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Documenting Elementary Teachers' Sustainability of Instructional Practices: A Mixed Method Case Study

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Documenting Elementary Teachers' Sustainability of Instructional Practices:

A Mixed Method Case Study

by

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DEDICATION

I dedicate this doctoral dissertation to my friend and mentor, Kathy Borman, Professor Emeritus. Kathy, you have been one of the most important people in my academic career – serving as my professor, advisor for my master's degree, supervisor when you hired me to work on my first large-scale, mixed method research project, and throughout the years we worked together. You taught me how to conduct research, design studies, write fundable research proposals and even how to network at conferences by taking me to all the events and introducing me to the people whose work I read. Kathy, you have shaped me into the researcher I am today and for that I am eternally grateful.

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ABSTRACT

School reform programs focus on making educational changes; however, research on interventions past the funded implementation phase to determine what was sustained is rarely done (Beery, Senter, Cheadle, Greenwald, Pearson, et al., 2005). This study adds to the research on sustainability by determining what instructional practices, if any, of the Teaching SMART® professional development program that was implemented from 2005-2008 in elementary schools with teachers in grades third through eighth were continued, discontinued, or adapted five years post-implementation (in 2013). Specifically, this study sought to answer the following questions: What do teachers who participated in Teaching SMART® and district administrators share about the sustainability of Teaching SMART® practices in 2013? What teaching strategies do teachers who participated in the program (2005-2008) use in their science classrooms five years post-implementation (2013)? What perceptions about the roles of females in science, technology, engineering, and mathematics (STEM) do teachers who participated in the program (2005-2008) have five years later (2013)? And, What classroom management techniques do the teachers who participated in the program (2005-2008) use five years post implementation (2013)?

A mixed method approach was used to answer these questions. Quantitative teacher survey data from 23 teachers who participated in 2008 and 2013 were analyzed in SAS v. 9.3. Descriptive statistics were reported and paired *t*-tests were conducted to determine mean differences by survey factors identified from an exploratory factor analysis, principal axis factoring, and parallel analysis conducted with teacher survey baseline data (2005). Individual

teacher change scores (2008 and 2013) for identified factors were computed using the Reliable Change Index statistic. Qualitative data consisted of interviews with two district administrators and three teachers who responded to the survey in both years (2008 and 2013). Additionally, a classroom observation was conducted with one of the interviewed teachers in 2013. Qualitative analyses were conducted following the constant comparative method and were facilitated by ATLAS.ti v. 6.2, a qualitative analysis software program.

Qualitative findings identified themes at the district level that influenced teachers' use of Teaching SMART® strategies. All the themes were classified as obstacles to sustainability: economic downturn, turnover of teachers and lack of hiring, new reform policies, such as Race to the Top, Student Success Act, Common Core State Standards, and mandated blocks of time for specific content. Results from the survey data showed no statistically significant difference through time in perceived instructional practices except for a perceived decrease in the use of hands-on instructional activities from 2008 to 2013. Analyses conducted at the individual teacher level found change scores were statistically significant for a few teachers, but overall, teachers reported similarly on the teacher survey at both time points.

This sustainability study revealed the lack of facilitating factors to support the continuation of reform practices; however, teachers identified strategies to continue to implement some of the reform practices through time in spite of a number of system-wide obstacles. This sustainability study adds to the literature by documenting obstacles to sustainability in this specific context, which overlap with what is known in the literature. Additionally, the strategies teachers identified to overcome some of the obstacles to implement reform practices and the recommendations by district level administrators add to the literature on how stakeholders may support sustainability of reform through time.

CHAPTER ONE:

INTRODUCTION

> The success or failure of a school reform can be measured by whether the reform has become an accepted, effective, and sustainable part of the school's culture (Main, 2009, p. 457).

This chapter presents an overview of the study. The chapter includes a brief review of information to situate the need for research on sustainability, a description of the Teaching SMART® professional development program, an overview of stages of reform, a statement of the problem, the purpose and research and evaluation questions that guided the study, the methodology with a description of the data that were used to answer the questions. A description of the scope, delimitations, assumptions, limitations, significance of the study, and operational definitions of relevant terminology is presented. The chapter concludes with the organization of the chapters that follow.

Situating the Need for Research on Sustainability

As more and more schools fail to meet the requirements of adequate yearly progress under the *No Child Left Behind* (NCLB) Act of 2001, there is a need for evidence-based reform strategies to improve student achievement (Coburn & Talbert, 2006). Under the NCLB Act of 2001, Title I schools that do not meet their state's goals for adequate yearly progress for two consecutive years are identified as needing improvement. Those schools are required to create a two-year improvement plan using practices grounded in scientifically-based research (Reid, 2004). The U.S. Department of Education (2003), under *No Child Left Behind*, defined scientifically-based research as having reliable evidence that the program or practice works. The US Department of Education's What Works Clearinghouse (WWC) provided "critical assessments of scientific evidence on the effectiveness of education programs, policies, and practices (referred to as "interventions") and a range of products summarizing this evidence standards" (U.S. Department of Education, 2013, p. 1).

With the proposed reauthorization of the Elementary and Secondary Education Act (NCLB Act of 2001), *A Blueprint for Reform* (US Department of Education, 2010), states and school districts are provided an opportunity through grant competitions, specifically Race to the Top, to develop innovative reform programs to raise student achievement and teacher quality, among other focus areas. Four focus areas are included in *A Blueprint for Reform* (US Department of Education, 2010) with the fourth area described as "to improve student learning and achievement in America's lowest-performing schools by providing intensive support and effective interventions" (p. 3). But how are effective interventions determined?

Under the NCLB Act of 2001, and included in *A Blueprint for Reform* (US Department of Education, 2010), districts and schools are charged with identifying scientifically-based or effective strategies that will improve instructional practice and increase student achievement. However, there continues to be a gap between what has been found to be evidence-based instruction and actual classroom practice (Buzhardt, Greenwood, Abbott, & Tapia, 2006). To promote effective instructional strategies and create widespread change in student performance, "states and school districts are looking at large scale strategies to help underperforming schools, with most focusing on district-wide reform efforts" (Reid, 2004, p. 16).

According to Fullan (2000), the first large-scale school reform effort occurred in the 1960s but was not successful because implementation "did not address local institutions and cultures" (p. 5). In the past decade, there is a movement in educational research to identify the conditions under which interventions can succeed when applied on a large scale (Buzhardt, Greenwood, Abbott, & Tapia, 2006; Lee & Luykx, 2005; Schneider & McDonald, 2007). However, identifying interventions that have been not only successfully implemented but also show evidence of sustaining change must be explored before spreading a reform to a larger scale (Coburn, 2003). According to Coburn (2003), "Most studies focus on schools in their first few years of implementing a new external reform, failing to capture sustainability" (p. 6). Indeed, studying the outcomes of a reform for longer periods of time after the implementation phase is needed to better understand if and how reform practices are sustained (Taylor, 2009). In the next section, an introduction to the school reform that was implemented 2005-2008 and is the focus of this sustainability study is presented.

Teaching SMART®

Teaching Science, Mathematics, and Relevant Technologies (Teaching SMART®) is an educational professional development reform program for upper level elementary teachers (grades third through fifth) designed to enhance their science inquiry instructional methods. Originally developed by Girls, Incorporated as an after school program for elementary-aged girls, the program evolved by taking the same instructional techniques used in the program and providing them to teachers as a staff development program (Girls, Inc., 2004).

Teaching SMART® is a prescribed professional development program, in terms of resources and programmatic activities, and is designed to be implemented over the course of three school years. A logic model for the Teaching SMART® professional development program (Table 2, Chapter 3), created by the developers of the program, consists of inputs into the program, the resources and activities that are prescribed by the developers, outputs that are expected to occur as a result of implementation, and then short-term and long-term outcomes for the teachers who participated in the program and their students. In the sustainability study, the Teaching SMART® logic model, presented and described in chapter two, served as the guiding framework. Specifically, the long-term teacher objectives are the focus of this study and are described below:

- Improved teaching: The concept of improved teaching consists of an increase in, or sustained high use of, student-centered learning activities (where students are actively engaged in their learning through experiments) or conversely, a decrease in, or sustained low use of, teacher-centered activities (i.e., teaching from a book and/or worksheets).
- Improved perceptions about the roles of females in science, technology, engineering, mathematics (STEM): As part of the Teaching SMART® professional development, equity-based teaching strategies are taught and reinforced during the three-year implementation to raise teachers' awareness of their own perceptions of females in STEM and provide techniques to facilitate equity in the classroom (i.e., using a random method for calling on students).
- Improved classroom management techniques: The Teaching SMART® professional development program emphasizes the use of roles or jobs by the students to ensure active involvement and the use of small cooperative learning groups where students investigate and solve problems in their groups while the teacher monitors behavior and provides guidance or feedback when needed.

The long-term teacher objectives are reflected in the evaluation questions and are addressed through analyses of teacher survey, interview and observational data.

Stages of Reform

As an educational reform program, Teaching SMART® is an innovation developed to create change in teachers' instructional practices through professional development. An innovation has been defined as a concept, idea, practice or object that is perceived to be new by an individual or other unit of adoption (Sherry, 2003). Rogers popularized the theory of diffusion of an innovation in the seminal work, *Diffusion of Innovations* (1962). Ellsworth (2000), in his review of educational change systems, refers to Rogers as one of the "elder statesmen" for change research (p. 1). As Rogers (1995) explained, "if the idea seems new to the individual, it is an innovation" (p. 11).

Diffusion of an innovation to users throughout a system occurs in three stages: initiation, implementation, and institutionalization. Initiation or adoption of an innovation by the users is the first stage. Rogers (1995) defined adoption as, "A decision to make full use of an innovation as the best course of action available, and rejection as a decision not to adopt an innovation" (p. 21).

Once initiated, the next stage of a reform or innovation is for it to be used, or implemented. Teacher SMART® was implemented in one Florida school district in the 2005 – 2006 school year for the prescribed three years, ending in June 2008. The program was implemented as part of a randomized controlled trial funded by the US Department of Education's Institute of Education Sciences' Teacher Quality Research program. The randomized controlled trial involved 10 elementary schools (specifically, grades three through five) as the treatment schools to implement the Teaching SMART® professional development, along with 10 business-as-usual schools that continued their normally scheduled professional development opportunities and served as the control schools. Teachers in the randomly selected treatment schools were asked to participate in the Teaching SMART® program and research activities associated with the randomized controlled trial. This study focused on the sustainability of Teaching SMART® practices by teachers who were part of the implementation during the randomized controlled trial.

The final stage of reform, institutionalism, was referred to as “reinvention” by Rogers (1995) who defined it as “the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation” (p. 174). In this study, the term sustainability was used in place of the terms institutionalism and reinvention. A more in-depth description and definition of the word sustainability is provided in Chapter Two.

Statement of the Problem

School reform programs focus on making educational changes; however, few innovations achieve the goal of becoming sustained or institutionalized by participants in the reform (Hargreaves & Goodson, 2006). The inability to make lasting changes in education past the implementation stage of a reform program has created a need for more research on how to “enhance sustainability of such programs after the initiatives end” (Florian, 2000, p. 1). The topic of sustainability of educational reform programs has become increasingly important at the national and local levels as stakeholders are left wondering how to continue a program after funding for implementation has ended.

Understanding how well a program is sustained once the implementation phase is over is an area of research that is being explored by researchers in education (e.g., Datnow, 2002; Hargreaves, 2002; Hargreaves & Goodson, 2006) and health care fields (e.g., Beery, Senter, Cheadle, Greenwald, Pearson, et al., 2005; Scheirer, 2005) using qualitative and mixed method approaches. Both health care and education researchers study the sustainability of programs that are funded for a cycle and expected to make lasting changes in the participants and recipients of the reform.

Researchers conducting sustainability research in education and health care have pointed out the need for additional research on this topic (e.g., Bobis, 2011; Coffey & Horner, 2012; Scheirer, 2005; Sindelar, Shearer, Yendol-Hoppy, & Liebert, 2006). Scheirer (2005) stated, “The growing literature on the general theme of what happens to projects after their initial funding ends has not yet coalesced into a single research paradigm, a shared set of statistical methods, or even a common terminology” (p. 321). Schierer’s (2005) review of research on health initiatives identified the need for further research on sustainability, especially in other fields, such as education, and a common lens to view program sustainability. Similarly, Coffey and Horner (2012) have called for empirical analyses in sustainability research. This sustainability study adds to the literature by answering the call for more research on sustainability and was informed by how researchers have defined sustainability, the common elements of sustainability, and factors that facilitate or create barriers to sustainability, as presented in Chapter Two. Most research is focused on documenting outcomes at the end of implementation of a reform, but the need for research on how practices are sustained through time, post-implementation, is well documented and imperative for scaling-up reforms found to have been effective at the end of the implementation phase.

Purpose of the Study

The purpose of this mixed method study was to determine what strategies and practices teachers sustained, modified, or discontinued five years post-implementation of an educational reform, in this case, Teaching SMART®, a professional development program that was implemented by elementary teachers over the course of three years and which ended in June 2008. This study built on a randomized controlled trial that sought to determine the efficacy of the intervention, Teaching SMART®, by using the third year of teacher survey data collected in 2008 as baseline data to measure changes in practices and strategies five years later (2013) for the participating teachers. All of the Teaching SMART® teachers who responded to the 2013 survey were asked to participate in an interview and observation of a science lesson to illustrate how and to determine to what degree, if any, there was evidence of sustainability of reform practices. Additionally, interviews with key informants, two school district administrators, were conducted to identify state, district, and school level policies and practices that have been implemented and the effect, if any, on sustainability of Teaching SMART® practices. Specifically, the sustainability study sought to determine if the long-term outcomes identified for teachers in the Teaching SMART® logic model are obtained. The three long-term outcomes for teachers are: improved teaching strategies, improved perceptions about the roles of females in STEM, and improved classroom management techniques. The long-term outcome "improved teaching strategies" consists of an increase in student-centered learning activities or conversely, a decrease in teacher-centered activities (see Definitions of Terms at the end of this chapter). Improved perceptions about the roles of females in STEM are part of equity-based instruction where teachers encourage all students to participate. Improved classroom management techniques include the use of roles or jobs for students and the assignment of students to small cooperative learning groups. Documentation of the extent to which the long-term outcomes are continued, modified, or discontinued by participating teachers, and obstacles and facilitators to sustainability identified by stakeholders provide empirical evidence to inform the field of education and build on what is known.

Research and Evaluation Questions

The following research and evaluation questions guided the sustainability study. These questions were addressed using mixed methods: qualitative interview data with district administrators and teachers as well as observational data from one of the interviewed teachers provided the data to answer the research questions and quantitative teacher survey data from 2008 and 2013 along with teacher and district administrator interview data were used to answer the evaluation questions. The following research questions provided an opportunity to address how and why sustainability occurred:

Research Question (RQ) 1: What do teachers who participated in Teaching SMART® (2005-2008) and district administrators share about the sustainability of Teaching SMART® practices in 2013?

a. What Teaching SMART® instructional practices are evident from an observation of a teacher's science lesson in 2013?

Three evaluation questions, with subparts, specifically addressed the long-term objectives detailed in the Teaching SMART® logic model, presented in Chapter Three:

Evaluation Question (EQ) 1: What teaching strategies do teachers who participated in the Teaching SMART® professional development program (2005-2008) utilize in their science classrooms five years post implementation (2013)?

a. Compared to 2008, is there an increased, decreased, or sustained use of student-centered learning activities in 2013?

b. Compared to 2008, is there an increased, decreased, or sustained use of teacher-centered learning activities in 2013?

EQ 2: What perceptions about the roles of females in science, technology, engineering and mathematics (STEM) do teachers who participated in the Teaching SMART® professional development program (2005-2008) have five years post implementation (2013)?

a. Compared to 2008, is there an increased, decreased, or sustained use of equity based teaching strategies in 2013?

EQ 3: What classroom management techniques do the teachers who participated in the Teaching SMART® professional development program (2005-2008) use five years post implementation in 2013?

a. Compared to 2008, is there an increased, decreased, or sustained use of the Teaching SMART® roles during lessons in 2013?

b. Compared to 2008, is there an increased, decreased, or sustained use of small, cooperative learning groups during lessons in 2013?

The main research question sought to document how and why sustainability occurred, if at all. A subset of three teachers who responded to the survey served as case study examples by participating in the qualitative research component. These case study teachers were interviewed and one was also observed teaching science. Additionally, two school district administrators from the participating school district were interviewed. The two district administrators were purposively selected to serve as key informants, that is, a person with specialized information on specific topics (Homburg, Klarmann, Reimann, & Schilike, 2012; Tremblay, 1957), because of their familiarity of the Teaching SMART® professional development program and their in-depth knowledge of state, district, and school level policies and practices as well as other contextual factors that may influence sustainability of a reform.

The three evaluation questions were developed based on the Teaching SMART® logic model's identified long-term teacher outcomes. These questions sought to determine the extent to which teachers who participated in the Teaching SMART® professional development program (2005-2008) have met the long-term objectives of improving teaching practices, perceptions about the roles of females in STEM, and classroom management techniques five years post implementation, in 2013. Quantitative analyses were conducted using survey data from 2008 and 2013. Group mean differences were calculated as well as individual teacher survey responses from 2008 were compared to 2013 to determine if change occurred at the individual level and was significant or not.

Together, the research and evaluation questions guiding the mixed method sustainability study addressed the purpose of the study and provided empirical evidence of what was sustained (or not) from a professional development reform program. This information added to the current body of knowledge on sustainability. Additionally, teacher interviews about their instructional practices and policy insight from the district administrators provided a deeper context for understanding how and why sustainability occurred, if at all.

Method of Study

To more fully understand if a reform was sustained and the processes and adaptations that occurred to encourage sustainability, it was important to conduct an empirical sustainability study. In this study, a mixed method approach was used for a number of reasons (Venkatesh, Brown, & Bala, 2013). Mixed methods allowed for complementary views about the same phenomena through the use of multiple data collection methods (teacher survey, district administrator interview, teacher interview, classroom observational data documented through field notes and forms). Mixed methods also helped to ensure as complete a picture as possible of what practices were sustained, or not, and how. The use of mixed methods allowed data to compensate for weaknesses inherit in one approach, such as the use of in-depth qualitative data to compensate for small sample sizes in the quantitative data. A mixed method approach also allowed data from one approach to confirm findings from the other approach.

Quantitative, teacher survey data, and qualitative, interview and observational data, were collected in the fifth year of sustainability of the Teaching SMART® professional development program during the 2012-2013 school year. Results from these data were compared to quantitative (teacher survey) data collected in May 2008, the end of the implementation phase of the Teaching SMART® program.

To allow comparison through time, all the teachers who participated in the Teaching SMART® professional development program in 2008 and met the inclusion criteria, described in Chapter Three, were invited to complete the same teacher survey in 2013 that they completed in 2008. Individual teacher responses from the 2013 administration of the survey were compared to their 2008 responses to determine if there was a change in means for specific factors of the survey using the reliable change index (RCI) as the statistical method (Jacobson & Truax, 1991). Group mean differences for participating by survey factors were analyzed using the *t*-test for paired observations. In addition, the *t*-test for paired observations was used to analyze group mean difference by survey factor for participants who received three years of Teaching SMART® or two years of the program. Some teachers participated in the full, three years of implementation (2005-2008) and are referred to as Alpha teachers while other teachers were added at the beginning of the second year of implementation and received two full years of the Teaching SMART® professional development program (2006-2008). These teachers are referred to as Beta teachers.

A subsample of teachers were identified for inclusion in the qualitative research, interviews and observations, based on the sample of Teaching SMART® teachers who completed the survey in 2013. All teachers who completed the 2013 survey were invited to participate. The subsample of teachers provided case study illustrations of how Teaching SMART® was being implemented in the classroom five years post-implementation and facilitated addressing the research question. Additionally, interviews with school district administrators on the influence of state, district, and school policies and practices were conducted to provide additional contextual information. The mixed method design provided data to address the research and evaluation questions while contributing empirical evidence on sustainability of a reform to the body of knowledge on reform sustainability.

Significance of the Study

Tracking intervention activities past the end of a funded implementation period to determine what is sustained is rarely done (Beery, Senter, Cheadle, Greenwald, Pearson, et al., 2005). A need for a common definition of sustainability and identification of indicators to measure sustainability is well established in the research literature in both health and education fields (Beery, Senter, Cheadle, Greenwald, Pearson, et al., 2005; Hargreaves & Goodson, 2006; Scheirer, 2005). The lack of a common definition and understanding of what reform sustainability is and looks like in practice inhibits communication among researchers, policy makers and practitioners and creates inconsistencies in research efforts; in short, there is a need for empirical research on sustainability factors (Sindelar, Shearer, Yendol-Hoppy, & Liebert, 2006). Prior research on facilitators and barriers to sustainability (Coburn, 2003; Datnow, 2002; Florian, 2000; Fullan, 2002; Hargreaves & Goodson, 2006; Scheirer, 2005) are presented in Chapter Two. The evaluation of the sustainability of Teaching SMART® professional development instructional practices using the Teaching SMART® logic model provided an example of what, if anything, was sustained in practice while documenting how modifications and adaptations were made in a specific reform.

Scope and Delimitations

The scope of the study was confined to the school district and the teachers who participated in the Teaching SMART® professional development program from 2005-2008 and who were still in the school district teaching science in grades 3-5 during the 2012-2013 school year.

A delimitation of the study was that students were not included. As part of the Teaching SMART® professional development program, the focus of the intervention was on teachers with students benefiting from the improved classroom practices. The Teaching SMART® logic model includes five long-term outcomes for students that mirror those for teachers. The exclusion of students from the sustainability study allowed a more focused look at how teachers have continued, modified, or discontinued use of practices and knowledge obtained from the Teaching SMART® professional development program.

Assumptions and Limitations

As a researcher in the randomized controlled trial efficacy study of the Teaching SMART® program, I possess an emic or insider perspective (Patton, 2002) of how the Teaching SMART® program was presented, supported and implemented during the three-year implementation phase. While my involvement in the efficacy study was as a researcher and external to the implementation, the experience of studying the implementation afforded me a solid foundation of understanding of the Teaching SMART® professional development program. My prior understanding of the intervention, while beneficial to understanding this specific intervention, may have influenced my choice of methods used and perception of the meaning of the data, which would not have been beneficial. Dellinger and Leech (2007) referred to this researcher bias as a foundation element in their validation framework. To address this potential bias, a systematic literature review was conducted to inform relevant elements of the research process, such as the district interview guide and construct identification.

An assumption that informed this study was that teachers who participated in the Teaching SMART® professional development program would choose aspects of the program to continue as prescribed by the developers, discontinue, or modify as needed to address the needs of their students and/or match their instructional style. Therefore, it was expected that Teaching SMART® teachers would not implement all of the programmatic features as prescribed by the Teaching SMART® developers. Instead, teachers would implement elements of the program in ways that address their individual needs and those of their students, or not at all.

It was also assumed that not all of the teachers who participated in the Teaching SMART® program remained in the school district and/or in their same teaching positions. The expectation was that some of the teachers would no longer be teaching science in grades three through five. Teacher attrition, or experimental mortality, is a common threat to internal validity in educational research as high rates of teacher turnover are common occurrences (Klugh & Borman, 2006). Experimental mortality is a threat because it may lead to differential loss of participants, that is, there may be a commonality among the participants who leave. To address this potential threat in this study, demographic characteristics of teachers who responded to the survey in 2008 and met the eligibility for inclusion in 2013 but did not respond to the survey in 2013 were compared to the teachers who responded in 2013 (Chapter Three, Table 4).

Another assumption that informed this study was that events may have occurred in the school district and/or schools that affected the sustainability of teacher practices. A potential threat to internal validity that stems from the passage of time is history, where events may occur in one or more treatment sites but not consistently across all sites. The use of qualitative interviews to retrospectively document the events that have occurred within the participating school district and schools from 2008 to 2013 does not stop this threat from occurring, but provides documentation to interpret the effects of events that may have occurred on sustainability of instructional practices.

Definitions of Terms

There are an abundance of terms used in educational reform sustainability research and professional development. The most common terms associated with this mixed method sustainability study are presented. They are defined as used in this study below.

Cooperative Learning

Cooperative learning is a teaching technique where students are in groups to investigate and solve problems (Johnson & Johnson, 1999). There are two main types of cooperative learning, group study and task specialization (Kyndt, Raes, Lismont, Timmers, Cascallar, & Dochy, 2013). In group study, all members learn together and have the same responsibilities, whereas in task specialization, each member is responsible for one part of the task. As a teaching technique, cooperative learning facilitates creating a community of learners where students have the opportunity to teach one another while also receiving instruction from the teacher (Conrad, 2012).

Culturally Responsive Classroom Management

Classroom management has been found to be one of the key factors to contribute to student success in school (Jones, Jones, & Vermette, 2013). Culturally Responsive Classroom Management (CRCM) is "a pedagogical approach that guides the management decisions that teachers make" (Metropolitan Center for Urban Education, 2008, p. 2). CRCM focuses on the management of classrooms in culturally competent ways. Specific management techniques include creating a physical setting that supports academic goals (i.e., desks arranged in clusters to allow students to work together); establishing expectations for behavior; creating a caring, inclusion classroom through cooperative learning activities; and communicating with families about expectations for classroom behavior (Weinstein, Curran, & Tomlinson-Clarke, 2003).

Equity-Based Instruction

The National Science Education Standards (National Research Council, 1996) stated all students, regardless of age, sex, cultural or ethnic background, disabilities, aspirations, or interest and motivation in science, should have the opportunity to attain high levels of scientific literacy. The National Research Council's *A Framework for K-12 Science Education* (2012) continued to promote equity-based instruction for science standards through inclusive instructional strategies. Inclusive instructional strategies encompass a range of techniques and approaches that build on students' interests and backgrounds so as to engage them more meaningfully and support them in sustained learning. A classroom environment that engages students in tasks that require social interaction, the use of scientific discourse, the application of science representations and tools are examples of inclusive strategies.

Hands-on Activities

Teachers provide students an opportunity to manipulate objects, through hands-on activities, as part of their instructional strategies. The National Research Council (1996) discouraged the use of hands-on activities unless teachers guide student-centered learning while manipulating objects. The National Research Council (1996) stated, "Hands-on activities are not enough- students also must have 'minds-on' experiences" (p. 20). The National Research Council's *A Framework for K-12 Science Education* (2012) cited the continued relevance of the teaching standards published in 1996.

Science Inquiry

The National Research Council (2011) characterized effective science instruction as follows:

> Effective instruction capitalizes on students' early interest and experiences, identifies and builds on what they know, and provides them with experiences to engage them in the practices of science and sustain their interest.

The definition provided by the National Research Council (1996) for inquiry is, "Inquiry refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world" (p. 23). When engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. Students identify their assumptions, use critical and logical thinking, and consider alternative explanations (National Research Council, 1996, 2012).

Student-centered Learning Activities

The National Research Council's (1996) Teaching Standard B stated, "Teachers of science guide and facilitate learning" (p. 32). To meet this standard, teachers support student learning by encouraging active learning through scientific inquiries where students are allowed to construct their own knowledge. The National Research Council (2012) identified the need for teachers to support student learning, "Without support, students may have difficulty finding meaning in their investigations…" (p. 255).

Sustainability

In this study, sustainability is defined as, "a continuation of classroom practices or other activities that have been implemented during the reform program's existence, and the decisions, actions, and policies by school and district leaders that support continuation" (Florian, 2000, p. 3). In Chapter Two, a review of the literature on how researchers have defined sustainability is provided with an explanation as to why this definition was used for this study.

Teacher-centered Activities

Teacher-centered activities are characterized by the National Research Council (1996) as:

> Teachers presenting information and covering science topics. The perceived need to include all the topics, vocabulary, and information in textbooks is in direct conflict with the central goal of having students learn scientific knowledge with understanding (p. 20-21).

The National Research Council (1996) stressed the importance of moving away from teacher-centered activities toward student-centered learning. The National Research Council (2012) further supported the importance of student-centered learning and highlighted the importance of using a range of instructional strategies to guide student inquiry.

Chapter Summary

This chapter described the current research environment for sustainability studies and presented the need for empirical studies. An overview of the sustainability study of a specific reform, the Teaching SMART® professional development program, was described along with the statement of the purpose, research and evaluation questions, and how they were addressed through the mixed method design

In Chapter Two, a review of the research literature on sustainability is provided. Specifically how sustainability has been defined, factors that have been found to enhance sustainability and obstacles to sustainability and the need for more research on these topics. An overview of literature on professional development and science instruction is also provided.

Chapter Three presents the methods used to conduct the sustainability study and address the research and evaluation questions. Chapter Four provides the findings from the data by research and evaluation questions. Themes from interview data and individual teacher case studies illustrate what Teaching SMART® practices have been continued, modified, or discontinued and what factors influenced their practice. Teacher survey findings are presented by evaluation question with qualitative data providing contextualization. Chapter Five provides a discussion of the findings and situates this sustainability study within the literature to add to the knowledge base.

