book- or lecture-based activities because, "I think if you only teach kids through experiments and demonstrations and more hands-on opportunities, then they're never going to be confident at the other end of the spectrum, which is the writing, the note-taking" (Erin, I3, Lines 665-667).

When introducing new concepts or difficult vocabulary, Erin attempted to illustrate those concepts in new and interesting ways or physically acted out the vocabulary. For example, when discussing classification with students, Erin brought in a set of Russian nesting dolls to illustrate how species fits within genus, how genus fits inside family, etc. (Erin Obs. 110811). When answering questions about classification, the students were able to refer to the dolls to understand those concepts. While introducing dominant and recessive genes, Erin often 'showed her muscles' when talking about dominant genes and how they work (Erin Obs. 112911). And when explaining how nonvascular plants move food and water throughout their structure, Erin leaned up against a student, simulating the passing of things from cell to cell (Erin Obs. 112111).

While the lead teacher, Erin rarely seemed hesitant about the content, nor did she misinform students with incorrect content knowledge. Rather, she was particularly adept at connecting the science topic at hand to real-life and showed her students that learning science could be enjoyable. Gwen pointed out that,

...she makes the kids interested in it and she gets...excited about it. When y'all talked about Yellowstone National Park [in a professional development session], she showed a video about Yellowstone National Park to the kids because what she was learning and what she was figuring out about...She connected [geology] to her granddad and that was really cool...So I think she has fun with it. (Gwen, I2, Lines116-125)

In closing... Erin, a young and enthusiastic teacher, had a 'back to basics' attitude towards teaching often found in more experienced teachers. In her eyes, hard work and perseverance were the keys to success in life and she intended to pass this work ethic on to her students – her book- and lecture-based instruction techniques equaled tough love. Concerning
science, Erin had the vision and drive to be a solid science teacher, but perhaps due to her short three years in the classroom, she was still struggling with exactly how to make it happen. For all her short-comings regarding execution however, it was difficult not to admire her spunk and passion for making things better for her students and the system overall. But, passion can burn quickly and fiercely and sometimes exhaust people. Erin shared with me, "I don't know if I can do this whole teaching thing forever...I don't like it when I can't put things into my reality" (Erin, I2, Lines 249-253). Erin's reality, or hoped-for reality, was much different than *actual* reality at RPECS. How long will she be able to teach in RPECS's reality?

Erin's system in terms of CHAT. In order to better understand the interactions between context and Erin's instructional practices, it is helpful to use a CHAT lens to view her teaching context. Figure 8 illustrates the major components of Erin's activity system.



Figure 8. Erin's activity system.

Through an examination of Erin's activity system, it is easy to see how interactions between various components result in her instructional practices. For example, Erin believed students should have basic 'life skills' (basic reading/writing/communication skills) and the district emphasized accountability in reading and math, resulting in Erin relying heavily on reading and writing in her science lessons. Another interaction that reinforced Erin's instructional style was between the district's rule that teachers should follow the pacing guide timing and the 'low' students in Erin's class. Erin felt that in order to keep pace with Titan while working with her

particular class of students, she did not have time to do experiments or scientific inquiry as these are quite time-consuming. Therefore, the most 'efficient' way to teach was via lecture, the textbook, and note-takers. Other interactions and interactions that resulted in contradictions will be discussed further in the cross-case analysis that follows these case studies.

Introduction to Cross-Case Analysis

To illustrate how context impacted teachers' instructional decisions, I will present findings from a cross case analysis. The initial part of this analysis will focus on the first research question, or how the context (or perceptions of the context) impacted these teachers' science instruction. The second part of this analysis will focus on contradictions present in the context and how these contradictions result in tension or growth.

It is important to note that when using a CHAT lens for research, analysis can quickly become unwieldy, as *everything* is interconnected. In order to streamline this cross-case analysis, I will highlight certain aspects of both the internally constructed and externally imposed context that all teachers' activity systems have in common, as indicated in the CHAT diagram Figure 9. This diagram serves to document the boundaries of this analysis. Specifically, all teachers in this study had the same basic tools in common (science materials, the lab, textbook, Titan), as they were provided by the school. Each teacher dealt with similar rules concerning standards, the pacing guide, incorporating the FLAP grant, and reading and math accountability, although it could be argued that the stakes were somewhat higher for Carole and Erin in the upper grades. The community for each teacher was similar, including a student teacher, PDS personnel, and team members, but Carole and Heather seemed to welcome more people into their community than Erin. The division of labor for each teacher was comparable in that each teacher was expected to plan lessons and teach, and the administrators in RPECS were expected to hand

down rules, evaluate, and support teachers. Finally, in general terms, each teacher brought to the system their own beliefs about the purpose of education and the importance of science based on individual prior experiences, as well as their personal goals for their students learning; these beliefs and goals differed by teacher, but they were significant in terms of how each teacher made decisions about science instruction.

The key findings that will be discussed in this cross-case analysis are:

- There were three major components of the activity system that were the most influential in guiding teachers' science instruction: the FLAP grant; the combination of state standards, the state test, and the district pacing; and the science resources available to the teachers.
- The way in which each teacher translated the aforementioned components into instructional practice was dependent upon their internal context (beliefs and goals) as well as their perceptions of other external contextual factors.
- 3. There were four major contradictions that all teachers in this study had in common (listed below); these are most likely consistent with contradictions elementary science teachers across the country encounter in public schools.
 - a. Beliefs about hands-on versus book-based learning for children
 - Rules about mandatory time for science instruction versus the importance of teaching math and reading
 - c. Beliefs about hands-on, engaging instruction versus enacting book- or lecturebased instruction in their classroom
 - d. What science instruction is like now versus what it could be

4. While many contradictions result in more tension, teachers can and do find ways to push for growth within their activity system.

These findings will be described in detail in the remainder of this chapter. The implications of these findings will be further described in the next chapter.



Figure 9. Elements of CHAT all teachers' activity systems had in common.

Cross-Case Analysis Part I: How Context Shapes Instruction

As explained in the literature review, I construe context in a way that includes both internally constructed and externally imposed components. As shown in Figure 9, the rules, community, tools, and division of labor all constitute pieces of the externally imposed context while the beliefs and goals of the subject constitute pieces of the internally constructed context. Moreover, the historicity found in elements such as the rules and division of labor, or the multivoicedness found in the community and tools are consistent with the tenets of CHAT. In the first portion of this analysis, I will discuss the three major components of the activity system that were most influential in guiding teachers' science instruction: the FLAP grant, standards/the pacing guide/state testing, and science resources. I will then demonstrate how each teacher translated the aforementioned components into instructional practice dependent upon their internal context as well as their perceptions of other external contextual factors.

The FLAP grant. Comments about the FLAP grant were prominent in nearly every conversation I had with Carole, Heather, and Erin. This is not surprising, given that the FLAP grant mandated that Spanish language instruction take place during science and social studies instruction; this requirement disrupted the ways in which these teachers typically conducted their science instruction. As with any major intervention within a school, the FLAP grant brought with it varied issues. First and foremost, each of the participants in this study was required to co-teach science with a teacher who was new to RPECS, and, in the case of David, someone who was not a certified teacher. At times, working with these FLAP grant teachers caused confusion about whose responsibility it was to plan lessons, or resulted in frustration concerning the style of the teaching. Additionally, the classroom teachers were constantly aware of the time constraints already in place regarding science as dictated by the pacing guide, Titan – could they really spare time for Spanish instruction? These were the major issues with the FLAP grant as described by Carole, Heather, and Erin. However, each teacher had a different perspective on these issues and this perspective was dependent upon her own personal history and internal context as well as how she viewed other components of the external context.

Heather's relationship with the FLAP grant evolved as the school year progressed. At the beginning of the year, Heather believed the grant was taking up a great deal of her instructional time and that the minimal level of communication/coordination with her collaborator was

unacceptable. However, toward the middle and end of the year, Heather's viewpoint changed, stating that the FLAP grant was allowing her greater depth into science and that her collaborator was a wonderful science resource. This evolution could be attributed to Heather's penchant for following the rules and desire to be efficient. At the beginning of the year, the schoolwide rules for the FLAP grant were strict, requiring a certain amount of the science lesson to be taught in Spanish, and for the lesson to be taught a certain way. Heather originally had some difficulty meeting these requirements due to the late arrival of Lisa (her FLAP co-teacher) to the school, which caused Heather a great deal of irritation with the FLAP grant as a whole. However, toward the end of the school year, the administration found out that the FLAP grant would not be funded for the 2012-2013 school year and became much more lax about the rules. This rule relaxation allowed Heather to see the FLAP grant as a resource and an 'extra' because she could alter the instruction to meet her goals for her students. Heather believed that her job was to teach students to read for information, teach them the prescribed standards, and prepare them for the state standardized test. As she was allowed more freedom within the FLAP grant to meet these needs, Heather's attitude toward the grant softened.

Although Heather initially did not care for the FLAP grant, she did maintain throughout the year that Lisa was a great resource for her in terms of science. She was quite satisfied to allow Lisa to take over science instructional responsibilities because Lisa often provided examples to demonstrate science topics, created 'interactive' components of the lesson, or assisted with small groups within the class. In fact, Lisa taught science so much that Heather's student teacher, Adrienne, rarely saw her mentor teach science at all. As a student, Heather had unmemorable science experiences and as a teacher she believed students need science in order to become well-rounded citizens but could not articulate why this was so. Additionally, she had

decided that for second graders, 'good' outcomes in science involved her students being able to answer questions verbatim from the text and score well on tests. Science instruction often seemed a nuisance to Heather, who could only mention a few topics that she enjoyed teaching, and as seen in the poetic introduction to her case study, she thought herself to be a 'terrible' science teacher. Keeping each of these beliefs in mind as well as being cognizant of the highstakes accountability atmosphere in which Heather taught, it is understandable why she would welcome anyone who could potentially be a science resource into her classroom. As long as Heather could work textbook reading and choral response question/answer sessions into Lisa's science lessons, Heather was thrilled to hand off the responsibility of science instruction to someone else.

While Heather liked the FLAP grant with a few reservations, Carole was blissfully happy with the FLAP grant. She often described her FLAP grant collaborator, David, as being a wonderful science resource due to his prior experience as a science professor in Honduras, and typically gave him as much time in class as he wanted. As Carole did not see herself as a science expert, she was absolutely thrilled to have a collaborator she could completely trust with science instruction. She also believed it is important for her students to see 'connections' between their lives and the topics at hand. In her mind, David was able to help her students make many connections through items he brought to class or stories he told, so he was also an incredible resource in that sense as well. Finally, Carole was acutely aware of the expectation at RPECS to be open to collaboration and co-teaching, so she believed that playing the role of 'supporter' as she allowed David to take the lead in science instruction allowed her to meet that schoolwide expectation.

Carole's attitude toward the FLAP grant certainly influenced her science instruction. As noted in her case study, Carole leaned on anyone she could find to teach science – be it a gifted collaborator, student teacher, or FLAP co-teacher. The FLAP grant seemed to give Carole one more option as far as someone to teach science for her. While Carole or the student teacher would decide on the big topic or activity for the day, Carole felt completely comfortable handing over nearly half of the science time to David and his PowerPoint presentations. Having David teach science also satisfied Carole's desire for her students see a lesson presented in multiple ways, which made her feel as though the FLAP grant was allowing her to do the utmost for her students in science.

Finally, although Heather and Carole were able to see the positive aspects of the FLAP grant, to Erin, the FLAP grant had no redeeming qualities. First and foremost, she saw the grant as a 'time thief' due to the expectation that she would have to give a portion of her science lesson over to Spanish language instruction. Several times, Erin mentioned the district pacing guide (Titan) as well as the state standardized testing and how she was struggling to keep up with the calendar despite her 'lower' students. In her mind, she did not have time to spare, and to give that time away to an instructor she thought of as terrible made it just that much worse. To be sure, Erin did not believe in her FLAP collaborator's abilities as an elementary science teacher. Interestingly, she worked with David – the same collaborator that Carole saw as a great science resource – and saw his droning lecture style as simply unacceptable. Given Erin's exciting experiences with science as a student and her beliefs about how science should be hands-on and personally relevant, it is easy to see how she viewed lecture and PowerPoint slides as deplorable.

Although Erin complained loudly about the FLAP grant, it should be noted that I never saw David teach science while in Erin's classroom. Erin saw herself as a 'protector' of science

time and rarely allowed David to conduct whole class instruction – even in social studies. Rather, David would stand in the back of the room or off to the side and throw in the occasional comment as Erin carried on with her lecture or book-based instruction. At times, she would ask David for the Spanish translation of a science vocabulary word, but rarely would she seek his input on content. When students were working on their own, David would take it upon himself to assist the Spanish-speaking students, and occasionally would be in charge of a small group of Spanish-speaking students as they worked in the hallway. This stance toward working with the FLAP grant was quite consistent with Erin's inclination to solve her own problems and pull herself up by her bootstraps. After trying to work with David's teaching style – to no avail – she found alternative ways to 'include' David in her science instruction without allowing him to take over.

It is interesting to discover how one school intervention can be viewed so differently by teachers. Carole saw the FLAP grant as absolutely wonderful while Erin could find no redeeming qualities in the grant, and Heather vacillated between the two. Each of these views was a direct result of the interactions between these teachers' internal contexts as well as the external context in which they taught. As will be seen, this was not the only topic about which these teachers disagree.

The pacing guide/state standards/state standardized testing. Another major driving force behind teachers' science instruction was the combination of the state standards, the standardized test based on these standards, and the district pacing guide 'Titan' that was designed to assist teachers in teaching students these standards in a timely manner. While these are each individually interesting factors to examine, I found in my conversations with the teachers that these were so interconnected; it is difficult to discuss one without the other. 'The

Test' was often mentioned as the ultimate reason for all instructional decisions at RPECS. As described in the literature review, standardized tests often focus on math and reading, motivating administrators and teachers to focus on these two subjects to the detriment of others. RPECS, while attempting to present a well-rounded education to its students, still demonstrated that reading and math are the most important subjects through its policies, both official and unofficial. In order to prepare for the test, teachers needed to base lessons on the state standards, and used Titan to inform the timing and activity choices for these lessons. All teachers in this study faced the same pressures in terms of these factors, with Erin having slightly more pressure with fifth graders being tested in science in addition to math, reading, and writing.