CHAPTER TWO:

REVIEW OF THE LITERATURE

Evidence of a reform's sustainability is needed to document the efficacy of a reform in making change at the site of implementation (Coburn, 2003). One of the goals of reform is to move into new or larger populations (Bobis, 2011; Coburn, 2003). Moving small-scale initiatives that have shown positive outcomes for teachers and/or students to large-scale reform initiatives (scaling up) is a common trend in education. However, a major challenge for reform stakeholders is identifying which reforms are worthy for scaling up, that is, "the enactment of interventions whose efficacy has already been established in new contexts with the goal of producing similarly positive impacts in larger, frequently more diverse populations (Schneider & McDonald, 2007, p. 4)." According to Bobis (2011), "the ability to sustain and scale up programs of professional development remains key issues in educational reform and improvement" (p. 34). Understanding how professional development programs are sustained through time is critical for change to occur at the local implementation level, and provides evidence to determine if a program is viable for scaling-up at a regional or national level. In this chapter, a review of the literature on sustainability of reforms is presented. Next, background on professional development and science reform is provided. Last, an overview of prior research on outcomes from the Teaching SMART® professional development program is provided to situate what outcomes have been documented in the past and why this sustainability study is needed.

Literature Search Method

A broad search of the literature on reform sustainability, professional development, and instructional strategies was conducted using two main methods, using on-line databases and Google Scholar. On-line reference databases, such as academic search premier, JSTOR, ProQuest Dissertations, and Web of Science were searched using the one or more combinations of key words related to sustainability, professional development, and instructional strategies, such as institutionalism, routinization, education reform, and science inquiry. Google Scholar was used to search for articles, research reports, and other documents from related websites as well as to locate PDFs of references.

Sustainability

Moving a reform program from the implementation stage to the institutionalization or sustainability stage has become a priority in education as reform efforts and innovations fail to make change occur (Hargreaves, 2002). A growing body of research is focused on the sustainability of reform programs. However, there remains a lack of a common definition of sustainability and limited empirical research on factors that sustain a reform (Sindelar, Shearer, Yendol-Hoppey, & Liebert, 2006). Due to the need for more research on how sustainability has been defined by researchers and the factors that sustain or inhibit reform, a review of literature on these topics was conducted to document what is known, identify areas in need of more research and how this study addressed some of those areas. Table 1 organized the literature review information by including the reference source (author(s) and year), the definition of sustainability, facilitating factors, and obstacles to sustainability. Not applicable (N/A) was used in the table if the reference did not provide that information.

Table 1

Definitions of, Facilitating Factors for, and Obstacles to Sustainability

Source	Definition	Facilitating Factors	Obstacles
Bassett, P. F. (2005)	To keep up, prolong.	1) Financially (becoming more efficient and less costly), 2) Environmentally (becoming more green and less wasteful), 3) Globally (becoming more networked internationally and less parochial), 4). Programmatically (more focused on skills and values of the marketplace and less on traditional disciplines approach to teaching and learning), and 5) Demographically (becoming more inclusive and representative of the school-age population.	N/A
Beery, W. L., Senter, S., et al. (2005)	The continuation of community health or quality-of-life benefits over time.	1) Resources, 2) Staffing, 3) Defining a role for partnership, and 4) Devising ways to ensure continuation of policy and systems changes.	N/A
Benz, M. R., Lindstrom, L., Unruh, D., & Waintrup, M. (2004)	Sustainability is the end result of several stages of development that require both the innovation and the school to adapt to one another through a process the literature calls mutual adaptation.	School and community context: 1) Existing and emerging school policies and practices, 2) administrative leadership including constancy and stability in leadership personnel, 3) Economic climate. Program characteristics: 1) Services associated with the innovation, 2) Effectiveness of the program on students, and 3) Actual costs and benefits of the program.	N/A

Table 1

(Continued)

Coburn, C. E. (2003)	N/A	1) Supportive professional community of colleagues in the school that reinforces normative changes and provided continuing opportunities to learn, 2) Knowledgeable and supportive school leadership, 3) Connections with other schools or teachers engaged in similar reforms, and 4) Normative coherence or alignment between the district policy context and the reform.	1) Competing priorities, 2) Changing demands, and 3) Teacher and administrator turnover.
Datnow, A. (2002)	A taken-for-granted feature of life in a school.	1) Genuine interest in change, 2) Teacher and administrator support, 3) A critical mass involved in implementation, 4) Sustained professional development, 5) A practical plan for implementation and monitoring of the change effort.	1) Absence of the factors, 2) Presence of competing reforms, 3) Instability of leadership.
Elias, M. J., Zins, J. E., et al. (2003)	N/A	1) Change did not take place unless issues related to poverty, racism, and single-parent families were addressed clearly and strongly.	1) Turnover, 2) Short term goals favored instead of long term, 3) Interventions not delivered as planned, 4) Operating theory of learning not explicated, and 5) Management, resources, and organization requirements are underestimated.

Table 1

(Continued)

Florian, J. (2000)	A continuation of classroom practices or other activities that have been implemented during the reform program's existence, and the decisions, actions and policies by school and district leaders that support that continuation.	1) Methods or practices that teachers experienced as effective in accomplishing school goals, 2) School principals who effectively promoted, supported and managed change, 3) Political support for new practices from district and, if possible, state levels, 4) Continual high quality PD and/or assistance for staff, 5) Active recruitment for highly qualified faculty..	N/A
Fullan, M. (2002)	N/A	1) Opportunity and depth of learning, 2) Policies for individual development, 3) Learning in context and systemness, 4) Leadership succession and leaders at many levels, 5) Improving the teaching profession.	N/A
Hargreaves, A. (2002)	Improvement over time, within available or achievable resources that does not impact negatively on the surrounding environment and that promotes ecological diversity and capacity more widely.	N/A	N/A

Table 1

(Continued)

Hargreaves, A., & Fink, D. (2003)	Sustainability does not simply mean whether something can last. It addresses how particular initiatives can be developed without compromising the development of others in the surrounding environment, now and in the future.	1) Improvement that fosters learning not altering schooling, 2) Improvement that endures over time, 3) Can be supported by available and obtainable resources, 4) does not negatively affect the surrounding environment of other schools and systems, and 5) promotes ecological diversity and capacity throughout the educational and community environment.	1) Changes in leadership.
Hargreaves, A. & Goodson, I. (2006)	Environmental sustainability…on sustainable development, in which development meets the needs of the present without compromising the ability of future generations to meet their own needs.	N/A	1) Waves of policy reform, 2) Changes in leadership, 3) Changing teacher demographics, 4) Shifting student and community demographics, 5) Changing patterns of relations among schools.
Lawrenz,F. Keiser, N., Lavoie, B. (2003)	The ability to prolong or to supply with sustenance.	1) Collaboration: critical because collaborators provide the support necessary for sustaining the innovation, 2) Program improvement, numbers of students in a program are strong indicators of a program's sustainability, 3) Professional development, 4) The development of multi-year plans which outline the process for sustaining the innovation.	N/A

Table 1

(Continued)

Lewis-Spector, J., Richardson, J. S., Janusheva, V. (2011)	An ongoing change process, not an outcome after funding ends.	1) Aligned/integrated with education goals; 2) Sense of ownership by school-based stakeholders and the community, 3) Funding available through external sources, 4) need for program evident by stakeholders.	1) Lack of support by director limited interaction among stakeholders creating "separate silos", 2) Lack of support for teachers to continue attending workshops, 3) External funding not provided; 4) Economic environment changed at program end in 2008, 5) Teacher turnover
Sarriot, E., Winch, P., et al. (2004)	N/A	1) Project design and implementation, 2) Organizational setting, and 3) Community environment.	N/A
Scheirer, M. A. (2005)	Measuring health benefits for individuals after the initial program funding ends.	1) Program is modifiable over time, 2) Key roles of a program champion, 3) Substantial fit with the underlying organizations mission and procedures, 4) Benefits to staff members and/or clients that are readily perceived, 5) Importance of support from other stakeholders in the community.	N/A
Sindelar, P. et al. (2006)	N/A	N/A	1) Changes in leadership, 2) Teacher turnover, 3) Shift in district and state priorities, 4) Reduced resources.

Table 1

(Continued)

Taylor, J. E. (2009)	1) Sustained reform relationship is defined as a continuing formal relationship between a school and several external entities; 2) Sustained implementation of a reform is defined as consistently high levels of fidelity to the practices of a reform program over the years.	1) High local school capacity, 2) Supportive community context, 3) Sufficient funding, 4) Positive student outcomes, 5) Fit or alignment between reform design and the school, 6) Instructional leadership stability, 7) Faculty retention, 8) Faculty commitment, 9) Practical concrete reform specifications, 10) Sustained professional development, 11) Protection from competing reforms.	N/A
Zech, L. K., Gause-Vega, C. L., et al. (2000)	N/A	1) A growing reliance on the examination of evidence in discerning students' understanding of content, 2) Seeking out, and learning from multiple perspectives, and 3) Viewing expertise as emerging from the group's shared inquiry and conclusions.	1) Access to resources that substitute for the important role that the facilitators currently play.

Defining Sustainability

A review of the literature related to sustainability of a reform revealed the lack of an accepted, or common, definition. Scheirer (2005) found in her systematic review of empirical literature on sustainability of health-related projects that "only a few studies provided explicit operational definitions of what was meant by sustainability" (p. 334). When definitions are included, researchers provided an operational definition of sustainability that typically highlighted characteristics (Table 1 Definitions of, Facilitating Factors for, and Obstacles to Sustainability).

Common characteristics of sustainability included the following: lasts through time (Berry, Senter, Cheadle, Greenwald, Pearson, et al., 2005; Florian, 2000; Hargreaves, 2002); uses available resources (Florian, 2000; Hargreaves, 2002); becomes a "taken-for-granted" feature (Datnow, 2002, p. 224); and involves development without compromising development of others in the environment (Hargreaves & Fink, 2003). Because sustained reform has meant different things in the literature, an examination of definitions used in the research literature is provided and how this study defines sustainability, and why, is provided.

In this study, Florian's (2000) definition of sustainability of an education reform was used because of its inclusion of overlapping characteristics cited by other researchers, such as the continuation of reform practices and the actions of stakeholders to support that continuation. Florian (2000) defined sustainability as "a continuation of classroom practices or other activities that have been implemented during the reform program's existence, and the decisions, actions, and policies by school and district leaders that support continuation" (p. 3). In other words, in this study, how Teaching SMART® teachers continued their implementation of practices learned from the Teaching SMART® professional development program and the perceived support to continue the practices from school and district leaders.

This definition of sustainability taps into some of the common characteristics of sustainability identified by other researchers, indicated above, such as practices last through time. Florian (2000) clarified that for a practice to be deemed "sustained" it would have to continue after the reform has ended (p. 4). The timeline for when a practice is determined sustained has varied from the first year of implementation to more than 15 years; however, most empirical sustainability studies are conducted at the end of the funding period (Savaya, Elsworth, & Rogers, 2009). There is a need for empirical research on sustainability of reform practices past the first year when implementation of the reform ends (Taylor, 2009). This empirical study addressed the need by focusing on sustainability of reform practices five years post-implementation.

The definition of sustainability that was used in this study also includes mechanisms to support continuation of a practice, through decisions, actions and policies. Datnow (2002) found that "schools sustained reform when there was political support" for the reform practices (p. 224). Coburn (2003) agreed stating, "Teachers are better able to sustain change when there are mechanisms in place at multiple levels of the system to support their efforts" (p. 6). While Florian (2000), in her qualitative study involving interviews with staff involved in the reform from four districts nine years after the reform's beginning, listed school and district leaders as important actors for providing support. Coburn (2003), in her review of theoretical and empirical research on scaling up, reform implementation, and sustainability, included a supportive professional community of colleagues, such as other teachers, as important actors to implementing the reform practices in addition school and district leaders as identified in

Florian's (2000) study. In this study, the inclusion of district administrators who were knowledgeable about the reform, Teaching SMART®, as well as policies that have been enacted post-implementation of the reform program addressed the need for research to document influences on sustainability at multiple levels, state, district, and school.

Another definition of sustainability that stemmed from ecological and environmental research was reported in the literature. Hargreaves (2002) defined sustainability as "involving improvement over time, within available or achievable resources that does not impact negatively on the surrounding environment and that promotes ecological diversity and capacity more widely" (p. 189). Hargreaves's definition of reform sustainability resonates with the definition for sustainable development that emerged in 1987 from the Brundtland Commission of the United Nations, "Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future" (United National General Assembly, 1987, p. 39). Hargreaves and Fink (2003) continued to link the concept of reform sustainability to sustainable development stating, "Sustainability does not simply mean whether something can last. It addresses how particular initiatives can be developed without compromising the development of others in the surrounding environment, now and in the future" (p. 694). Hargreaves and Fink (2003) claimed that most common definitions of sustainability trivialize the concept of sustainability while their definition offers a deeper meaning by getting in tune with the ecological origins of the concept. Hargreaves and Goodson (2006) explained that the key principles for sustainability appear to focus "on what matters, that makes improvement last and spread, and that achieves its ends without doing harm to others around it" (p. 35). Hargreaves (2002) and colleagues' (Hargreaves & Fink, 2003; Hargreaves & Goodson, 2006) inclusion of ecological considerations in the definition of reform program sustainability adds to the body of literature and should be considered in future work. The definition of sustainability used in this study, as proposed by Florian (2000), does not include reference to the ecological notion of sustainability that Hargreaves (2002) introduced in his definition of sustainability. The focus on the ecological aspects of sustainability, as described in Hargreaves (2002) definition did not align with this study's purpose. Lawrenz, Keiser, and Lavoie (2003) provided this summary, "Sustainability can be simply defined as the ability to prolong or to supply with sustenance, but the issues surrounding sustainability are complex. It can take many forms but, in general, implies that the valuable portions of a new project will be supported and therefore continued in some form" (p. 48). Florian's (2000) definition allowed for the documentation of what practices have been continued, modified, or discontinued while determining how and why.

As found in the literature review, the definition of sustainability used by researchers is either not provided or focuses on a variety of characteristics. By identifying and using an existing definition, this study adds to the literature through documentation of findings using this definition. Factors that enhance sustainability or create obstacles to sustainability were identified in the literature review and are described below along with how this study built on this information.

Factors that Enhance Sustainability

Researchers have identified a large number of factors that enhance the sustainability of a reform (Table 1 Definitions of, Facilitating Factors for, and Obstacles to Sustainability); however, not enough is known about what makes programs sustainable (Savaya, Elsworth, & Rogers, 2009). Scheirer (2005) cautioned that the factors that support sustainability are variable by site and program due to the contexts in which the programs are implemented making it difficult to develop a "how to do it" guide (p. 325). Identifying common factors and investigating them in different empirical studies with different programs and populations adds to the body of knowledge on what it takes to increase sustainability. The facilitating factors presented in this section are the most commonly cited in the literature. Factors identified to facilitate sustainability presented in Table 1 were grouped into three overarching categories of the most commonly reported factors found in the review of literature. The three categories are: support from leadership and stakeholders, having a plan for sustainability in the implementation plan, and ongoing professional development or learning opportunities. The three categories of factors that enhance sustainability identified in the literature review are presented next.

Support from leadership and stakeholders. Within a school, support from fellow teacher colleagues and school administrators who are knowledgeable about the program and can effectively promote and manage change have been identified as crucial for program sustainability (Coburn, 2003; Datnow, 2002; Florian, 2000). In Datnow's (2002) qualitative, longitudinal study involving 13 elementary schools in a large, urban school district that implemented an externally developed school reform program, she found that "in the schools that sustained reforms, there was more likely to be continuity of leadership, commitment to the reform among key stakeholders, and the reform was an obvious feature of the structure and culture of the school" (p. 228). Having a commitment from school leadership and faculty facilitates reform sustainability. But, what does commitment from these stakeholders entail to support reform sustainability?

Coburn (2003) found in her review of theoretical and empirical research on scale and sustainability that "teachers are better able to sustain change when there are mechanisms in place at multiple levels of the system to support their efforts" (p. 6). Scheirir (2005) identified in her literature review of the sustainability of health-related projects the importance of a program champion, that is, someone who has "influence on, or control over, day-to-day program activities" (p. 339). The program champion is an advocate for the needs of the program to ensure success, such as finding funding or resources to facilitate continuation.

Outside the school site, political support for new practices from the school district and, if possible, state levels support sustainability of programmatic change (Florian, 2000). Studies included in Florian's analysis of the literature (2000) found that school districts supported sustainability of reform practices by "creating new positions and restructuring responsibilities of existing positions, establishing new committees, modifying hiring practices, and changing funding allocations during or after the initiative" (p. 18). Scheirer (2005), in her review of empirical studies of program sustainability identified the importance of support from other stakeholders in the community specifically as it concerned securing funding to support reform efforts or in-kind resources from organizations outside of the place of implementation. The majority of the studies identified in Scheirer's literature review (2005) emphasized the importance of identifying funding from other sources with the exception of two studies. According to Scheirer (2005), these two studies (O'Loughlin, Renaud, Richard, Sanchez-Gomez, & Paradis, 1998; Scheirer, 1990) "both found that the actual availability of new funding was not a predictor of sustainability but that funding was perceived by respondents to be very important to continuation" (p. 339). Lawrence, Keiser, and Lavoie (2003), when looking at sustainability of reform from 113 projects that were funded by the National Science Foundation's advanced technological education (ATE) program within community colleges using a sequential, nested, mixed method design consisting of survey data from all the projects followed by in-depth qualitative data at a subset of 13 projects, agreed with Scheirer's (2005) findings that continuation of reform practices were supported by external funding sources. However, the authors highlighted the importance of internal funding. Lawrence, Keiser, and Lavoie (2003) stated that the use of “internal funding could mean that more money is made available or that priorities are shifted within existing funding levels” (p. 48). To support sustainability, school and district leaders have to be able to shift funds within a school as reform priorities change as well as find external sources of funding. However, more research on what support from leadership looks like at the state, district, and school level is needed as well as what contextual external and internal conditions influence sustainability of practice.

Implementation and sustainability plan. Having a practical plan for implementation and monitoring of a reform is essential to not only implementing program, but also sustaining change through time (Datnow, 2002). Lawrenz, Keiser, and Lavoie (2003) stated, "in order to help achieve sustainability, we suggest the development of multi-year plans which outline the process for sustaining the innovation" (p. 60). Implementation and sustainability plans need to allow the program to be modifiable over time (Scheirer, 2005) as policies, leadership and systems change (Berry, Senter, Cheadle, Greenwald, Pearson, et al., 2005). Shifting policies and changes in leadership are obstacles to sustainability as identified in the literature. Having a plan that aligns with the district policy context (Coburn, 2003) as well as the underlying organization’s mission and procedures will facilitate sustainability (Scheirer, 2005) in face of these obstacles. Further research is needed on how sustainability plan are created and used, and to what extent. This information was collected in qualitative interviews in this study.

Ongoing professional development. To facilitate ongoing use of reform practices in the classroom, teachers benefited from participating in sustained professional development (Datnow, 2002). Coburn (2003) stressed the importance of teachers having “a deep understanding of the pedagogical principles of a reform" in order to respond to new demands and changing contexts in ways that are consistent with the reform (p. 6). Having continual opportunities to learn supports growth in understanding of reform principles and practices through time (Coburn, 2003; Florian, 2000; Fullan, 2002). Obtaining a deep understanding of reform principles, especially if those principles counter current practice, takes time and dedication.

A supportive professional community in the school reinforces new ideas and changing of practices in alignment with the reform principles (Coburn, 2003; Florian, 2000). An engaged, professional community supports ongoing growth in pedagogy by providing continual opportunities to learn through mentoring and/or expert coaching (Fullan, 2002). As new staff members join the professional community, professional development and support from their colleagues can ameliorate the negative influence of teacher turnover on sustaining reform practices. Florian (2000) points out that as positive outcomes are observed as a result of using reform practices, sustainability of those practices occurs.

Obstacles to Sustainability

Three main types of obstacles to successful sustainability of a reform were identified from the literature review and are presented in table 1 (Definitions of, Facilitating Factors for, and Obstacles to Sustainability). The three identified obstacles are: changes in leadership and teacher turnover, shifting reform priorities, and inadequate resources.

Changes in leadership and teacher turnover. Continuity of leadership facilitates sustainability of school reforms (Datnow, 2002); however, changes in school leadership are common. To support strong leadership at a school is the practice of distributed leadership, that is, leadership that is comprised of a network of people both within and outside the school.

Distributed leadership allows for changes in administrators and teacher turnover without disrupting growth and sustainability of programs at the local school level. Hargreaves and Fink (2003) stated, "Sustainable leadership outlives particular individuals" (p. 697). In schools with individual leaders, change of personnel at the administrative and instructional levels can pose a major obstacle to sustainability at the school. Hargreaves and Fink (2003) summed up, "…changes in leadership always pose a threat to sustainable improvement" (p. 697). One reason that leadership change creates obstacles for reform sustainability is that with the new leader come new ideas and knowledge, and typically, a lack of embracement of current practice.

Hargreaves and Goodson (2006), found from their project, Change Over Time?, that used qualitative interviews, observations, and archival data from teachers and administrators at eight high schools, that poor leadership succession, in terms of supporting reform efforts while bringing in new ideas, stems from the type of knowledge principals use during the succession process. Hargreaves and Goodson identified three types of knowledge (2006):

> *Inbound knowledge*, is the knowledge of leadership or a particular school that is needed to change it, make one's mark on it, or turn it around. *Insider knowledge* is the knowledge one gains from and exercises with other members of the community after becoming known, trusted, and accepted by them. *Outbound knowledge* is the knowledge needed to preserve past successes, keep improvement going, and leave a legacy after one has left (p. 19, original italics).

In the eight schools included in their qualitative study, Hargreaves and Goodson (2006) found that inbound knowledge dominated. Principals entered schools with the goal of initiating and imposing changes. Few principals in Hargreaves and Goodson's Change Over Time? study (2006) stayed long enough to gain insider knowledge. However, three of the schools fostered outbound knowledge by identifying a successor, an assistant principal. Overall, Hargreaves and Goodson (2006) found that sustainability of school improvement efforts was undermined by "extensive emphasis on the inbound knowledge of leadership at the expense of equally important outbound concerns" (p. 20). In school districts where principals are procedurally rotated, sustainability of classroom-specific strategies may suffer (Sindelar, Shearer, Yendol-Hoppey, & Liebert, 2006). Fullan (2002) pointed out that identifying strategies and planning for successful succession of leaders at a school is a "neglected topic in research, policy, and practice" (p. 17).

In tandem with changes in school leadership, teacher turnover was also detrimental to the sustainability of a reform. Teachers are the main change agents in a school improvement reform. Coburn (2003) stated:

> At the classroom level, teachers with have a deep understanding of the pedagogical principles of a reform are better able to respond to new demands and changing contexts in ways that are consistent with underlying principles of reform, thus sustaining and, at times, deepening reform over time (p. 6).

Supporting teachers by providing a professional community of colleagues and knowledgeable leadership will facilitate teachers to better sustain change in spite of changing demands (Coburn, 2003). However, teacher turnover undermines sustainability due to the possibility of a lack of understanding and acceptance of reform principles by incoming staff (Sindelar, Shearer, Yendol-Hoppy, & Liebert, 2006). Sindelar, Shearer, Yendol-Hoppy, and Liebert (2006) found in their qualitative case study of inclusive school reform with teachers, administrators, and staff that as staff departed during the implementation of the program the commitment to the reform program diminished with the addition of new staff. Staff turnover "impairs the ability of organizations to develop the knowledge base" (Elias, Zins, Gracyk, & Weissberg, 2003, p. 309) and sustain knowledge through time.

Shifting reform priorities. Schools are subjected to an onslaught of reforms that are deemed essential during a specific time period. For instance, the 1980s marked the beginning of the standards-based movement with the publication of *A Nation at Risk* (1983) by the National Commission on Excellence in Education. This publication labeled American schools complacent and mediocre and called for the need to have higher standards for teachers and students. Hargreaves and Goodson (2006) pointed out that "waves of reform are experienced by teachers are not only cumulative but also as contradictory" (p. 18). One example was the increase in the use of portfolio assessments while high stakes testing was being mandated. Hargreaves and Goodson (2006) found that almost all teachers in their qualitative study thought "these contractions enervating and exasperating, and their commitment to change weakened as their inventiveness was eventually overcome and their energy could no longer be sustained" (p. 18). Scheirer's review of the literature (2005) found that studies that emphasized "fit" of the new program within the existing organizational mission or standard procedures were more likely to receive internal support (p. 339). Internal support, or "buy-in," by stakeholders "is critical to sustaining efforts" (Sarriot, Winch, Ryan, Edison, Bowie, et al., 2004, p. 12).

Alignment between the policy context and the reform is essential for teachers to sustain change when reform priorities shift through time (Coburn, 2003). Competing reforms serve as obstacles for sustainability as teachers are forced to make adaptions to or discontinue reform implementation to comply with state and district policies (Datnow, 2002). In Sindelar, Shearer, Yendol-Hoppy, and Liebert's (2006) case study of inclusive school reform, teachers reported feeling pressure to prepare their students for the state assessment test. The authors found that teachers on longstanding teams were least likely to report changes to their instruction, while newly constructed teams of teachers were more heavily influenced by the pressure and adopted state-developed practice materials. This finding by Sindelar, Shearer, Yendol-Hoppy, and Liebert (2006) highlighted the importance of reducing teacher turnover to allow for longstanding teams of teachers to develop in order to respond appropriately to changes in reform. Alignment among policies at the state, district and school levels facilitates sustainability of practices by producing a supportive policy context for reform. Research on sustainability needs to include information on the policy context to provide further information on how to facilitate alignment and the impact of different policies on sustainability of practice. This study adds to the knowledge base through qualitative interviews that explore the impact of policy on reform practices.

Inadequate resources. Another common obstacle to sustainability is having inadequate resources to continue the implementation of practice. Reform programs are often funded for a limited number of years with a budget supporting the implementation phase. In the case of the Teaching SMART® professional development program, funds were available for three years of implementation; however, as is often the case, once the funding period ended, so did the money. Elias, Zins, Gracyk, and Weissberg (2003) noted that management of resources is often neglected at the early planning stages and underestimated to continue a reform past implementation. Elias et al. (2003) pointed out that new sources of funds for resources to sustain practices are “harder to create because the context of excitement, attention, resources, and professional rewards is often quite different” compared to the adoption and implementation stage (p. 313). Further research on sustainability over time is needed, as “most investigations of educational change are based on snapshots of early implementation” (Hargreaves & Goodson, 2006, p. 5) and not on sustaining change over time.

For classroom-based reforms, teachers need access to resources that played important roles during the implementation phase to sustain practices (Zech, Gause-Vega, et al., 2000). These resources include not only physical materials but human resources as well such as facilitators or specialists hired to support the reform during the implementation phase. To be self-sustaining, overcoming reduced resources at the end of the implementation phase by planning early on for sustainability is needed.

Sindelar, Shearer, Yendol-Hoppy, and Liebert (2006) stated that the reduction of resources for sustainability is a "by-product" resulting from three main factors that they found to be obstacles to sustainability: "changes in leadership, teacher turnover, and shifts in district and state priorities" (p. 325). Datnow's (2002) qualitative, longitudinal research showed that "reform sustainability does not result from individuals or institutions acting in isolation from one another" (p. 232-233). States, districts, schools, and classrooms, "all interact to shape the adaptability and longevity of reform" (Datnow, 2002, p. 232-233). Reinforcing a context for reform sustainability takes action on all levels, within the school with leadership and teachers, and at the district and state levels to promote alignment of reform. There is a need for further research on sustainability to identify and relate external contextual issues to internal behaviors in schools (Datnow, 2005) and through time. This study's qualitative data focused on identifying internal and external factors and they influenced sustainability of teachers' practices.

In the next section, literature on professional development reform is presented. This review focuses on best practices to change teacher practice to make lasting pedagogical changes.

Professional Development Reform

In order for successful professional development to occur and educational reform to last through time, there is a need for teachers to modify their teaching practices and develop new expectations for student outcomes within the context of reform. Darling-Hammond and McLaughlin (1995) stated,

> the success of this agenda ultimately depends on teachers' success in accomplishing the serious and difficult tasks of *learning* the skills and perspectives assumed by new visions of practice and *unlearning* the practices and beliefs about students and instruction that have dominated their professional lives to date (p. 597).

In other words, professional development for teachers needs to involve them as learners and provide teachers with an environment and support system where this learning can continue to take place. Science-specific induction, mentoring, and ongoing professional development are needed to support teachers (National Research Council, 2012). Sustained learning opportunities, such as those provided through regular study groups, observing others and being observed, coaching or mentoring and immersion into inquiry are the types of professional development activities that are more likely to create change (Earley, 2010).