Once again, each teacher in this study viewed these factors differently and allowed them to drive their science instruction differently based on their internal contexts and views of the external context. Beginning with Heather, consistent with her no-nonsense attitude toward teaching, the Titan/standards/testing combination did not seem to trouble her – these are just part of the reality of schooling. In order to be as efficient as possible and to follow the rules, she found herself embracing this accountability culture: her major goals for her second graders were that they should be able to understand and perform the assigned standard, read for information, and follow directions. The standards, testing, and Titan were all there to help guide Heather in her quest for students to achieve these goals.

Translating these goals and beliefs into instructional practices, Heather wanted to prepare her students as much as possible for the standardized testing in the spring, and believed the best way to do this was to have her students read for information and answer multiple choice questions. And, based on local and national emphases on accountability and increasing test scores, Heather had little reason to teach students things that are not on the test. For example,

when talking about her student teacher, Adrienne, she was thrilled that her students were getting more hands-on activities because they are fun, but was concerned that Adrienne was not giving the students enough time to do the book-based learning that would be on the test – the test was definitely not hands-on. To these ends, Heather's instruction (or instruction that she worked into Lisa's or Adrienne's lessons) was quite lecture- and book-based, relying heavily on the textbook and workbook. When she had class discussions, she asked low-level questions – questions that might be found on the state test – and required choral responses or one-word fill-in-the-blank answers. There were times when Heather used BrainPOP movies to augment her lesson, but this was to give students information, and she rarely commented on the content of these movies. Heather's aversion to and low self-efficacy in science made it difficult to speculate as to whether her instruction would be different were it not for the state standards and testing. However, it certainly seemed as though Heather welcomed the structure of Titan and the standards and appreciated that the multiple-choice state test was something she could consider an end-goal for her science instruction.

Carole also seemed to readily accept the reality that state standards, testing, and the pacing guide have created at RPECS. She shared with me that teachers have no choice when it came to that trio of factors, so she found ways to work with them. When planning a lesson, like the other teachers in the study, she turned to the standards/Titan first to see what she needed to cover. In the past, Carole said that she had been more focused on the fun and hands-on components of science instruction, but she then felt like she must give the standards equal attention. Perhaps Carole was able to unquestioningly accept these factors as reality because she was a 23-year teaching veteran and felt confident in her ability to cover all the content (science as well as math and reading) by the time testing came around in the spring.

This tacit acceptance of the 'rules' of accountability-laden schooling was certainly reflected in Carole's instruction. She did state that the standards were the driving force for all of her lessons – again, why teach something that is not going to be on the test? When Carole was the lead teacher for science, lecture was her primary strategy, using PowerPoint and SmartBoard files as well as BrainPOP movies as bases for these lectures. However, Carole did make a point to try to make 'connections' during these lectures for and with her students. She wanted to make sure students saw the science content as being either related to their personal lives, or related to something else they had learned about (science or otherwise). This may be a result of Carole's perception that Titan caused science content to be fragmented, as it was split into discrete three to four week units. Carole stated that she was unable to see the 'flow' of the pacing guide if there was one, so perhaps making connections with her students was her way of compensating for the pacing guide's shortcomings. Again, her FLAP collaborator, David, also taught quite a bit of the science lessons, but this was consistent with Carole's belief that students will learn a topic better (and thus perform better on tests) when they see a topic multiple times and presented in multiple ways. So while Carole did not seem to be stressed out by the pressure of testing, she did try to teach in ways that would ensure her students success on the test.

Again, Erin had a very different view of the standards, state testing, and pacing guide. In short, she resented each of these components of the context and saw them as barriers to teaching science as she desires. One of her biggest complaints was with Titan. First and foremost, Erin felt it was often 'full of junk,' brimming with errors, and out-of-date. At times it seemed Erin took the county's push for teachers to use the pacing guide as a personal affront to her professionalism – she was expected to be a professional but the county was not held to the same standard. Further, Erin believed that the schedule on Titan was unrealistic and required her to

breeze through topics her students had not fully learned. Erin's final complaint about Titan was concerning time. She did not have enough time to find resources, plan, teach inquiry-based lessons, or include all the 'fluff' lesson elements for the district while staying on pace with Titan, a problem Erin believed was the result of too many meetings, a great deal of paperwork, and the district's focus on reading and math. Moving 'up' the accountability scale, Erin also took issue with the state standardized test. She was dissatisfied with standardized testing as well as the emphasis on reading and math to the detriment of science. These 'rules' of public education took away from her science instructional time and contributed to the larger problem of schools producing students who were uninterested in science and problem-solving – something she believed should be a goal of quality science education. In short, she often saw her own roles and responsibilities as a teacher in RPECS in direct opposition to those the national and local policies would ask her to play. Erin believed that what she was being asked to do and/or what was best for her students in terms of science was difficult if not impossible, given the mandates handed down from above.

These attitudes towards Titan and the state test certainly influenced Erin's science instruction. She seemed to be at constant battle with her conscience as she struggled to instill life skills versus conducting engaging activities, professional judgment versus district requirements and keeping her job, and protecting science time while preparing students for the testing and accountability scores that 'counted'. As much as Erin disliked this system, she recognized that the type of learning the accountability measures encourage (multiple-choice, low-level questions, reading for information, etc.) will be a reality for her students as they continue on into middle school, and felt that she would be remiss not to prepare her students for that reality. Consequently, Erin used the textbook a great deal in her science instruction and while she asked

quite a few questions during reading to monitor comprehension, this was far from discourse or discussion. 'Note-takers' and worksheets were favorite teaching strategies for Erin as well and students worked a great deal filling these out, either individually or in groups. At the end of the year, Erin did try to create more 'interactive' lessons, but the extent of the interaction was that students were required to match pictures and definitions or cut and paste continents on a map. Erin spoke quite a bit about her goals of instilling 'life skills' such as basic math and reading skills into her students, and her instruction was consistent with this purpose, as she often tried to point out connections between the subjects. Finally, with time being at a premium and Titan a glaring reminder of this, Erin just did not feel she could neither afford to give time to the FLAP grant nor go much beyond the book to teach inquiry-based science lessons. Erin was frequently negative about her attempts to teach science in a manner she would deem satisfactory, but seemed to feel she was doing the best she could, given the situation she was in.

It is interesting to see how the state standards, state test, and district pacing guide can become so polarizing, given teachers' personal beliefs and goals as well as their perspectives on the external context. Carole and Heather seemed to accept these factors as pieces of the context that must be dealt with and accommodated, and could be used to productively guide instruction. Erin, on the other hand, seemed to accept that she must prepare her students to do well on the state test, but believed her science instruction could be so much more engaging if only she could have taken the time to teach in ways that would allow students to think deeply and problem-solve – she certainly did not see Titan as a helpful guide to assist students in learning science. In discussions with the teachers, the FLAP grant and this trio of factors were mentioned most frequently as driving teachers' instructional decisions. However, one more piece of the context seemed to be just as important: the science resources found at RPECS.

Science resources. When describing science resources, it is easy to see in Figure 9 that science resources can refer to people or things. All of the teachers in this study saw people such as student teachers, collaborative teachers, team members, and PDS personnel as potential science resources. But these resources were named in addition to the more obvious science resources, the physical resources such as batteries and bulbs, magnets and mealworms used to aide in teaching science. Again, how the teachers viewed the adequacy of these resources varied in terms of their internal contexts as well as their views of the external context.

Heather was very vocal in stating that she did not believe that RPECS had as many resources available for science and social studies as for other subjects, which she felt was due to the large emphasis placed on success in math and reading. She also shared with me, on several occasions, how disappointed she was that they no longer subscribed to a certain educational video service because she thought those videos were better quality, but also because she did not have the time available to set up new 'playlists' and preview new videos for her class. Concerning her views toward human resources, Heather was very positive. She appreciated (within reason) the number of extra people the PDS partnership brought into her room because it allowed for more small-group work with students. In fact, Heather did not feel that she would otherwise be able to take advantage of the science lab or the materials in the lab if she did not have enough adults in the room to create small groups of students.

Examining how these views were reflected in Heather's science instruction is quite interesting. Heather taught in a lecture- or book-based manner, rarely doing hands-on activities – those types of activities were done by her student teacher, Adrienne. The second grade team as a whole scheduled time in the science lab every week at the beginning of the year, which Heather thought was a great idea as the students saw this as an exciting change of scenery. However, by

the end of the year, they did not go to the science lab much at all, which Heather said was because they could do the very same experiments in the classroom. The science activities conducted by Heather that required materials other than a textbook or workbook required simple office supplies, such as paper and crayons. This made her statement about the lack of science resources at RPECS a bit confusing. One could say that her lecture-/book-based teaching was a result of the lack of resources, but due to her beliefs and goals surrounding science instruction, it was more likely that her teaching style would persist even if RPECS had every resource a teacher could ever need. Heather did use BrainPOP videos quite often, which was consistent with her belief that these videos (and the videos from the previous video service) were the 'experts' while she was not. Perhaps this was why she rarely commented on or paused the videos for discussion - maybe she felt as though she had nothing to add. Utilizing the human resources available to her, I often saw people in Heather's classroom circulate while students were working independently. It was only during Adrienne's science lessons when I saw students split into small groups to work on science activities. Feasibly, some of the dissatisfaction with the material resources and underutilization of human resources stemmed from Heather feeling as though she did not have enough time to explore the resources. Certainly with a limited amount of planning time and a system that had high expectations for reading and math, these instructional practices and attitudes were understandable.

In Carole's case, her focus was almost solely on the human resources available for science. She mentioned in passing that the science lab was a great resource because there were all kinds of materials they could use for lessons, but did not go into any more depth on the subject. For Carole, the most important resources were the people who could plan science lessons and provide ideas, stories, videos, and PowerPoint slides while teaching the science

lessons. Carole leaned on David, Jackie (her student teacher), Dorothy (her gifted collaborative teacher), and student teachers of the past in order to get through the year's science lessons. She saw these resources as invaluable because she did not feel as though science was her strength and, perhaps consistent with a successful veteran teacher, did not have any qualms about asking for help or delegating responsibilities.

It was easy to see how Carole's perspectives on the science resources at RPECS translated into her science instruction. Quite simply, Carole rarely led science lessons. Student teachers in her room 'picked up' science first and 'put down' science last as far as their teaching responsibilities, and when student teachers were not available, Carole leaned heavily on Dorothy or David to provide content for the lesson. When Carole was the lead teacher, she used PowerPoint/SmartBoard files as well as BrainPOP movies as bases for lecture and discussion. Although she mentioned the abundance of physical resources from the science lab, I did not see her take advantage of these as a lead teacher, even though she felt very strongly about her students learning through hands-on activities. So while Carole did want high-quality, studentcentered science instruction, this did not play out in her instruction. But, because she was not daily concerned with the ins and outs of the system (finding resources, planning lessons, dealing with the pacing guide, etc.), she did not have a great deal to complain about. Carole had people to teach science for her and since it was not her most comfortable subject, this situation probably provided her with a great deal of contentment and perhaps relief. Moreover, Carole had 23 years to watch policy initiatives come and go and she adapted her science teaching (by relying heavily on others) such that she would be continuously successful, no matter what RTTT or future policies may bring - she had no reason to change the ways in which science instruction happened in her classroom.

Erin spoke about both the physical resources and the human resources in measured tones. She was satisfied with the resources, but felt there was certainly room for improvement; the physical resources in the science lab were adequate and she was appreciative of the fact that I had organized the lab so that resources were easy to find. However, given the time constraints in the pacing guide, her 'lower' students, and the pressure to focus on math and reading, Erin did not feel she could do many hands-on activities, and certainly did not think it was worth her time to physically take her students to the lab (although it was on the same hall as her classroom). The PDS partnership held great potential for Erin as she appreciated all the extra people available to help her because of the partnership. But, Erin believed that the partnership was being underutilized in terms of professional development opportunities, especially in terms of science. Given Erin's major dissatisfaction with the FLAP grant and the standards/Titan, it could be said that Erin had relatively positive views of the science resources available in RPECS. Despite this positive attitude, it was difficult to see how she put these resources to use in her classroom.

In terms of science instruction, once again, Erin stayed pretty close to the textbook and used SmartBoard slides to supplement her discussions. I was able to observe two relatively hands-on lessons involving quite a few physical materials as well as the lab (physical/chemical changes and circuits) but these lessons were led by Gwen, her student teacher. Erin's concerns about time as well as her concerns about the students in her classroom overrode her desire for innovative science that provoked critical thinking. On a few occasions, she mentioned how activities that took 10 minutes in previous years were now taking 45 minutes with her current class, ruling out any 'extra' hands-on activities. Moreover, even though Erin wanted to do inquiry-based science lessons, she felt as though she did not have the time available in the pacing guide and in the school day to walk students through the activities – noting that she even had to

teach her students how to report what they saw. In Erin's mind, she was conducting the best science lessons she could, given the constraints of the context (Titan, testing, time, lower students, etc.), even though she was personally disappointed to continue the trend of teaching from the textbook.

Summary. While there were many components within the teachers' activity systems – both internally constructed and externally imposed – that impacted their science instruction, these three items (the science resources, the standards/testing/pacing guide issues, and the FLAP grant) seemed to be the most influential. From an outsider's perspective, it may be easy to make blanket statements about these components, about what was helpful and what was not, or about how teachers should react to these components. But as this analysis demonstrates, teaching is much more complex than that. At any given time, teachers are juggling a multitude of demands, initiatives, rules, and people. How the teachers choose to view and integrate these with their own personal views on science pedagogy can result in very different enactments of science instruction. As teachers, we are taught that each student is unique and that each student views education in his/her own way, resulting in a variety of reactions to strategies used in schooling – teachers are no different. This point is key in understanding the larger issues surrounding the success or failure of science education reform.

Cross-Case Analysis Part II: Contradictions, Growth, and the Bigger Picture

In this cross-case analysis, Part I focused on how the context shapes science instruction on a small scale, within individual classrooms. However, instruction is at the crux of science education reform. Therefore, in this second portion of the cross-case analysis, I will focus on contradictions found within teachers' instruction. There were four major contradictions that all teachers in this study had in common and while many of these contradictions resulted in more

tension, the teachers could and did find ways to push for growth within their activity system. Examining contradictions within instruction illustrates that reform is about more than just time, resources, and possessing adequate content knowledge. These components certainly come into play, but science education reform is more complex; teachers must deal with competing messages on a daily basis and I contend that this problem is intensified at the elementary level because elementary teachers teach all subjects and must divide their energy amongst *all* competing messages – not just the messages pertaining to science. In contrast, middle school science teachers by and large do not have to be concerned with math standards, new math initiatives, or math education reform whereas elementary teachers do.

One of the strengths of using a CHAT framework is that a researcher has the ability to make the invisible visible. In this case, I had the opportunity to make visible why science education reform is so difficult by illuminating the contradictions present in these three teachers' activity systems. Contradictions in a system can result in either continued tension or expansive growth (Engeström, 2001; Bakhurst, 2009). One may think that with the current science education reform initiatives, this could be a great time for growth; there may be supports available in the form of increased funding or professional development. Despite these supports, however, change is still difficult to implement. Before discussing the contradictions found in this study, I will remind readers about key findings concerning elementary science instruction:

- Many elementary teachers lack the science content knowledge required to teach science well (Davis & Smithey, 2009; Miller, 2010).
- 2. Perhaps as a result of inadequate science content knowledge, many elementary teachers lack confidence in their ability to teach science (Appleton, 2003; Queenan, 2011).

- There is often a lack of physical resources in elementary schools to teach science in a manner consistent with science reform documents (Johnson, 2006; Davis & Krajcik, 2005; Marx & Harris, 2006).
- 4. There is often a dearth of quality science professional development at the elementary level (Fulp, 2002; Weiss et al., 2001).

These barriers alone may be sufficient to impede the progress of science education reform, but it is also important to note how contradictions in individual classrooms compound these barriers when considering the chances for success or failure of science education reform. Building on my discussion of major factors impacting science instruction in the three teachers' classrooms in this study, I will now look deeper into the contradictions present in these teachers' systems and frame them within the bigger picture of national science education reform.

Examining the activity systems of Carole, Heather, and Erin through a CHAT lens, contradictions became readily apparent. Within a CHAT framework, there are different classifications of contradictions. Primary contradictions are contradictions within one element of the system, such as a contradiction between different rules present in the system. A secondary contradiction is between two elements of the system, such as a contradiction between the rules and the division of labor. A tertiary contradiction is between an activity as it currently exists and possible forms that are more advanced, such as how science instruction exists now in a classroom and how it could be (Roth, Lee & Hsu, 2009). The following paragraphs discuss the primary contradiction found within the teachers' beliefs, the primary contradiction found within the rules of the systems, the secondary contradiction found between the teachers' beliefs and their instruction, and the tertiary contradiction between the systems as they are now and the 'what if' scenarios they wish for in terms of science instruction.

Primary contradiction: Within teachers' beliefs. The first primary contradiction found in all cases pertained to teachers' beliefs. Each teacher believed that students needed to experience hands-on science and/or that using hands-on activities was a good strategy for teaching science. However, they also believed -for various reasons - that students needed some sort of textbook learning in science as well. While this contradiction in and of itself does not necessarily set up a dichotomy between book-based and hands-on science, the teachers in this study treated these two pedagogical strategies as being at odds – a teacher should strive for hands-on (all the time) rather than book-based science. When considering the immediate external context, perhaps this contradiction is even exacerbated due to the district's dual expectations of seeing hands-on engagement in each lesson during walk-throughs as well as high test scores at the end of the year. Heather and Erin both struggled with this contradiction, each mentioning that they needed to learn how to balance these two seemingly mutually exclusive types of instruction. Carole also struggled with this contradiction, but to a lesser extent; she worried about her students not being able to do more book-based work that may be required of them in middle school, but stated that she would not change her (as she thought of it, 'hands-on' or 'interactive') instruction to accommodate this concern. She also saw the value in reviewing for standardized tests and reading from a book, but reading from the book was so 'meaningless' for her, she did not want to impose this teaching style on her students.

It is understandable how teachers could have this contradiction, given the national and local contexts. The most recent recommendations for quality science education found in *A Framework for K-12 Science Education* (NRC, 2012) were that, "…students [should] themselves engage in the [scientific and engineering] practices and not merely learn about them secondhand. Students cannot comprehend scientific practices, nor fully appreciate the nature of scientific

knowledge itself, without directly experiencing those practices for themselves" (p. 30, NRC, 2012). On the other hand, policies such as NCLB and RTTT emphasize standardized testing and accountability measures that encourage rote memorization of discrete facts (NRC, 2012). When examining these policies, it is certainly reasonable for teachers prioritize satisfying the NCLB and RTTT requirements, as there are negative consequences tied to failure. In essence, the science education policy can be ignored because there are no consequences associated with it for these teachers.

Additionally, keeping in mind what we know about elementary science instruction, there becomes a question as to whether or not teachers *could* actually implement reform-based instruction within the reality of elementary schools. Many elementary teachers, including the teachers in this study, lack science instructional time (because math and reading are emphasized or the pacing guide is unrealistic), resources, and adequate science content and pedagogical content knowledge (via professional development). It could be hypothesized that while the teachers in this study wanted to teach hands-on, inquiry-based science, they felt as though this was something that could not happen within the walls of RPECS and that they needed to find alternative ways in which to teach science – ways that were more book-based and comfortable for them. Therefore, it is possible that this contradiction within their beliefs was an attempt to reconcile their wishes with reality.

Primary contradiction: Within the rules. The second primary contradiction was within the rules of the systems. On one hand, teachers at RPECS were expected to teach science for 50 minutes a day (when not teaching social studies during that time) and follow the pacing guide so that they 'covered' all the objectives by the specified times. They were held accountable for their students' learning in science through district benchmark testing. Complicating this contradiction

was that teachers were required to 'give up' more of their science time to the FLAP grant. But while these rules were explicit, the implicit rules concerning science were seemingly much more accepted at RPECS. Consistent with schools across the country, reading, writing, and math had taken priority in the school day such that science is often a forgotten subject. Erin knew that her team data meetings were centered on reading and math and that the district would be focusing on these subjects. Heather was cognizant of this goal and crafted her science instruction to focus on reading for information. Carole felt this contradiction as well and was concerned about having enough time to 'cover' what was on the pacing guide in science. Each teacher accommodated the FLAP grant in ways that allowed them to teach science as they saw fit while still emphasizing teaching strategies that would allow students to be successful on the state test.

This contradiction exemplifies the fact that teachers must make choices between competing messages in education. They have prioritized the subjects that are most often tested and count for AYP and give these subjects more time (the state in which this study took place tests science beginning in grade three while reading and math are tested every year; science did not 'count' towards AYP until the 2011-2012 school year, and is tested only in fifth grade). Teachers have also based this decision on the fact that in the past, NCLB had few consequences for letting science 'disappear'. Looking forward, the state in which this study took place has decided to use science as an AYP indicator in the future, which may shift some of these priorities. However, with science only being tested in fifth grade in elementary school, this policy has few consequences for lower-grades teachers such as Heather and Carole.

Secondary contradiction: Between beliefs and instruction. There was one secondary contradiction each system had in common, and that was a contradiction between their beliefs and their instruction. As previously discussed, each teacher felt hands-on teaching was an important

method for students to learn science because that type of instruction motivated and engaged students in ways the textbook cannot. However, in observing the teachers' instructional practices, lecture- and book-based instruction seemed to 'win' over hands-on instruction. Erin and Heather were overt in their justifications for this type of instruction. Erin felt life skills were important for her students and that with her 'lower' class, she could not teach in more interactive ways. Heather, on the other hand, believed that reading for information and being able to answer workbook questions were important second grade skills to master. So while Erin and Heather may have felt hands-on instruction was important, evidently it was not as important as their other beliefs. Overall, Carole's motivations for lecture- and book-based instruction seemed to be a bit more buried and complex than the other teachers' motivations. Still, Carole understood that her students needed to be able to understand science texts and practice for standardized tests. Although she stated that she would not change her instruction to accommodate these more test-related goals, these concerns compounded with her lack of comfort in science seemed to have led her to fall back on modes of teaching that were distinctly not hands-on.

This contradiction, again, is reasonable when situated in the space and time of current school reform context. Based on their training as teachers, or perhaps just a 'motherly' understanding of how children learn, these teachers knew that lecture- and book-based instruction may not be the most effective way for students to learn science. However, when given the expectations associated with NCLB, RTTT, and American public middle/high schools, these teachers were trying to find ways for their students to be successful in the larger educational context. The desire for students to be successful seems to have been a driving force for each of these teachers and they were doing the best they knew how in order to help their students be successful. An alternative cause for this contradiction may have been that, when

viewed in the context of what we know about elementary teachers' science content knowledge and confidence in teaching science, the teachers in this study put forward reasons that 'excused' them from teaching rigorous, inquiry-based science. Appleton (2003) found that elementary teachers may exhibit avoidance behavior toward science in the form of "finding ways not to teach science at all" (p. 9) or giving flimsy justifications to reduce the time teaching science. When observing the instruction found in these three teachers' classrooms, it often looked more like a reading or writing lesson rather than a science lesson – science just happened to be the topic of the focus of the reading and writing. Once again, it appears as though there are many reasons as to why teachers may not be teaching in reform-oriented ways.

Tertiary contradiction: What is versus what could be. Finally, each system shared the same tertiary contradiction. Each teacher articulated an 'if only' scenario for their instruction. 'If only' they had something more or did something more, their instruction would be better, more engaging, more exciting, higher quality. Carole's 'if only' was in terms of student-led instruction. Due to a number of constraints, Carole felt unable to teach in the way that she thought would most benefit students; 'if only' she were able to implement student-led instruction, students would be more engaged and learn more. Similarly, Heather had a vision of what her science instruction could look like 'if only' she had more resources. While she did not truly define what this 'better' instruction would look like, it could be inferred that 'if only' she had more resources, her instruction could be more hands-on, interactive, and inquiry-based. Lastly, Erin believed that 'if only' she departmentalized and focused on science and social studies, she could provide the type of instruction that is required for quality science in the classroom.

Each of these teachers recognized that the system could be improved in some way so that science instruction could be 'better.' However, these teachers were also acutely aware of the historicity of the context. The current public school context was not an isolated moment in time, but rather it was situated against its own history and future. Although there have been many reform initiatives implemented in American public schools throughout the 20th century, little has changed regarding the 'core,' of schooling – most changes have been surface level changes. Perhaps the reason each teacher had an 'if only' wish that was not reality was because they realized only so much could be done within their context. Elmore (1996), in discussing the failure of school reform initiatives throughout the 20th century, stated that most initiatives overlooked

...the complex process by which local curricular decisions get made, the entrenched and institutionalized political and commercial relationships that support existing textbook-driven curricula, the weak incentives operating on teachers to change their practices in their daily work routines, and the extraordinary costs of making large-scale, long-standing changes of a fundamental kind in how knowledge is constructed in classrooms. (p. 13)

These teachers' 'if only' scenarios imply a recognition that little is likely to change in education, as little has changed in education over the past century.

The contradictions seen across all cases are summarized in Figure 10.



Figure 10. Primary and secondary contradictions across cases.

Summary of contradictions. While there were certainly contradictions unique to each teacher's activity system, such as the highly influential factors in Part I of this cross-case analysis, it was thought-provoking to explore the commonalities among these very different teachers. I would contend that the contradictions found in all three of these teachers' activity systems are consistent with those that other public elementary school teachers struggle with on a daily basis, namely:

- I believe hands-on learning and book-based learning have merit which should I choose?
- I have been told simultaneously that science is important and that it is not a priority – what should I do?
- 3. I believe hands-on learning is beneficial, but this is not truly possible how should I proceed?

4. I have a vision for something 'more' in science instruction, but feel stuck given the history of public elementary schools – is it hopeless?

When considering the barriers to science education reform, it is evident from these teachers' experiences that the barriers transcend money, content knowledge, and time. Rather, the barriers to true reform are a combination of these factors along with other rules/reforms, expectations, and the need to promote the status quo in public education. It is only when these contradictions are made visible that we can have productive conversations on how to tackle these barriers.

The importance of contradictions. Contradictions, from a CHAT standpoint, are what cause expansion and transformation of a system over time. Engeström (2001) described the notion of transformation as follows:

Activity systems move through relatively long cycles of qualitative transformations. As the contradictions of an activity system are aggravated, some individual participants begin to question and deviate from its established norms. In some cases, this escalates into collaborative envisioning and a deliberate collective change effort. An expansive transformation is accomplished when the object and motive of the activity are reconceptualized to embrace a radically

wider horizon of possibilities than in the previous mode of the activity. (p. 137) As the teachers in this study taught science, they were confronted with many contradictions that they may have ignored, keeping the equilibrium of the system, or they may have questioned these contradictions, causing a transformation and growth. In terms of science education reform, we may think of a true change in the ways in which we teach science as expansive growth in the system. The teachers in this study have demonstrated just how difficult it can be to teach reformoriented science at the elementary level, even when they have the best of intentions. But this is

not to say that growth is impossible. While most contradictions found in this study – both across cases and within individual cases – contributed to tension and frustration, there were instances in which Erin and Carole either were in the process of pushing for change, or had made small changes in their system. For example, Carole was in the process of discussing the possibilities for new learning strategies with district personnel while Erin is in the process of investigating the possibility of departmentalization. How these teachers went about pushing for change in their system is instructive to science education stakeholders who are interested in how teachers initiate reform/change at the elementary level.

In addition to the shared contradictions, in terms of seeking instances of growth, it is also important to examine contradictions that were unique to each teacher's system. While contradictions unique to Heather's activity system seemed to be perpetuating the tensions within the system rather than resulting in growth or transformation, there were contradictions unique to Erin's and Carole's systems that were resulting in growth. Contradictions that were resulting in growth in Carole's system are:

- Primary contradiction within rules → Teachers should help all students, but Carole felt she had been instructed to only focus on 'bubble' students.
- Secondary contradiction between beliefs and rules → Carole believed that she should and could help 'far to go' students, but felt as though she had been discouraged from focusing on these students.

In reflecting upon these contradictions regarding the 'bubble' and 'far to go' students, they caused Carole to question the system. Armed with strategies typically used for dyslexic students, she contacted the superintendent and shared her frustration and possible solutions. The superintendent put her in touch with a special education resource from the district and the

conversations continued. Whether or not these conversations will ultimately change the system remains to be seen, but Carole took the first step.