Fragmented, one-shot workshops where participants listen passively rarely change behavior (Darling-Hammond, 1996; Earley, 2010). Flint, Zisook, and Fisher (2011, p. 1163) commented that one-day workshop with "train the trainer" models are still the most common forms of professional development being offered by school districts across the US. Research has demonstrated that collaborative professional development opportunities that are learning centered facilitates growth and change in teacher practice (Darling-Hammond, 1996; Flint, Zisook, & Fisher, 2011; Kuipers, Houtveen, & Wubbels, 2010; Semadeni, 2009). According to the National Center for Education Statistics (NCES) 2001 report, *Teacher Preparation and Professional Development: 2000*, teachers associate increased time spent in professional development and collaborative activities with the perception of significant improvements in teaching (US Department of Education, 2001). Specifically, teachers who participated in weekly scheduled collaborative opportunities with other teachers were four times more likely to report that participation improved their teaching than were those who only participated occasionally (45% versus 7%). According to the U.S. Department of Education (2001), teachers continue to participate in professional development opportunities that last fewer than eight hours, despite consistently reporting that professional development with a longer duration is more effective.

Professional development models that enable teachers to learn and use new knowledge enhance effective teaching that not only produces positive changes in teachers' attitude toward the subjects they are teaching but also translates into student success (Kuipers, Houtveen, & Wubbels, 2010). The main conclusion drawn from Joyce and Showers' (2002) research was that professional development that provided opportunity for teachers to understand the theory underlying the reform practices, demonstration by the professional development leaders so that teachers could see how the practices are implemented, practice with the new practices in a safe setting, such as in a workshop with their colleagues, and peer coaching "is needed to guarantee transfer of the recently acquired teacher skills into the classroom" (p. 77). According to Earley (2010), "Joyce and Showers' (2002) research showed that, without an opportunity for feedback and coaching, there is no measureable impact on classroom practice" (p. 211). The National Research Council in 2012 has maintained their position on the importance of on-going professional development that included the experiences identified in 1996 (National Research Council, 1996). In 1996, the National Research Council stated, "If reform is to be accomplished, professional development must include experiences that engage prospective and practicing teachers in active learning that builds their knowledge, understanding, and ability" (p. 56). Researchers agree; ongoing professional development of teachers is critical to school reform success (Darling-Hammond, 1996; Flint, Zisook, and Fisher, 2011; Kuipers, Houtveen, Wubbels, 2010; Semadeni, 2009).

This sustainability study looked at the reform success as measured by teacher surveys to determine what, if any, instructional practices learned from a three-year intensive professional development program, Teaching SMART®, have been continued. The Teaching SMART® professional development program is described in detail in Chapter Three. While best practices of professional development have not changed since the standards in 1996 were published, science content reform has occurred. In the following section, an overview of the current context of science reform is described.

Science Reform

Recommendations for science education have stressed inquiry-based methods of teaching science since the early 1990s (American Association for the Advancement of Science, 1990, 1993; National Research Council, 2000) and continues with the National Research Council's, *A Framework for K-12 Science Education* (2012). The National Research Council (2012) identified three areas to focus on as part of their vision to move science education toward coherency, that is, away for "long lists of detailed and disconnected facts" (p. 10). The three areas are National Research Council (2012):

1) Learning as a developmental progression. Students continually build on and revise their knowledge and abilities, the goal is to guide students' knowledge toward a more scientifically based and coherent view of the sciences and engineering;
2) Offer a limited number of core ideas in science and engineering to avoid shallow coverage of a large number of topic to allow time for teachers and students to explore each idea in greater depth; and
3) Integration of content knowledge and the practices needed to engage in scientific inquiry and engineering design (p. 11).

To be effective, teachers need content knowledge and expertise in teaching science content, but the research suggests that science and mathematics teachers are particularly underprepared for these demands (National Research Council, 2011). The lack of preparation is reflected in a lack of comfort by teachers in teaching the required content. Using the criterion of whether at least 75 percent of teachers reported feeling comfortable teaching the major topics in the middle school curriculum, one survey found that no topic met that criterion (National Research Council, 2011). Elementary teachers are often uncomfortable teaching science, partly due to their lack of scientific knowledge and concomitant lack of facility with teaching practices (Atwood & Atwood, 1996; Cobern & Loving, 2002; Kelly & Staver, 2004). Inquiry-based methods of teaching science require a high level of science content knowledge, as well as comfort with the challenges that come with guiding students toward important concepts and procedures. Teachers who are uncomfortable with the dual demands of rich content knowledge and inquiry-based methods of teaching will likely pass on their discomfort to their students, or avoid teaching science altogether. Further research on not only why teacher's report feeling uncomfortable with science teaching but strategies on how to alleviate this issue is needed.

The National Research Council's Center for Science, Mathematics, and Engineering Education in Washington, D.C., emphasized the goal of science instruction, at all grade levels, should be to focus on content selection and an inquiry approach to teaching that develops the ability to think critically and gives a deep understanding of content (Pratt & Hackett, 1998, National Research Council, 2011). Specifically, the National Research Council (2011) characterized effective science instruction as follows:

> Effective instruction capitalizes on students' early interest and experiences, identifies and builds on what they know, and provides them with experiences to engage them in the practices of science and sustain their interest.

This description of effective instruction is consistent with the vision that inspired the conceptual framework for new science education standards (National Research Council, 2012). The

National Science Education Standards (NSES) have guided most aspects of teaching and learning since 1996. According to the NSES (National Research Council, 1996),

> The *Standards* call for more than "science as process," in which students learn such skills as observing, inferring, and experimenting. Inquiry is central to science learning. When engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way, students actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills (p. 2).

The Next Generation of Science Standards is intended to redefine science education for students in the states that choose to adopt them (Cardno, 2013). The Next Generation of Science Standards developed out of the *Framework for K-12 Science Education* (National Research Council, 2012). The focus on updating the 1996 National Science Education Standards emerged as states were adopting common standards for English language arts and mathematics, Common Core standards, in 2010. In concert with the development of the Common Core standards, a state-by-state review of science standards (Finn, & Porter-Magee, 2012) found that by 2005 every state except Iowa had articulated K-12 science standards, however, the standards were rated overall mediocre on basis of content, rigor, clarity, and specification. Subsequent to the state review in 2005, Iowa developed their state science standards. Findings from this review showed that science standards varied state-by-state and were of low quality.

The Next Generation Science Standards (2013), as presented in the *Framework* (National Research Council, 2012, p. 30), identified eight practices that are essential for students to learn:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data

5. Using mathematics and computational thinking

6. Constructing explanations (for science) and designing solutions (for engineering)

7. Engaging in argument from evidence

8. Obtaining, evaluating, and communicating information

It is important to note that the term “practices” is used instead of “science process” or “inquiry” in the Next Generation Science Standards (Next Generation Science Standards, 2013; National Research Council, 2012). Students need to not only know science concepts but also use their understanding to investigate the natural world through the practices of science inquiry (Next Generation Science Standards, 2013).

The Next Generation of Science Standards was released in 2013 (Next Generation of Science Standards, 2013) and, to date, only eight states and the District of Columbia have adopted it (Heitin, 2014). Heitin (2014) suggested that the slow adoption by states may be a result of their focus on implementing the Common Core standards for English language arts and mathematics. There is federal financial incentive to adopt Common Core standards as part of the Race to the Top program; however, there are no federal incentives for science standards. Further research on the adoption and implementation of the Next Generation Science Standards is needed. The state participating in this study had not adopted the new science standards at the time of this research.

The National Science Education Standards (1996) and the Next Generation Science Standards (2013) both focused on transforming traditional (or teacher-centered) instructional strategies to those scientific inquiry practices. The idea of changing traditional instructional strategies from a teacher-centered approach to an inquiry-based strategy where students are involved in creating their own knowledge is not a new idea. It was first supported by John

Dewey in the early 1900s. Inquiry-based practices were seen to as essential by Dewey for students to develop "habits of mind," a way of thinking that promotes scientific reasoning skills (Jeanpierre, 2006, p. 58). Today, the Next Generation Science Standards (2013) re-emphasizes the need for teachers to implement inquiry-based science practices. Reform recommendations include not only improving teacher content knowledge through sustained, long-term professional development, but also implementing classroom practices and varied instructional approaches including cooperative groups, open-ended questioning, extended inquiry, and problem-solving (Kahle, Meece, & Scantlebury, 2000). However, research shows that many teachers do not employ inquiry-based methods and are instead relying on traditional, didactic methods for teaching science (Dickerson, Clark, Dawkins, & Horne, 2006). Further research is needed to document teacher instructional practices and the influences on what they teach and how. This study addressed this need by documenting teacher instructional practices through time, how their practices have changed, or not, and identified influential factors.

Prior Research on Teaching SMART®

Prior research on the impact of the Teaching SMART® professional development program on teacher practice was found from three studies. A program evaluation conducted 1999-2002 by Matyas (2002), an external evaluator of the Teaching SMART® program; a randomized controlled trial with a pre/post- test design was conducted in the third year, and final year, of implementation of the program, in 2004, by the Institute for Educational Leadership and Evaluation (2006); and the randomized controlled trial conducted 2005-2008 by Borman and Associates (2009). Each study is briefly described below with the main findings highlighted.

Matyas (2002) conducted a formative and summative program evaluation of Teaching SMART® from 1999-2002. Findings from the evaluation's annual administration of its teacher survey (N=154) showed that Teaching SMART® made a significant difference in the quality of teaching over time. Teachers reported statistically significant increases in time spent teaching science, implementing hands-on activities and inquiry approaches to science. Approximately 6,500 students in Teaching SMART® (treatment) and control teachers' classrooms participated in the study. There were statistically significant increases in problem-solving skills and science knowledge for students with treatment teachers, but not for students in the comparison/control group. Matyas (2002) concluded that the findings from the program evaluation suggested that participation in the three years of the Teaching SMART® professional development program makes a difference in the quality of teaching and the improvement of students' attitudes toward science and knowledge about science.

The Institute for Educational Leadership and Evaluation (2006) conducted an evaluation to document the final year's findings from the implementation of Teaching SMART® in four states (North and South Dakota, Minnesota, and South Carolina). Students completed a pre-and post-test of specific science content areas. They found that students of Teaching SMART® (treatment) teachers showed a statistically significant positive change in knowledge about specific content areas compared to students in control teacher's classes. In the content area of natural science, students in treatment teachers' classrooms increased their score by 21.5%. Third, fourth, and fifth grader students in treatment teachers' classrooms showed improvement in the test scores (17.9%, 28.8%, and 19.9%, respectfully). Treatment teachers (N=129) reported significant increases in their use of hands-on activities, inquiry approach, and problem-solving teaching strategies. The authors concluded that teachers participating in Teaching SMART®

reported significant changes in their classroom practices and students showed statistically significant improvement in test scores.

Borman and associates (2009) found in their randomized controlled trial with 20 schools that treatment (Teaching SMART®) teachers reported a statistically significant increase in use of inquiry strategies in their teaching practices and students reported an increase in participating in hands-on activities in the classroom. Fifth grade students in control and treatment teachers' classrooms completed the state science assessment, Florida Comprehensive Assessment Test (FCAT). The student scaled scores were used to analyze the impact of the Teaching SMART® program on overall achievement in science. Analyses excluded gifted students in both control and treatment schools. The overall control-treatment effect size for student science FCAT was .10 (p=.10), a small effect size. HLM results for each school's change in science FCAT scores per year show that in nine of the ten treatment schools science FCAT scores increased, while three of the ten control schools had decreases in their FCAT scores. These findings suggested that by the end of the implementation phase of Teaching SMART® teachers perceived a change in their teaching practices in terms of implementing science activities and inquiry methods and fifth graders in Teaching SMART® teachers' classrooms showed increased FCAT science scores. Importantly, measures of fidelity to implementation found that the professional development trainings were consistently delivered through time to both Alpha and Beta teachers (teachers who received three years or two years of the professional development).

Prior research (Borman & Associates, 2009; Institute for Educational Leadership and Evaluation, 2006; Matyas, 2002) conducted on the impact of the Teaching SMART® professional development program on teacher practice and student learning and attitude toward science are encouraging. Further research on the impact of Teaching SMART® post-implementation is warranted. Assessing sustainability requires further data collection to examine whether the activities and benefits of the implementation phase continue post-implementation (Scheirer, 2005). This study examined the sustainability of Teaching SMART® instructional practices from the randomized controlled trial conducted by Borman and Associates (2009). Student outcomes were not included in this study for one main reason: the focus of this study was on change in teacher practices learned during the Teaching SMART® professional development program, not on sustainability of student outcomes.

Chapter Summary

This chapter provided a review of the literature regarding the topics of sustainability, professional development and science reform, and an overview of prior research conducted on the Teaching SMART® professional development program. While a commonly shared definition of sustainability does not exist in the literature, researchers have identified the need for sustainability research to operationally define the elements of sustainability being used and why.

The literature review revealed common features of definitions of sustainability that have been published. In this study, the definition for sustainability supplied by Florian (2000) embraced the main components endorsed by the literature and aligned with the goals of this study. Factors for enhancing sustainability as well as obstacles were identified from the literature; however, there is a call for empirical research on sustainability to determine what makes programs sustainable (Savaya, Elsworth, & Rogers, 2009). Professional development and science reform have emphasized the need to move teachers' instructional practices away from teacher-centered pedagogy toward student-centered, inquiry-based practices to encourage learning opportunities for students. The new Next Generation Science Standards built on the prior science standards (National Research Council, 1996) and continued to promote inquiry-based practices as best practices. Research studies on how reform practices are sustained, or not, adds to the literature base. Scheirer (2005) stated, “Research that builds on the methods and findings of reviewed studies is strongly needed to consolidate empirical evidence and to test strategies aimed at increasing the numbers of sustained programs” (p. 325). The Teaching SMART® logic model provided a framework for implementation (Chapter Three, Table 2) and served as the foundation for evaluating the degree to which the long-term teacher objectives have been met, if at all, five years post-implementation.

CHAPTER THREE:

METHOD

In this chapter, the methods used to address the research and evaluation questions are described. This study re-administered the teacher survey in spring 2013 that was last administered in spring 2008, the end of the three-year implementation phase as part of a randomized controlled trial (RCT) that was conducted to determine the efficacy of the intervention, Teaching SMART®. Therefore, reference to the past RCT is made throughout this chapter. In addition, teachers who participated in the implementation of the Teaching SMART® professional development program, and responded to the survey in 2008 and 2013 were invited to be interviewed and/or observed and served as case study examples of sustainability. Key informant interviews with district administrators were conducted to identify state, district, and school level policies and practices that may have influenced sustainability. The chapter is organized into the following sections: overview of the Teaching SMART® professional development program, purpose of the study, research and evaluation questions, and design of the study that includes a description of the dependent and independent variables, study site, sample, data sources, institutional review board procedures, methods for data collection, analyses, and methods for ensuring credibility. Lastly my role in this study is presented.

Teaching SMART® Professional Development Program

The Teaching SMART® professional development program was developed to be implemented with intermediate elementary teachers, grades 3 through 5, to teach the methods and philosophies endorsed by the National Science Education Standards (NSES) Science as Inquiry Standards (National Research Council, 1996). The developers of the Teaching SMART® professional development program have identified the resources, activities, and outputs needed to meet the short-term and long-term outcomes for the participating teachers in the program and their students. A description of each of the model's elements are described below and represented in Table 2, the logic model for the Teaching SMART® professional development program. Permission was granted by Girls Incorporated® of Rapid City, a program of Youth & Family Services of Rapid City, South Dakota, to include the Teaching SMART® Logic Model and the four Mirror Coaching forms in this study. (Appendix A: Copyright Permission).

Table 2

Teaching SMART® Logic Model

Resources →	Activities →	Outputs →	Short-term outcomes →	Long-term outcomes
• Teaching SMART® project staff • Three-year professional development model • 100+ lesson plans • Science supplies and equipment • TS Website and Listserv	• Site Specialist training (train the trainer model) • Teacher training • In-class visits • Mirror coaching • Ongoing technical assistance • Formal evaluation	• Site Specialists trained in beginning, intermediate and advanced levels • 90 hours of professional development for Site Specialists plus ongoing support • Teachers trained in beginning, intermediate and advanced levels • 60 hours of professional development for teachers plus ongoing support	Teachers: • Increased student-centered learning activities • Decreased teacher-centered learning activities • Equity-based teaching strategies Students: • Students engaged in hands-on inquiry-based science and math	Teachers: • Improved teaching • Improved perceptions about the roles of females in STEM • Improved classroom management techniques Students: • Increased confidence • Improved attitudes toward STEM studies and careers • Increased interest in STEM studies and careers • Increased content knowledge and problem-solving skills • Improved achievement

Source: Girls Incorporated®

Resources

In the Teaching SMART® program, both human and material resources are identified. A Teaching SMART® program specialist, who is employed by the developer, oversees the implementation of the professional development and serves as a resource for the teachers participating in the program as well as the site specialist. A site specialist is identified (or hired) by the school district to lead the professional development on-site with the teachers participating in the Teaching SMART® program. A full-time site specialist may work directly with 45 teachers, while a half-time site specialist may work with up to 25 teachers.

The professional development model consists of three years of on-going, site based training for the participating teachers. Year one is referred to as, "Beginning," year two, "Intermediate," and year three, "Advanced." Each year there is a training that consists of a two-day training session at the beginning of the school year followed by two half-days of "Networking Sessions" where all the teachers gather to discuss aspects of implementation and learn new components of the program or practice strategies.

In addition to attending the trainings, teachers are given a three ring binder that contains over 100 lesson plans that have been development by Teaching SMART®, and aligned with national science standards, the state's science standards, in this case Florida's Sunshine State Standards, and the participating school district's curriculum. Participating teachers are required to teach a minimum of two Teaching SMART® lessons per month for a total of 16-20 lessons a year. Teachers are expected to complete a Lesson Feedback Form for every lesson they use. This form is given to the site specialist who keeps track of the number and name of the lessons taught to ensure compliance with the minimum number of lessons to be taught per month.

Science supplies and equipment are provided to every teacher participating in the professional development along with an equipment kit for each participating school. Science supplies are given to each teacher in a large plastic container and consist of both consumable (i.e., baking soda, vinegar) and non-consumable materials (i.e., microscope slides, beakers). The science materials in the individual teacher kits are aligned with the lessons that are identified for the specific year of implementation (Beginning, Intermediate, or Advanced). This ensures that teachers will have everything they would need to complete a Teaching SMART® lesson in each year of the program. At the end of each year, teachers complete an inventory of their science materials and the site specialist fills their kit for the following year's lessons (Intermediate in year two, and in year three, Advanced).

An equipment kit is provided to the school for the teachers participating in the professional development to access and utilize. The equipment kit contains class sets of microscopes, dissecting kits, goggles and other equipment that is needed to complete the lessons. The equipment kit is provided at the beginning of the program and is expected to last for at least the three years of implementation with the expectation that the equipment will remain at the school post-implementation for continued use.

In addition to the consumable and non-consumable supplies and materials, Teaching SMART® provides a website for teachers to use to access information along with the option of establishing an email listserv for participating teachers. Teachers may access these online resources but participation is not required.

Activities

In the Teaching SMART® logic model, there are six activities identified to support the implementation of the professional development program. Each activity is described below.

Site specialist training. Prior to the annual training at the beginning of each school year, a Teacher SMART® program specialist provides training for the site specialist(s), following a "train the trainer" professional development model, where program specific information is taught directly to the site specialists who will work with the participating teachers. This training includes an overview of the yearly activities and materials, training agendas, and enables the site specialist to become prepared to lead the two-day training session at the beginning of the school year.

Teacher training. Each teacher participates in a two-day training at the beginning of each school year for each of the three years of the program to learn what is expected at the Beginning, Intermediate, and Advanced years. Additionally, teachers attend two half-days of networking sessions each school year that allow teachers to come together as a group to discuss how they are implementing the program and their challenges and successes. The site specialist determines what should be a focus for the networking session based on observations of the teachers implementing the program. Networking sessions provide an opportunity for any course corrections that need to be made to ensure implementation is occurring as prescribed.

The Beginning year of Teaching SMART® introduces the main components of the program, referred to as three Es and an F to promote science inquiry in the classroom. The three Es and an F are: Empowerment (of teachers and students), Equity (in the classroom), Exploration (of scientific concepts), and Fun. The scientific method is introduced and used to promote hands-on learning in the classroom. The Intermediate year builds on year one by adding in mirror coaching, that is, the site specialist visits the science classroom, observes, and provides detailed information for the teacher on one of four main areas of instruction identified by the Teaching SMART® program (Appendices B, C, D, E: Teaching SMART® Mirror Coaching Forms). The four main areas of mirror coaching are:

1) Cooperative Grouping (Appendix B);

2) Equity Techniques/Career Applications (Appendix C);

3) Language Used/Questioning Techniques (Appendix D); and

4) Scientific Method/Process Skills (Appendix E).

By the end of the second, or Intermediate Year, mirror coaching for each of the four areas is to have occurred. Year three, Advanced, consists of building on the prior years' activities by adding a focus on applying science inquiry strategies to other content areas, such as mathematics and social studies, through interdisciplinary lessons. In addition, the Advanced Year includes an opportunity for teachers to reflect on their own practice through observing themselves teach a Teaching SMART® lesson that was videotaped by the site specialist. The teacher selects the lesson the want to have video-recorded and the site specialist provides the recording at the end of the visit. Only the teacher receives the recording for his or her personal use to improve their pedagogy.

In class visits. In year one, Beginning, the site specialist visits each of his or her assigned teachers monthly to either observe the teacher, facilitate the lesson, or model Teacher SMART strategies as requested by the teacher. Year two, Intermediate, the site specialist makes four visits over the course of the school year, typically two in the fall and two in the spring semester. These visits are used as mirror coaching opportunities where one of the four areas identified by Teaching SMART® (described above) is used. The classroom teacher selects which area will be the topic of the mirror coaching visit, but all four areas are required to be covered by the end of the school year.

Year three, Advanced, consists of two classroom visits by the site specialist for each participating teacher. One visit occurs in the fall semester where the teacher uses an interdisciplinary lesson that he/she created and the site specialist observes or facilitates that lesson, and one in the spring where the site specialist video-records the teacher instructing. This video is given to the teacher so that they can reflect on their practice.

Mirror coaching. As described above, mirror coaching is conducted by the site specialist in the teacher's classroom while instruction is occurring. The teacher selects one of the four mirror coaching areas and the site specialist observes, completes the form on the topic selected by the teacher, and provides the form to the teacher at the end of the lesson. The teacher may ask questions or just review the form for feedback to improve their practice.

On-going technical assistance. The site specialist provides on-going assistance to the participating teachers by offering a range of services including classroom site visits, yearly formal training, and by being available via email and cell phone throughout the day. Site specialists receive on-going support from the Teaching SMART® program specialist, who is available not only during the formal trainings with the site specialist, but via email and cell phone too.

Formal evaluation. Teachers are provided with information to evaluate their practice in three main ways. One, lesson feedback forms provide an immediate evaluation of how well the lesson was received by the students as well as their own opinion of the lesson. Teachers ask the students to give a "thumbs up" or "thumbs down" at the end of the lesson and circle the students' judgment on the lesson feedback form. There is space on the form for the teacher to include student feedback along with their own thoughts. Two, mirror coaching forms that are completed by the site specialist provides insight on each of the four main areas of Teaching SMART®. Once a mirror coaching form is completed, the site specialist hands the form to the teacher to review at their own convenience. The site specialist is available for questions the teacher may have, but the form is not reviewed together. Three, the video-recording of each teacher's instruction in the third year of program implementation provides an opportunity for reflection and self-evaluation.

Outputs

Both the site specialists and the teachers who participate in the Teaching SMART® professional development program receive training at the Beginning, Intermediate, and Advanced levels. Site specialists participate in 90 hours of training over the three years and teachers 60 total hours. In addition to the training sessions, site specialists receive ongoing support from the Teaching SMART® program specialists while participating teachers received ongoing support from the site specialists.

Short-term Outcomes

Through participation in the Teaching SMART® professional development program, there are four anticipated immediate, or short-term, outcomes. One short-term outcome is an increase in student-centered learning activities. The 100 plus lessons developed by Teaching SMART® are aligned with national and state standards and encourage the use of student-centered learning activities. With the increase of student-centered learning activities, it is expected that teachers will decrease the use of teacher-centered activities, a second short-term outcome. A third short-term outcome is the use of equity-based teaching strategies that allows for all students to participate in classroom activities and their own learning, regardless of ability, gender, or race. The final short-term outcome is having students engaged in hands-on, inquiry based science and mathematics. Through the incorporation of student-centered learning activities, teachers provide hands-on opportunities for students and learn during the course of the three-year Teaching SMART® professional development program inquiry-based strategies to strengthen students' ability to lead their own knowledge production.

Long-term Outcomes

As part of the logic model, the developers of Teaching SMART® anticipate long-term outcomes for the teachers who participated in the three years of professional development, and for their students. Teachers may benefit from improved teaching practices as they move from using a teacher-centered approach to a student-centered learning instructional style. Improved perceptions about the roles of females in science, technology, engineering and mathematics (STEM) are encouraged through ongoing equity discussions and activities. Improved classroom management is the last long-term outcome expected for teachers and is encouraged through the use of roles and/or assigned jobs during science experiments.

For students, the long-term outcomes are increased confidence as they are provided opportunity to lead their own learning activities in class, and improved attitudes toward STEM and careers through the integration of career topics in lessons and STEM guest speakers. Academically, it is anticipated that students will increase their content knowledge in science and problem-solving skills leading to overall improved achievement.

The main goal of the Teaching SMART® professional development program is to promote the use of science inquiry in the classroom by emphasizing the scientific method, questioning techniques, cooperative grouping, and equity strategies that promote career integration to enable all students to realize the relevance of science in their lives. Teaching SMART® guides teacher instructional practice to be based on inquiry-based practices. To encourage the use of inquiry in the classroom, subsequent goals are to change teacher attitudes to one that is more positive about science by making teachers more comfortable in their science instruction and to enhance student achievement in science.

Purpose of the Study

The purpose of this mixed method study was to determine what practices, if any, of the Teaching SMART® professional development program have been sustained by elementary teachers who participated in the program during the implementation phase (2005-2008). The sustainability study sought to determine the ways in which the teachers who participated in Teaching SMART® continued, discontinued, or adapted the methods and strategies in their classrooms five years post implementation (2013). Knowing how programs work, if they fail or succeed or how they can be made better, is an outcome in which schools, organizations, policy makers and the public at large are interested (Fitzpatrick, Sanders, & Worthen, 2004). The need in the literature for information on how to successfully sustain reform efforts over time is well-documented (Bobis, 2011; Coffey & Horner, 2012; Scheirer, 2005; Sindelar, Shearer, Yendol-Hoppy, & Liebert, 2006) as few innovations achieve this goal (Hargreaves & Goodson, 2006).

This study adds to the literature by providing evidence of how teachers who participated in a professional development reform increased, decreased, or sustained use of instructional practices learned during implementation of the program five years later while identifying factors that influenced their practice.

Research and Evaluation Questions

The following research and evaluation questions guided the sustainability study. The research questions (RQ) provided an opportunity to address how and why sustainability occurred, if at all. To answer the research questions, qualitative interviews with district administrators and teachers along with an observation of classroom instruction were conducted.

Research Question (RQ) 1: What do teachers who participated in Teaching SMART® (2005-2008) and district administrators share about the sustainability of Teaching SMART® practices in 2013?

a. What Teaching SMART® instructional practices are evident from an observation of a teacher's science lesson in 2013?

Evaluation questions (EQ) focused on the long-term objectives of the Teaching SMART® program presented in the logic model (Table 2). Teacher survey data from 2008 and 2013 were used to answer these questions along with district administrator and teacher interview data to provide contextual information.

Evaluation Question (EQ) 1: What teaching strategies do teachers who participated in the Teaching SMART® professional development program (2005-2008) utilize in their science classrooms five years post implementation (2013)?

a. Compared to 2008, is there an increased, decreased, or sustained use of student-centered learning activities in 2013?

b. Compared to 2008, is there an increased, decreased, or sustained use of teacher-centered learning activities in 2013?

EQ 2: What perceptions about the roles of females in science, technology, engineering and mathematics (STEM) do teachers who participated in the Teaching SMART® professional development program (2005-2008) have five years post implementation (2013)?

a. Compared to 2008, is there an increased, decreased, or sustained use of equity based teaching strategies in 2013?

EQ 3: What classroom management techniques do the teachers who participated in the Teaching SMART® professional development program (2005-2008) use five years post implementation in 2013?

a. Compared to 2008, is there an increased, decreased, or sustained use of the Teaching SMART® roles during lessons in 2013?

b. Compared to 2008, is there an increased, decreased, or sustained use of small, cooperative learning groups during lessons in 2013?

Research Design

To answer the research and evaluation questions, an objectives-oriented evaluation (Fitzpatrick, Sanders, & Worthen, 2004) using a mixed method approach was employed. Specifically, a sequential, embedded, equal status, mixed method design was used where the quantitative survey data were collected, and from the respondents to the survey, the participants for the qualitative interviews were identified. In this mixed method approach, the quantitative data were collected and analyzed first, then respondents to the survey were invited to participate in the qualitative research, therefore, the qualitative sample was embedded within the quantitative. Both sets of data were used, given equal status, to answer the evaluation questions (Johnson & Onwuegbuzie, 2004). The use of both quantitative and qualitative data provide a fuller understanding of how the teachers who participated in the Teaching SMART® professional development program continued, discontinued, or adapted their instructional practices through time.