Contradictions unique to Erin's activity system that were resulting in growth were:

- Primary contradiction within the division of labor → Erin was torn between being a
 professional who made decisions that were best for her students and being a follower of
 the rules.
- Secondary contradiction between beliefs and rules → Erin believed science was important while the district wanted teachers to focus on reading, writing, and math.
- Secondary contradiction between beliefs and rules → Erin believed the FLAP grant was
 not beneficial to her students in science, but had been told to give over instructional time
 to her FLAP collaborator.
- Secondary contradiction between rules and instruction (object) → Erin had been told to give over time to her FLAP collaborator during science, but did not do this.

These contradictions resulted in Erin either questioning the norms or deviating from the norms by circumventing the system. Regarding her personal identity as either a professional or a rulefollower, Erin deviated from the norms, as demonstrated by her teaching the scientific method even though it is not found in the pacing guide, and continued to question who knows best for her students, the district or their teacher. Erin's belief that science was important and should be taught in a higher quality manner resulted in her (and her team) creating a plan to departmentalize the following year. Similarly Erin found a way to cope with the FLAP grant that was causing her such grief: she chose not to deal with it and instead assigned her FLAP collaborator to small groups or left him silently standing in the corner while she taught science. Each of these are examples of Erin finding 'solutions' to the contradictions that were making her job more difficult than it needed to be.

The growth in these teachers' systems may seem quite small and insignificant. Moreover, we do not know if some of the 'plans' to improve their situations will ever take shape. When considering how significant or insignificant these changes may be, it is important to frame these contradictions and pushes for growth within the larger American public education system context. As previously discussed, American public education seems slow to change, and when it does change, these changes are often 'surface-level' or what Cuban (1988) called "first order changes." First order changes as applied to education are changes that,

...try to make what already exists more efficient and more effective, without disturbing the basic organizational features, without substantially altering the ways in which adults and children perform their roles. Those who propose first-order changes believe that the existing goals and structures of schooling are both adequate and desirable. (Cuban, 1988, p. 342)

Changes that do not fundamentally alter the goals and structures of education lead many teachers to live by the saying, "What once was old will be new again," meaning that whatever pedagogical strategy is popular now will go out of style and be reborn with a different name in ten years. With this type of history and tradition stacked against them, it is understandable how difficult it is for an individual teacher to push for deeper change, or changes that Cuban (1988) termed "second order changes." These types of changes,

... seek to alter the fundamental ways in which organizations are put together.

They reflect major dissatisfactions with present arrangements. Second-order changes introduce new goals, structures, and roles that transform familiar ways of

doing things into new ways of solving persistent problems... [these changes attempt] to fundamentally alter existing authority, roles, and uses of time and space. (Cuban, 1998, p. 342).

So while second order changes may be more in line with Engeström's (2001) notion of expansive growth resulting from contradictions in a system, these types of changes are much more difficult to implement because they require altering an organization and educational philosophy that has been tightly held by the American public for such a long time.

Moreover, it is important to remember that a teacher's voice is but one among several stakeholders' voices. While an educational system may appear to be supportive on the surface, when one probes deeper, one is confronted with the complexity involved in making real change. Within this complexity, it is often the voice that is the loudest, most threatening, or most powerful that is heard above the fray, but typically this voice does not belong to a lone teacher. This, again, emphasizes how difficult true school reform is within our education system and, therefore, how challenging it is to change and expand an educational system in order to accommodate science education reform. When seen in this light, one is hard-pressed to fault teachers, such as those in this study, for allowing contradictions to persist and teaching in ways that are not consistent with science education reform documents.

Summary of Cross-Case Analysis

This cross-case analysis serves to synthesize the findings in the three case studies in this research and, more importantly, to frame these findings within the larger context of science education reform within the American public education system. Using a CHAT framework, I noted how a teacher's internal context (goals and beliefs) as well as her views on components of the external context (tools, rules, community, and division of labor) can influence how she views

influential components of the external context and, in turn, how these views impact science instruction. Further, by making typically invisible contradictions visible, I was able to demonstrate the issues involved in a teacher's efforts to provide the best science instruction possible to their students. Finally, I explored those situations in which Carole and Erin were pushing for change within the system as well as how difficult those pushes are.

By examining the teachers' views as well as the contradictions in the system, one may have a better sense of why science education reform must go deeper than providing professional development and money. These teachers' views and contradictions that may be representative of those found across the country complicate the typical low content knowledge, low confidence, lack of physical resources, and sparse professional development in science that is found in elementary settings, leading one to wonder if we are asking the impossible of elementary science teachers. If we are serious about science education reform at the elementary level, we must be ready to face troubling perspectives and contradictions and provide more opportunities for growth and expansion of the system. In the following chapter, the conclusions and implications based on this analysis will be discussed in detail.

CHAPTER 5

DISCUSSION AND CONCLUSIONS, IMPLICATIONS, AND DIRECTIONS FOR FUTURE RESEARCH

Introduction

Perhaps the most important pieces of a research study are the conclusions and implications. These pieces answer the question, "So what?", causing the researcher to step back from the data and think about why the research is significant to someone other than themselves. In the previous chapter, the four key findings in the data were described. They were:

- There were three major components of the activity system that were the most influential in guiding teachers' science instruction: the FLAP grant; the combination of state standards, the state test, and the district pacing; and the science resources available to the teachers.
- The way in which each teacher translated the aforementioned components into instructional practice was dependent upon their internal context (beliefs and goals) as well as their perceptions of other external contextual factors.
- 3. There were four major contradictions that all teachers in this study had in common (listed below); these are most likely consistent with contradictions elementary science teachers across the country encounter in public schools.
 - a. Beliefs about hands-on versus book-based learning
 - Rules about mandatory time for science instruction versus the importance of teaching math and reading
- c. Beliefs about hands-on, engaging instruction versus book- or lecture-based instruction
- d. What science instruction is like now versus what it could be
- 4. While many contradictions result in more tension, teachers can and do find ways to push for growth within their activity system.

In this final chapter, the three major conclusions drawn from this data will be described and compared to current literature. Implications of these conclusions will then be proposed, along with future research directions.

Discussion and Conclusions

Based on the data collected and the analysis conducted, I have drawn three major conclusions:

- 1. While all teachers taught in a traditional manner, they had different reasons for doing so.
- 2. Teachers feel pulled between competing demands.
- 3. The desire to push for change in science seems to be related to beliefs about science.

Beginning with the first conclusion, each teacher had a unique story and context, yet all teachers used teaching strategies that relied heavily on the textbook, lecture, workbooks, or worksheets. When elementary teachers teach in this manner, it is generally assumed that they are lacking the content knowledge to teach in reform-oriented ways (Fulp, 2002) or have confusion concerning how to enact science as inquiry (Bybee, 2000). However, Erin believed in teaching life skills and felt constrained by the pacing guide while Heather believed in teaching her students comprehension and felt physical resources at the school to be inadequate. Lack of content knowledge may have been a large factor in Carole's instructional practices (when she taught science), but she also taught lessons that others planned, reflecting their beliefs rather than

hers. Thus, to treat all of these teachers as the same in terms of their needs for teaching reformoriented science would be a mistake because of the varied contradictions within each teacher's contextual system.

This conclusion warrants a short discussion concerning teacher beliefs. Beliefs teachers hold are created and influenced by personal experiences and are often difficult to alter (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). Many teacher beliefs are resistant to change because teachers feel there is a continuity between their goals for teaching and their educational practices (Da-Silva, Ruiz & Porlan, 2006) while other teacher beliefs may be associated with positive feelings as they were critical to survival in the teacher's experience (Sinatra & Mason, 2008). Crawford (2007) stated that, "It is reasonable to assume that what teachers know and what teachers believe impact their decisions in planning, prior to stepping into the classroom, and in carrying out their plans, once they enter the classroom" (p. 616). Therefore, more important than examining how a teacher enacts science instruction are the beliefs behind the ways in which a teacher plans and enacts science instruction. When studying the instruction in Erin, Carole, and Heather's classrooms, there may very well be issues concerning a lack of science content knowledge or confusion surrounding the concept of inquiry, but these teachers' beliefs about what types of instruction are appropriate for their students, how their external context constrains their choices, and what goals the district/school deem to be a priority appeared to be far greater influences on their teaching practices. Consequently, one could make a blanket statement about their 'non-reform-oriented' instruction, but each teacher's individual beliefs were a driving force behind this instruction, making each teacher's instruction distinctive.

In addition to thinking about teachers' beliefs as catalysts for science instructional practices, it is also important to examine the externally imposed context in which these teachers

worked. Therefore, a second conclusion in this study is that as the teachers in this study explained their motivations for their teaching styles to me, in addition to expressing their personal beliefs, the teachers often commented on the fact that they felt pulled between competing demands and were making attempts to negotiate these demands to the best of their ability. Teachers in this study described dealing with demands for high mathematics and reading scores, the FLAP grant, integrating enrichment skills, and teaching all subjects at a high level of proficiency. The many initiatives within the school often led to contradictions for the teachers, such as the contradiction within the rules consistent across all three teachers' contextual systems. Officially/explicitly, teachers were required to 'cover' everything in the science standards and teach science for 50 minutes each day in a manner that ensured students pass the standardized science test. However, the implicit rule in the system was that reading and math always took precedence over science for purposes of accountability, even if that led to less time for science instruction. This multi-faceted contradiction caused teachers to use coping mechanisms that were inconsistent with reform-oriented science instruction. In other words, teachers primarily used lecture- and book-based teaching strategies, as they felt pulled to 'cover' required content in a very small amount of time and prepare students for testing.

Several studies (e.g. Saka, 2007; Yore, Henriques, Crawford, Smith, Zwiep, & Tillotson, 2007) have found that external contextual factors, such as the need to cover content or reform initiatives, are often cited by teachers as barriers to reform-oriented science instruction. Standardized testing in particular is often demonized as *the* item in the school context that overshadows or even causes teachers to ignore science instruction (Shaver et al., 2007). Lustick (2009) described this frustrating situation for teachers as follows:

[S]cience teachers...are overwhelmed by three important realities of the classroom. First...teachers struggle with classroom management, assessment practices, and the administrative demands associated with...individual learners. Second, teachers experience a pervasive and powerful pressure to prepare students for the state science exam at the end of the year...Since the tests place most of their emphasis on recall of content through multiple choice questions, it is not surprising that teachers spend most of their time on this aspect of science as well...Finally, the scope and sequence of mandated curriculum is so dense, teachers see little opportunity to realistically explore any one topic in depth. Students are expected to learn about such a wide array of content objectives, that

teachers feel a need to 'cover' material rather than 'uncover' knowledge. (p. 597) Given this type of instructional environment, it is reasonable that teachers may see reformoriented science as 'getting in the way' of what they must do to be successful in that environment (Spector, Burkett & Leard, 2007). And so, in order to cope with the daily demands of teaching in the accountability-laden 21st century, many teachers resort to 'drill and kill' teaching methods (Jorgenson & Vanosdall, 2002) or textbook-focused direct instruction (Quigley, Marshall, Deaton, Cook, & Padilla, 2011).

Teachers feeling pulled between competing demands appears to be, according to educational literature, a symptom of the larger problem of the intensification of the teaching profession. In 1986, Michael W. Apple was seemingly the first to begin the discussion of intensification in teaching in his book entitled *Teachers & Texts*. Intensification is the process by which teachers have become so overloaded with the various demands of teaching (as well as things beyond the realm of teaching, but that have been included in the job that is called

'teaching') that they are forced to deskill, cut corners, and reduce the quality of their output just to 'get things done.' Apple (1986) pointed out that intensification is found especially in schools with pre-determined curricula, extensive testing, and strict accountability systems. Now, these conditions are the norm, as is the intensification of the teaching profession. The climate has created a system in which teachers, both in RPECS and across the country, feel pulled in several different directions at once.

The final conclusion stems from teachers feeling pulled in several directions, in that in terms of the contradictions within the systems, only Erin really felt the need to push for change; Carole and Heather did not feel the need to do so. This seems to be related to how the teachers felt about science, as Erin valued science a great deal while Carole and Heather did not seem to value science as much. Consequently, as Erin yearned for more rigorous science for her students, she saw an existing system that was incompatible with this type of instruction and she pushed for something more. As an example of this, Erin longed for more time to conduct inquiry and find ways to make science relevant to students, resulting in a request to the administration for her grade level to departmentalize so she could focus more on science rather than juggling five subjects. Moreover, she was dissatisfied with a pacing guide she saw as inadequate, so she secretly taught additional topics that are not in the pacing guide because she felt they should be included. These actions seem to indicate a determination to chip away at the system in order to create positive change, opposed to Carole and Heather's relative acceptance of and satisfaction with the context.

Erin's extreme dissatisfaction with the external context and desire to change the context was consistent with the literature, as Lustick (2009) hypothesized that those who truly feel pulled between systemic demands and reform-oriented science feel as though they are in an impossible

situation. Bybee (2000) noted that teachers often point to classroom management issues, the need to meet state requirements, the time crunch for science, and issues obtaining the proper supplies/equipment as reasons not to teach science as inquiry. This statement implies that teachers recognize that reform-oriented science (or at least science that is beyond didactic book-focused science) requires more of them as teachers and more of the external context in terms of physical and moral support. Leonard, Boakes, and Moore (2009) found that beginning teachers who were inquiry-minded during their pre-service education were highly influenced by their school contexts: "If schools place science on the back burner or if the curriculum is too rigid for inquiry to flourish, then...teachers will find it impossible to sustain inquiry-based practices learned in teacher preparation programs" (p. 47). One could infer that teachers in a situation such as this would be highly dissatisfied with the external context, as they see it being incompatible with the science instruction they envision for their classroom – just as Erin seemed rather frustrated with the RPECS context and was attempting to change the system.

Concurrent with the external school context, one could argue that the science education community is setting up teachers for failure, as open inquiry science is often idealized to the exclusion of all other effective means of teaching science. Settlage (2007) contended that this myth has been perpetuated to the detriment of our teachers, with open inquiry being upheld as a quite common teaching method appropriate for all students when in fact it is relatively uncommon (even the examples in the National Science Education Standards [NRC, 1996, 2000] were fictionalized according to Settlage) and ineffective for some school settings. Consequently, while it may be understandable for an observer to have seen why a teacher such as Erin talked a great deal about wanting to teach hands-on, inquiry-based science yet implemented different

instructional strategies altogether, the teacher herself may only believe the school context to be failing her, and in turn, she failing her students.

In 1998, Beach and Pearson reported on a study concerning how teachers coped with conflicts and tensions from their student teaching through their first year of teaching. These teachers encountered conflicts and tensions surrounding curriculum and instruction, interpersonal relationships, their own self-concepts, and contextual/institutional issues. Relevant to this particular conclusion is how Beach and Pearson categorized the ways in which the teachers coped with these conflicts and tensions:

Level I strategies represented attempts to avoid, deny, mask over, or rationalize the conflicts and tensions...Level II strategies consisted of references to shortterm expedient strategies, or survival techniques (LaBoskey, 1993). Level III strategies involved the consideration and/or implementation for long-term change in one's theories or beliefs. Participants went beyond a short-term focus to reflect on conflicts and tensions in terms of implications for their theories of teaching. (p. 340)

Carole and Heather were relatively content with the context, but occasionally displayed Level I coping strategies in which they voiced their dissatisfaction but then either dismissed it as part of life at RPECS, or something that would go away. Erin seemed to have displayed some Level III coping strategies in that she examined her own theories concerning science instruction (students need hands-on activities, more time, in-depth instruction, etc.) and was seeking long-term solutions to the conflicts with the external context in order to provide instruction more in line with her personal beliefs.

Interestingly enough, Beach and Pearson's (1998) study found that as time went on in a teacher's career, they were more likely to consider Level III coping strategies. This seems to run counter to the findings here, as Erin had the least amount of teaching experience while Carole had the most teaching experience. Perhaps this was because Carole was operating in a completely different dimension of teacher qualities. Rather than living in a realm defined by persistence versus resistance as Erin was, Carole's long-lived career may have been evidence of her resilience, which is an entirely different construct. Brunetti (2006) defined teacher resilience as a quality that enables teachers to "maintain their commitment to teaching" (p.813). Qualities of resilience include being flexible, being able to 'bounce back' from difficulties, having a positive and optimistic attitude despite problems, possessing a network of people from whom a teacher can seek advice and assistance, seeing themselves as a learner, and viewing their instruction as a 'work in progress' (Mansfield, Beltman, Price & McConney, 2012). Certainly Carole exemplified these qualities which could lead to a long, satisfying career in teaching.

These three conclusions paint a complex picture of science instruction at the elementary level. Teachers are using lecture- and book-based teaching strategies for many different reasons, based on their personal beliefs as well as how they are negotiating competing demands within their instructional context. However, while all teachers may have moments of dissatisfaction with the context, most teachers may accept the context as is, without pushing for change within the system. There are several implications that follow from these conclusions for how professional development in elementary science should be delivered, how elementary teachers should be prepared, and how elementary schools can alter their cultures in order to promote more reform-oriented science instruction.

Implications for the Teaching, Learning, and Research of Science

The findings above confirm Johnson's (2006) observations concerning the existence of numerous internal and external barriers to reform-oriented science, but at an elementary level, illuminating the difficulties elementary teachers encounter on a daily basis when teaching science. Moreover, the findings indicate conditions under which change in a system may take place. This has implications for school administrators, teacher educators, and policy-makers.

Implications for elementary school personnel. This study illuminates just how complex elementary science instructional decisions can be. As elementary school administrators attempt to support teachers so that the science indicator for AYP can be met and quality science can be taught in all classrooms, the findings from this study hold three important implications for them. First, administrators need to be more thoughtful concerning professional development (PD)/professional learning requirements/offerings within the school. Second, administrators need to empower their teachers in terms of making decisions for the school concerning curriculum and instruction.

When examining the findings of this study, it is evident that thoughtful and well—chosen PD could play a large role in improving the state of elementary science instruction. Cohen and Ball (1999) have found that while schools districts may offer a great deal of PD to their teachers, "most goes to sponsor inservice activities which are intellectually superficial, disconnected from deep issues of curriculum and learning, fragmented, and non-cumulative" (p. 12). Given the findings of this study, it is important to think about PD that is more focused and appropriate than this. Kent (2004) has stated that for PD to be truly effective, it needs to focus on specific and identified needs, and help link theory to practice. Certainly PD such as this could ameliorate several issues that arose in this study. For example, each teacher in this study had different

motivations for her science instruction and therefore all teachers should not be treated the same in terms of their PD needs. Administrators need to open up the lines of communication with teachers in an honest, non-evaluative way. Rather than demanding teachers all attend the same PD that treats the symptom (e.g. providing PD that teaches science content because teachers rely heavily on textbooks), there should be discussions about the causes/motivations of undesirable instructional practices and PD designed to address these (e.g. providing PD for some teachers that explores ways in which to incorporate inquiry with difficult classes while providing PD for other teachers that demonstrates how to prepare students for standardized testing through handson activities). In this way, PD can become more individualized and administrators would be encouraging a climate of growth and reflection rather than fear and boredom. Moreover, this strategy reflects current research that indicates a need for exploring teachers' beliefs (e.g. Keys, 2005) as well as the perceived external context of a school (e.g. Conderman & Woods, 2008) when creating PD programs.

While much PD should be individualized, this study points to the importance of all elementary teachers gaining an understanding of what quality reform-oriented science instruction looks like. Erin pushed for change within the system, but only because she had a deeper understanding of what quality science instruction should entail. Teachers need accurate notions of the importance of reform-oriented science for elementary students as well as what is required to implement this type of instruction. Only when teachers understand the goals they should be working toward can they push the system to accommodate these goals. Therefore, administrators should require science PD that can educate elementary teachers on recent science reform initiatives and instructional techniques.

Finally, in terms of PD it appears as though it would be beneficial to provide PD to teachers concerning the state standardized science test. The teachers in this study implied that the test was a collection of low-level trivia and thus, taught in ways that would cause their students to be successful on such a test. However, a closer examination of the state standardized science could indicate that while there are, indeed, low-level fact-based questions in which students would simply memorize information, there may also be questions on the test that require higher level thinking and a knowledge of the nature of science. Therefore, it is possible that if teachers were more familiar with the specific structure of the test as well as the kinds of questions found on the test, they may be more inclined to teach in ways that would go beyond simple memorization and trivia.

A second implication in this study concerning elementary school personnel is that administrators should aim to empower their teachers to make decisions for themselves and for the well-being and education of the students in the school. Carole gained a great deal of selfsatisfaction when she was able to suggest strategies for her 'far-to-go' students. Erin was quite proud of herself when she 'snuck' in the Scientific Method because she believed students would benefit from that knowledge. Too often in schools, changes are top-down, and schools and districts apply for grant monies for particular 'sexy' educational topics when other needs are much more pressing. Again, part of the success at Washington Irving Elementary School came from the fact that decisions were made democratically, and teachers decided if they wanted to pilot certain strategies within their classrooms. As a school, they decided that reading would be their focus, and so teachers were invested in making that initiative successful. Administrators can empower teachers in this way simply by asking them what the pressing needs are within the school, what monies are needed, and what strategies they want to try. As seen in this study, teachers want to apply their professional judgment in order to do what is best for their students. Administrators need to allow for these types of conversations and innovations.

Along these lines, it may behoove teachers and administrators to have a conversation concerning departmentalization within grade levels. Erin was quite vocal about the fact that she just wanted time to focus on one thing so that she could be successful. While there is research indicating that students who participate in departmentalized instruction without looping with their teachers may feel less connected to their teachers/school (Chang, Muñoz, & Koshewa, 2008) or that students who participate in departmentalized instruction may score lower on achievement measures than their counterparts in a self-contained classroom (McGrath & Rust, 2002) departmentalization may still be a viable option for schools and teachers. Chan and Jarman (2004) stated that there are many advantages to departmentalization at the elementary level, including the fact that teachers may specialize in certain content, which leads to better-utilized instructional time as well as greater teacher satisfaction and stability. Additionally, these researchers pointed out that departmentalization may better prepare students for the departmentalization found in middle school and may allow for more flexible between/withingrade grouping for ability. Surely there are many things to consider when looking at departmentalization at the elementary level, but opening the lines of communication between teachers (particularly upper-elementary grades teachers) and administration as to what is best for the students in terms of departmentalization could prove to be beneficial for all involved.

Implications for pre-service teacher educators. While it is important for school administrators to lead their teachers in ways that encourage quality science instruction, it is equally important for pre-service teacher educators to 'arm' future teachers with the skills and perspectives they need in order to be successful elementary science teachers. As such, this study

holds two implications for teacher educators. First, we must arm teacher candidates (TCs) with realistic and productive problem solving techniques in terms of science instruction. Second, it will be beneficial to take a reflective/critical stance when instructing TCs so that TCs may be more thoughtful in their actions in future elementary placements. Finally, we need to better prepare our teachers to teach reform-oriented science.

Each of the teachers in this study coped with their science instructional circumstances in a different way, and while some of these coping mechanisms could be termed 'productive' or 'healthy' (e.g. Erin asking to departmentalize in order to focus on her strengths or Carole asking others for help in a weak area), many coping mechanisms could be termed 'unproductive' or 'unhealthy' (e.g. Carole giving up science instruction to others or Heather nearly always teaching directly from the book). Teacher candidates often yearn for teacher education to be realistic, as what they are told in class may not match up with what they are seeing during field placements. Therefore, it would be wise for teacher educators to take a cue from 'real life' and present TCs with real situations confronting teachers – competing messages, limited time/resources, weak content knowledge - and take the time to discuss productive ways to cope with these issues. This may take the form of teaching the skills that allow teachers to 'work smarter,' encouraging working with peers to improve teaching practices, or simply assessing the context and walking through ways in which the context could be improved. In these ways, TCs may be able to make better connections between university theory/best practices and the reality of classrooms, and negotiate for themselves how to balance the two in ways that are consistent with reform-oriented science teaching.

Hand in hand with arming TCs with productive problem-solving skills is encouraging TCs to take both a reflective and critical stance toward teaching. This could begin with having

TCs take the time to explore their own orientation toward science and their beliefs/goals about science education and understanding how those orientations mesh with reform-oriented science practices. By encouraging TCs to be reflective, they will be better able to self-assess their coping mechanisms and teaching practices, which may help TCs seek out assistance when needed, or simply allow TCs to redirect their teaching when they feel they have gotten too far away from reform-oriented science instructional practices. Turning this reflection outward, TCs should learn to be critical (analytical and skeptical rather than fault-finding) of the context in which they teach. As professionals, they have been trained on what is beneficial to student learning, and what is beneficial may not always be what is happening in the schools. TCs need to learn how to apply their professional judgment to questioning the status quo in productive ways so that we may move closer to quality science instruction for all students.

While these problem-solving strategies and stances are certainly helpful to a new teacher, they cannot take the place of knowing how to implement reform-oriented science. When recalling their own teacher education preparation in science, both Erin and Heather indicated that they were taught via activities rather than provided instruction on *how* to teach in a reform-oriented/inquiry-oriented manner. This type of instruction is consistent with Appleton's (2002) 'activities that work' mode of teaching/learning in that Erin and Heather were given a library of fun and manageable activities that had negligible scientific content. Abell, Appleton, and Hanuscin (2010) observe in their book *Designing and Teaching the Elementary Science Methods Course* that most preservice teachers will "enter the science methods course expecting to learn a 'script' to follow, and as a result they may be resistant to open-ended and inquiry methods and reform-based practices" (p. 67). Further,

prospective teachers may be likely to focus on superficial features of the activity, such as whether it would be fun or easy to do – without consideration of whether the activity led to a deep conceptual understanding in their students. It is important for the methods instructor to help students critically evaluate curriculum resource for use in their teaching. (p. 73)

These comments indicate a need to look beyond providing preservice teachers a collection of ready-to-use activities and truly teach preservice teachers what reformoriented science instruction looks like and how to implement it in their classrooms. While PD can enrich this knowledge once teachers are in the classroom, PD is no substitute for the foundational knowledge in reform-oriented knowledge the teachers in this study were so obviously lacking.

Implications for policymakers. In this day and age, school administrators and teacher educators are subject to the policies that are passed down concerning education in general and science education in particular. Therefore, this study holds three major implications for educational policymakers. First, this study begs for awareness of the contradictory implicit messages/unintended consequences of reform initiatives that do not seem to currently be in evidence. Second, policymakers need to shift their thinking from one-size-fits-all initiatives to initiatives that allow for flexibility and individuality. Finally, there seems to be a large chasm between policymakers and teachers – communication between these two entities must be made stronger.

Teachers are incredibly savvy. They must be, as they are given roughly six hours per day to accomplish hundreds, if not thousands of tasks. As such, they know exactly what they *must* do, and what can be pushed to the side. Two of the unintended consequences of NCLB and the

accountability movement are the reduction in time for non-tested subjects and reduction in quality for tested subjects. Interestingly enough, it seems as though no policymaker foresaw these consequences when NCLB was created. For each of the teachers in this study, standardized testing was a huge factor in what was/was not taught, as was the district pacing guide, which was an educational policy on a smaller scale. This indicates a need for policymakers to play the 'what if' game more extensively before implementing reform initiatives. Additionally, policymakers need to take into account that their particular policy may not be the only policy in play at any given school. Therefore, policymakers need to be cognizant of how certain policies may interfere with other policies to the detriment of student learning.

Along the same lines, policymakers need to realize that schools are not carbon copies of each other – each school has its own particular demographics, issues, needs, strengths, and weaknesses. As educators, we promote differentiation for our students, but when it comes to policy, it seems as though this is a foreign concept. When one-size-fits-all, top-down policies are handed down to schools and school systems, it encourages uniformity, silence, and satisfaction with a context that may not meet the needs of students. Policies should to have built-in flexibility so that initiatives can be responsive to the needs of schools and encourage problem-solving rather than stifling it. The success of Washington Irving Elementary School was initially credited to the ways in which the school worked with district mandates in order to mesh the mandates with the needs of the school. It was when the Chicago school district began disallowing alternatives and the new principal began passing along the uniform mandates that "school reform [was] dead," as Cathy La Luz put it. In this study, Erin and Carole wanted things to be different but felt (to a certain extent) as though their hands were tied. School reforms succeed or fail

because of teachers, and how individual teachers interpret and enact reforms is different for a variety of reasons. Keys and Bryan (2001) stated,

When reform efforts are based on documents that represent the intended curricula of the researchers rather than the enacted curricula of teachers, there is a mismatch that impedes science education reform...[C]urriculum reforms, however well-meaning, are shaped and altered by teachers' beliefs and understandings of the local context. (p. 635)

If policymakers recognize that schools are made up of *people* who want what is best for students, then it should follow that policies have the ability to be responsive to these people.