Providing evidence for the effectiveness of a program is the focus of evaluation work. Program evaluation concerns itself with the merit, worth or quality of programs, whereas research focuses on knowing how or why programs work or fail to work (Scriven, 1994). This is the key distinction between research and evaluation. Fitzpatrick, Sanders, and Worthen (2004), explain,

> The primary purpose of research is to add to knowledge of the field, to contribute to the growth of theory. Evaluation's primary purpose is to help those who hold a stake in whatever is being evaluated (stakeholders) make a judgment or decision (p. 6).

This objectives-oriented evaluation focused on specific goals and objectives, defined by the developers of Teaching SMART® in their logic model (Table 1), and the extent to which they have been attained (Fitzpatrick, Sanders, & Worthen, 2004). The strength of the objectives-oriented approach is that it is straightforward - achievement of the objectives determines success or failure. While this approach tends to be driven mainly by testing outcomes, Fitzpatrick, Sanders, and Worthen (2004) cautioned against using a single outcome as the basis for judgment. The American Evaluation Association (2006) issued a public statement regarding the importance of using multiple measures:

> To encourage the highest quality accountability systems, we advocate approaches that feature rigor and appropriate methodological and procedural safeguards… Empirical evidence from multiple measures, data sources, and data types is essential to valid judgments of progress and to appropriate consequences (p. 2).

One of the strengths of using multiple methods, as suggested by the American Evaluation Association (2006), is in the triangulation of data to validate responses. Triangulation refers to the combination of several research methodologies in the study of the same phenomenon (Bogdan & Biklen, 2006).

Determining the effectiveness of the Teaching SMART® professional development program in meeting its long-term teacher outcomes (Table 2) was addressed by evaluation questions one through three. Evaluation Question (EQ) 1: What teaching strategies do teachers who participated in the Teaching SMART® professional development program (2005-2008) utilize in their science classrooms five years post implementation (2013)? EQ 2: What perceptions about the roles of females in science, technology, engineering and mathematics (STEM) do teachers who participated in the Teaching SMART® professional development program (2005-2008) have five years post implementation (2013)? EQ 3: What classroom management techniques do the teachers who participated in the Teaching SMART® professional development program (2005-2008) use five years post implementation in 2013? Matched teacher survey data from 2008 and 2013 (n=23 for the whole sample, n=16 for Alpha teachers, those who participated in all three years of the intervention, and n=7 for Beta teachers who participated in two years of the intervention) were used to provide evidence of whether or not instructional practices were sustained, increased, or decreased five years post-implementation. Additionally, qualitative interview data from two district administrators and three teachers who also responded to the teacher survey at both time points (2008 and 2013) were used to provide information and contextualization of the survey findings.

Documenting how and why the program strategies have been sustained, if at all, was the focus of the research questions. Research Question (RQ) 1: What do teachers who participated in Teaching SMART® (2005-2008) and district administrators share about the sustainability of Teaching SMART® practices in 2013? What Teaching SMART® instructional practices are evident from an observation of a teacher's science lesson in 2013? To address the research questions, teachers who responded to the 2013 teacher survey were invited to participate in the qualitative research activities, interviews and/or observations. Teachers who elected to participate in the qualitative research served as case study examples to contextualize how a reform is sustained, in what ways, or discontinued. Key informant interviews with district administrators provided contextual information and insight into state, district and school level policies and practices.

The use of multiple methods followed a critical realist approach to research. Critical realism, according to Zachariadis, Scott, and Barrett (2013), "Is often seen as a middle way between positivism and interpretivism" (p. 856). Critical realism embraces the use of various methodological approaches to create an understanding of reality (Zachariadis, Scott, & Barrett, 2013).

Dependent Variables

The Teaching SMART® logic model (Table 1), identified three long-term teacher outcomes that are the dependent variables in this study. Each evaluation question focused on one of the long-term outcomes. There are three dependent variables that were used for analyses to address the evaluation questions.

The three long-term outcomes identified in the Teaching SMART® logic model are: improved teaching, perceptions about the role of females in science, technology, engineering, and mathematics (STEM), and classroom management techniques. The long-term outcomes were operationalized as follows:

- Improved teaching was operationalized as an increase in student-centered learning activities. The dependent variable, student-centered learning activities, was measured using teacher survey responses (2008 and 2013, *n*=23, *n*=16 for Alpha teachers, *n*=7 for Beta teachers), teacher interview responses (2013, *n*=3), and classroom observational data (2013, *n*=1).
- Perceptions about the role of females in science, technology, engineering, and mathematics (STEM) was a dependent variable that was measured using teacher survey responses (2008 and 2013, *n*=23, *n*=16 for Alpha teachers, *n*=7 for Beta teachers), teacher interview responses (2013, *n*=3), and classroom observational data (2013, *n*=1).
- Classroom management techniques was a dependent variable that was measured by the use of roles or jobs in the classroom and the assignment of students to small cooperative learning groups. Data from teacher survey responses (2008 and 2013, *n*=23, *n*=16 for Alpha teachers, *n*=7 for Beta teachers), teacher interview responses (2013, *n*=3), and classroom observational data (2013, *n*=1) were used.

Study Site

The participating school district is located in the southeast of the US and is a combination of small towns and diverse rural areas serving over 67,000 students across 84 schools, in the

2011-2012 school year (District School Board Factsheet). In 2011-2012, there were 46 elementary schools ranging in size from approximately 400 to 1000 students (District School Board Factsheet). It is projected that the total number of enrolled students will exceed 75,000 by the 2020-2021 school year (Superintendents Annual Report, 2011). In 2011, the total minority population enrolled in the school district was over 22,000 students, almost 32% of the district's total student body (18.97% Hispanic, 5.7% Black, 2.5% Asian/Pacific, 4% Multi-racial, less than 1% Native American). The school district had the largest growth in minorities in the whole state for the decade since the 2000 census -181% (Superintendents Annual Report, 2011, p. 4). District high schools have an 88.5% graduation rate, higher than the state graduation rate of 80.1%.

Sample

There were three samples for the sustainability study. The first sample was for the quantitative, survey, portion of the study that provided data to answer the three evaluation questions. This sample for the sustainability study built on the former randomized controlled trial (RCT) conducted from 2005-2008. The second sample consisted of a qualitative subsample of teachers from the quantitative, survey, respondents in 2013. The third sample consisted of key informant interviews with school district administrators who were knowledgeable about state, district, and school policies and practices and how they may have influenced sustainability. The qualitative, subsample of teacher participants and the key informant interviews provided data to answer the overarching research question as well as additional information and contextualization for the three evaluation questions. A description of the RCT sample is presented below followed by the sampling procedure used for the sustainability study.

Randomized controlled trial sample. At the time of random assignment in 2005, the school district had 35 elementary schools. However, 14 elementary schools were identified by school district administrators as not available for randomization due to their Title 1 status and involvement in other reforms to raise their student achievement scores. Of the remaining 21 eligible elementary schools, the school principals agreed to participate in the study and to randomization into either the treatment or control conditions by the research team. Ten schools were assigned to the treatment condition and 11 were assigned to the control or business-as-usual condition. One of the control schools did not participate in the research, citing preference for participating as a treatment school instead, leaving 10 schools in each condition.

Within each of the 20 randomly assigned elementary schools, principals asked for volunteer teachers to participate. In Table 3, the number of teachers who participated in each year of implementation of Teaching SMART® is shown.

Table 3

Treatment Teacher Participation by Year during Teaching SMART® Implementation (2005-2008)

Implementation Year	Number of Treatment Teachers	Completed End-of-Year Survey
2005-2006	136	129
2006-2007	168	126
2007-2008	115	95

Participating teachers taught in the elementary intermediate grade levels (3rd-5th). In the fall of 2006, the second year of implementation (2006-2007), a second cohort of 55 treatment teachers was added due to teacher interest and, at the request of the school district, to compensate for normal teacher attrition. The developers of Teaching SMART® approved the addition of subsequent teachers because these teachers would still have the opportunity for two full years of Teaching SMART®. This new cohort of teachers was referred to as "Beta" teachers by the school district during the implementation of Teaching SMART® while the original cohort of teachers was referred to as "Alpha" teachers. The newly added teachers were trained by the site specialists and baseline assessments were carried out by the research team. No new teachers were added to the professional development program in the third year of implementation. In spring of 2008, the last semester of implementation, 115 teachers were participating in Teaching SMART®'s professional development program and 95 of them responded to the end-of-year teacher survey in spring 2008.

Sample for the sustainability study. The sample for the sustainability study consisted of two related teacher samples (quantitative and qualitative), and a sample of school district administrators. A description of the samples is provided below.

Quantitative sample. Participants in the sustainability study's end-of-year teacher survey in 2013 were drawn from the respondents to the RCT's end-of-year teacher survey in 2008. Ninety-five teachers responded to the teacher survey in 2008 (see Table 3). The inclusion criteria for participation in the sustainability study's teacher survey in 2013 are presented below:

- Participated in the Teaching SMART® professional development program in the final year of implementation (2008)
- Responded to the teacher survey that was administered in spring 2008
- Taught science in the school district (2013)
- Taught grades three, four, and/or five (2013)
- Agreed to participate in the sustainability study

Teachers excluded from participation in the sustainability study included all the control, or business-as-usual teachers in the RCT; teachers who did not respond to the teacher survey in spring 2008; teachers who were no longer teaching science or grades three, four or five in 2013; and teachers who did not agree to participate. By working closely with school district administrators, the teachers who met the inclusion criteria were identified. Administrators at the schools where the teachers were assigned were informed of the study via email.

All teachers who met the inclusion criteria were contacted via email to participate in the sustainability study. Of the 95 teachers who participated in the final year of Teaching SMART® professional development program and responded to the survey in 2008, 37 teachers did not meet the inclusion criteria (39%). Of the 37 ineligible teachers, 30 were no longer in the school district, four no longer taught at the elementary level, two had positions as administrators (no longer elementary teachers), and one teacher no longer taught science. Fifty-eight teachers met the inclusion criteria and were contacted via email to participate. Of the 58 eligible teachers, 23 agreed to participate in the sustainability study and completed the survey, resulting in a sample return rate of 40%. Of the 23 participating teachers in 2013, 16 were Alpha teachers (participated in three years of Teaching SMART®) and seven were Beta teachers (participated in two years of Teaching SMART®). Characteristics of the teachers who were ineligible to participate (n=58), who were eligible and did not participate (n=35), participated in 2013 (n=23), and participated in 2013 and where Alpha (n=16) or Beta (n=7) teachers are presented in Table 4.

As shown in Table 4, the majority of the 37 ineligible teachers in 2008 and 23 participating teachers in 2013 had been teaching for over 15 years, with most of them at their current school for the past four to nine years. The majority of all the participants' had earned a bachelor's degree. Most of all the teachers taught science for more than 24 weeks of the school year.

Table 4

Teacher Characteristics by Eligibility and Participation 2008 and 2013, and Teacher Type in 2013

Teacher Characteristics	Ineligible 2008 (*n*=37)	Eligible 2013 did not participate (*n*=35)	Eligible 2013 participated (*n*=23)	2013 Alpha Teachers (*n*=16)	2013 Beta Teachers (*n*=7)
Number Years Teaching					
<4 years	10 (27%)	5 (14%)	4 (17%)	0 (0%)	0 (0%)
4 to 9 years	5 (14%)	13 (37%)	6 (26%)	3 (19%)	1 (14%)
10 to 15 years	6 (16%)	6 (17%)	4 (17%)	4 (25%)	1 (14%)
>15 years	16 (43%)	11 (31%)	9 (39%)	9 (56%)	4 (57%)
Did not indicate	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (14%)
Number Years at Current School					
<4 years	18 (49%)	12 (34%)	8 (35%)	1 (6%)	1 (14%)
4 to 9 years	8 (22%)	10 (29%)	11 (48%)	7 (44%)	3 (43%)
10 to 15 years	5 (14%)	6 (17%)	2 (9%)	5 (31%)	2 (29%)
>15 years	6 (16%)	7 (20%)	2 (9%)	2 (13%)	1 (14%)
Did not indicate	0 (0%)	0 (0%)	0 (0%)	1 (6%)	0 (0%)
Highest Degree Earned					
Bachelor's degree	28 (76%)	24 (69%)	15 (65%)	11 (69%)	3 (43%)
Master's degree	9 (24%)	11 (31%)	7 (30%)	5 (31%)	4 (57%)
Other	0 (0%)	0 (0%)	1 (4%)	0 (0%)	0 (0%)
Number of Weeks Per Year Science Taught					
<6 weeks per year	1 (4%)	0 (0%)	2 (9%)	0 (0%)	0 (0%)
6-12 weeks per year	1 (4%)	2 (6%)	1 (4%)	1 (6%)	0 (0%)
13-18 weeks per year	12 (32%)	5 (14%)	5 (22%)	2 (13%)	3 (43%)
19-24 weeks per year	4 (11%)	12 (34%)	2 (9%)	4 (25%)	1 (14%)
>24 weeks per year	19 (51%)	16 (46%)	13 (57%)	9 (56%)	3 (43%)
Number of Science Lessons Taught Per Week					
1 lesson per week	15 (41%)	6 (17%)	6 (26%)	1 (6%)	0 (0%)
2 lessons per week	8 (22%)	13 (37%)	3 (13%)	2 (13%)	1 (14%)
3 lessons per week	8 (22%)	11 (31%)	9 (39%)	6 (6%)	3 (43%)
4 lessons per week	3 (8%)	3 (9%)	2 (9%)	5 (31%)	1 (14%)
5 lessons per week	3 (8%)	1 (3%)	3 (13%)	2 (13%)	2 (29%)

Table 4

(Continued)

Did not indicate	0 (0%)	1 (3%)	0 (0%)	0 (0%)	0 (0%)
Average Length of Time of Science Lesson					
15-30 minutes	9 (24%)	9 (26%)	5 (22%)	6 (6%)	3 (43%)
31-45 minutes	13 (35%)	21 (60%)	12 (52%)	9 (56%)	3 (43%)
46-60 minutes	14 (38%)	5 (14%)	5 (22%)	1 (6%)	1 (14%)
>60 minutes	1 (4%)	0 (0%)	1 (4%)	0 (0%)	0 (0%)
Gender					
Male	3 (8%)	7 (20%)	2 (9%)	2 (13%)	0 (0%)
Female	34 (92%)	22 (63%)	21 (91%)	14 (88%)	7 (100%)
Ethnicity/Race					
Black or African American	0 (0%)	2 (6%)	1 (4%)	1 (6%)	0 (0%)
Hispanic	1 (4%)	1 (3%)	0 (0%)	0 (0%)	0 (0%)
White	34 (92%)	32 (91%)	21 (91%)	14 (88%)	7 (100%)
Did not indicate	2 (5%)	0 (0%)	1 (4%)	0 (0%)	0 (0%)

The majority of the ineligible teachers in 2008 reported teaching one science lesson per week, the majority of the 35 eligible in 2013 but did not participate teachers reported teaching 2 lessons per week in 2008, and the majority of the 23 participating teachers in 2013 reported teaching 3 lessons per week. The majority of the 2008 ineligible teachers reported the average length of a science lesson as 46-60 minutes long; and the other teachers reported the average length of a science lesson as 31-45 minutes. The majority of all the participants were white females. Overall, the characteristics of the teachers in the groups were similar and allowed comparability among the groups.

Of the 23 teachers in the sustainability study, four of the teachers changed schools between 2008 and 2013 and three new elementary schools were represented in 2013. In all, there were 10 elementary schools represented by the 23 teachers who responded to the survey.

Qualitative sample. The qualitative sample consisted of teachers and district administrators. All of the teachers who responded to the survey in spring 2013 were asked to participate in the qualitative case study component of the study, consisting of individual interviews and/or classroom observations. Three teachers agreed to participate in the qualitative research activities and were interviewed using a semi-structured interview. One of the three teachers, Teacher One, agreed to be observed teaching science. The other two teachers did not agree to be observed. Each teacher's case study write-up was included in the findings chapter and provided an illustrative look at how and why teachers sustain instructional practices or not. Table 5 provides an overview of the case study teacher's characteristics compared to the rest of the teachers who participated in 2013.

Table 5

Teacher Characteristics of the 2013 Participants and Case Study Teachers

Teacher Characteristics	2013 Participants (*n*=23)	2013 Teacher One (Beta)	2013 Teacher Two (Alpha)	2013 Teacher Three (Alpha)
Number Years Teaching				
<4 years	0	0	0	0
4 to 9 years	4	0	0	1
10 to 15 years	5	1	1	0
>15 years	13	0	0	0
Did not indicate	1	0	0	0
Number Years at Current School				
<4 years	2	0	0	0
4 to 9 years	10	0	1	1
10 to 15 years	7	1	0	0
>15 years	3	0	0	0
Did not indicate	1	0	0	0
Highest Degree Earned				
Bachelor's degree	14	1	0	1
Master's degree	9	0	1	0
Other	0			
Number of Weeks Per Year Science Taught				
<6 weeks per year	0	0	0	0
6-12 weeks per year	1	0	0	0
13-18 weeks per year	5	0	0	0
19-24 weeks per year	5	0	0	1
>24 weeks per year	12	1	1	0

Table 5

(Continued)

Number of Science Lessons Taught Per Week				
1 lesson per week	1	0	0	0
2 lessons per week	3	0	0	1
3 lessons per week	9	0	1	0
4 lessons per week	6	1	0	0
5 lessons per week	4	0	0	0
Average Length of Time of Science Lesson				
15-30 minutes	9	1	1	0
31-45 minutes	12	0	0	1
46-60 minutes	2	0	0	0
>60 minutes	0	0	0	0
Gender				
Male	2	0	0	0
Female	21	1	1	1
Ethnicity/Race				
Black or African American	1	0	0	0
White	21	1	1	1
Did not indicate	1	0	0	0

All three case study teachers were white females and taught science in addition to the other content areas. Teacher One taught third grade general education and had been for the past three years. During her participation in Teaching SMART®, she taught grades 3 and 4 as a continuous progress class, where both grade levels are in the same class and stay with the teacher for two years. She was a Beta teacher during the Teaching SMART® professional development program and had changed her teaching assignment to a new school (her school during Teaching SMART® was closed after 2008). Teachers Two and Three were both Alpha teachers during the implementation of Teaching SMART®. Teacher Two had taught fifth grade general and gifted education for the past five years (since 2008). During her participation in Teaching SMART®, she taught students in grades 3 through 5 as a continuous progress class. She has remained at the same school she taught at during Teaching SMART®. Teacher Three taught fourth grade general education and has been teaching fourth grade for the past three years. During Teaching SMART®, she taught students in grades 4 and 5 as a continuous progress class. She also has remained at the same school she taught at during Teaching SMART®.

Two school district administrators were invited to serve as key informants, that is, a person with specialized information on specific topics (Homburg, Klarmann, Reimann, & Schilike, 2012; Tremblay, 1957). Both agreed to participate as key informants and were interviewed using a semi-structured interview guide. When Teaching SMART® was implemented, 2005-2008, both administrators were working at the district level and were involved to varying degrees in the Teaching SMART® implementation. To maintain confidentiality, no demographic information or other information that may reveal their identities, such as their current positions, was provided.

Data Sources

In this mixed method study, multiple methods to collect data were used to provide data to address the research and evaluation questions. A teacher survey was administered to obtain quantitative data on perceived practices and answer the three evaluation questions. Qualitative methods consisted of a district administrator interview and teacher semi-structured interviews and classroom observations where the Teaching SMART® mirror coaching forms were completed in addition to field notes. The qualitative interview and observation data addressed the research question and provided information to augment data for the evaluation questions. A description of the data sources follows.

Quantitative data source: Teacher survey. During the randomized controlled trial (RCT) (2005-2008), teachers in the treatment (Teaching SMART® professional development) and control (business-as-usual) elementary schools were administered a survey that was a modified version of the Study of the Enacted Curriculum: Survey of Classroom Practices in Science (SCP) that was developed by the work of Andrew Porter and Rolf Blank in the 1990's (Blank, Porter, & Smithson, 2001). The survey items were designed to be appropriate for a broad range of instructional activities allowing teachers to find familiar ways of describing their practices, whether using traditional or reform-oriented instructional approaches, such as scientific inquiry-based or standards-based approaches (Blank, Porter, & Smithson, 2001). Blank, Porter, and Smithson (2001) report, "[The teacher survey has] undergone numerous field tests and piloting by teachers, and they have been revised and improved at each stage" (p. 59). To validate the survey data, Blank, Porter, and Smithson (2001) used multiple sources of data, classroom observational data, teacher logs that documented instructional practice, and the responses from identical items from the student survey to compare results.

Prior to use in the RCT, 2005-2008, the teacher survey was modified to limit the survey to five sections with 110 questions (Appendix F: Teacher Survey). The five sections were:

1) Background information (12 items);

2) Instructional activities in science (33 items);

3) Teacher opinions about science (24 items);

4) Teacher comfort teaching science (22 items); and

5) Professional development activities in science education (19 items).

Section one, background information, consisted of 12 items to obtain information such as the number of years taught as well has how often the respondent taught science. Section two, instructional activities in science, consisted of 33 items that were broken into two parts. The first part had the stem question, "*About how often do* ***students*** *experience each of the following as part of their science class?*" There were 23 items following the stem question. The second part had the stem question, "*About how often do* ***you*** *do each of the following as part of your science instruction in this class."* There were 10 items following this stem question. The response options in both parts of section two were: 1. Never; 2. Rarely (e.g., a few times a year); 3. Sometimes (e.g., once or twice a month); 4. Often (e.g., once or twice a week); 5. All or almost all science lessons.

In section three, teacher opinions about science, there were 24 items with response categories ranging from one to five with one indicating "strongly disagree" to five "strongly agree." Section four, teacher comfort teaching science, the stem question asked, "*How comfortable/confident do you feel* ***right now*** *about the following."* There were 22 items with response categories ranging from one "not at all comfortable" to five "very comfortable."

The last section, section five, professional development activities in science education, consisted of 19 items. The response options to the stem question, "*Thinking about all your professional development activities in science* ***during the past year***, ***How often have you,"*** were (1) never, (2) once or twice a year, (3) once or twice a term, (4) once or twice a month, and (5) once or twice a week.

The modified teacher survey was administered at each of the following time points in the RCT, fall 2005, spring 2006, fall 2006 for the second cohort of 55 teachers added to the program, spring 2007, and spring 2008. The initial group of teachers (Alpha teachers) responded to the survey at baseline, fall 2005, prior to participation in the professional development and at three follow-up administrations (spring 2006, 2007 and 2008). The second cohort of teachers (Beta teachers) was given the teacher survey in fall 2006 as a baseline and experienced two follow-up administrations of the teacher survey (spring 2007 and 2008).

Survey score reliability. An exploratory factor analysis (principal axis factoring) was conducted with the baseline teacher survey data in 2005 to identify the conceptual factors for the following sections of the survey: instructional activities in science, teacher opinions about science, and teacher comfort teaching science. Two sections of the survey, background information and professional development activities in science, were not included in the exploratory factor analysis because the items did not inform the research and evaluation questions of this study. The exploratory factor analysis that was conducted is described below.

Exploratory factor analysis. Principal axis factoring analysis with Promax rotation was conducted using SPSS Statistics 21 for the items in the three sections of the survey informing this study: instructional activities in science, teacher opinions about science, and teacher comfort teaching science. Parallel analysis was also conducted to facilitate determination of the optimal number of factors to extract (O'Connor, 2000). Comparison of the random data eigenvalues produced in the parallel analysis to the real-data eigenvalues from the principal axis factor analysis revealed a possible number of factors to be retained. Principal axis factoring analysis was conducted again with the fixed number of factors identified in the parallel analysis. Item loadings and factors were re-assessed to determine if they should be retained. Below is a description of the initial principal axis factoring analysis, the parallel analysis and the factors identified along with the Cronbach's alphas for all three sections of the teacher survey.

Principal axis factoring analysis of the 33 items on the 2005 teacher survey instructional activities in science section from 275 teacher respondents revealed the presence of seven factors with eigenvalues greater than one, explaining 58.57% of the cumulative variance. Comparison of the random data eigenvalues produced in a parallel analysis to the real-data eigenvalues from the principal axis factor analysis revealed four factors to be retained. Principal axis factoring analysis was conducted again with four fixed factors specified. Item 23, write their reflections in a notebook or journal, was deleted due to having a negative item-to-total correlation (-.25) and both the parallel analysis and principal axis factoring were re-run with this item deleted. Table 6 shows the four-factor solution for baseline (2005) teachers' 32 instructional activities in science items.

A factor loading equal to or greater than .40 was used to assign items to a factor. In cases of items loading below .40 (items 20, 28, 32, and 45) the content of the item was considered and the items were conceptually assigned to factors. Similarly, if an item was double-loaded (item 44), that item was conceptually assigned to a factor (Appendix G. List of Items by Factor).

Based on the items within each component, the four factors in the instructional activities in science section of the teacher survey were named:

1) Hands-on, instructional activities that allow students to conduct science activities.

2) Empowering, instructional activities that enable and encourage student participation in science activities.

3) Inquiry, instructional activities that provide students with a variety of opportunities to explore science content and lead their own science investigations.

4) Traditional teaching, instructional activities are guided by the teacher and are driven mainly by textbooks.

Table 6

Four-factor Solution for Baseline (2005) Teachers' Instructional Activities in Science Items (n=275)

Items	Factors 1	2	3	4
17 Do a hands-on activity, investigation, or experiment.	**.99**	.02	-.23	-.14
25 Use science equipment or measuring tools.	**.76**	-.01	-.03	-.07
26 Record, represent, and/or analyze data.	**.60**	.01	.22	.01
24 Follow specific instructions in science activities.	**.59**	.16	-.12	.25
18 Watch the teacher demonstrate a scientific activity.	**.57**	-.08	-.01	.24
35 Write up results or prepare a presentation from a hands-on activity, investigation, experiment or project.	**.52**	-.16	.40	-.04
27 Design or implement their own investigations.	**.51**	-.18	.30	-.04
34 Conduct science projects lasting longer than a week.	**.46**	-.05	.26	-.03
21 Do a class science activity outside of the classroom.	**.45**	-.08	.20	-.09
38 Ask open-ended questions encouraging multiple answers.	-.09	**.85**	-.01	.04
37 Use "wait-time" when asking questions.	.00	**.75**	-.18	.09
41 Allow students to work at their own pace.	-.05	**.61**	-.11	-.04
39 Encourage students to explain concepts to one another.	.01	**.60**	.14	-.03
43 Evaluate my practice for subtle biases or stereotypes.	-.24	**.53**	.25	-.20
42 Emphasize connections among disciplines.	-.06	**.51**	.31	.02
36 Encourage all students to participate in a variety of tasks.	.30	**.51**	-.06	.12
44 Show enthusiasm about science activities.	.46	**.47**	-.21	-.05
45 Encourage student-led inquiry or investigations.	.28	**.37**	.23	-.18
20 Work in cooperative learning groups.	.25	**.27**	.13	.03
30 Hear guest speakers illustrating diverse career roles.	-.01	-.13	**.65**	.04
33 Discuss/consider real-world careers related to activities.	-.14	.15	**.61**	.15
16 Write about science in a report/paper on science topics.	.21	-.25	**.56**	.11
40 Use media illustrating women and minorities in science.	-.13	.17	**.54**	-.09
22 Use computers, calculators or other technology.	.20	.12	**.46**	-.11
19 Use mathematics as a tool in problem solving.	.15	.04	**.44**	.08
14 Read other (non-textbook) science-related materials.	.03	-.02	**.43**	.01
28 Participate in student-led discussions.	.18	.21	**.31**	-.07
32 Engage in performance tasks for assessment purposes.	.22	.20	**.26**	.17
29 Answer textbook, workbook, or worksheet questions.	-.20	.06	.04	**.69**
31 Review homework, assignments, or prepare for a test.	-.02	.10	.11	**.63**
15 Work individually on science assignments.	.00	-.14	.13	**.47**
13 Listen to the teacher explain something to the whole class.	.09	-.04	-.12	**.47**

Extraction Method: Principal axis factoring. Rotation Method: Promax with Kaiser Normalization. Rotation converged in 6 iterations.

Cronbach's alpha internal consistency reliability estimates for the four factors identified through factor analysis (principal axis factoring) and parallel analysis were computed. According to Shelby (2011), statisticians have debated about what constitutes an acceptable size for Cronbach's alpha with .65 to .70 considered an "adequate" scale for research on attitudes and beliefs while other statisticians have recommended a high of .80 and others a lenient .60. For this analysis, the scale of Cronbach's alpha from .65 to .70 was used to indicate an acceptable internal consistency. Applying this scale, the Cronbach's alpha's for the four factors were .87 for factor 1, .85, factor 3 .79; factor 4, .64. Three factor's Cronbach's alphas indicated acceptable internal consistency (factors 1 through 3), but factor 4 was .01 less than the acceptable range but higher than the lenient .60.