Finally, policymakers need to make closer connections with teachers. Teachers understand the political nature of education, but sometimes it seems as though the process by which a policy is made is a 'black box' shrouded in mystery. This black box exemplifies the disconnect between policymakers and teachers in the classroom. The current joke on the internet goes, "'I wish a politician with no teaching experience would just come in and tell me how to teach,' said no teacher ever." This joke would not be funny if there were not a shred of truth or perception of truth in it. Many teachers, including the teachers in this study, are uninformed about the purposes behind many education initiatives, and certainly most teachers are uninvolved in the decisions that go into creating educational policy. On the flip side, most policymakers are not currently involved in classroom teaching – perhaps they are educators who left the classroom a while ago, or people who have studied education on a theoretical level. Therefore, it seems as though education would benefit greatly from a closer relationship between classroom teachers and policymakers. Erin in particular had productive ideas about how to improve science educational experiences for students, but seemingly had no way for her ideas to be heard by

those who make decisions for RPECS. If only the lines of communication between policymakers and classroom teachers were clearer, perhaps science educational policies could be more responsive, realistic, and rigorous.

Implications for research. Lessons learned from the act of research can be just as important as the lessons learned from the data collected. Therefore, the final implications stemming from this research are in terms of the theoretical framework applied to this study: Cultural Historical Activity Theory (CHAT). What I have learned from conducting a CHATframed study may inform other educational researchers regarding what CHAT was able to assist me in seeing as well as the limitations of CHAT.

As previously stated, Roth, Lee, and Hsu (2009) observed that CHAT is useful for making visible normally invisible structures, processes, relations, and configurations. I found this to be quite true for this study, as the CHAT triangle heuristic forced me to think about each component individually and then in relation to other components. This can easily be seen in how I coded and analyzed the data, taking each component and relationship step by step. Additionally, contradictions in systems are often 'invisible' as well, but because contradictions were such a key part of the CHAT framework, my attention was drawn to interactions causing tension within the various systems in the study. Consequently, I believe the CHAT framework to be incredibly fruitful for school-based research. This framework may allow researchers to have a better grasp of the complexity involved in school settings as well as an appreciation for the different and multi-layered relationships within a school setting. This is certainly a framework I would recommend educational researchers to investigate when designing a school-based study.

On the other hand, CHAT – like any theoretical framework – cannot 'do it all.' There are pieces of the framework that I had to alter in order to compensate for a major limitation of the

framework: the 'cold cognition' standpoint of the framework. Roth (2007) has noted, "...there now appears to be an emerging sense in the research community that emotion, and the derivative concepts of motivation and identity, ought to be included in the integral analysis of human activities generally..." (p. 40). Thus, humans are not animals that respond to stimuli without their emotions, motivation, and identity playing a role in those responses. Teachers in this study did not make decisions about science purely based on the elements in the CHAT triangle, but also based on how they felt about science, why they felt science is important (or if they felt science is important) to teach, and who they were as learners and as teachers. Moreover, how they felt about the school, their collaborators, their resources, and the norms within the school affected how they taught science. Consequently, it would be an enormous oversight to leave these feelings out of the analysis. Roth (2009) stated that, "Only by including these needs, emotions, and feelings do we capture the activity system as a whole, that is, as intended by cultural-historical activity theory since its inception" (p. 70).

Therefore, I included a subject's goals and beliefs (which included these aforementioned emotions, identity, and motivation) when thinking about the subject of the system, which can be seen in the heuristics I use throughout the study. Additionally, when examining the interactions between the teachers and other people or objects, I was acutely aware of the emotional language the teachers used, whether they did not enjoy working with their collaborative teacher or felt valued by the district. I believe my attempts to overcome the 'cold cognition' aspect of CHAT to be successful in this research, as my attention to the participants' emotions enriched the data collected and, consequently, the analysis that took place. As a result, I would recommend that researchers who do adopt CHAT as a theoretical framework to keep in mind the 'human' aspects of activity systems and perhaps make adaptations to the framework as I did.

Directions for Future Research

Although this study involved nine months of working with the teachers of RPECS and several more months analyzing the data and writing the results, this is but a drop in the bucket concerning the research that needs to be done concerning the many issues that arose from this study. Possible 'offshoots' from this study include research concerning reform implementation, PDSs, and school administration.

While one of the major focal points of this study was context, it naturally led to investigations of school reform and reform initiatives. Throughout this study, I was privy to how NCLB, RTTT, and the FLAP grant impacted teachers at RPECS. Future research that hones in on particular reforms and examines the enactment of those reforms at different grade levels with different teachers may be fruitful. This may better inform the education community as to exactly how reforms are translated into everyday school life. Some such research already exists, such as Wiley, Good, and McCaslin's 2008 study of Comprehensive School Reform measures enacted in reading and math in grades 3-5, and Schneider, Krajcik, and Blumenfeld's 2005 study on how four middle school teachers enacted an inquiry science unit. However, I believe that larger, longitudinal studies on national reform initiatives like NCLB and RTTT may reveal even more about the state of school reform in actual schools today.

Moreover, this study allowed me to observe the effects of a very short-lived reform effort in terms of the FLAP grant. I was able to glean why the FLAP grant came to be, how it functioned during its short existence at RPECS, why it was discontinued, and how all of this impacted teachers. Similarly, it would be informative to examine other particular reform initiatives throughout their life cycle. That is, how did the reform initiative come about (bottomup, top-down, joint decision making, money was given, etc.), how was it enacted throughout its

life cycle (getting off the ground, maintenance, endings, etc.), how/why did it end (end of funding, change in school/district focus, etc.), and how did this birth, life, and death of an instruction-altering reform initiative affect the teachers and school? While there are studies such as Schneider et al.'s (2005) study that discuss the development of reform materials and the enactment of these materials, I believe research that delves further into policy decisions could be beneficial, as the data gathered from such studies would allow for more insight as to what perpetuates reform and what 'kills' it, as Ira Glass phrased it in the NPR podcast. Although a study such as this may be conducted on a small scale, there may be findings that could be scaled-up to apply to large initiatives such as RTTT or the *Next Generation Science Standards* implementation.

A second direction for future research stems from the PDS setting of this research. And while the 'PDS-ness' of the setting was not front and center, it was certainly a large piece of the context that could not be ignored. By and large, the teachers in this study saw the PDS partnership between RPECS and SU to be beneficial. However, based on some of my observations, I wondered if, on average, PDSs have more schoolwide initiatives and events going on than 'average' (non-PDS, non-charter) schools, and if so, does this lead teachers within PDSs to be more overwhelmed than teachers at 'average' schools? Further, if teachers within PDSs are more overwhelmed, will this eventually lead to higher turnover rates within PDSs as teachers become burned out with the many educational balls they are juggling at any given time? It has been noted that regarding PDSs,

...thousands of articles have been written about PDS partnerships. Unfortunately, a number of scholars in the field...have noted that much of what was written in the past was not high–quality research...As a result, those wanting to learn more

about PDS models will have to navigate the large body of literature and discern which studies are of sufficient quality in order to generate meaningful conclusions about such partnerships. (Breault & Breault, 2012, p. 1)

Therefore, high-quality research that examines the intersection between schoolwide initiatives and PDSs would be a valuable contribution to the literature and would help us better understand how to create and perpetuate mutually beneficial PDS partnerships.

A final direction for future research arises from the implications above regarding school personnel. It would be interesting to explore how various elementary school administrators truly view science and how this plays out in their actions with their staff as they attempt to balance multiple demands. Moreover, for those administrators who truly value science – or are 'science leaders' for their school - how do they attempt to make science 'of value' in their schools? In what ways do they 'buffer' initiatives or give certain initiatives priority so that science may remain a vital part of the schools' curriculum? There are very few studies that attempt to examine the role of school leadership in the success of elementary science. Spillane, Diamond, Walker, Halverson, and Jita (2001) explored this relationship in an urban Chicago setting while Lewthwaite (2004, 2006) investigated the interaction between principals as well as superintendents and the delivery of science instruction, but these studies seem to represent the bulk of the literature on the topic. Because school administrators cope with several competing needs on a daily basis, it would be beneficial to the science education community to better understand how decisions concerning science are made and how these decisions are communicated (explicitly or implicitly) to their school.

With all that is happening in the world of elementary science education, there are certainly several worthy topics of which study would be beneficial. However, I believe these

three areas – school reform enactment, PDSs, and school leadership for science – to be directions for research that have the potential to impact several fields significantly and simultaneously.

CHAPTER 6

EPILOGUE

Introduction

When reading particularly compelling case studies in educational research, I often wonder, "What happened to them *after* the study?" For various reasons, this question typically goes unanswered. However, because of my continued relationship with RPECS, I am able to give readers a glimpse of what happened *after* the voice recorders were shut off and my observation notes were put away.

The Teachers

Carole. Carole is still breezing through the hallways, loving on her students and encouraging them to think for themselves. Once again, she has a student teacher (the intern from the spring) and an intern from SU. As I spoke with the student teacher in the halls one day, she thanked me for the ideas I shared with her during science methods, as science was the first subject she 'picked up' in Carole's class.

Heather. Heather is still all-business, guiding her students and expecting perfection from eight-year-olds. She does not have any SU placements this semester, which is how Heather prefers it. She does, however, seem very excited to work with SU science centers this year.

Erin. Erin is no longer at RPECS. At the end of the spring, she applied for a job with a school that was closer to home and, as she shared with me, was just a 'typical' school that did not have an SU partnership or charter.

RPECS as a School

At the time of this writing, RPECS is approximately two-thirds of the way through the 2012-2013 school year. The school lost a few classroom teachers, but not many, and most of these were due to life choices on the parts of the teachers rather than the school itself. The FLAP grant has been dismantled due to lack of funding. Of the four FLAP Spanish teachers who were employed at RPECS, one remains as a Spanish 'specials' teacher because there was just enough money left to fund a teacher for one year. The other three (including the teachers who worked with Erin, Carole, and Heather) no longer work at RPECS. Remnants of the FLAP grant can still be seen in the hallways; the walls carry signs that say *el pared*, there are flags hung up that represent Spanish-speaking countries, and in one small hallway by the office, students and teachers who reached certain levels of proficiency in Spanish writing, reading, and speaking last year have their pictures posted along with the words, *¡Yo puedo!* (I can!).

While the FLAP grant is gone, the school has received a new Striving Readers grant. The funding from the grant will pay for more materials that are both culturally relevant and in a variety of genres – roughly 25 books per child in the building – in addition to professional learning. As a result of the grant, the literacy block has increased by about 20 minutes, giving students approximately 130 minutes of literacy each day. The instructional time for literacy is 'taking' time from math, which is a subject that the RPECS students have been much more successful in (Evelyn, interview 050712). Typically RPECS students struggle with reading and writing due to language barriers and so although this was another top-down mandate that RPECS would participate in this grant, Serena pointed out that they were lucky in that the grant fit their needs (Serena, interview 053112). As such, the teachers are excited to work with this grant because it has been an identified need for the students and continues the work that had previously

been started concerning science notebooks, and reading and writing in the content areas. During the literacy block this year, informational reading and writing is taught with science and social studies often used as contexts for that reading and writing. The RPECS instructional coach hopes that this will give teachers more time to read the science textbook (during the literacy block) so that they may use science time to actually do hands-on activities related to the science content. She believes that these change will allow teachers to see that science and social studies are a part of literacy rather than 'add-ons' to the curriculum (Evelyn, interview 050712). Serena is still leery about this, hoping that teachers will not think that just because they have read from the science textbook that they have 'done' science with their students for the day (Serena, interview 053112).

As I wandered the halls of RPECS this year, it still had that 'feel' about it. The staff of RPECS cares immensely about their students' success. Prior to the summer break, the librarian wrote a small grant that gave each child in the school twelve books of his/her own to read over the summer – yet another example of the staff of RPECS going above and beyond. Evelyn shared with me that the students were "ear-to-ear grinning" as they picked out their very own books about sharks, animals, and everything else one could imagine. These truly cared-for students still enthusiastically greet visitors and wave to you in the halls – I was even hugged by one of Carole's former students who is now a mighty fifth grader. RPECS, despite its struggles with school reforms, a traditionally difficult population, and constantly changing accountability measures (the Common Core State Standards for English Language Arts and Math were rolled out this year for RPECS), is still a wonderful place to be, and I couldn't help but smile as the rooster crowed while I was walking to my car.

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APPENDIX A

CONTEXT BELIEFS ABOUT TEACHING SCIENCE (CBATS) INSTRUMENT

Environmental Factor	The following factors would enable me to be	How likely is it that these factors will
	an effective teacher (SA = strongly agree)	occur in your school? (VL = very likely: SL
	A = agree; UN =	= somewhat likely; N
	undecided; D =	= neither; SU =
	disagree; $SD = strongly$ disagree)	somewhat unlikely; VU = very unlikely)
1. Professional staff development on teaching		(c (ci ý dilinici ý)
(workshops, conferences, etc.)		
2. State and national guidelines for science education		
(standards and goals)		
3. Support from other teachers (coaching, advice,		
mentoring, modeling, informal discussions, etc.)		
4. Team planning time with other teachers		
5. Hands-on science kits (activities and equipment)		
6. Community involvement (civic, business, etc.)		
7. Increased funding		
8. Extended class period length (e.g. block scheduling		
9. Planning time		
10. Permanent science equipment (microscopes,		
glassware, etc.)		
11. Classroom physical environment (room size,		
proper furniture, sinks, etc.)		
12. Adoption of an official school science curriculum		
(goals, objectives, topics, etc.)		
13. Expendable science supplies (paper, chemicals)		
14. Support from administrators		
15. Science curriculum materials (textbooks, lab		
manuals, activity books, etc.)		
16. Technology (computers, software, Internet)		
17. Parental involvement		
18. An increase in students' academic abilities		
19. Involvement of the state board of education		
20. A decrease in your course teaching load		
21. A reduction in the amount of content you are		
required to teach		
22. Reduced class size (number of pupils)		
23. Involvement of scientists		
24. Involvement of university professors		
25. Classroom assessment strategies		
26. Teacher input and decision making		

From Lumpe et al. (2000), p. 289-290

APPENDIX B

STATE SCIENCE STANDARDS⁶

GRADE TWO

Habits of Mind

Students will be aware of the importance of curiosity, honesty, openness, and skepticism in science and will exhibit these traits in their own efforts to understand how the world works.

a. Raise questions about the world around them and be willing to seek answers to some of the questions by making careful observations and measurements and trying to figure things out.