Principal axis factoring analysis of the 24 items on the 2005 teacher survey teacher opinions about science section from 273 teacher respondents revealed the presence of six factors with eigenvalues greater than one, explaining 56.22% of the cumulative variance. Comparison of the random data eigenvalues produced in a parallel analysis to the real-data eigenvalues from the principal axis factor analysis revealed four factors to be retained. Principal axis factoring analysis was conducted again with four fixed factors specified. Ten items were identified for removal due to small loadings (<.40) and/or not conceptually fitting with other items in a factor. Both parallel analysis and principal axis factoring analysis were conducted with the remaining 14 items and two factors emerged, explaining 49.5% of the cumulative variance. Table 7 shows the two-factor solution for baseline (2005) teachers' opinions about science items (*n*=275).

The two factors were named:

1) Science teaching efficacy, knowing how to teach science concepts effectively and enjoy teaching science, and
2) Teacher collegiality, teachers have the support of their colleagues to try new ideas in teaching science and regularly observe each other teaching science.

Table 7

Two-factor Solution for Baseline (2005) Teachers' Opinions about Science Items (n=275)

Item	Factors 1	Factors 2
65 I know how to teach science concepts effectively.	**.78**	.01
66 I understand science concepts well enough to be effective in teaching elementary science.	**.76**	-.02
50 I really enjoy teaching science.	**.71**	.05
68 I am typically able to answer students' science questions.	**.69**	-.08
67r I find it difficult to explain to students why science experiments work.	**.68**	-.09
59r I do not know what to do to turn students on to science.	**.67**	.02
64r Even when I try very hard, I do not teach science as well as I teach other subjects.	**.65**	.07
51r I am not very effective in monitoring science experiments.	**.60**	-.03
69 When teaching science, I usually welcome student questions.	**.58**	-.12
54r Given a choice, I would not invite the principal to evaluate my science teaching.	**.54**	.20
55 Teachers in this school regularly observe each other teaching science classes.	-.01	**.62**
60 Most teachers in this school actively contribute to decisions about the science curriculum.	-.03	**.57**
53 Teachers in this school regularly share ideas and materials for teaching science.	.07	**.52**
58 I have adequate time during the regular school week to work with my peers on science curriculum/instruction.	-.10	**.44**

Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalization. Rotation converged in 3 iterations.
Note: Items with an "r" have been reversed for analysis.

Cronbach's alpha internal consistency reliability estimates for the two factors identified through factor analysis (principal axis factoring) and parallel analysis were computed. Using the scale of Cronbach's alpha from 0.65 to 0.70 to indicate acceptable internal consistency, factor 1 met this criterion with a .88. Factor 2 did not meet this criterion, but was above the lenient criterion of .60 with a Cronbach's alpha of .61.

Principal axis factoring analysis of the 22 items on the 2005 teacher survey teacher comfort teaching science section from 275 teacher respondents revealed the presence of four factors with eigenvalues greater than one, explaining 61.37% of the cumulative variance. Comparison of the random data eigenvalues produced in a parallel analysis to the real-data eigenvalues from the principal axis factor analysis revealed three factors to be retained. Principal axis factoring analysis was conducted again with three fixed factors specified, explaining 55.85%

of the cumulative variance. Table 8 shows the three-factor solution for baseline (2005) teachers' comfort teaching science items (*n*=275).

Table 8

Three-factor Solution for Baseline (2005) Teachers' Comfort Teaching Science Items (n=275)

	Factors		
Items	1	2	3
88 Using a variety of science assessment strategies.	**.90**	-.05	-.10
87 Providing science instruction that meets standards.	**.84**	.03	-.12
83 Teaching science at your assigned level.	**.81**	-.04	-.08
71 Doing hands-on science activities with your students.	**.76**	-.10	-.01
72 Helping students document and evaluate their own work.	**.70**	-.04	.03
85 Integrate science with other subjects.	**.69**	.04	.04
84 Using/managing cooperative learning groups in science.	**.68**	.05	-.01
73 Having a staff member visit your classroom to observe science lessons.	**.64**	-.06	.29
91 Involving parents in their child's science education.	**.62**	.08	.01
89 Accounting for students' prior conceptions about natural phenomena when planning curriculum and instruction.	**.57**	.14	-.02
77 Modeling science activities for other teachers.	**.51**	-.03	.36
80 Developing an interdisciplinary/cross curricular lesson that included a variety of curricular areas.	**.39**	.29	.21
78 Teaching students from a variety of cultural backgrounds.	-.01	**.76**	-.05
76 Teaching classes with students with diverse abilities.	-.06	**.71**	.04
79 Learning about equity techniques for female and minority students.	-.10	**.67**	.07
86 Encouraging participation of minorities in science.	.14	**.63**	-.08
74 Teaching students with disabilities.	-.05	**.61**	-.05
70 Encouraging the participation of females in science.	.09	**.40**	-.01
90 Teaching students who have limited English proficiency.	.25	**.39**	-.08
75 Visiting another teacher's classroom to observe science lessons.	-.04	**.39**	.17
81 Being videotaped conducting an interdisciplinary lesson.	-.09	-.01	**1.00**
82 Doing a self-assessment of the videotaped lesson (above).	0.30	.01	**.74**

Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalization. Rotation converged in 6 iterations.

A factor loading equal to or greater than .40 was used to assign an item to a factor. In cases of items loading below .40 (items 80, 90 and 75) the content of the items were considered and conceptually assigned to a factor.

The three factors were named:

1) Strategies: comfort using different assessment strategies and instructional strategies to meet standards and involve students.

2) Diversity: comfort teaching science to students with diverse abilities and students with disabilities.
3) Evaluation: comfortable being videotaped teaching and self-assessing the video lesson.

Cronbach's alpha internal consistency reliability estimates for the three factors identified through factor analysis (principal axis factoring) and parallel analysis were computed. Using the scale of Cronbach's alpha from 0.65 to 0.70 to indicate acceptable internal consistency, the three factors exceeded this criterion with a .93 for factor 1, .80 for factor 2, and .87 for factor 3.

Confirmatory factor analysis. Based on the findings from the exploratory factor analysis, principal axis factoring, and parallel analysis conducted with the baseline data from 2005, confirmatory factor analysis was conducted using the 2008 teacher survey responses (n=187) to validate the conceptual model identified from the exploratory factor analyses using Mplus, a statistical software program used to estimate models containing latent, or unobserved variables. In the model identified in 2005, there were nine latent variables that composed the first-order constructs loading on three second-order constructs (instructional activities in science, teacher comfort teaching science, and teacher's opinions about science). Estimation of model parameters was conducted using maximum likelihood estimation and overall model fit, goodness-of-fit, was evaluated by chi-square probability where $p>.05$ is acceptable, Comparative Fit Index (CFI) where CFI $\geq$ .95 represents acceptable fit, Root Mean Square Error of Approximation (RMSEA with confidence interval) where RMSEA < .06 (acceptable fit), and Standardized Root Mean Square Residual (SRMR) where SRMR < .08 represents acceptable fit.

The model identified during the EFA using 2005 teacher survey data was not validated with the 2008 teacher survey data, χ^2 (2174, n=187)= 4065.55, p<.001. The CFI was .65 which represents poor fit. RMSEA was .07 which indicated lack of fit. SRMR was .08 which represents acceptable fit. The goodness-of-fit indices point overall to less than acceptable fit.

To further explore the model, the nine first-order factors identified in the EFA and used in the analyses were reviewed individually to determine goodness-of-fit (Table 9). Estimation of model parameters was conducted using maximum likelihood estimation in MPlus. Overall model fit, goodness-of-fit, was evaluated by chi-square probability where p>.05 is acceptable, Comparative Fit Index (CFI) where CFI $\geq$ .95 represents acceptable fit, Root Mean Square Error of Approximation (RMSEA with confidence interval) where RMSEA < .06 (acceptable fit), and Standardized Root Mean Square Residual (SRMR) where SRMR < .08 represents acceptable fit. Cronbach's alphas are also included in Table 9.

Table 9

Goodness-of-Fit Indicators of Factors for Instructional Practices, Teacher Opinions, and Teacher Comfort 2008 (n=187)

Factors	# of items	χ^2	*df*	CFI	RMSEA	SRMR	Cronbach's Alpha
Hands-on	9	96.15***	27	.81	.12	.09	.87
Empowerment	10	102.13***	35	.85	.10	.07[a]	.85
Inquiry	9	51.51**	27	.89	.07	.06[a]	.75
Traditional	4	8.29	2	.91	.13	.04[a]	.64
Efficacy	10	74.84***	35	.90	.08	.06[a]	.88
Collegiality	4	.83	2	1.00	.00	.01[a]	.54
Strategies	12	156.39***	54	.84	.10	.07[a]	.93
Diversity	8	63.19***	20	.91	.11	.06[a]	.80
Evaluation	2						.87

Note: The factor, evaluation, did not have an identified model to compute χ^2.
***p < .001
**p<.01
[a] denotes fit

Goodness-of-fit indices by factor for the 2008 data (Table 9) revealed that chi-square for five factors, empowerment, hands-on, efficacy, strategies and diversity, had a p<.001, two factors had chi-square p<.01 (inquiry) and two factors (traditional and collegiality) had p=.02

indicating lack of fit. The factors' CFI ranged from .07 to .91 indicating lack of fit. RMSEA ranged from .06 to .13 with one factor, Inquiry, indicating acceptable fit (.06). All but one factors' SRMR was < .08 indicating acceptable fit (hands-on's SRMR was .09). The lack of acceptable fit across all factors and multiple goodness-of-fit indices suggests that the factors are not purely unidimensional.

Cronbach's alpha internal consistency reliability estimates for the nine factors were computed (Table 9). Using the scale of Cronbach's alpha from .65 to .70 revealed that all but two factors, traditional (.64) and collegiality (.54), had acceptable internal consistency. Seven of the nine factors exceeded this criterion with Cronbach's alphas ranging from .75 to .93.

Table 10 provides Cronbach's alpha internal consistency reliability estimates for the identified factors with 2008 (n=23) and 2013 (n=23) teacher survey data used in the analyses to address the evaluation questions. Cronbach's alpha internal consistency reliability estimates for the nine factors were computed. Using the scale of Cronbach's alpha from .65 to .70 revealed that all but one factor (collegiality in 2008 and 2013 was .25 and .39 respectively) had acceptable internal consistency. Seven of the nine factors exceeded this criterion with Cronbach's alphas ranging from .71 to .89.

Examination of item correlation was conducted to determine if deletion of items that have poor correlation (<.3) increased Cronbach's alpha for specific factors. Review of the 2008 factors revealed that hands-on had two items <.3 and, if deleted, a maximum of .03 increase in Cronbach's alpha (from .77 to .80).

The factors empowering, traditional, strategies, and evaluation had no items <.3. Inquiry had one item <.3 (.17) and if deleted Cronbach's Alpha would increase by .02 (from .83 to .85).

Efficacy had one item <.3 (.23) and if deleted the Cronbach’s alpha would have remained the same for this factor, .78. Collegiality had three items <.3 and the maximum increase of Cronbach’s alpha if items were deleted was .13 (from .25 to .42). Diversity had one item <.3 and if deleted the Cronbach’s alpha would increase by .03 (from .74 to .77).

Table 10

Cronbach’s Alpha Internal Consistency Reliability Estimates for Teacher Survey Factors 2008 (n=23) and 2013 (n=23)

Factors	# of Items	Cronbach’s Alpha		Lower	Upper	Lower	Upper	Range of Corrected Item-to-Total Correlations	
		2008	2013	2008		2013		2008	2013
Hands-on	9	.77	.72	.59	.89	.51	.87	.11-.72	.01-.57
Empowerment	10	.88	.71	.78	.94	.49	.86	.42-.76	.13-.52
Inquiry	9	.83	.73	.70	.92	.52	.87	.17-.75	.24-.62
Traditional	4	.71	.71	.45	.87	.46	.87	.30-.72	.20-.56
Efficacy	10	.78	.74	.62	.90	.55	.87	.23-.68	.19-.63
Collegiality	4	.25	.34	.44	.65	-.24	.69	-.02-.56	.05-.37
Strategies	12	.88	.88	.79	.94	.79	.94	.39-.84	.26-.79
Diversity	8	.74	.84	.53	.88	.71	.92	.07-.68	.41-.82
Evaluation	2	.89	.80	.74	.96	.54	.92	.81-.81	.67-.67

The factors with 2013 data showed a similar trend when examination of item correlation was conducted to determine if deletion of items that have poor correlation (<.3) increased Cronbach’s alpha for specific factors. Review of the 2013 factors revealed hands-on had two items <.3 and would increase Cronbach’s alpha by .01 if deleted (from .72 to .73). Empowering had three items <.3 and an increase of .01 in Cronbach’s alpha if deleted (from .71 to .72). Inquiry had three items <.3 and if two of the items were deleted there would be no change while the deletion of one of the items would result in a decrease in Cronbach’s alpha .01 (from .73 to .72). Traditional, diversity, and evaluation had no items <3. Strategies had one item <.3 and if deleted there was no increase in Cronbach’s alpha. Efficacy had one item <.3 (.23) and if deleted the Cronbach’s alpha would have remained the same for this factor, .78. Collegiality had three items <.3 and the maximum increase in Cronbach's alpha if items were deleted was .09 (from .34 to .43).

The slight increases in Cronbach's alphas due to item deletion were not large enough to convince me to delete the items as they were specified in the model in 2005. While the overall model had poor fit when using 2008 data, examination of the identified factors, as presented in Table 10, showed adequate internal consistency in 2008 and 2013, except for one, collegiality. These nine factors, served as the dependent variables to address the evaluation questions in this study.

Descriptive statistics for the identified factors in 2008 and 2013 with the 23 participating teachers are shown in Table 11.

Table 11

Descriptive Statistics for Teacher Survey Factors 2008 (n=23) and 2013 (n=23)

Factors	# of Items	*M*		*SD*		Skewness		Kurtosis		95% CI of the Mean			
										L	U	L	U
		2008	2013	2008	2013	2008	2013	2008	2013	2008		2013	
Hands-on	9	3.20	2.90	0.59	0.43	0.24	-0.41	-0.09	1.54	2.94	3.46	2.72	3.09
Empowerment	10	4.11	4.10	0.52	0.40	-0.41	-0.50	-0.36	0.21	3.89	4.34	3.92	4.27
Inquiry	9	3.08	2.97	0.59	0.45	-0.51	-0.88	-0.43	1.79	2.82	3.34	2.78	3.16
Traditional	4	3.33	3.28	0.88	0.60	-0.08	0.26	-0.26	0.50	2.95	3.71	3.02	3.54
Efficacy	10	3.85	3.87	0.53	0.46	0.03	-0.25	-0.20	-0.73	3.62	4.08	3.68	4.07
Collegiality	4	2.18	2.32	0.48	0.55	-0.36	0.68	-0.24	0.40	1.97	2.40	2.08	2.55
Strategies	12	4.01	4.11	0.57	0.52	-0.03	-0.30	-1.01	0.28	3.76	4.26	3.88	4.33
Diversity	8	4.39	4.49	0.42	0.43	-0.85	-1.18	0.35	0.98	4.20	4.57	4.30	4.67
Evaluation	2	2.75	3.04	1.12	1.01	0.50	0.34	-0.20	-0.77	2.25	3.25	2.61	3.48

Note. Scales for all factors ranged from 1 to 5.

The means and standard deviations remained fairly consistent for the 23 participants through time. Skewness in 2008 and 2013 revealed a majority of the values were <0 indicating a left skewed distribution with most values concentrated to the right of the mean. Kurtosis values in 2008 revealed all but one of the values (Diversity .35) were <0 and in 2013 all the values were

>0 except for two (efficacy -0.73, and evaluation -0.77). Overall, skewness and kurtosis values don’t identify any major departures from normality.

Qualitative Data Sources

Three sources of qualitative data were included in the sustainability study: district administrator interviews, teacher interviews, and observations of science instruction. The teacher interview and observation forms were implemented during the RCT (2005-2008). The district administrator interview was added for the sustainability study. The qualitative tools are described below.

District administrator interview. The district administrator interview was composed of 17 semi-structured questions under seven topic areas (Appendix H: District Administrator Interview). The first set of questions focused on the current school district reforms being implemented and turnover of school administrators and teachers. The next section asked the interviewee to reflect on the implementation of Teaching SMART® from 2005-2008. There were three questions in the next section on the plan for sustainability, and two questions about support from leadership. Two questions were asked about ongoing professional development in the school district and the interview ended with two closing questions. The questions were generated from the literature review on facilitators and barriers of treatment interventions.

Teacher interview. The semi-structured teacher interview consisted of 23 open-ended items (Appendix I: Teacher Interview). There were five general topics in the interview. The first section of the interview focused on the teacher’s instructional assignment, such as what grade levels and content areas he/she was teaching, and whether or not he/she was team teaching or co-teaching. This section was followed by questions about how often and what types of strategies were used while teaching science. The third section targeted the teacher's attitude toward science while the fourth section asked about professional development activities. The last section included questions specifically about the teachers' opinions of the Teaching SMART® professional development program that they participated in, including changes they perceived to have made in their instructional practices. The teacher interview questions were based on the interview guide used during the RCT from 2005-2008 with additional questions included on sustainability that were generated out of the literature review.

Classroom observation. During the observation of science instruction, the four mirror coaching forms created by Teaching SMART® were completed along with open field notes that documented what was occurring in the observation without specified parameters. Field notes were taken to capture student and teacher activities, questioning, and general observations about the science lesson. The four forms focus on the main Teaching SMART® instructional strategies: (1) Cooperative Grouping, (2) Equity Techniques/Career Applications, (3) Language Used /Questioning Techniques, (4) Scientific Method/Process Skills (Appendices B, C, D, and E).

The "Cooperative Grouping" form focused on the Teaching SMART® suggested roles that were to be assigned to the students. Teaching SMART® encouraged the assignment of roles to ensure that all students have the opportunity to participate in an activity. While the use of roles was a required method, teachers could use roles other than the Teaching SMART® suggested ones. The Teaching SMART® suggested roles were:

- Engineer: keeps the group in task and encourages participation by all students;
- Materials Manager: picks up all materials needed for the activity and ensures that all materials are cleaned and properly returned;

- Recorder is the student who will record the procedural information, data, and results;
- Reporter is the student who reports to the class; and
- Quiet Captain ensures that the group is quiet.

It was the teacher's responsibility to monitor the assignment of roles so that every student had the opportunity to participate in each role.

The "Equity Techniques/Career Applications" form documented the use of equity techniques used in the science lesson, such as wait time to allow all students the opportunity to think, while career applications were made for the students to see connections between what they were learning in the lesson to real life. The "Language Used/Questioning Techniques" form focused on the use of gender-specific or gender-neutral language and the use of open-ended or closed questioning. Lastly, the "Scientific Method/Process Skills" form documented the use of the scientific method during the lesson. Field notes documented the events that occurred during science instruction and provided contextualization to situate the four forms.

Institutional Review Board

The University of South Florida's Institutional Review Board (IRB) was informed of the study through the application of initial review. All research and evaluation studies conducted through universities by faculty members and/or students are required to follow this process. The application was reviewed by members of the IRB committee to ensure the rights and welfare of human subjects were protected. Similarly, an application to conduct research was submitted to the participating school district as required by the school district's research and evaluation office. Both USF's IRB and the school district's research and evaluation office approved this study (Appendix J: IRB Approval Letter).

Upon approval to conduct the study from USF's IRB and the school district's research and evaluation office, an official request to identify the teachers remaining in the school district was made via email to a school district liaison. When the school district supplied an updated list of teachers remaining in the district, a letter, approved by USF IRB and the school district, was sent to the principals of the schools where the teachers were located to inform them of the study.

Data Collection Procedures

Following the sequential, equal status, embedded mixed method design, the survey was administered and respondents to the survey were subsequently invited to participate in the qualitative research. Below is a description of the procedures used during data collection for both the quantitative and qualitative components.

Quantitative Survey Administration

All the teachers who met the inclusion criteria to participate in the sustainability study's end-of-year teacher survey were sent an email with information about the study, consent, and a link to the online survey (created using Qualtrics). In 2008, teachers were administered a hard copy survey, but in communication with a school district administrator, online survey administration was recommended. Teachers who clicked on the link were directed to the online survey that contained an informed consent statement and an option not to participate in the study. The 110-item online survey took approximately 20 minutes to complete. Confidentiality of participants was maintained by restricting access to the individual responses to the investigator only.

After one-week, a reminder to each non-responding teacher was sent along with a hard copy of the email (in the form of a letter), informed consent, and survey was sent to each teacher with a deadline of one-week for completion. A self-addressed, postage paid envelope was included for ease of return of the completed survey. The survey response rate was 40.4%. Each teacher who completed the survey (either on-line or hard copy) was entered into a raffle for a drawing for an iPad mini (approximate value of $350). Once the two-week window closed, all of the respondents were eligible for the iPad mini raffle. To select a winner for the raffle, an ID code that was assigned to each respondent was written on a piece of paper and placed in a bowl. One number was randomly selected by an unbiased, third-party person (the researcher's daughter). An email was sent notifying the winner of the iPad mini and a mutually agreed upon date, time and location to deliver the prize was determined.

Qualitative Research Procedure

Teachers who responded to the online or hard copy version of the teacher survey were contacted via email to solicit participation in the qualitative case study component of the sustainability study. Three teachers responded positively to being interviewed but of the three, only one teacher agreed to be observed teaching science. All three teachers were scheduled for their interview at a time most convenient for them. Teacher One selected her planning period for the interview and the science observation occurred immediately following her planning period. The interview took approximately 60 minutes and the observation lasted 90 minutes. Teachers Two and Three elected to be interviewed after school. Both of their interviews lasted approximately 45 minutes. Neither of these teachers wanted to be observed teaching science due to the close proximity to the end of the school year.

Two district level administrators who were knowledgeable about the implementation of Teaching SMART® from 2005-2008 and who had remained in the same position since then served as key informants. As key informants, the district administrators were purposively selected based on the specialized knowledge and information they had. A semi-structured interview was conducted at a day and time specified by each district administrator and took approximately 60-minutes to complete with each administrator.

All interviews were audio-recorded with permission from the participants using a digital recorder. Participant IDs were used on the recordings and subsequently as file names in the electronic databases used for data management and analyses to ensure confidentiality. To further safeguard the data during data collection, the digital recorders were password protected and encrypted. The computer storing the data was also password protected.

Data Analysis

Following the mixed method design of the sustainability study, both quantitative and qualitative analyses were conducted and integrated to provide a fuller understanding of how and why teachers who participated in the Teaching SMART® professional development program continued, discontinued, or adapted their instructional practices through time. The data sources and analyses conducted to address the research and evaluation questions are summarized in Table 12 and described below by question.

Research question 1 and 1a. The guiding research question was "What do teachers who participated in Teaching SMART® (2005-2008) and district administrators share about the sustainability of Teaching SMART® practices in 2013?" The subquestion was "What Teaching

SMART® instructional practices are evident from an observation of a teacher's science lesson in 2013?"

Qualitative data analysis consisted of three, iterative phases: data reduction, data display, and data interpretation (Miles & Huberman, 1994). Due to the iterative nature of qualitative data analysis, these three phases did not occur sequentially. To address research question one, qualitative data analysis of the district administrator and teacher interview data were conducted

Table 12

Summary of Research and Evaluation Questions, Data Sources, and Method of Analysis

Research Question	Data Sources	Method of Analysis
1. What do teachers who participated in Teaching SMART® (2005-2008) and district administrators share about the sustainability of Teaching SMART® practices in 2013? a. What Teaching SMART® instructional practices are evident from an observation of a teacher's science lesson in 2013?	Qualitative: District administrator (*n*=2) and teacher (*n*=3) interviews Teacher observation field notes and four mirror coaching forms (*n*=1)	Constant comparative approach (Glaser, 1992; Glaser & Strauss, 1967; Lincoln & Guba, 1985) to coding interview data to develop themes.
Evaluation Questions	**Data Sources**	**Method of Analysis**
1. What teaching strategies do teachers who participated in the Teaching SMART® professional development program (2005-2008) utilize in their science classrooms five years post implementation (2013)? a. Compared to 2008, is there an increased, decreased, or sustained use of student-centered learning activities in 2013? b. Compared to 2008, is there an increased, decreased, or sustained use of teacher-centered learning activities in 2013?	Quantitative: Survey factors (Hands-on; Inquiry; Traditional; Efficacy; and Collegiality) Qualitative: Teacher interviews (*n*=3)	Group mean change for all participants (*n*=23); Alpha teachers (*n*=16); and Beta teachers (*n*=7) (dependent *t*-tests); individual mean change (reliable change index) Constant comparative approach (Glaser, 1992; Glaser & Strauss, 1967; Lincoln & Guba, 1985)

Table 12

(Continued)

2. What perceptions about the roles of females in science, technology, engineering, and mathematics (STEM) do teachers who participated in the Teaching SMART® professional development program (2005-2008) have five years post implementation (2013)?	Quantitative: Survey factors (Strategies; Diversity; and Evaluation)	Group mean change for all participants (*n*=23); Alpha teachers (*n*=16); and Beta teachers (*n*=7) (dependent *t*-tests); individual mean change (reliable change index)
a. Compared to 2008, is there an increased, decreased, or sustained use of equity based teaching strategies in 2013?	Qualitative: Teacher interviews (*n*=3)	Constant comparative approach (Glaser, 1992; Glaser & Strauss, 1967; Lincoln & Guba, 1985)
3. What classroom management techniques do the teachers who participated in the Teaching SMART® professional development program (2005-2008) use five years post implementation in 2013?	Quantitative: Survey factor (Empowering)	Group mean change for all participants (*n*=23); Alpha teachers (*n*=16); and Beta teachers (*n*=7) (dependent *t*-tests); individual mean change (reliable change index)
a. Compared to 2008, is there an increased, decreased, or sustained use of the Teaching SMART® roles during lessons in 2013?	Qualitative: Teacher interviews (*n*=3)	Constant comparative approach (Glaser, 1992; Glaser & Strauss, 1967; Lincoln & Guba, 1985)
b. Compared to 2008, is there an increased, decreased, or sustained use of small, cooperative learning groups during lessons in 2013?		

to generate themes following the constant comparative approach (Glaser, 1992; Glaser & Strauss, 1967; Lincoln & Guba, 1985) using the qualitative analytical software, ATLAS.ti v. 6.2.

The constant comparative approach, as presented by Glaser and Strauss (1967) and Lincoln and Guba (1985), allowed for the development of themes from narrative or open responses by breaking the text into units of information and then categorizing the related units.

This method facilitated data reduction. Glaser (1992) stressed the use of systematic comparison for categories to emerge. Categories became codes and were applied to similar text. As an example, the teacher interview excerpt below highlights how text was interpreted for meaning and applied a code:

> Researcher: When teaching science, what strategies do you use to encourage student inquiry?
>
> Teacher One: Just lots of hands-on where they are working together and I have jobs [for the students].

The teacher's response to the interview question about instructional strategies to encourage student inquiry was categorized as "using hands-on activities and jobs." The codes, "hands-on" and "job," were applied to this segment of text. All subsequent responses about using hands-on activities and/or jobs as instructional strategies during science instruction were coded with these codes. As codes emerged from the interview data, a codebook was created to facilitate keeping track of the codes (Appendix K: Qualitative Code Book). In all, 20 codes were generated. Using the query tool in ATLAS.ti v. 6.2, output (coded text) was generated and subsequently organized in tables to display the data for ease of analysis. The themes that emerged from these data are presented in Chapter Four.

To address research question 1a, classroom observation data, field notes and the four mirror coaching forms (Appendices B-E: Cooperative Grouping; Equity Techniques/Career Application; Language Used/Questioning Techniques; Scientific Method/Process Skills) from Teacher One's class was used. Field notes were typed and the four forms completed. Observational data were integrated in the case study write-up for this teacher and added to the contextualization of her science instructional practices.

Evaluation question 1. Evaluation question one had a stem question with two subparts: What teaching strategies do teachers who participated in the Teaching SMART® professional development program (2005-2008) utilize in their science classrooms five years post implementation (2013)? a. Compared to 2008, is there an increased, decreased, or sustained use of student-centered learning activities in 2013? b. Compared to 2008, is there an increased, decreased, or sustained use of teacher-centered learning activities in 2013?

The analysis for this question and subparts was mixed method. Descriptive statistics, mean, standard deviation (*SD*), skewness, and kurtosis were analyzed using SAS v. 9.3 for the teacher survey items (2008 and 2013) composing the factors of the construct, instructional activities in science and teacher opinions about science. The exploratory factor analysis revealed four factors for the construct instructional activities in science. Specifically, the group means for three factors, hands-on, inquiry, and traditional teaching activities were used to address this evaluation question and both subparts. The fourth factor for the construct instructional activities in science, empowering, focuses on instructional activities that enable and encourage student participation in science activities. This factor is used to address evaluation question 2. Additionally, both survey factors of the construct, teacher opinions about science, (efficacy and collegiality) were used to address this evaluation question and subparts. The *t*-test for paired observations, dependent *t*-test, was used to compare means for teacher's responses in 2008 and 2013 for the identified factors, and for Alpha teachers (teachers who received three years of the intervention) and Beta teachers (teachers who received two years of the intervention) from 2008 and 2013. Confidence intervals were reported to indicate the size and direction of the results. Individual teacher change scores were calculated using the reliable change index to provide findings at the individual level (Jacobson & Truax, 1991; Zahra, 2010). Type 1 error rate was controlled at alpha level .05 at the comparison level given concerns of power. To augment the findings, qualitative data from the teacher interviews were analyzed following the constant comparative method described above to generate themes.

Evaluation question 2. Evaluation question two included a stem question and one subpart: What perceptions about the roles of females in science, technology, engineering, and mathematics (STEM) do teachers who participated in the Teaching SMART® professional development program (2005-2008) have five years post implementation (2013)? a. Is there an increased, decreased, or sustained use of equity based teaching strategies compared to 2008?

The analysis for this question and subparts was mixed method. The mean, standard deviation (*SD*), skewness, and kurtosis were analyzed using SAS v. 9.3 for the teacher survey items (2008 and 2013) composing the factors of the construct, teacher comfort teaching science. The exploratory factor analysis revealed three factors for this construct: strategies, diversity, and evaluation. All three factors were used to address this evaluation question and subpart. The strategies factor was comprised of items that addressed teacher's comfort using different assessment strategies and instructional strategies to meet standards and involve students. The diversity factor items focused on teacher's comfort teaching science to students with diverse abilities and students with disabilities. The evaluation factor items targeted teacher's comfort being videotaped teaching and self-assessing the video lesson. The evaluation factor did not directly address this evaluation question, but reviewing their instructional practices via video may be a strategy teachers use to assess their own biases in the classroom, such as calling on one gender of students over the other or specific students. Together, these factors provide data on teacher's comfort using instructional strategies to meet the needs of students with diverse needs as well as females in science. The *t*-test for paired observations, dependent *t*-test, was used to compare means for teacher's responses in 2008 and 2013 for the identified factors, and for Alpha teachers (teachers who received three years of the intervention) and Beta teachers (teachers who received two years of the intervention) from 2008 and 2013. Confidence intervals were reported to indicate the size and direction of the results. Individual teacher change scores were calculated using the reliable change index to provide findings at the individual level. Type 1 error rate was controlled at alpha level .05 at the comparison level given concerns of power. In addition, teacher and district interview responses were analyzed following the constant comparative approach to develop themes.

Evaluation question 3. Evaluation question three had a stem question and two subparts: What classroom management techniques do the teachers who participated in the Teaching SMART® professional development program (2005-2008) use five years post implementation in 2013? a. Compared to 2008, is there an increased, decreased, or sustained use of the Teaching SMART® roles during lessons in 2013? b. Compared to 2008, is there an increased, decreased, or sustained use of small, cooperative learning groups during lessons in 2013?

The analysis for this question was also mixed method. Descriptive statistics for the construct, instructional activities in science, were analyzed in SAS 9.3. The exploratory factor analysis revealed four factors for this construct. One of the factors for this construct, empowering, was used to address this evaluation question and subparts a and b. The empowering factor was comprised of items that addressed strategies to involve students in their own learning through the use of roles and cooperative groups. The *t*-test for paired observations, dependent *t*-test, was used to compare means for teachers' responses in 2008 and 2013 for the identified factors, and for Alpha teachers (teachers who received three years of the intervention) and Beta teachers (teachers who received two years of the intervention) from 2008 and 2013. Confidence intervals were reported to indicate the size and direction of the results. Individual teacher change scores were calculated using the reliable change index to provide findings at the individual level. Type 1 error rate was controlled at alpha level .05 at the comparison level given concerns of power. Qualitative data from the teacher interviews were analyzed using the constant comparative method to generate themes in ATLAS.ti v.6.2.

Summary

The mixed method design of the sustainability study includes the use of three main data sources to answer the research and evaluation questions guiding the study. Quantitative data, teacher survey responses from 2008 and 2013, were analyzed to address the evaluation questions by comparing group means for the total sample in 2013 (n=23) and by type of teacher (Alpha n=16; Beta n=7) by conducting a dependent t-test and confidence intervals for factors identified in the exploratory factor analysis conducted in 2005. To look at individual changes through time, the reliable change index was conducted for each evaluation question. The data were analyzed in statistical analysis program, SAS v. 9.3 and the RCI calculator (Zahra, 2010), based on Jacobson & Truax's (1991) formula, was used to calculate individual change scores.

The qualitative data consisted of interview and classroom observational data. Interviews were conducted with two district administrators and three teachers, a subsample of teachers who responded to the survey and volunteered to participate in the qualitative component of the study. One of the interviewed teachers was observed teaching science. The observational data consisted of field notes and the completion of four mirror coaching forms. The constant comparative approach was used to analyze the data and develop themes. Case studies of the three interviewed teachers were generated. The qualitative data addressed the research questions and provided contextualized data for the three evaluation questions.

Ensuring Credibility

To ensure credibility of the data and subsequent findings, multiple methods were used to compensate for limitations inherent in the methods, such as the potential for research bias in qualitative analysis and producing quantitative knowledge that is too general or abstract for direct application to individuals or local contexts (Johnson & Onwuegbuzie, 2004). Dellinger and Leech (2007) presented a validation framework that built on what was known in mixed method literature regarding validity. In their validation framework, Dellinger and Leech (2007) added a foundational element that "reflects researchers' prior understanding of a construct and/or phenomenon under study" (p. 323). Due to the my familiarity with the Teaching SMART® program and the teachers who participated in the professional development program during the RCT, 2005-2008, there was a potential threat to internal credibility. Onwuegbuzie and Leech (2007) refer to this type of threat as research bias which occurs "when the researcher has personal biases or a priori assumptions that he/she is unable to bracket" and may subconsciously affect participant behavior and attitudes (p. 236). To reduce the effect of researcher bias, some of the strategies recommended by Onwuegbuzie and Leech (2007, p. 242) were followed:

- Using unobtrusive measures where possible, such as sitting in the back of a classroom during an observation and not bringing attention to myself.
- Making the research intentions clear and providing an opportunity for participants to see the data collected from them (member-checking).
- Triangulating data.

- Keeping the research questions in mind.

While there is no one way to ensure credibility of qualitative data, the use of the strategies mentioned next and multiple methods facilitated dependability and trustworthiness. Multiple sources of data were gathered in this sustainability study and used to compare and combine data through triangulation, the combination of several research methodologies in the study of the same phenomenon (Bogdan & Biklen, 2006). Quantitative survey data and qualitative interview and observational data were combined at the data interpretation phase in the analysis process to triangulate teacher's perceptions of their practice as reported in the survey, how they describe their practice in the interview data, and what was actually observed during classroom instruction.

Interview transcripts were transcribed and shared along with case-study write-ups with participating teachers, who served as member checks. Member-checking is the process where researchers share categories and interpretations with the participants to confirm or identify if something is missing or misrepresented (Goldblatt, Karnieli-Miller, & Neumann, 2011). Interviewed teachers were sent their transcript via email as well as their case study write-up for their review.

Following a critical realism perspective about external validity, data from this study should not be assumed to be generalizeable to other contexts. Zachariadis, Scott, and Barrett (2013) summed up, "the same relationship may appear but not involve exactly the same mechanisms, or may not appear, but this does not imply that the specific mechanisms were absent because they might have been counterbalanced by the presence of other mechanisms" (p. 861). Context and the mechanisms, in this study, factors, are important considerations when implementing reform with different populations and/or locations.

Evaluator's Role

In the randomized control trial conducted 2005-2008, I was the project director and lead qualitative researcher. As project director, I communicated with the school district, participating school administrators, and teachers to obtain permission and consent, schedule data collection activities, and ensure all project activities were conducted as planned. As the lead qualitative researcher, I led all the observation and interview data collection activities. I participated in all the professional development activities led by both the Teaching SMART® project specialist and the site specialists working with the teachers in the Teaching SMART® program. As a result, I had an in-depth understanding of the Teaching SMART® program and how it was implemented by both the site specialists and classroom teachers.

My involvement in the randomized control trial implementation study informed the sustainability research in a number of ways. First, I developed close contacts with the developers of Teaching SMART®, school district and school administrators in the treatment and control schools, and the teachers in both the treatment and control conditions. While my familiarity with the school district administrators facilitated their involvement as key informants to my study, none of the three teachers who participated in the qualitative research component remembered me. For the teachers who participated in the quantitative, survey, component only, I have no way of knowing if they recognized me. All of the participants, teachers and district administrators, were informed of the link between the sustainability study and the RCT that they participated in from 2005-2008. One possible drawback that may have resulted from the participants' familiarity with the prior study and knowing that this study was looking at sustainability of that program was that they may have behaved according to how they thought they should. This is referred to as researcher bias (Onwuegbuzie & Leech, 2007) or reactive effect (Gall, Gall, &

Borg, 2007) where participants react to cues as to what is expected and is an example of a threat to validity.

The terms internal and external evaluations distinguish between evaluations conducted by program employees and those conducted by outsiders (Fitzpatrick, Sanders, & Worthen, 2004). An internal evaluator brings familiarity to the organization and is onsite; whereas the external evaluator brings greater credibility and perceived objectivity, typically more breadth and depth of technical expertise, and has knowledge of how other similar organizations or programs work (Fitzpatrick, Sanders, & Worthen, 2004). In randomized controlled trials, where an evaluation will cross multiple sites, such as in the case of large scale experimental studies, technical expertise and objectivity are desirable characteristics. However, insider knowledge is extremely useful and should not be discounted. As an external evaluator, there are approaches to evaluation that involve stakeholders so that their views and ideas are incorporated. My role in the study was as an external evaluator with some measure of familiarity of an internal evaluator.

Chapter Summary

In this chapter, the methodology used to address the research and evaluation questions was presented. The research question addressed how and why practices have been sustained, modified, or discontinued through interview and observations data. The evaluation questions focused on the long-term objections as specified in the Teaching SMART® logic model and whether or not teachers participating in the Teaching SMART® professional development program increased, decreased, or sustained their use of programmatic features and strategies compared to 2008, the end of the implementation phase. Together, the research and evaluation questions facilitated documentation of how a reform was sustained, or not, five years post implementation. The next chapter, chapter four, presents the results of the research and evaluation data analyses.

CHAPTER FOUR:

FINDINGS

This sustainability study sought to determine what practices from a professional development program that occurred from 2005-2008 were sustained, or not, five years post-implementation in 2013 as well as evaluate whether or not the long-term objectives of the Teaching SMART® professional development program were met. This chapter provides the findings from the teacher survey that was administered in 2013 to those teachers who participated in Teaching SMART® in 2008 and met the inclusion criteria, along with in-depth case study documentation of the district context and three individual teachers who were interviewed to explore factors that influenced an increased, decreased, or sustained use of Teaching SMART® strategies.

Research and Evaluation Questions

The research and evaluation questions that guided the sustainability study are presented in Table 13 with an overview of the findings by question. Following Table 13, findings are presented by each question.

Table 13

Overview of Findings by Research and Evaluation Questions

Research Question	Findings
1. What do teachers who participated in Teaching SMART® (2005-2008) and district administrators share about the sustainability of Teaching SMART® practices in 2013? a. What Teaching SMART® instructional practices are evident from an observation of a teacher's science lesson in 2013?	Identified themes are obstacles to sustainability: • Economic recession; • Teacher turnover and reorganization; • Shifting reform policies; • Suggestions to facilitate sustainability. No facilitators to sustainability were identified. Observational data revealed the partial use of cooperative learning and equity-based learning strategies, and full use of open-ended questioning, gender neutral language, the scientific method and process skills for students
Evaluation Questions	**Findings**
1. What teaching strategies do teachers who participated in the Teaching SMART® professional development program (2005-2008) utilize in their science classrooms five years post implementation (2013)? a. Compared to 2008, is there an increased, decreased, or sustained use of student-centered learning activities in 2013? b. Compared to 2008, is there an increased, decreased, or sustained use of teacher-centered learning activities in 2013?	Survey factors, inquiry-based and traditional instruction, teacher efficacy teaching science and collegiality found no statistically significant difference for the 23 teacher respondents and Alpha and Beta teachers from 2008 to 2013. One factor, hands-on, found a statistically significant decrease in teachers' reported use of hands-on activities in science from 2008 to 2013 for all 23 participants and Alpha teachers. At the individual level, four of the 23 teacher's change scores were statistically significant (two teachers had positive collegiality RCI indicating an increase of support from colleagues; one teacher had a positive efficacy RCI indicating an increase in knowing how to teach science effectively; and one teacher had a negative hands-on RCI indicating a decrease in use of hands-on activities. Qualitative data revealed a perceived decline in inquiry-based and hands-on science activities due to integration of science readers in 90-minute reading block.

Table 13

(Continued)

2. What perceptions about the roles of females in science, technology, engineering and mathematics (STEM) do teachers who participated in the Teaching SMART® professional development program (2005-2008) have five years post implementation (2013)? a. Compared to 2008, is there an increased, decreased or sustained use of equity based teaching strategies in 2013?	Survey factors, strategies, diversity, and evaluation, revealed no statistically significant difference for the 23 teacher respondents and Alpha and Beta teachers from 2008 to 2013. At the individual level, two of the 23 teacher's change scores were statistically significant. One teacher had positive change scores for strategies and diversity and another teacher also had a positive change score for diversity indicating an increase in use of equity-based strategies for those teachers. Qualitative data revealed the use of job roles and cooperative groups as equity-based strategies.
3. What classroom management techniques do the teachers who participated in the Teaching SMART® professional development program (2005-2008) use five years post implementation in 2013?	Survey factor, empowerment had no statistically significant differences for the 23 teacher respondents and Alpha and Beta teachers from 2008 to 2013. At the individual level, none of the 23 teacher's change scores were statistically significant from 2008 to 2013.
a. Compared to 2008, is there an increased, decreased or sustained use of the Teaching SMART® roles during lessons in 2013?	Qualitative data revealed the use of job roles, cooperative groups, and providing opportunities to students to relate to science as classroom management strategies.

Research Question 1 and 1a

Qualitative data analysis of interview addressed the research questions, What do teachers who participated in Teaching SMART® (2005-2008) and district administrators share about the sustainability of Teaching SMART® practices in 2013? And, What Teaching SMART® instructional practices are evident from an observation of a teacher's science lesson in 2013?

To address research question 1, themes from the interview data analysis revealed that the district administrators and teachers identified obstacles to sustainability of reform practices. The themes were: the impact of the economic recession, teacher turnover and reorganization of the school district, shifting reform policies, changes in professional development and delivery, and lastly, suggestions for facilitating sustainability. No facilitating factors to sustainability of reform practices were identified, only perceived obstacles and suggestions for what could have been done to facilitate sustainability of practice. Each theme is presented below and is followed by case studies of the three interviewed teachers. Their case studies provided additional contextualization of the themes identified from interview data.

Research question 1a, What Teaching SMART® instructional practices are evident from an observation of a teacher's science lesson in 2013?, was addressed by observational data from Teacher One. This question was addressed within Teacher One's case study write-up.

District Context: Economic Recession

Prior to the implementation of Teaching SMART® in 2005, the school district experienced a very rapid period of growth that reflected the economic upswing of the mid-2000s. The housing market in the school district, which is the entire county, was booming and as a result the school building program was too. It was a period of growth for the school district; as new schools were built, teachers were hired to fill the newly created positions. When the housing market collapsed and the economy overall began to decline around 2008, the needs of the school district changed. School district key informant #2 summed up the economic impact on the district that was occurring at the time Teaching SMART® was ending in 2008:

> Unfortunately the economic downturn beginning in 2008 and slightly earlier than that, by cognition in 2008, resulted in a massive decline in our growth so much so that student

enrollment was either stagnant or dropped, the building program just fell out, when the building stopped so did the paychecks, and as the paychecks stopped it increased the amount of poverty in the schools and what the students were experiencing and with the increase in poverty came some really different kinds of needs expressed by the students. We not only saw our free and reduced lunch rates rise at all levels, kindergarten all the way through 12th grade but we saw increasing issues with homelessness among our students as their families lost their homes to foreclosures. I think we were one of the highest foreclosure rates in the nation at one point. And we are not too far off of it today. So the changes that first occurred were systemic changes about the needs of students. We also have our own employees who for six years have not had a raise. We are the largest employer in the County, the school district, and those people have had no raises. We also had with each, next budget crunch that came, we have laid off employees in record numbers for our school district, during my 30 years here anyway, and all of those economic impacts of course impacted the schools as well that also created some of the turnover that we are seeing, you know, dissatisfaction with the status quo when the status quo is uncomfortable leads people to make changes.

The county's residents and school district suffered financially from the economic downturn that started when the implementation of Teaching SMART® was ending.

Table 14

School District and County Economic Indicators from 2006 to 2012

	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
# of Schools	67	72	74	82	84	84
# District Employees	>9000	>9200	>9700	>9400	>9350	>9289
Income						
Median Household	$41,939	$44,526	$42,212	$40,154	$40,154	$40,766
Per Capita	$23,095	$23,782	$22,822	$21,524	$21,524	$22,327
% Free/reduced Lunch	44%	45%	49%	52%	53%	54%
% Below Poverty	10%	12%	12%	13%	13%*	15.7%
% Unemployed	3.4%	6.8%	12.2%	12.7%	11.7%	9.9%

*Reported by 2009 U.S. Census Bureau

Annual superintendent reports from that time period highlights the economic impact on the county and school district. Table 13 includes economic indicators reported in the 2006-2007, 2007-2008, 2008-2009, 2010-2011, and 2011-2012 annual superintendent reports.

The impact from the country's economic downturn affected the county's residents and school district as reported in the annual superintendent reports from 2006/07 through 2011/12. In this period of time, 17 new schools were opened but only approximately 300 new district employees added. This suggests a reduction in the number of positions across all schools and at the district level. Income indicators, median household and per capita, peaked in 2007/08 and as of 2011/12, have not yet recovered. The percent of students eligible for free and/or reduced lunch rose steadily from 2006 with over half of the students eligible. The percent of families below the poverty level also rose from 2006 to 2012 (10% to 15.7%, respectively). The percent of unemployed residents doubled from 2006/07 to 2007/08 and then almost doubled again from 2007/08 to 2008/09. In 2011/12, the percent of unemployed residents was almost triple to the percent in 2006/07. Overall, the school district and county's residents were financially affected by the overall economic downturn that occurred across the country during the time period following the implementation of Teaching SMART®.

Teacher Turnover and Reorganization. The economic downturn in the county influenced the school's budget and staffing needs at the school and district levels. As a result, turnover occurred. In terms of instructional staff, the school district, according to district administrator #2, "had been rapidly growing and hiring between 600 and 1200 teachers a year." The last year of Teaching SMART® implementation, in 2008, was the first year the school district did not reappoint annual contract people. This is significant to the sustainability of Teaching SMART® because the three site specialists who conducted all the professional development trainings for Teaching SMART® were district contract employees. Therefore, at the end of their contract in 2008, they either retired or were re-hired in an instructional position. Their professional development positions were eliminated. Additionally, the 2008/09 school year was the first year the school district did not hire teachers, rather, they cut over 400 teaching positions, followed by an additional 200 positions in 2009/10 and 100 positions in 2010/11 (district administrator #2 interview). In 2011/12 there were no lay-offs but in the current school year, 2012/13, according to district administrator #2, "we eliminated the positions of media specialists, literacy specialists, technology specialists and are putting them into one [position]." Merging positions are part of the overall plan to reorganize the school district that resulted from having a new superintendent.

The change in superintendence was one of the biggest recent changes for the school district. The former superintendent served eight years and was seeking re-election when he/she lost the primary. The new superintendent, former assistant superintendent of the school district, began his/her new position in the 2012-2013 school year.

The new superintendent decided to re-organize the school district according to recommendations that were made from a survey that was conducted by the Florida Association of Superintendents (FAS) during the former superintendent's term, according to district administrator #2. Starting in the 2013-2014 school year, the school district will be organized into four geographic regions. Each region will have a Learning Communities Executive Director overseeing the region, two Common Core specialists who will function as instructional coaches to teachers, a staff development specialist who will focus on the professional development needs of the region, an Information Communication Technology Specialist, a newly created position for instructional technology (IT) in each region rather than IT personnel at each school, resulting in school-based media and technology specialist positions to be eliminated, a Compliance Specialist to ensure each region is in compliance with federal mandates, and a Resolution Specialist. District administrator #1 explained, "The superintendent did some reconfiguring of staff here at the district level so instead of having multiple assistant superintendents, there are two, an assistant superintendent of teaching and learning and an assistant superintendent for school facilities and support." District administrator #1 clarified that turnover at the school district level has mainly been due to retirement or re-assignment as a number of district employees assumed newly created positions resulting from the reorganization.

Shifting reform policies. Since the end of implementation of Teaching SMART® in 2008, the school district has had a number of reforms occur that have affected teaching and learning. Senate Bill 736, the Student Success Act, according to district administrator #2, "has impacted what we do in terms of the courses that we offer and drives the decision making that we are in right now about how are we going to implement professional development." As a result of the Student Success Act, the school district shifted to end-of-course assessments for biology, algebra, and geometry from fourth, eighth and eleventh grade science FCAT. The school district participates in Race to the Top, a federal grant program, that if you received the money, explained district administrator #2, "you institute a pay for performance plan that had to include teacher evaluation results that were tied to some type of additional value that the teachers added." In tandem to Race to the Top, the Student Success Act delineated the requirements for the value-added model used in Race to the Top. District administrator #1 explained that the school district is using Marzano's framework (Learning Science International, 2013) to observe and evaluate teacher performance as part of the value added model. In the value-added model, explained district administrator #1, "students' scores are tied directly to teachers' performance. It has played a big role and a huge toll on teachers overall."

Marzano's teacher evaluation model consists of over four domains with 60 elements. Domain 1: Classroom Strategies and Behaviors is composed of the most elements, 41, and according to Learning Science International (2013), the developers of the model, "is shown in causal studies to have the most direct effect on student performance" (p. 1). Domain 2: Planning and Preparing consists of eight elements and is directly related to Domain 1. Domain 3: Reflecting and Teachers consists of five elements and focuses on "teachers' awareness of their own instructional practices (Learning Science International, 2013, p. 1)". Domain 4: Collegiality and Professionalism is composed of six elements to capture school environment and the teachers' and administrators' roles. In the 2012/13 school year, district administrator #1 explained, "we have been on Domain 1, instructional practices, and really haven't been able to hone in on [the other domains]. Everyone is still learning the process, those strategies, and it's very difficult for them to go to the next step."

State regulations from the Department of Education regarding the amount of uninterrupted reading blocks that the students receive, influences science instructional time while, at the same time, there is a push toward science, technology, engineering, and mathematics (STEM) education. Additionally, the state of Florida adopted the Common Core State Standards, referred to as simply "Common Core," in 2010 with full implementation required in the 2014-2015 school year. According to the mission statement for Common Core (Council of State School Officers, & National Governors Association, 2012, p. 1), "The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers." To prepare for full implementation of Common Core, the school district "backwards planned," explained district administrator #2, by determining where students need to be and then started in the lower grades to ensure students are prepared when it is time to be assessed. District administrator #2 explained, "we started blending the next generation Sunshine State Standards with what we understood for Common Core three years ago in Kindergarten, first grade this past year, second grade this year, and then next year third grade." The school district is providing this scaffolding for students to ensure they are receiving the content that they are going to be assessed on. District administrator #2 stated, "Time will tell if we are rolling the right dice," in terms of content emphasis as students are assessed in Common Core areas.

The curriculum since Teaching SMART® was implemented has moved to an online format that keeps the curriculum maps together. The school district uses Know, Understand, and Do for the curriculum with Essential Questions built in. Their pacing is set with the new standards for teachers to follow. During Teaching SMART®, district administrator #1 explained, "The curriculum was integrated, we had flipcharts that had quarterly, primary, and intermediate focus for grades three through five, now the curriculum is very grade specific." An online format resulted in a shift in teacher resources from a reliance on textbooks, which also influenced instruction to move away from being text-driven. A consumable workbook may be used along with "whatever resources teachers have that help them to best reach the standards," stated district administrator #2.

During the implementation of Teaching SMART®, the school district prided itself on having continuous progress classrooms, that is, classrooms composed of multiple grades such as third through fifth, third and fourth, or fourth and fifth grades. Due to retention policies from the state where third graders are retained if minimum requirements for FCAT are not met, the school district has formally stopped configuring continuous progress classes. However, according to district administrator #2, the philosophy remains: "students' need to be able to matriculate through the system as their needs dictate instead of as chronological age dictates."

Changes in professional development delivery and focus. With the new reform priorities being implemented in the school district, professional development for teachers has changed. The school district created a "training expectation form," according to district administrator #2 who explained, "We now expect teachers to reflect on how they were using the learning that they had received," rather than "sit and get." Professional development at the school district has focused on preparing teachers for Common Core and administrators for evaluating teachers as part of Marzono's framework in response to Race to the Top. District administrator #2 clarified:

> We didn't spend a lot of time with our teachers deepening their knowledge of what those elements are in domain one [of Marzono's framework]. I don't mean this the wrong way, we always emphasized planning, but I don't know if we ever got to the level of where we need to be for Common Core so we are looking then at the framework and then we are also putting together Common Core training where we really go through our professional learning communities to create those collaborative structures where the teachers can really talk about what they are asking students to do, is what they are asking students to do being measured, is it being effective, and what do they need to do next?

Professional learning communities (PLCs) are being restructured to focus on preparing teachers for the Common Core. Department chairs and grade level persons are being eliminated and replaced with PLC facilitators for the 2013/14 school year. PLCs will continue to meet weekly and will focus on how, as a professional learning group, they are collaborating "to understand what it is our students' know, what we want them to understand, and what they can do then how are we measuring what we are doing when they don't reach that mark" (district administrator #2).

Due to budget constraints, professional development on a large-scale has been difficult to implement. District administrator #1 explained, "With the amount of teachers we have and what we know about professional development, it is not just a make and take, we have to have the follow-up supports along the way. So with what we know about effective practices for professional development, we are not able to offer as much." Strategies the school district incorporated are to have blended professional development where teachers attend face-to-face and via online environments as well as use PLCs to provide ongoing support to teachers throughout the year.

Suggestions to Sustain Teaching SMART®. During the implementation of Teaching SMART®, school administrators were asked if their school would participate in the RCT implementing the program, but were not invited to participate in the implementation of the professional development program because the reform focused on teachers and did not include administrators. To support the continuation of reform practices, district administrator #1 pointed out the necessity of having school administrator support and involvement to prioritize strategies learned during the reform as well as identifying key teachers to support continuation of these practices:

> To really make sure that the instructional leaders at the school administrative staff were involved with some of the professional development so that it would have continued to be a priority with them. Also to have key contacts, key teachers that would serve as lead teachers there at the school to also maintain the integrity of the program as it closed out.

School administrator support for continuing the use of reform strategies as well as key teachers to facilitate the use of instructional strategies learned during the implementation of the program is necessary for continuation. However, school-based support was largely absent. District administrator #1 cited an isolated example of teachers at one school where Teaching SMART® was implemented who decided to teach science to students after release time when the principal was in the parking lot because there was no support provided to them due to the major emphasis placed on reading and mathematics.

To facilitate maintenance and growth of the program post-implementation, district administrator #1 highlighted the importance of the three site specialists who worked with the teachers. The specialists provided ongoing support to teachers during the implementation of the program. However, the site specialists were not able to continue in their positions post-Teaching SMART® due to budget constraints to support their positions. District administrator #2 pointed out the lack of a plan for sustainability stating, “There was a fairly decent plan for professional development associated with it [Teaching SMART®] but I don’t know what happened with that for sustainability.” There was no funding to support the professional development site specialist positions as 2008 was the year that the school district did not reappoint contract people and terminated staff due to the budget shortfall resulting from the economic downturn.

The Teaching SMART® professional development program required an abundance of science consumable materials that teachers would need to conduct science experiments. The lack of funding to replenish consumable materials hindered sustainability. District administrator #2 asked, “How do we financially arrange this for the future when there is no source of funding and an economic downturn?”

To support sustainability of Teaching SMART® instructional strategies, district administrator #2 pointed out the importance of aligning the program with what was already occurring in the school district. This administrator stated, “People are truly weary of the next big thing and to me Teaching SMART® was not the next big thing, it was a solution that would have applied across the board if we would have been able to implement it across the board.”

Teacher Case Studies

Three teachers who responded to the teacher survey in 2008 and 2013 agreed to participate in an interview and one of them also agreed to be observed (Teacher One). Each of the teachers' experiences and ideas about sustainability of Teaching SMART® is presented below, in turn.