Students will have the computation and estimation skills necessary for analyzing data and following scientific explanations.

a. Use whole numbers in ordering, counting, identifying, measuring, and describing things and experiences.

b. Readily give the sums and differences of single-digit numbers in ordinary, practical contexts and judge the reasonableness of the answer.

c. Give rough estimates of numerical answers to problems before doing them formally.

d. Make quantitative estimates of familiar lengths, weights, and time intervals, and check them by measuring.

⁶ These standards are from the state Department of Education website. However, to preserve anonymity, neither the state nor the web address will be listed here.

Students will use tools and instruments for observing, measuring, and manipulating objects in scientific activities.

a. Use ordinary hand tools and instruments to construct, measure, and look at objects.

b. Assemble, describe, take apart, and reassemble constructions using interlocking blocks, erector sets and other things.

c. Make something that can actually be used to perform a task, using paper, cardboard, wood, plastic, metal, or existing objects.

Students will use the ideas of system, model, change, and scale in exploring scientific and technological matters.

a. Identify the parts of things, such as toys or tools, and identify what things can do when put together that they could not do otherwise.

b. Use a model—such as a toy or a picture—to describe a feature of the primary thing.

c. Describe changes in the size, weight, color, or movement of things, and note which of their other qualities remain the same during a specific change.

d. Compare very different sizes, weights, ages (baby/adult), and speeds (fast/slow) of both human made and natural things.

Students will communicate scientific ideas and activities clearly.

a. Describe and compare things in terms of number, shape, texture, size, weight, color, and motion.

b. Draw pictures (grade level appropriate) that correctly portray features of the thing being described.

c. Use simple pictographs and bar graphs to communicate data.

The Nature of Science

Students will be familiar with the character of scientific knowledge and how it is achieved.

Students will recognize that:

a. When a science investigation is done the way it was done before, we expect to get a similar result.

b. Science involves collecting data and testing hypotheses.

c. Scientists often repeat experiments multiple times and subject their ideas to criticism by other scientists who may disagree with them and do further tests.

d. All different kinds of people can be and are scientists.

Students will understand important features of the process of scientific inquiry.

Students will apply the following to inquiry learning practices:

a. Scientists use a common language with precise definitions of terms to make it easier to communicate their observations to each other.

b. In doing science, it is often helpful to work as a team. All team members should reach their own individual conclusions and share their understandings with other members of the team in order to develop a consensus.

c. Tools such as thermometers, rulers and balances often give more information about things than can be obtained by just observing things without help.

d. Much can be learned about plants and animals by observing them closely, but care must be taken to know the needs of living things and how to provide for them. Advantage can be taken of classroom pets.

Content

Earth Science

Students will understand that stars have different sizes, brightness, and patterns.

a. Describe the physical attributes of stars—size, brightness, and patterns.

Students will investigate the position of sun and moon to show patterns throughout the

year.

a. Investigate the position of the sun in relation to a fixed object on earth at various times of the day.

b. Determine how the shadows change through the day by making a shadow stick or using a sundial.

c. Relate the length of the day and night to the change in seasons (for example: Days are longer than the night in the summer.).

d. Use observations and charts to record the shape of the moon for a period of time.

Students will observe and record changes in their surroundings and infer the causes of the changes.

a. Recognize effects that occur in a specific area caused by weather, plants, animals, and/or people.

Physical Science

Students will investigate the properties of matter and changes that occur in objects.

- a. Identify the three common states of matter as solid, liquid, or gas.
- b. Investigate changes in objects by tearing, dissolving, melting, squeezing, etc.

Students will identify sources of energy and how the energy is used.

- a. Identify sources of light energy, heat energy, and energy of motion.
- b. Describe how light, heat, and motion energy are used.

Students will demonstrate changes in speed and direction using pushes and pulls.

a. Demonstrate how pushing and pulling an object affects the motion of the object.

b. Demonstrate the effects of changes of speed on an object.

Life Science

Students will investigate the life cycles of different living organisms.

a. Determine the sequence of the life cycle of common animals in your area: a mammal such as a cat or dog or classroom pet, a bird such as a chicken, an amphibian such as a frog, and an insect such as a butterfly.

b. Relate seasonal changes to observations of how a tree changes throughout a school year.

c. Investigate the life cycle of a plant by growing a plant from a seed and by recording changes over a period of time.

d. Identify fungi (mushroom) as living organisms.

GRADE FOUR

Habits of the Mind

Students will be aware of the importance of curiosity, honesty, openness, and skepticism in science and will exhibit these traits in their own efforts to understand how the world works.

a. Keep records of investigations and observations and do not alter the records later.

b. Carefully distinguish observations from ideas and speculation about those

observations.

c. Offer reasons for findings and consider reasons suggested by others.

d. Take responsibility for understanding the importance of being safety conscious.

Students will have the computation and estimation skills necessary for analyzing data and following scientific explanations.

a. Add, subtract, multiply, and divide whole numbers mentally, on paper, and with a calculator.

b. Use fractions and decimals, and translate between decimals and commonly encountered fractions – halves, thirds, fourths, fifths, tenths, and hundredths (but not sixths, sevenths, and so on) – in scientific calculations.

c. Judge whether measurements and computations of quantities, such as length, area, volume, weight, or time, are reasonable answers to scientific problems by comparing them to typical values.

Students will use tools and instruments for observing, measuring, and manipulating objects in scientific activities utilizing safe laboratory procedures.

a. Choose appropriate common materials for making simple mechanical constructions and repairing things.

b. Measure and mix dry and liquid materials in prescribed amounts, exercising reasonable safety.

c. Use computers, cameras and recording devices for capturing information.

d. Identify and practice accepted safety procedures in manipulating science materials and equipment.

Students will use ideas of system, model, change, and scale in exploring scientific and technological matters.

a. Observe and describe how parts influence one another in things with many parts.

b. Use geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps, and stories to represent corresponding features of objects, events, and processes in the real world. Identify ways in which the representations do not match their original counterparts.

c. Identify patterns of change in things—such as steady, repetitive, or irregular change using records, tables, or graphs of measurements where appropriate.

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Students will have the computation and estimation skills necessary for analyzing data and following scientific explanations.

a. Add, subtract, multiply, and divide whole numbers mentally, on paper, and with a calculator.

b. Use fractions and decimals, and translate between decimals and commonly encountered fractions – halves, thirds, fourths, fifths, tenths, and hundredths (but not sixths, sevenths, and so on) – in scientific calculations.

c. Judge whether measurements and computations of quantities, such as length, area, volume, weight, or time, are reasonable answers to scientific problems by comparing them to typical values.

Students will use tools and instruments for observing, measuring, and manipulating objects in scientific activities utilizing safe laboratory procedures.

a. Choose appropriate common materials for making simple mechanical constructions and repairing things.

b. Measure and mix dry and liquid materials in prescribed amounts, exercising reasonable safety.

c. Use computers, cameras and recording devices for capturing information.

d. Identify and practice accepted safety procedures in manipulating science materials and equipment.

Students will use ideas of system, model, change, and scale in exploring scientific and technological matters.

a. Observe and describe how parts influence one another in things with many parts.

b. Use geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps, and stories to represent corresponding features of objects, events, and processes in the real world. Identify ways in which the representations do not match their original counterparts.

c. Identify patterns of change in things—such as steady, repetitive, or irregular change using records, tables, or graphs of measurements where appropriate.

The Nature of Science

Students will be familiar with the character of scientific knowledge and how it is achieved. Students will recognize that:

a. Similar scientific investigations seldom produce exactly the same results, which may differ due to unexpected differences in whatever is being investigated, unrecognized differences in the methods or circumstances of the investigation, or observational uncertainties.

b. Some scientific knowledge is very old and yet is still applicable today.

Students will understand important features of the process of scientific inquiry.

Students will apply the following to inquiry learning practices:

a. Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments.

b. Clear and active communication is an essential part of doing science. It enables scientists to inform others about their work, expose their ideas to criticism by other scientists, and stay informed about scientific discoveries around the world.

c. Scientists use technology to increase their power to observe things and to measure and compare things accurately.

d. Science involves many different kinds of work and engages men and women of all ages and backgrounds.

Content

Earth Science

Students will compare and contrast the physical attributes of stars, star patterns, and planets.

a. Recognize the physical attributes of stars in the night sky such as number, size, color and patterns.

b. Compare the similarities and differences of planets to the stars in appearance, position, and number in the night sky.

c. Explain why the pattern of stars in a constellation stays the same, but a planet can be seen in different locations at different times.

d. Identify how technology is used to observe distant objects in the sky.

Students will model the position and motion of the earth in the solar system and will explain the role of relative position and motion in determining sequence of the phases of the moon.

a. Explain the day/night cycle of the earth using a model.

b. Explain the sequence of the phases of the moon.

c. Demonstrate the revolution of the earth around the sun and the earth's tilt to explain the seasonal changes.

d. Demonstrate the relative size and order from the sun of the planets in the solar system.

Students will differentiate between the states of water and how they relate to the water

cycle and weather.

a. Demonstrate how water changes states from solid (ice) to liquid (water) to gas (water vapor/steam) and changes from gas to liquid to solid.

b. Identify the temperatures at which water becomes a solid and at which water becomes a gas.

c. Investigate how clouds are formed.

d. Explain the water cycle (evaporation, condensation, and precipitation).

e. Investigate different forms of precipitation and sky conditions. (rain, snow, sleet, hail, clouds, and fog).

Students will analyze weather charts/maps and collect weather data to predict weather events and infer patterns and seasonal changes.

a. Identify weather instruments and explain how each is used in gathering weather data and making forecasts (thermometer, rain gauge, barometer, wind vane, anemometer).b. Using a weather map, identify the fronts, temperature, and precipitation and use the information to interpret the weather conditions.

c. Use observations and records of weather conditions to predict weather patterns throughout the year.

d. Differentiate between weather and climate.

Physical Science

Students will investigate the nature of light using tools such as mirrors, lenses, and prisms.

a. Identify materials that are transparent, opaque, and translucent.

b. Investigate the reflection of light using a mirror and a light source.

c. Identify the physical attributes of a convex lens, a concave lens, and a prism and where each is used.

Students will demonstrate how sound is produced by vibrating objects and how sound can be varied by changing the rate of vibration.

- a. Investigate how sound is produced.
- b. Recognize the conditions that cause pitch to vary.

Students will demonstrate the relationship between the application of a force and the resulting change in position and motion on an object.

a. Identify simple machines and explain their uses (lever, pulley, wedge, inclined plane, screw, wheel and axle).

b. Using different size objects, observe how force affects speed and motion.

c. Explain what happens to the speed or direction of an object when a greater force than the initial one is applied.

d. Demonstrate the effect of gravitational force on the motion of an object.

Life Science

Students will describe the roles of organisms and the flow of energy within an ecosystem.

a. Identify the roles of producers, consumers, and decomposers in a community.

b. Demonstrate the flow of energy through a food web/food chain beginning with

sunlight and including producers, consumers, and decomposers.

c. Predict how changes in the environment would affect a community (ecosystem) of organisms.

d. Predict effects on a population if some of the plants or animals in the community are scarce or if there are too many.

Students will identify factors that affect the survival or extinction of organisms such as adaptation, variation of behaviors (hibernation), and external features (camouflage and protection).

a. Identify external features of organisms that allow them to survive or reproduce better than organisms that do not have these features (for example: camouflage, use of hibernation, protection, etc.).

b. Identify factors that may have led to the extinction of some organisms.

GRADE FIVE

Habits of the Mind

Students will be aware of the importance of curiosity, honesty, openness, and skepticism in science and will exhibit these traits in their own efforts to understand how the world works.

a. Keep records of investigations and observations and do not alter the records later.

b. Carefully distinguish observations from ideas and speculation about those

observations.

c. Offer reasons for findings and consider reasons suggested by others.

d. Take responsibility for understanding the importance of being safety conscious.

Students will have the computation and estimation skills necessary for analyzing data and following scientific explanations.

a. Add, subtract, multiply, and divide whole numbers mentally, on paper, and with a calculator.

b. Use fractions and decimals, and translate between decimals and commonly encountered fractions – halves, thirds, fourths, fifths, tenths, and hundredths (but not sixths, sevenths, and so on) – in scientific calculations.

c. Judge whether measurements and computations of quantities, such as length, area, volume, weight, or time, are reasonable answers to scientific problems by comparing them to typical values.

Students will use tools and instruments for observing, measuring, and manipulating objects in scientific activities.

a. Choose appropriate common materials for making simple mechanical constructions and repairing things.

b. Measure and mix dry and liquid materials in prescribed amounts, exercising reasonable safety.

c. Use computers, cameras and recording devices for capturing information.

d. Identify and practice accepted safety procedures in manipulating science materials and equipment.

Students will use ideas of system, model, change, and scale in exploring scientific and technological matters.

a. Observe and describe how parts influence one another in things with many parts.

b. Use geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps, and stories to represent corresponding features of objects, events, and processes in the real world. Identify ways in which the representations do not match their original counterparts.

c. Identify patterns of change in things—such as steady, repetitive, or irregular change using records, tables, or graphs of measurements where appropriate.

d. Identify the biggest and the smallest possible values of something.

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Students will communicate scientific ideas and activities clearly.

a. Write instructions that others can follow in carrying out a scientific procedure.

b. Make sketches to aid in explaining scientific procedures or ideas.

c. Use numerical data in describing and comparing objects and events.

d. Locate scientific information in reference books, back issues of newspapers and

magazines, CD-ROMs, and computer databases.

Students will question scientific claims and arguments effectively.

a. Support statements with facts found in books, articles, and databases, and identify the sources used.

b. Identify when comparisons might not be fair because some conditions are different.

The Nature of Science

Students will be familiar with the character of scientific knowledge and how it is achieved.

Students will recognize that:

a. Similar scientific investigations seldom produce exactly the same results, which may differ due to unexpected differences in whatever is being investigated, unrecognized differences in the methods or circumstances of the investigation, or observational uncertainties.

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c. Scientists use technology to increase their power to observe things and to measure and compare things accurately.

d. Science involves many different kinds of work and engages men and women of all ages and backgrounds.

Content

Earth Science

Students will identify surface features of the Earth caused by constructive and destructive processes.