Teacher One. Teacher One participated in the Teaching SMART® professional development program for two full years as a Beta teacher, from 2006-2008. During the implementation of Teaching SMART®, she taught a continuous progress class consisting of students in grades three and four. In 2013, she taught third grade. When she participated in Teaching SMART® in 2006, she was a newer teacher, having taught about two years. She described her teaching back then as "very hands-on and interactive with the children" and was pleased that the Teaching SMART® program was "more student-led and I was more of like a coach. So that was the way I have kept science and really for the most part all of my teaching." Two years after Teaching SMART® ended, her school closed and she transferred to the school in which she currently teaches. The school she transferred to was also a Teaching SMART® school, but she was not aware of any other former Teaching SMART® teachers at the school. However, she stated in her interview that she gave a copy of her Teaching SMART® notebook that contained all the Teaching SMART® lessons to a teacher who also taught science and had a lab where she conducted experiments.

Teacher One pointed out that the Teaching SMART® program highlighted cooperative groups and that she continued to teach that way. Her classroom was arranged into groupings of four or five desks and all around the room are science materials and in one she has area animals-quails, ant farm, and butterflies to name a few. She explained that she is a teacher who enjoys teaching science:

> I am not afraid of science where unfortunately so many teachers are afraid of science. I will break out the owl pellets at the beginning of the year, we dissect bananas, we have a garden outside and we are always observing the plants, we have carrots growing and we grow beans, we've got quails incubating over there so you know, it's constant.

With all the activities she discussed in her quote above, she concluded that her biggest weakness with teaching science was not having enough time to do everything she wanted to do. There was a mandated 90-minute reading block where science was incorporated. She explained, "I hold guided reading groups so the children need to be doing something [when she is working with each reading group] so there are centers…obviously not science experiments but there are wonderful readers that I have the children work together on." Due to time constraints, Teacher One incorporated science into the mandated 90-minute reading block where reading is emphasized, not experiments.

Research question 1a: What Teaching SMART® instructional practices are evident?

Teacher One's classroom was observed and provided insight into what instructional practices from Teaching SMART® she continued to use in her classroom. Her classroom was a portable off the main building. There were four groupings of desks with four or five desks in each grouping. There was no teacher desk. The teacher told the researcher before the observation that she removed her desk because it took up space and she never sat behind it; instead, the teacher had a six foot table in place of a desk. The table was used for multiple purposes: for reading groups, as a center, and to put materials on [which was the case of the lesson that was observed]. There was a large whiteboard that went along the entire wall at the front of the room. There was one computer and a printer on a table near the front door. The teacher stated that the school has a cart full of laptops that can be checked out and used by the students. However, she explained that her students mainly used the computer in the class to complete assignments. Along the left side wall were displays of science activities and animals. There were fish, an ant farm, geranium, and the remnants of a butterfly growing house. There were containers of science goggles for each group at the front of the room. Shelves ran along the walls and were full of books and containers with materials. The classroom looked like it was full of materials and was more organized than disorganized yet about to burst at the seams. The back door led to a green space around the back of the portable and along one entire side. The class had planted a vegetable garden and the teacher had a special see-through container that carrots are grown in so that the students can observe them growing in the dirt. In the interview, the teacher explained how she acquired materials: she takes them out of other teacher's trash or other teachers give it to her because they know that she wants them. The see-through carrot container was taken out of another teacher's trash. It was in the original box, never used. The teacher explained to me in her interview that most teachers don't want to take the time to use science materials so she has been very successful in getting all the materials she needs or wants from others who aren't using them.

The observation occurred at the end of the school day. The students returned to the classroom at 2pm from specials, PE, and the lesson started within minutes of their arrival. Below are the field notes from the observation. My comments are bracketed; "T" indicates the teacher, "S" refers to the students. The teacher started the lesson by proclaiming:

T: We are going to do a little experiment today.
Many S: Yes!
S: That's a good word! [Student is referring to the word "experiment"]

S: Let me get my goggles! [In the teacher interview, the teacher said that when they do science they always wear their goggles, even when they aren't doing anything with liquids because the students love wearing them and it makes them feel like scientists.]

T: Not yet. [The teacher does a charade of what they will be investigating and students call out what they think. After a few guesses, the students figure out that they will be conducting a lesson with a flying object.]

T: We are going to be doing an experiment that involves flying, you are right. Let's talk a little about flying – what are some ways things can fly?

Many S call out: wings, air, pilot, force

T: Why force?

S: gravity pulls it down so need force to pull up.

T: very good! [The students continue to guess]

S: engine

T: do we need an engine?

A number of S: No, there are gliders! Parachutes.

T: Remember when we saw gliders… [She brings up a time they all saw gliders to relate to real life. Students continue to name other flying objects].

S: Hot air balloon

T: Remember the picture I took of the hot air balloon? [Again, the teacher relates the student's comment to real life] Talk in groups about different ways to fly.

[Students discussed a minute or two in their groups]

T: you are going to create something that flies. [Students are all excited]. There are materials on the back table for you to use. You will create a plan of what you will build and what materials you will need.

S: a blue print

T: yes, and you are going to use your journals. The purpose of this activity is - you are going to have a delicate passenger, very delicate, that you must get to the ground in one piece. [The teacher reaches into a box and pulls out…]

Many S: an egg! Ohhhh!

T: you have to create something to get the passenger to the ground safely. One person will drop the flying machine to the ground; about 6 feet and we will see if any of you can keep the egg safe. Tools, materials are up here. [The teacher walked to the back table and told the students what materials were there by calling out the objects while holding them up for them to see]

T: funnels, beans, rubber bands, white bags, Publix plastic bags, Styrofoam cups, chalk, straws, paper cups, plates, plastic knives, pipe cleaners, tin foil, our famous coffee filters [apparently an inside joke with the students because they all laughed], toothpicks, dessert shells [the kind used for strawberry shortcake], and tissue paper.

T: Talk together to determine how to create a flying object. Sketch out a plan. Team leaders get out journals, goggles.

[There was a lot of talking as the students tried to determine what they wanted their flying machine to look like and what materials they will be using.]

T: you have 7 minutes. [The teacher went to one of the groups and told them to have 1 minute to review the materials on the table and then they can go back to their group to talk about it.]

T: Once you have your materials, begin creating. I am giving you your passenger in a baggie and it must remain in the baggie for obvious reasons. I will allow you to go back to the materials table one more time [it became clear that as students were creating their flying machines they underestimated what materials they would need and how much. Also, it seemed that at least one group realized that their design wasn't very well thought out and were re-designing as they were creating. Three of the groups decided to do parachutes and one group was really focused on protecting the egg and not on the flying object. That group had made wings out of aluminum but they did not know how to attach them to the Styrofoam cup holding the egg.].

[A special education teacher entered the room. She works with two students with IEPs in this class and there was a writing exercise that she was going to do with them. She did not pull the two students from class because they were so actively engaged in the lesson. She stayed in the back of the classroom near me and watched them. The special education teacher turned to me and said, "[This teacher] always has interesting activities and uses cooperative learning. Most teachers can't handle this level of noise, but it's good noise."]

T: 3, 2, 1, alright, you are finished. Each group present what you did, your plan. We want to observe what you created and hear your plan. [Each group had a volunteer to report out to the class.]

T: Think about your design and the other team's design. Take one minute to make a prediction about which design you think will not break the egg when dropped.

[Each team discussed and it sounded like most of them thought that their design was the best – except for the fourth team who seemed pretty sad that they had no parachute like the other 3 teams to help their egg. All the teams had spent a lot of time protecting the egg.]

T: Take your flying object and line up to go outside.

[Everyone lined up and went down the steps outside the portable. The teacher called each group to select one person who would drop the egg. All of the eggs remained intact. Back in the classroom, they discussed the activity and what they would do differently next time.]

The four Teaching SMART® mirror-coaching forms were completed for this observation to document how the teacher addressed each of the major components of the program. The four forms are: Cooperative Grouping, Equity Techniques/Career Application, Language Used/Questioning Techniques, and Scientific Method/Process Skills (Appendices B-E).

The Cooperative Grouping form included observations of the roles assigned to students and their job description. In this observation, there was a team leader and a materials collector.

- Team Leader: this student was already assigned to each grouping of 4-5 desks. The team leader was instructed to assign someone in the group to be a "materials collector" to get the needed materials from the table. In actuality, multiple group members helped collect the materials, including the team leader. The team leaders also appeared to get the goggles for their group instead of the assigned materials collector. After talking with the teacher, it became clear that the teacher alternates who the team leader is for the group on a regular basis. Everyone at the group becomes team leader at some point.

- Materials collector was to be selected by the team leader. However, the other members of the team all wanted to participate so, in each group, 2 to 4 members of the team went to the materials table to gather the needed materials.

The roles, or jobs, team leader and materials collector were Teaching SMART® strategies. There was no designated recorder or reporter, the other two roles that Teaching SMART® encouraged. Instead, in each group, every student wrote up the design and what materials would be needed in their science journals. When it was time for each group to present on their design and talk about how they decided what to do, in most cases it was the team leader who presented but not for every group.

In this observation, the Teaching SMART® roles that were taught during the professional development program were not used completely, only partially. During the interview, Teacher One confirmed, “They did talk about jobs and they are very specific in Teaching SMART®, but I find that I don’t ever use them.” The teacher had her own system of assigning jobs to students that involved a colored dot on each student’s desk. They teacher would call out a specific color for a task or to answer a question. The teacher preferred the colored dot system because, she said that it was quick and easy for her to use. In the observed lesson, the teacher did not use the colored dots for identifying the materials collector, recorder, and presenter. Instead, students participated however they wanted.

The form, Equity Techniques/Career Application, consisted mainly of noting the equity techniques that were observed being used in the lesson.

- Gender equity: The groups were gender diverse (2-3 males and 2-3 females in each group). The designated team leaders for each group was also diverse (not all males or all females but instead a mixture).
- Ensuring all students participate: The teacher did not use a systematic way of calling on students. The teacher's color dot system, described earlier, is a method that would ensure participation by all students. However, that method was not used during the lesson that was observed.

In this observation, Teacher One grouped the students to ensure gender diversity. The teams were composed of a split of males and females and the team leads varied by gender as well. The teacher's colored dot system that she described in her interview was not used in this observation. No instructional method to ensure each student had an equal opportunity to participate was observed, including the Teaching SMART® strategies of using job roles within each group.

The form, Language Used/Questioning Techniques, revealed gender neutral language was used as well as scientific/academic language, such as goggles, predict, present, design, create a plan, and reference to using journals to name a few. Additionally, Teacher One used a number of open-ended questions throughout the lesson and encouraged students to discuss within their groups to reach consensus. The gender neutral and scientific language used and open-ended questioning during this observation aligned with Teaching SMART® instructional practices.

The form, Scientific Method/Process Skills, revealed that the majority of the scientific method and processing skills taught by Teaching SMART® were present in the observed lesson.

The purpose of the lesson was stated by the teacher: to create a flying machine that would protect an egg when dropped six feet. Students predicted what they thought would happen in their groups. Think time was given to the groups to allow them time to design their flying machine and to plan for the materials they would need. Try time, conducting the activity, consisted of building their flying object and testing it to determine if it protected the egg. Lastly, they were given share time, each group presented to the class their design and then after the activity they discussed the results and what they learned. During the experiment, students used the following scientific processing skills: predicted the result of the activity, observed the flying objects and outcomes, inferred or explained what they observed, communicated about the activity throughout the lesson within their teams, to other class, and documented in their journals. During the introduction to the lesson and in the wrap-up the teacher related aspects of the activity to the real world to assist students in making meaningful connections in their life.

This observation provided the data to answer research question 1a, What Teaching SMART® instructional practices are evident from an observation of a teacher's science lesson in 2013? It was evident from the observed lesson that Teacher One the Teaching SMART® roles that were taught during the professional development program to encourage cooperative learning were not used completely, only partially. Equity instructional techniques consisted of grouping the students to reflect gender diversity but there were no observed strategies to ensure all students had an opportunity to participate. The language used and open-questioning methods used in this observation aligned with Teaching SMART® instructional practices. Similarly, the observation revealed the scientific method and processing skills were used well by both the teacher and the students.

Sustainability of Teaching SMART® practices. Teacher One incorporated science activities and experiments into the day, in spite of not having a dedicated time for science. When asked what she learned and still practices today from the Teaching SMART® program, she stated:

> They [Teaching SMART® site specialists] taught me that it is not a teacher directed thing. The children have to make their own decisions and I guide them so I am a coach and they are the leaders really. Some of the lessons that I learned, organizing and getting things together before the lesson, bringing in the career aspect of it is very important.

When reflecting on the strengths of the program, Teacher One highlighted her assigned site specialist and the notebook of Teaching SMART® lessons that every teacher received as a resource. The three site specialists were each assigned up to 25 teachers. Site specialists went into the classrooms of their assigned teachers and either modelled specific Teaching SMART® practices or strategies or observed and provided feedback to the teacher to facilitate their learning and growth. The notebook of lessons was a resource that was mentioned as being very useful during the implementation of Teaching SMART® and was kept by Teacher One to use as needed. Noting her own professional growth with teaching science, Teacher One stated, "I looked at the manual last night and the lessons that are in the Teaching SMART® manual I thought were great, and now I think, not so much." Teacher One explained that she still used some of the lessons each year and named the following: meal worm, the solar oven; owl pellets, as ones she used without any adaptations. Other lessons, such as the one that was observed (Create a Helicopter in Teaching SMART®), have been adapted by merging Odyssey of the Mind principles, an educational program that focuses on problem-solving principles. Teacher One explained, "I am very involved with Odyssey of the Mind so I come up with a lot of my hands on things with Odyssey of the Mind and this is one that came from there but I incorporated

Teaching SMART®." Teacher One has continued some practices of Teaching SMART®: use of specific lessons, career integration, and cooperative grouping; adapted some Teaching SMART® strategies, such as roles by using her colored dot system, and merged Teaching SMART® lessons with other curricula, specifically, Odyssey of the Mind.

The weakness of the program, according to Teacher One, was not having more time with her site specialist. This weakness speaks volumes to the perceived strength of the site specialists to provide support to teachers in the classroom. When asked what assistance she currently received for enhancing her science instruction, Teacher One replied, "I am pretty much on my own." Teacher One stated that she typically attended at least one summer professional development training for one of the content areas, depending on what was offered from the district. During the school year, teachers at her school participated in professional development every Thursday morning for the Common Core standards. The reading coach at the school provided the weekly training but that position was terminated for the next school year (2014) as part of the restructuring of the school district. The greatest strengths of the professional development that Teacher One had participated in since Teaching SMART® were learning "different ways to easily bring it into the classroom and to have access to science materials." The greatest weakness of the science professional development were "not enough" offerings, according to Teacher One.

Teacher Two. Teacher Two was an Alpha teacher (participated in all three years) during the implementation of the Teaching SMART® professional development program. Back then, she taught a continuous program class consisting of third, fourth, and fifth graders. Today, she remained at the same school and taught fifth grade general education and was a gifted teacher too. All of the fifth grade teachers planned together; some of Teacher Two's fifth grade colleagues were former Teaching SMART® teachers. When asked how she would describe her current teaching strategies for science and how she has evolved since Teaching SMART®, Teacher Two responded, “Or devolved, I would say, because the curriculum that we are expected to use now doesn’t really, it’s not inquiry, it’s read and do projects and read and read.” Teacher Two explained that the emphasis on Common Core resulted in infusing science into the 90-minute reading block. She stated,

> In the beginning of the year, we had a specific set time, a half hour before we went to specials. Then we started getting more information about Common Core and started infusing it into our reading so we would read nonfiction whether it was social studies or science.

When Teaching SMART® was implemented, Teacher Two explained that science experiments using the inquiry method were conducted. Once Teaching SMART® ended in 2008, being held accountable for teaching experiments ended too. Teacher Two stated, “In Teaching SMART® we were required to do at least a certain number of lessons. I think that forced a lot of people who didn’t do science as often to make them do it.” Now, Teacher Two said that she taught an experiment “maybe one a week” and followed several of the Teaching SMART® strategies. She used roles to ensure that everyone in a group had a job and collaborated. She said that she incorporated careers by asking the students questions. By asking the students what careers related to the lesson, Teacher Two allowed the students to lead the discussion while she facilitated.

For professional development opportunities, Teacher Two said she did not get assistance from colleagues or administrators at the school because she was “pretty good with science.” She stated, “Science is cool because if you don’t know something, you can have the kids find out the answer and then that incorporates technology or them going home to talk to their parents.” Teacher Two attended formal science training offered at the district, such as interactive science notebook trainings and trainings on force and motion. She stated, “Anytime they [the school district] offer something over the summer I have attempted to go to it.” What attracted her to specific professional development trainings were those that provided “make-and-take”. Something that is relevant.” As an example, Teacher Two described the force and motion professional development that she attended the prior summer, “They set it up just like inquiry and you have like five different rotations and you have a notebook to take notes.” Participating in the rotations and writing about it in the notebook was valuable, according to Teacher Two because “it’s make-and-take without the stuff because you actually did the experiment there so you know how it was supposed to turn out.” Aside from the district provided professional development opportunities, none were provided at the school for science.

Sustainability of Teaching SMART® practices. Teacher Two emphasized the Teaching SMART® notebook of lessons as the biggest take-away for her and was still a resource she used. According to Teacher Two, her team of teachers has discussed doing a lot more of the Teaching SMART® lessons “because we realize how well it was for our FCAT.” During the implementation of Teaching SMART®, the school’s FCAT science scores for fifth grade “blew all the other schools away, it was really, really good.” In the years following the implementation of Teaching SMART®, Teacher Two confirmed that their science FCAT scores declined as the use of Teaching SMART® lessons and strategies were discontinued.

The biggest strengths of the Teaching SMART® program, according to Teacher Two, was the binder of lessons, incorporating experiments, “more than having to read stuff in books”, and being observed by the site specialist who was able to step in and assist as needed. Additionally, Teacher Two pointed out the strength of having a continuous progress class, “if you had those kids for three years you were able to do a lot of the projects in the binder,” rather than do the same ones each year with a new group of students. The weaknesses of Teaching SMART®, according to Teacher Two, were relating the content of the experiment to the job force, simplifying the vocabulary or providing pictures if the students did not understand scientific terms, and making sure all the materials were available for a lesson. During Teaching SMART® implementation, participating schools were provided with all the non-consumable materials, such as microscopes, goggles, and dissecting kits, and consumables for specific lessons, but not all needed materials due to some required items being perishable (i.e. bananas for the dissecting lesson) and some materials assumed to be available in the classroom (i.e. paper).

Teacher Two confirmed that Teaching SMART® practices and strategies were mainly discontinued at her school. She maintained the use of job roles, cooperative learning, specific lessons from the program, and the inquiry method when she was able to fit in an experiment during the school day. However, the emphasis on Common Core and the 90-minute reading block limited the opportunity to teach science using an inquiry method. For the 2013/2014 school year, Teacher Two stated that the current principal, who was in her second year at the school, indicated to her that teaching science inquiry may be allowed next school year. Additionally, Teacher Two pointed out that with the reorganization at the district level and priorities, administrators "are realizing we don't have the materials and resources here to hit those Common Core Standards so I think they may be backing off a little bit and letting us be teachers." Teacher Two and her team of teachers have started discussing preparations for science next year and the possibility of using the Teaching SMART® notebook of lessons.

Teacher Three. Teacher Three participated in all three years of Teaching SMART® professional development (she was an Alpha teacher) and has remained at the same school.

Teacher Three confirmed that there was one other teacher on her grade level team who also participated in Teaching SMART®. Grade level teams planned together for 50-minutes once a week. During the implementation of Teaching SMART®, Teacher Three taught a continuous progress class consisting of fourth and fifth graders and currently taught fourth grade general education. Next school year, 2013/2014, Teacher Three stated she will be teaching all the mathematics and science for two fourth grade classes as part of a mathematics and science STEM emphasis. The teacher explained, "Math and science are my weaker areas but I did it because we are starting the Common Core and this will give me a lot of time to spend with the standards and get to know them better."

Science instruction over the past few years, according to Teacher Three, has been impacted on the 90-minute reading block, and state assessments, FCAT and Florida Writes (tested only at the fourth grade level). To prepare for Florida Writes, there was a mandated 60 minutes of straight writing instruction. The new emphasis on Common Core for mathematics and reading has also influenced science instruction. Teacher Three explains:

> Science has turned into: we teach it really strong the first quarter, we don't teach it at all the second and third quarter, and then fourth quarter, as soon as Florida Writes and FCAT are over, that's all we do is science.

The 90-minute reading block, according to Teacher Three, was used to "build the background knowledge so that when they got to fourth quarter we would just do the activities." During the 90-minute reading block, students read nonfiction books related to science topics, but "it's not like true science." When asked what other policies have affected science instruction, Teacher Three pointed out that science and mathematics shared a block of time but that mathematics has a required timeline specifying dates when chapters have to be completed. Teacher Three explained,

> All the chapters have to be completed prior to FCAT. So trying to teach an entire year prior to FCAT and then we still have to have a two-week window at the end to review and a two-week window at the beginning to review the skills from third grade. What we find in fourth grade, because they spend so much time trying to pass the reading FCAT in third grade, is that they lack in math. So you are filling in a lot of gaps which slows down on the timeline.

The timeline is set by the school district and the teachers' schedules are set by the school. When teaching science in the first quarter, Teacher Three said she taught using the inquiry method and using some of the Teaching SMART® strategies and lessons. Teacher Three stated,

> First quarter we spent a lot of time with scientific method and brought in some of the SMART teaching. Fourth quarter is not as much inquiry but we cover standards we didn't and do experiments to make new things connect.

To facilitate science instruction using experiments and the inquiry method, Teacher Three accessed Teaching SMART® non-consumable resources that remained at the school, such as microscopes, goggles, and dissecting kits. To supplement the science resources, the school principal allocated some Title 1 money to purchase science materials. The principal gave Teacher Three the money to order needed materials. Teacher Three described the process of identifying what science materials were needed:

> I went through all the stuff we had from SMART, it was kind of a mess. So we cleaned out the mess and then went back and ordered. We used the SMART list to kind of guide us too.

Teaching SMART® site specialists, during implementation of the program, ordered all the materials needed each year and provided participating teachers with a list so they would know what was ordered. Teacher Three used this list to order science supplies with the Title 1 money the principal allocated for science.

Sustainability of Teaching SMART® practices. When asked what happened after Teaching SMART® implementation ended in 2008, Teacher Three responded, "It pretty much disappeared." For Teacher Three, the main take-away from the program was the notebook that contained all the lessons. She explained, "The notebook was very laid out for you which was really nice. It minimized the amount of planning." Teacher Three incorporated a number of Teaching SMART® instructional strategies and practices. During her interview, she mentioned a number of lessons from the Teaching SMART® notebook that she used every year. For her, the notebook was one of the main strengths of the program. When teaching lessons from the program, Teacher Three clarified, "we bring in the careers some, we don't bring them in as much as when we were actively with SMART…that's kind of faded away. But we do talk a lot about gender so that's something that stayed." Incorporating careers into lessons was one strategy that was not used often while the emphasis on gender equity remained. Additionally, Teacher Three stated that she used cooperative groups and the jobs for students as strategies to engage and encourage collaboration.

The main weaknesses of the Teaching SMART® program, according to Teacher Three, "wasn't the program, it was within the classrooms to be able to apply the program." Not having the time to teach science was the biggest obstacle during the implementation of the program. For Teacher Three, the Teaching SMART® program made her focus on science more. She explained, "It made science less stressful because of the way it was set up and organized and having the resources. That was a huge benefit."

To assist Teacher Three and her colleagues with science instruction, the school district sent a coach to plan with the teachers on her team and design science lessons based off the science text, but that was the extent of one-on-one guidance. According to Teacher Three, "It's not a priority right now, especially with Common Core changing and things like that." Teacher Three tried to attend a summer professional development training if there was something offered to use in her classroom. For the upcoming summer, she was planning to attend training on mathematics and science Common Core standards since she will be teaching that next school year.

In the next section, the quantitative findings from the survey data are presented by evaluation question. Qualitative data were incorporated into the evaluation questions findings to provide contextualization of how the findings relate to practice.

Evaluation Question 1: Sustainability of Teaching Strategies.

On the teacher survey of instructional practices, teaching strategies are composed of two types, student-centered learning activities and teacher-centered learning activities. Student-centered learning activities are composed of the factors inquiry and hands-on, while teacher-centered learning activities are captured by the factor traditional. The factor, inquiry, allows students to design and implement their own science experiments; hands-on instruction allows students to conduct science activities; and traditional instruction strategies are mainly driven by the teacher and textbooks. In addition to these three factors, two related instructional factors, efficacy and collegiality were also included in the analysis to address this evaluation question. Teacher efficacy refers to a teacher knowing how to teach science concepts effectively and enjoy teaching science. Teacher collegiality refers to teachers having the support of their colleagues to try new ideas in teaching science and regularly observe each other teaching science. Both of these factors may influence teacher instructional strategies in science and were therefore included in this analysis.

Table 11, Chapter Three, includes descriptive statistics (means, standard deviations, skewness, kurtosis, and 95% confidence intervals) for each factor from 2008 and 2013 for the participating sample (n=23). As reported in Table 11, means for each factor in 2008 and 2013, inquiry (*M*=3.08, *SD*=0.59; *M*=2.97, *SD*=0.45), hands-on (*M*=3.20, *SD*=0.59; *M*=2.90, *SD*=0.43), and traditional (*M*=3.33, *SD*=0.88; *M*=3.28, *SD*=0.60), indicated that on average teachers reported "sometimes," once or twice a month, using these instructional methods to teach science. Means for teacher opinions about teaching science in 2008 and 2013 revealed that teachers reported "neutral/uncertain" about knowing how to teach science concepts effectively and enjoy teaching science for the factor efficacy (*M*=3.85, *SD*=0.53; *M*=3.87, *SD*=0.46); and teachers reported "disagree" to having the support of their colleagues to try new ideas in teaching science for the factor collegiality (*M*=2.18, *SD*=0.43; *M*=2.32, *SD*=0.55).

Table 15 displays the mean differences from 2008 and 2013 survey responses, standard deviation of the difference scores, confidence intervals, *t*-values with *df*(22), and *p*-values for each factor. A paired *t*-test revealed that there were no statistically significant differences ($p>.05$) from 2008 to 2013 for the factors inquiry, traditional, efficacy, and collegiality. One factor, hands-on, had statistically significant differences ($p<.05$) from 2008 to 2013. By taking the mean difference of .30 and dividing by the pooled standard deviation of 0.52, the effect size was estimated to be .58 indicating about a half of standard deviation drop.

Table 15

Difference Means, Standard Deviations, Confidence Intervals, t-values (22) and p-values for Teaching Strategies Factors (n=23)

Factors	*M*	*SD*	Alpha 95% CI Lower	Upper	*t*-value (22)	*p*-value
Inquiry	.11	0.61	-.15	.47	.87	.39
Hands-on	.30	0.59	.04	.45	2.41	.02[a]
Traditional	.04	1.02	-.40	1.02	.20	.84
Efficacy	.01	0.58	-.25	.58	.07	.94
Collegiality	.11	0.57	-.36	.44	-.94	.36

Note: [a]$p<.05$

These findings demonstrate no statistically significant difference for the 23 teachers through time regarding their perceptions of using inquiry-based (student-centered) and traditional (teacher-centered) teaching strategies. Similarly, there were no statistically significant differences for the 23 teachers through time regarding their perceptions of efficacy and collegiality. Positive mean differences for each factor indicated slightly higher means in 2008 than reported in 2013, though not statistically significant. However, one factor, hands-on, revealed a positive statistically significant difference from 2008 to 2013. This means that teachers in 2008 reported using more hands-on science activities with their students than in 2013.

Similarly, a paired *t*-test for Alpha teachers' survey scores (*n*=16) and Beta teachers (*n*=7) revealed that there were no statistically significant differences (*p*>.05) from 2008 to 2013 for the factors inquiry, traditional, efficacy, and collegiality (Table 16).

Table 16

Difference Means, Standard Deviations, Confidence Intervals, t-values (15; 6) and p-values for Teaching Strategies Factors by Alpha (n=16) and Beta (n=7) Teachers

Teacher Type	Factors	*M*	*SD*	Alpha 95% CI Lower	Upper	*t*-value (15; 6)	*p*-value
Alpha	Inquiry	-.01	0.63	-.34	.46	.49	.96
Beta	Inquiry	.22	0.62	-.35	.40	.97	.36
Alpha	Hands-on	.27	0.52	-.00	.39	2.10	.05[a]
Beta	Hands-on	.34	0.75	-.36	.75	1.18	.28
Alpha	Traditional	.00	0.90	-.48	.66	.00	1.00
Beta	Traditional	.14	1.33	-1.09	1.34	.28	.79
Alpha	Efficacy	-.03	0.57	-.33	.57	-.22	.83
Beta	Efficacy	.12	0.63	-.55	.39	.45	.67
Alpha	Collegiality	-.01	0.51	-.28	.51	-.07	.95
Beta	Collegiality	-.12	0.45	-.59	.45	-.65	.54

Note: [a]*p*<.05

One factor, hands-on, had statistically significant differences (*p*<.05) from 2008 to 2013 for Alpha teachers, but not Beta teachers. By taking the mean difference of .27 and dividing by the pooled standard deviation of 0.46, the effect size was estimated to be .59 indicating about a half of standard deviation drop. This finding indicated that Alpha teachers in 2013 reported a decrease in hands-on activities with their students compared to 2008.