- a. Identify surface features caused by constructive processes.
- Deposition (Deltas, sand dunes, etc.)
- Earthquakes
- Volcanoes
- Faults
- b. Identify and find examples of surface features caused by destructive processes.
- Erosion (water—rivers and oceans, wind)

- Weathering
- Impact of organisms
- Earthquake
- Volcano

c. Relate the role of technology and human intervention in the control of constructive and destructive processes.

Examples include, but are not limited to

- Seismological studies,
- Flood control, (dams, levees, storm drain management, etc.)
- Beach reclamation (coastal islands)

Physical Science

Students will verify that an object is the sum of its parts.

a. Demonstrate that the mass of an object is equal to the sum of its parts by manipulating and measuring different objects made of various parts.

b. Investigate how common items have parts that are too small to be seen without magnification.

Students will explain the difference between a physical change and a chemical change.

a. Investigate physical changes by separating mixtures and manipulating (cutting, tearing,

folding) paper to demonstrate examples of physical change.

b. Recognize that the changes in state of water (water vapor/steam, liquid, ice) are due to temperature differences and are examples of physical change.

c. Investigate the properties of a substance before, during, and after a chemical reaction to find evidence of change.

Students will investigate the electricity, magnetism, and their relationship.

a. Investigate static electricity.

b. Determine the necessary components for completing an electric circuit.

c. Investigate common materials to determine if they are insulators or conductors of electricity.

d. Compare a bar magnet to an electromagnet

Life Science

Students will classify organisms into groups and relate how they determined the groups

with how and why scientists use classification.

a. Demonstrate how animals are sorted into groups (vertebrate and invertebrate) and how vertebrates are sorted into groups (fish, amphibian, reptile, bird, and mammal).

b. Demonstrate how plants are sorted into groups.

Students will recognize that offspring can resemble parents in inherited traits and learned behaviors.

a. Compare and contrast the characteristics of learned behaviors and of inherited traits.

b. Discuss what a gene is and the role genes play in the transfer of traits.

Students will diagram and label parts of various cells (plant, animal, single-celled, multi-celled).

a. Use magnifiers such as microscopes or hand lenses to observe cells and their structure.

b. Identify parts of a plant cell (membrane, wall, cytoplasm, nucleus, chloroplasts) and of an animal cell (membrane, cytoplasm, and nucleus) and determine the function of the parts.

c. Explain how cells in multi-celled organisms are similar and different in structure and function to single-celled organisms.

Students will relate how microorganisms benefit or harm larger organisms.

a. Identify beneficial microorganisms and explain why they are beneficial.

b. Identify harmful microorganisms and explain why they are harmful.

APPENDIX C

INTERVIEW PROTOCOLS

First Participant Interview Protocol

- 1. Basic information
 - a. How long have you been a teacher?
 - b. Did you go through a certification program? Tell me about this. What was emphasized in that program? Did you have to take science methods? Describe the methods course.
 - c. How long have you been at this school?
 - d. Why did you choose to interview for this school?
- 2. I'm interested in your science background. Is this something you like? Are you good at it?
 - a. People engage in science in different ways do you go outdoors, do you like building things, do you enjoy watching science TV shows (Mythbusters, Nat Geo, Discovery, Animal Planet)?
 - b. If you're not into science, then what are you into? What do you like to do?
- 3. I'm curious to know about your science instruction. Can you tell me about which science topics you teach in this grade?
 - a. Narrow down to a particular topic how would you teach this? Why would you teach this way?
- 4. One of the things I've seen is that you've had a Spanish teacher teaching some of the science in your classroom. What's going on in your head as you watch your Spanish teacher/intern teach science?
- 5. Think about a time when you taught a very successful science lesson. Tell me about this experience.
- 6. Tell me about your goals for science instruction in your classroom.
- 7. Do you have any fears or concerns about science instruction? If so, tell me about those.

Second Participant Interview Protocol

Focusing on topics teachers discussed in first interview.

- 1. FLAP grant
 - a. I've noticed that FLAP is taking a lot of time/energy. Can you tell me what you know about the FLAP grant? What were you told is the purpose of the FLAP grant?
 - b. How do you feel about it overall? Is it achieving the goals set out?
 - c. How is it impacting your science instruction?
 - d. How is it impacting the decisions you make concerning your science instruction?
- 2. Struggling with science (find an opening from previous interview personal experience mentioned, science story mentioned, etc.)
 - a. How does your team figure into science instruction?
 - b. How do other colleagues (EIP, different grades, Spanish teacher, etc.) figure into your science instruction?
 - c. What resources are available to you when you need help with science? Have you taken advantage of these?
- 3. Goals for science instruction
 - a. Is it important for your students to learn science? Why?
 - b. Why should kids learn science in general?
 - c. What are your personal goals for your kids in science (some have already touched on this)?
 - d. What do you do in your classroom to address those points?
- 4. Pacing guide ("Titan")
 - a. Some see the science pacing guide as a blessing, some as a curse. What is it to you? Why?
 - b. Do you feel the standards/skills set out by the science pacing guides are realistic? If not, what would you change?
- 5. Other impact factors
 - a. We've talked about FLAP and the pacing guide. What else impacts the ways in which you make decisions about your science instruction? (kids, technology, resources available, etc.)
 - b. To what extent do you feel able to make science instructional decisions for your own classroom?
- 6. RPECS
 - a. How is being at this particular school, with all that's going on (PDS, grants, new school, etc.) impact your science instruction?
 - b. How do you feel your science instruction would be different if you were at a different school?
 - c. What are the advantages/disadvantages of being at RPECS?

Third Participant Interview Protocol

Card sort \rightarrow I have a stack of cards here listing different items teachers have mentioned as impacting the decisions they make concerning their science instruction. Please put them in order from the item that impacts/influences your decisions about science instruction the most to the item that impacts/influences your decisions about science instruction the least. When you are done, I will ask you to explain some of your choices.

- FLAP grant
- Pacing guide (Titan)
- State standardized test
- Academic level of students in your classroom
- Collaboration with grade level team
- Working with a student teacher
- Enrichment strategies
- Using the science lab
- Confidence teaching science
- Wanting to reinforce other skills (reading comprehension, etc.)
- Instructional time
- Classroom management issues
- Using fun activities students will enjoy
- Available resources for planning (people, books, videos, etc.)
- Your own personal feelings about what and how kids should learn
- 1. Think of some of the requirements you're asked to complete in relation to your science teaching (lesson planning, working with FLAP, etc.) What do you think you do really well? Why?
- 2. Are there short-cuts that you feel you need to take in order to teach science the way in which you feel it should be taught? Explain.
- 3. When I started this project one of the things I wanted to investigate was the impact of mentoring on your science instruction. I'd like to ask some questions about what it's like to be a mentor.
 - a. Why did decide to mentor a student teacher this semester?
 - b. Have you mentored student teachers in the past? If so, what motivates you to continue to be a mentor?
 - c. What do you feel your student teacher is bringing to the relationship?
 - d. The phrase 'vicarious experience' has been used to describe mentor teachers watching their student teachers teach they're able to reflect on their practice by watching their student teachers and thinking about what they would do the

same/differently. Do you ever feel you're having a vicarious experience by watching your student teacher teach?

- e. Do you see working with a student teacher as a form of professional development? Why or why not?
- f. What have you noticed about your ST's science teaching?
- g. Where does your ST get her ideas to create a science lesson?

READ VIGNETTE TO PARTICIPANT: These are some of the things I've noticed about the ST's approach to teaching and I'm curious about whether my impression and your impression differ and if so why they differ.

- 1. How do you feel about the execution of this science teaching?
- 2. What do you feel students are getting out of this lesson?
- 3. What would you do differently? Is this realistic?

Adrienne Student Teacher Vignette (Read to Heather and Adrienne)

The student teacher begins the lesson by asking students what the overarching topic for the unit is and then what they talked about yesterday. She then tells them what topic they will be learning about today and briefly discusses the essential question on the board. The student teacher asks students to get out their books and point to the first line on a particular page. Once all the students are ready to go, the student teacher begins reading aloud. She read two or three sentences and then asks a few questions that help to monitor comprehension, connect to students' prior knowledge, or to apply the concept to a different situation. The student teacher continues in this manner for the next 10-15 minutes, which is the length of one section in the book. Occasionally she asks students to read one or two sentences aloud. Next, the student teacher explains that they will be doing an experiment. She shows the students materials and tells them they will be exploring the concept of the day and when they are finished, they will share their findings with the class. Before beginning the exploratory time, the student teacher reviews with the students proper behavior as well as how to observe. She then splits students into groups and allows them to work with the materials for about 15 minutes. When the time is up, the student teacher uses a sound signal to get students' attention and then asks students to return to their seats. She then asks the students to report about what they observed and asks probing questions to elicit more information. Occasionally, she asks other students if they agree with the observation made. After sharing for about 5 minutes, the student teacher closes her lesson by telling the students what a good job they did and reviewing the main vocabulary and concepts from the day's lesson.

Jackie Student Teacher Vignette (Read to Carole and Jackie)

The student teacher begins the lesson by passing around a ball with questions on it. Students are to answer the question that their left thumb lands on – many of these questions are review from the unit. After doing this for about 5 minutes, the student teacher collects the ball back and directs the students' attention to the SmartBoard. She has put together different slides with basic vocabulary words connected to an exploratory lesson they conducted the day before. The students help define the words using evidence from the exploratory lesson. The student teacher then asks students to take out their books and turn to a specific page. She has students take turns reading and after each main concept, the student teacher pauses to make a connection to the students' lives or to examples they may already know. Some students volunteer information they know and the student teacher comments that these are good 'bridge builders' or good 'connections.' To illustrate a concept from the book, the student teacher calls a student up for a quick demonstration. During this demonstration, the student teacher asks many "Why" questions and plays Devil's advocate with many answers, requiring students to clarify their thinking. After the demonstration, the student teacher asks students to define the key words and concepts of the day to close the lesson.

Gwen Student Teacher Vignette (Read to Erin and Gwen)

The student teacher begins class with a question on the board from the note-taker they worked on the day before. A student answers the question and the student teacher elaborates a little to explain the answer and then states a quick review of what they talked about yesterday. She then asks the students to take out their books and turn to a specific page, which she tells them to do by saying the hundreds, tens, and ones place of the number. The students turn to the correct page and the student teacher begins reading the section aloud. After reading one section, she pauses to ask students some clarifying questions to monitor comprehension, and then tries to make some connections to where students may have seen this phenomenon in their lives. The student teacher then continues reading the next three sections in the same manner, pausing after each section to ask questions. This lasts about 30 minutes. Once she gets to the end of the section, she passes back their half-completed note-taker from the day before and assigns students partners so they can finish the note-taker during the rest of science time. As the students work, she circulates the room, typically replying to students' questions with questions of her own, rather than giving away the answer. When there is ten minutes left in class, the student teacher collects the notetakers, asks students to return to their seats, and has them answer a summarizing multiple choice question that is up on the board on a piece of scrap paper. After students finish these and turn them in, the student teacher turns the rest of class over to the FLAP teacher so he can do a recap in Spanish.

First Student Teacher Interview Protocol

- 1. Basic information
 - a. Why did you choose to be an elementary teacher? Did you always want to be an elementary teacher?
 - b. Tell me about your science preparation in your college elementary education program what courses have you taken? Why did you take them? Were they helpful?
- 2. Do you like science? Do you feel you're good at it?
 - a. People engage in science in different ways do you go outdoors, do you like building things, do you enjoy watching science TV shows (Mythbusters, Nat Geo, Discovery, Animal Planet)?
 - b. If you're not into science, then what are you into? What do you like to do?
- 3. Tell me about your goals for science instruction in your classroom.
- 4. Describe for me what a successful science lesson would look like.
- 5. Do you have any fears or concerns about science instruction? If so, tell me about those.

Questions regarding student teacher vignettes:

1. How would you go about planning a science lesson?

READ VIGNETTE

- 2. How do you feel about the execution of this science teaching?
- 3. What do you feel students are getting out of this lesson?
- 4. What would you do differently if you could change anything? Is this realistic?

Second Student Teacher Interview Protocol

- 1. In what ways do you think your science instruction is similar to that of your mentor teacher's? In what ways is it different?
- 2. When you were watching your mentor teacher teach science, what was going through your head?
- 3. Have you and your mentor teacher had conversations about teaching science? If so, tell me about those conversations.
- 4. Do you think your mentor teacher enjoys teaching science? Please explain.
- 5. What do you think you have learned about science by working with your mentor teacher?
- 6. What do you think your mentor teacher has learned from you about teaching science?
Jack Interview Protocol

- 1. How long have you been involved with RPECS? How did you become involved with this school? How did you decide that you wanted to be involved with this school?
- 2. Tell me what you know about the creation of RPECS.
 - a. Major players
 - b. Chronology
 - c. Expectations/Goals
 - d. PDS information
 - e. Logistics
 - f. Jack's role at RPECS
- 3. Have you been able to observe science instruction at RPECS? If yes, what are your impressions about science instruction at RPECS? If no, why do you think you have not observed science instruction?
- 4. If you walked into a classroom to observe science instruction, what would you hope to see?
- 5. How do you think science fits into the school's mission?
- 6. Do you think the administration supports science instruction? Do you think the teachers support science instruction? Do you think the district supports science instruction? If you do not feel that there is support for science instruction, what do you think would have to happen to bring about support for science instruction?
- 7. Tell me what you know about the implementation of the FLAP grant.
 - a. Major players
 - b. Chronology
 - c. Expectations/Goals
 - d. Logistics
 - e. Reactions from administration/staff
 - f. Opinions of its success
- 8. What do you think is positive about RPECS? What is your sense about how the positive features of RPECS were cultivated?
- 9. What do you think is difficult/frustrating about RPECS?
- 10. What do you feel is the general climate at RPECS?
- 11. What else do you feel I need to know about RPECS?

Evelyn and Serena Interview Protocol

- 1. Please tell me about how RPECS came to be (charter, history, partnership, etc.).
- 2. What is your vision for the PDS?
- 3. What is your vision for the school?
- 4. What is your vision for science instruction in the school? (Is this realistic?)
- 5. When looking into a teacher's classroom, what would you like to see during science instruction?
- 6. What do you believe the current status of science instruction is in RPECS? If it needs to be improved, what needs to happen?
- 7. Can you give me a bit of information concerning how the FLAP grant came to be affiliated with science instructional time?
- 8. Are their instructional initiatives on the horizon that may impact science instruction in the future? If so, how do you see this playing out? (Common Core standards, NGSS, etc.)