At the individual teacher level, change through time for each of the factors was calculated using the Reliable Change Index statistic (Jacobson & Truax, 1991). Table 17 shows individual teacher's RCI scores for each factor. A negative RCI score indicates a decrease in perception of use of the type of teaching strategy, inquiry-based, traditional, hands-on, efficacy, and collegiality, while a positive RCI score indicates a perceived increase in use of the type of teaching strategy. A change score of $\pm$1.96 is statistically significant. The RCI score was not calculated one teacher (Teacher Twenty-one) for the factors traditional, efficacy, and collegiality due to missing data for all of the items for those factors. None of the individual teacher's change scores were statistically significant for the factors inquiry and traditional. For the inquiry factor, 14 of the teachers had negative RCI scores, eight had positive RCI scores, and one had no change (RCI= .00). The hands-on factor had 14 teachers with negative RCI scores, one teacher (Teacher 21) had a statistically significant negative change score (RCI= -2.22), nine had positive RCI scores. The factor traditional had 11 teachers with negative RCI scores, eight had positive RCI scores, and three had no change. For the efficacy factor, 13 teachers had negative RCI scores, nine had positive RCI scores, one teacher (Teacher Seventeen) had a statistically significant positive change score (RCI= 2.06). The collegiality factor had nine negative change scores, 11 positive change scores including one statistically significant change score (Teacher Fifteen, RCI = 3.36), and two with no change.

Qualitative data provided a more in-depth look into three of the Teaching SMART® teacher's instructional strategies as discussed in their individual interviews. Teacher One described being able to incorporate hands-on activities into her science instruction, in spite of time constraints due to the mandatory 90-minute reading block and the emphasis on incorporating science into the reading block. Teacher One's individual change scores, shown in Table 17, had small, non-significant, positive change scores for perceived use of inquiry (RCI= .16) and collegiality (RCI= .96) indicating an increase from 2008; negative change scores for perceived use of hands-on activities with her students (RI= -.52), traditional instructional strategies (RCI= -1.26), and efficacy teaching science (RCI= -.95) indicating a decrease from 2008.

Table 17

Individual Teacher RCI Scores for Teaching Strategy Factors (n=22)

Teacher	Inquiry	Hands-on	Traditional	Efficacy	Collegiality
1	.16	-.52	-1.26	-.95	.96
2	-.64	-1.19	1.69	-.16	-1.44
3	1.45	.50	.63	-.48	-.48
4	.31	.17	.00	.16	.48
5	-1.30	-1.86	1.05	1.11	-.48
6	-.64	.17	-.42	.95	-1.44
7	.96	1.36	-.84	1.27	1.44
8	-.96	-.85	-.42	-.32	.48
9	-.65	-1.34	-.42	-.63	1.44
10	-.64	-.35	.63	-.95	.96
11	-1.13	-.67	-.63	-.32	-.48
12	-.17	-.84	.00	-1.43	.96
13	-.32	-.17	-.42	.48	-.48
14	-.41	-.69	.42	-.16	-.96
15	.81	.34	-.21	-.95	3.36[a]
16	.65	.34	.63	.16	-.48
17	.00	.69	-.42	2.06[a]	.48
18	-.97	-1.36	.00	-.63	-.48
19	.96	.17	.42	.63	.00
20	-.49	-.84	-.21	-.32	.00
21	-1.64	-2.22[a]			
22	1.79	.34	1.69	1.27	.48
23	-.23	-1.52	-.84	-1.11	.48

Note: [a]Statistical significance RCI= ±1.96

Teacher Two described her science instructional strategies as "devolved" from the time of Teaching SMART® due to the emphasis on Common Core and incorporating science into the 90-minute reading block. Teacher Two's individual change scores, shown in Table 17, indicate negative change scores for use of inquiry-based practices (RCI= -.64), perceived use of hands-on activities (RCI= -1.19), efficacy teaching science (RCI= -.16), and collegiality (RCI= -1.44). Though not statistically significant, the change scores show a decrease in perception of her use of science inquiry, hands-on activities, and knowing how to teach science and enjoying it (efficacy) as well as support from her colleagues (collegiality) since 2008. There was a positive change for traditional instructional activities (RCI= 1.69) indicating the perceived use of more traditional instructional activities, though none of her change scores were statistically significant. This teacher noted in her interview that she was teaching fewer science experiments due to lack of instructional time and not being held accountable to teach a certain number of lessons as she was during Teaching SMART®.

Teacher Three confirmed in her interview that the 90-minute reading block and preparation for the state assessments, FCAT and Florida Writes, have limited the amount of time spent teaching science during the school year. Teacher Three's individual change scores, shown in Table 17, indicate positive change scores for inquiry (RCI= 1.45), hands-on (RCI= .50), and traditional (RCI= .63). These scores show non-statistically significant increases in perceived used of inquiry-based strategies, hands-on activities, and traditional strategies since 2008. A negative change score for efficacy (RCI= -.48) indicates a non-statistically significant perception in knowing how to teach science effectively and enjoying science and a negative change score for collegiality (RCI= .48) indicated a perceived decrease in support from other teachers. Teacher Three explained in her interview that she taught science inquiry the first quarter of the school year and then hands-on experiments the fourth quarter. The second and third quarters of the school year were focused on preparation for the state assessments and maintaining science knowledge through readers incorporated into the 90-minute reading block.

All three of the former Teaching SMART® teachers had non-statistically significant change scores since 2008 according to the teacher survey results for these factors. While the three interviewed teachers described having inadequate time to conduct science experiments due to mandated policies, all of them reported finding ways of incorporating science inquiry and hands-on activities into the school year.

Evaluation Question 2: Sustainability of Perceptions of Females.

On the teacher survey of instructional practices, perceptions of the roles of females in science, technology, engineering, and mathematics (STEM) are captured in three factors: strategies, diversity, and evaluation. The factor, strategies, refers to teachers comfort using different assessment and instructional strategies to meet standards and involve students; diversity refers to the level of comfort teachers report when teaching students with diverse abilities and students with disabilities; evaluation refers to teacher's comfort being videotaped and self-assessing the video lesson.

Table 11, chapter three, includes descriptive statistics (means, standard deviations, skewness, kurtosis, and 95% confidence intervals) for each factor from 2008 and 2013. As reported in Table 11, Chapter Three, the means for each of these factors for 2008 and 2013, strategies (M=4.01, SD=0.57; M=4.11, SD=0.52), diversity (M=4.39, SD=0.42; M=4.49, SD=0.43), and evaluation (M=2.75, SD=1.12; M=3.04, SD=1.01), indicated that teachers reported being "fairly comfortable" using a variety of assessment and teaching strategies and teaching diverse student, and “somewhat uncomfortable” using videotape to evaluate their instructional strategies.

Table 18 displays the difference means from 2008 and 2013, standard deviation of the difference means, confidence intervals, *t*-values with *df*(22), and *p*-values for each factor. A paired *t*-test revealed that there were no statistically significant differences (p>.05) from 2008 to 2013 for the factors strategies, diversity, and evaluation.

Table 18

Difference Means, Standard Deviations, Confidence Intervals, t*-values (22) and p-values for Perception of Females' Factors (n=23)*

Factors	*M*	*SD*	Alpha 95% CI Lower	Upper	*t*-value (22)	*p*-value
Strategies	-.09	0.55	-.34	.42	-.81	.43
Diversity	-.10	0.38	-.26	.38	-1.21	.24
Evaluation	-.30	1.01	-.74	.78	-1.38	.18

These findings demonstrate no statistically significant difference for the 23 teachers from 2008 to 2013 regarding their perceptions of females in STEM. However, the negative mean difference for each factor indicates slightly higher means in 2013, or more comfort using different assessment and instructional strategies, teaching students with diverse abilities and students with disabilities, being videotaped and self-assessing the video lesson than reported in 2008, though not statistically significant.

Similarly, a paired *t*-test for Alpha (*n*=16) and Beta (*n*=7) teachers' survey scores for these factors revealed no statistically significant difference (p>.05) from 2008 to 2013 (Table 19). All of the difference means were negative, indicating a slight, non-statistically significant increase in these factors in 2013 compared to 2008.

Table 19

Difference Means, Standard Deviations, Confidence Intervals, t-values (15; 6) and p-values for Perceptions of Females Factors by Alpha (n=16) and Beta (n=7) Teachers

Teacher Type	Factors	*M*	*SD*	Alpha 95% CI Lower	Upper	*t*-value (15; 6)	*p*-value
Alpha	Strategies	-.03	0.56	-.33	.42	-.19	.86
Beta	Strategies	-.28	0.51	-.81	.51	-1.34	.24
Alpha	Diversity	-.08	0.40	-.29	.29	-.80	.43
Beta	Diversity	-.34	0.34	-.50	.34	-1.05	.34
Alpha	Evaluation	-.06	0.93	-.56	.69	-.27	.79
Beta	Evaluation	-.92	1.02	-1.99	.64	-2.20	.08

At the individual teacher level, change through time for each of factor was calculated using the Reliable Change Index. Table 20 shows individual teacher's RCI score for each factor. A negative RCI score indicates a decrease in perception of use of the type of strategies to include females and minorities in science while a positive RCI score indicates a perceived increase in use of these types of strategies. Please note that Teacher Twenty-one was missing data for all the items in the three factors, therefore, RCI scores were not calculated for that teacher.

Out of the 22 individual teachers with change scores, two teachers had statistically significant RCI scores (Teachers Five and Seven). For the factor, strategies, Teacher Five had a statistically significant positive change score (RCI= 2.07) from 2008 to 2013 indicating an increase in the perceived use of a variety of assessment strategies. Overall, there were 10 teachers with positive change scores, 11 teachers with negative change score, and one teacher with no change.

For the diversity factor, Teacher Five and Teacher Seven had a statistically significant positive change scores (RCI= 2.02 for both) for the factor, diversity, indicating a perceived increase in the use of strategies to encourage the participation of female and minority students.

Table 20

Individual Teacher RCI Scores for Perceptions of Females' Factors (n=22)

Teacher	Strategies	Diversity	Evaluation
1	-.60	-.67	-.48
2	.14	.00	.00
3	-.44	-1.02	.48
4	.60	.00	1.93
5	2.07[a]	2.02[a]	-.96
6	1.93	1.35	.96
7	1.91	2.02[a]	1.93
8	-.30	.00	-.96
9	.60	-.35	.96
10	-.74	1.00	-1.44
11	-.44	-1.29	-.48
12	1.03	.35	.96
13	-.14	.00	.96
14	-.73	.67	.96
15	.00	-1.35	1.44
16	-.44	-1.00	-.96
17	.89	1.02	-.48
18	.16	.67	.00
19	.89	1.00	.48
20	-.30	1.70	.48
21			
22	-1.61	-.35	-.48
23	-.74	.00	.96

Note: [a] Statistical significance RCI= ±1.96

Overall, there were seven negative change scores, 10 positive change scores, and five teachers with no change from 2008 to 2013 for the diversity factor. For the evaluation factor, there were no statistically significant change scores. Overall, there were eight negative change scores, 12 positive change scores, and two teachers with reportedly no change from 2008 to 2013.

The qualitative data, district administrator interviews and teacher interviews, provided a context for the quantitative findings. The Teaching SMART® professional development program was created as an afterschool science inquiry program for elementary-aged girls. As a result, the professional development program retained a gender equity focus. District administrator #1 found the emphasis on gender equity to be a weakness of the program due to lack of relevance and not reflective of today's reality. District administrator #1 stated that males and females were equally represented as scientists and engineers compared to the past when there was a gender disparity. District administrator #1 summed up his/her thoughts stating, "[gender equity] was such a fundamental goal of Teaching SMART® that was kind of a couple decades too late." For this district administrator, issues of gender equity were no longer relevant.

Interview data from three former Teaching SMART® teachers revealed that all three of them use some form of job roles to ensure that all students are participating in the classroom. Teacher One stated that she did not use the Teaching SMART® roles but had her own system of calling on students in an equitable way. However, use of that system was not observed during the classroom observation. It should be noted that this teacher's student groups contained equal numbers of males and females, indicating that attention was paid to the gender composition of the groups. Teacher One's individual change scores indicated negative change scores for the three factors, strategies (RCI= -.60), diversity (RCI= -.67), and evaluation (RCI= -.48) meaning there was a slight decrease in the perceived use of these strategies, but the decrease was not statistically significant.

Teachers Two, in her interview, stated that she used the Teaching SMART® jobs to encourage participation of all students. Her individual change scores indicated a slight, non-statistically significant negative change score for strategies (RCI= .14), and no change in perceived practice for the factors, diversity and evaluation from 2008 to 2013 (RCI= .00 for both). For the factor, strategies, a positive change score (RCI= .14) indicates a slight, non-statistically significant, increase in perceived practice.

Teacher Three stated that she used the Teaching SMART® jobs to encourage participation of all students. Her individual change scores show negative change scores for two factors, strategies (RCI= -.44) and diversity (RCI= -1.02), indicating a perceived decrease in use of these strategies since 2008. For the factor, evaluation, this teacher had a slight, non-statistically significant positive change score (RCI= .48) indicating perceived increase in comfort being videotaped and assessing her own practice. When asked about practices from the Teaching SMART® program she still uses, Teacher Three responded, "We do talk a lot about gender."

In spite of one district administrators' statements about the lack of relevance issues of equity have in the classroom, these three teachers used some of the strategies from Teaching SMART® in their classrooms today, namely the use of jobs to encourage the participation of all students. In addition, incorporating discussions about gender and maintaining gender balance within student groups are other strategies utilized by the three interviewed teachers.

Evaluation Question 3: Sustainability of Classroom Management Techniques.

On the teacher survey of instructional practices, classroom management techniques are captured in one factor: empowerment. The factor, empowerment, focuses on encouraging student participation in science activities. Table 11, Chapter Three, includes descriptive statistics (means, standard deviations, skewness, kurtosis, and 95% confidence intervals) for this factor from 2008 and 2013. As reported in Table 11, Chapter Three, the means for the factor empowerment for 2008 and 2013 (M=4.11, SD=0.52; M=4.10, SD=0.40), indicated that, on average, teachers reported "often," once or twice a week using empowerment strategies to facilitate classroom management.

Table 21 displays the difference means from 2008 and 2013, standard deviation of the difference means, confidence intervals, *t*-values with *df*(22), and *p*-values for the factor empowerment. A paired *t*-test revealed that there was no statistically significant difference (*p*>.05) from 2008 to 2013 for the factor empowerment.

Table 21

Difference Means, Standard Deviations, Confidence intervals, t-values (22) and p-values for Classroom Management Factor (n=23)

			Alpha 95% CI			
Factor	*M*	*SD*	Lower	Upper	*t*-value (22)	*p*-value
Empowerment	.02	0.63	-.26	.49	.12	.91

This finding demonstrated no statistically significant difference for the 23 teachers through time regarding their perceptions of using classroom management strategies captured in this factor, such as providing students with a variety of opportunities to see themselves and others involved in science. However, the positive mean difference indicated a slightly higher mean in 2008 than reported in 2013, though not statistically significant.

Similarly, a paired *t*-test for Alpha (*n*=16) and Beta (*n*=7) teachers' survey scores for the empowerment factor revealed no statistically significant difference (*p*>.05) from 2008 to 2013 (Table 22). Alpha teachers had no change in mean from 2008 to 2013 and Beta teachers had a small, positive, non-statistically significant difference mean, indicating decrease in this factor in 2013 compared to 2008.

Table 22

Difference Means, Standard Deviations, Confidence Intervals, t-values (15; 6) and p-values for Classroom Management Factor by Alpha (n=16) and Beta (n=7) Teachers

				Alpha 95% CI		*t*-value	
Teacher Type	Factors	*M*	*SD*	Lower	Upper	(15; 6)	*p*-value
Alpha	Empowerment	.00	0.66	-.35	.49	.02	.98
Beta	Empowerment	.04	0.23	-.53	.40	.18	.86

At the individual teacher level, change through time for the empowerment factor was calculated using the Reliable Change Index. Table 23 shows the individual teacher's RCI scores for this factor.

A negative RCI score indicates a decrease in perception of use of empowerment strategies while a positive RCI score indicates a perceived increase. A change score of $\pm$1.96 is statistically significant. There were no statistically significant RCI scores for individual teachers for the empowerment factor. For the empowerment factor, there were 10 negative change scores and 13 positive change scores. This indicates that teachers' perceived use of empowerment strategies reportedly remained similar from 2008 to 2013.

Table 23

Individual Teacher RCI Scores for the Classroom Management Factor (n=23)

Teacher	Empowerment
1	-.28
2	-.57
3	1.42
4	-0.57
5	-1.13
6	.28
7	1.42
8	.14
9	-.85
10	-1.70
11	-1.13
12	-.71
13	.57
14	-.57
15	1.56
16	.43
17	.28
18	-1.13
19	1.13
20	.14
21	.28
22	.14
23	.34

In the qualitative teacher interviews, the three teachers discussed the use of roles or jobs as a way to encourage participation of all students for not only equitable learning opportunities, as presented in evaluation question two, but to also facilitate classroom management. With every student responsible for a job related to the activity, student behavior remains more on-task. For the three teachers who were interviewed, two teachers had change scores that were negative (Teachers One and Two), indicating a non-statistically significant decrease in perceived practice. Teacher Three had positive change score (RCI= 1.42) for empowerment indicating a non-statistically significant increase in perceived practice of encouraging student participation in science activities and providing students with a variety of opportunities to see themselves and others involved in science.

Chapter Summary

In this chapter, the research and evaluation questions were addressed after analysis of qualitative and quantitative data from district administrators and teachers who participated in the Teaching SMART® professional development program. Table 13 provided a summary of research and evaluation questions and findings.

The qualitative interviews with district administrators and teachers revealed a number of factors that have influenced the sustainability of Teaching SMART® practices. For instance, at the district level, the economic recession impacted the district's hiring practices. For the three site specialists who implemented the Teaching SMART® professional development program with the teachers, when their contract ended in 2008, the school district was not able to renew their contracts due to budgetary reasons. The high turnover rate of teachers since 2008, also a result of the economic downturn experienced in the county, ultimately reduced the number of teachers at each elementary school who participated in the Teaching SMART® program. Each of the three teachers, in their interviews, mentioned only knowing very few teachers at their school who participated in Teaching SMART® with them. This may have affected the number of teachers who met the eligibility criteria to participate in this study (39% of the teacher in 2008 were ineligible due to no longer teaching in the school district, among other criteria described in Chapter Three). Impact of the current reorganization of the district into four regions, starting in the 2013/14 school year, has not been a factor yet in the sustainability of Teaching SMART®, but may be a factor in the future.

A number of reform policies were introduced since 2008 that have influenced instructional practices at the elementary school level, such as Race to the Top, Student Success Act, and the Common Core State Standards for mathematics and English language arts. At the time of implementation (2005-2008), school district administrators did not have a plan for sustaining Teaching SMART® and there was no plan as part of the prescribed professional development program. Without a plan for sustainability, integration of reform practices into new policies and procedures was not facilitated. The three teachers who were interviewed described how the mandated 90-minute reading block affected their ability to teach science inquiry due to lack of time during the school day. The emphasis on Common Core also was described as taking away from the focus on science instruction and professional development.

Results from the evaluation questions from the survey data revealed no statistically significant differences through time, except for the hands-on factor for all 23 participants as well as the Alpha teachers (n=16). This indicated a perceived decrease in the use of hands-on activities in science from 2008 to 2013. At the individual teacher level, change scores were statistically significant for a few individual teachers but overall, individual teachers reported similarly on the teacher survey at both time points.

CHAPTER FIVE:

DISCUSSION

In this chapter, a discussion of the findings for the research and evaluation questions is presented along with limitations of the study and suggestions for future work. The purpose of this mixed method study was to determine what strategies and practices teachers increased, decreased, or sustained five years post-implementation of an educational reform, in this case, Teaching SMART®, a professional development program that was implemented by elementary teachers over the course of three years and which ended in June 2008. The study focused on teachers who participated in the implementation of Teaching SMART® and remained in the school district teaching science at the intermediate elementary level, grades three, four, or five.

Discussion of the Findings

To address the questions, a sequential, embedded, equal status mixed method approach was used. A teacher survey from 2008 was re-administered in 2013 to all the teachers who met the inclusion criteria. Interview data from two district administrators and three teachers, one of whom also agreed to be observed teaching science, were included in the qualitative research component. Qualitative data analyses were conducted to identify factors for sustainability to address the research question and to provide contextualization to the survey findings. Survey data were analyzed at the group and individual levels to address the three evaluation questions.

Research Question 1 and 1a: What Teacher and District Administrators Share about Sustainability of Practices

The literature review presented in Chapter Two, identified a need to add to the body of knowledge regarding the factors that sustain a reform (Sindelar, Shearer, Yendol-Hoppey, & Liebert, 2006) while recognizing that the role of context in sustainability of reform practices makes it impossible to generalize or develop a “how to do it” guide (Scheirer, 2005, p. 325). Interview data from district administrators and teachers in this study identified factors that influenced the sustainability of Teaching SMART® instructional strategies. These factors are:

- Economic recession
- Turnover of teachers
- District reorganization
- Shifting reform policies at the federal and states levels

These identified factors, when interwoven together, created an environment not supportive for continuation of Teaching SMART® instructional strategies at the teacher level. In fact, no facilitating factors were identified, but suggestions to facilitate sustainability were provided by the participants.

A major economic crisis was felt throughout the county and school district and resulted in a lack of funding to support a number of programmatic resources. Inadequate resources are common obstacles to continuation of reform practices (Elias, Zins, Gracyk, & Weissberg, 2003; Zech, Gause-Vega, et al., 2000). The one-on-one support provided by the three site specialists at the district level stopped at the end of the implementation phase when their contracts were not renewed and the positions were terminated. The school district did not renew any contract position in 2008 due to the economic downtown and lack of incoming funding. The professional development provided to the teachers in the Teaching SMART® program was discontinued as a result of the loss of these positions. Ongoing professional development is needed to support teachers to continue to develop reform practices and learn to adapt to incoming policies (Coburn, 2003; Darling-Hammond & McLaughlin, 1995).

Another outcome of the economic downturn was the layoff of hundreds of teachers. The school district had been hiring large numbers of teachers each year as new schools and positions opened up prior to 2008. However, the collapse of the economy slowed the building program and instead of hiring, positions were reassigned or multiple positions were merged into one. Teachers are the main change agents in a reform (Coburn, 2003) so when turnover happens, loss of knowledge of reform practices occurs. Interestingly, all three of the interviewed teachers knew of few, if any, other former Teaching SMART® teachers at their school and/or grade level team. This may be an indicator of an unsupportive or nonexistent learning community. Supportive learning communities are those that consist of coaching and mentoring opportunities and have been shown to create change or sustain practice (Earley, 2010).

Lack of dedicated funds to purchase science materials resulted in teachers having to locate the needed supplies to conduct experiments. Teacher One, in her interview, expressed that she found materials that she needed from other teachers' trash. While Teacher One's resourcefulness is to be commended, using other teachers' discarded science materials provides a sad commentary regarding the value placed on science education. In Teacher Three's interview, she explained that the principal gave her some Title 1 money last year (2012/13) to purchase science materials. By sorting through old Teaching SMART® materials, such as dissecting kits and microscopes, and using the allocated money provided by the principal, Teacher Three was able to purchase the supplies needed for that school year and to cover some expenses for the current school year. However, Teacher Three clarified, “I don’t think that money is there [for next year] so it will kind of be, when it’s gone it’s gone again until we get another lump sum of money.” Teacher Two, in her interview, explained that they haven’t really been able to teach science using experiments due to the integration of science into the 90-minute reading block and a newer school principal who had not emphasized science inquiry as a priority. However, Teacher Two stated that next school year, her grade level team was going to try to teach science inquiry. Teacher Two stated that teaching science experiments was difficult because “we have to find all of our resources…we find a lot of stuff online and trying to use that stuff; it’s tough.” All three of the interviewed teachers stated that they have the Teaching SMART® notebook of lessons as a resource and still taught some of the lessons annually. Not having sufficient funds to purchase materials needed to conduct science experiments was a challenge that teachers in this study tried to overcome by locating materials not being used by other teachers, reusing old materials, and downloading materials from online sites. Inadequate resources were found to be common obstacle in the literature review (Elias, Zins, Gracyk, & Weissberg, 2003) and for teachers in this study.

The district administrators interviewed in this study confirmed that there was no plan for sustainability when Teaching SMART® was being implemented. Having a plan for not only implementation but sustainability is one of the main facilitating factors for sustaining reform practices (Datnow, 2002; Lawrenz, Keiser, & Lavoie, 2003). A sustainability plan needs to be modifiable over time (Scheirer, 2005) to enable adaptations to occur as new policies and leadership occur through time. In the participating school district, new policies were introduced immediately following the implementation of Teaching SMART® and a complete re-organization of the school district was occurring at the time of this study (2012/13 school year).

The school district experienced a large number of education reform policies following the implementation of Teaching SMART®. The district administrators described the impact of federal and state mandates on teacher practice as new end-of-course assessments were implemented, teacher evaluations conducted, and Common Core State Standards introduced. With these mandates, the focus on science instruction was diminished, often resulting in being integrated into the 90-minute reading block. All three of the interviewed teachers had integrated science readers into the 90-minute reading block while also continuing to carve out some time to teach science inquiry. Science instruction was most often taught at the beginning and end of the school year due to the focus on preparing for state assessments, FCAT and Florida Writes, that dominated the second and third quarters of the school year. Teacher Three stated, once the state assessments are over, "all we do is science." The influx of new reform policies that were not aligned with the reform practices of the Teaching SMART® program created a policy environment that was not supportive of sustainability (Coburn, 2003).

All of the factors identified through interview data were classified as obstacles to sustainability. The main factors that enhanced sustainability, as identified in the literature, are support from leadership and stakeholders, having an implementation and sustainability plan, and ongoing professional development. However, even without facilitating factors supporting teachers in sustaining reform practices, the 23 teachers in this study were able to maintain some reform practices according to survey data which were supported by teacher interview data. Based on the teacher interview data, the strategies of teaching science at the beginning and end of the school year and using cooperative groups and job roles may explain how these teachers reportedly continued reform practices. The reported continuation of reform instructional strategies may highlight the ease of sustaining these practices without identified facilitating factors. Cooperative grouping, the use of roles, and inquiry-based approaches that were focused on during the implementation of Teaching SMART® may have been retained by the teachers through time due to their ease of practice in their classrooms. Would there have been reported statistically significant increases in the use of the reform practices if facilitating factors were present? Findings from this study cannot answer that. However, the definition of sustainability used in this study "a continuation of classroom practices or other activities that have been implemented during the reform program's existence, and the decisions, actions, and policies by school and district leaders that support continuation" (Florian, 2000, p. 3) highlighted the need to not only look at what has been continued but the contextual factors that influence sustainability.

Evaluation Question 1: Sustainability of Teaching Strategies

Teaching strategies, as measured by the survey of instructional practices, are composed of two types: student-centered learning activities and traditional centered-learning activities. Student-centered learning activities are captured by survey items in two factors, inquiry and hands-on. Science inquiry methods are where students guide their own learning and develop the ability to think critically (Pratt & Hackett, 1998) whereas hands-on activities allow students to conduct science activities but they are not necessarily guiding their own learning. Teacher-centered learning activities are characterized by presentation of information to students through lecture and text by the teacher. The factors, collegiality (support from colleagues) and efficacy (knowing how to teach science effectively and enjoying science) were also included in this analysis. Analyses revealed no statistically significant difference from 2008 to 2013 for the factors, inquiry-based practices, traditional teaching, collegiality, and efficacy. There was a statistically significant difference for the factor, hands-on, indicating a perceived decrease in hands-on activities for the 23 teachers as well as the Alpha teachers as reported on the survey from 2008 to 2013. At the individual teacher level, none of the change scores were statistically significant for the hands-on factor.

The survey data indicated that teachers reported continuing inquiry, hands-on, and traditional practices at a similar frequency, "sometimes (once or twice a month)" for all three factors, "neutral/uncertain" for the factor efficacy, and "disagree" for the collegiality. This indicated that teachers reported not having the support of their colleagues to try new ideas in teacher science. Therefore, they reported, on average, continuing similar instructional practices through time, but, as evidenced in the findings from the research questions the "decisions, actions, and policies by school and district leaders that support continuation" (Florian, 2000, p. 3) part of the definition of sustainability were not met. Identified factors that influence sustainability revealed obstacles to sustainability, not facilitating factors. One would assume discontinuation or a statistically significant decline in perceived practices through time due to system-wide barriers. The teacher case studies revealed that in spite of time constraints imposed by mandated reading blocks and test preparation, the lack of follow-along support through professional development at the district and school level, and the lack of provided resources to conduct science experiments, they were able to incorporate some inquiry science methods and hands-on activities during the school year. Importantly, all three teachers who were interviewed noted a decline in the number of science inquiry experiments but reported infusing science into the mandated 90-minute research block and focusing on science inquiry at the beginning and end of the school year. Aside from the statistically significant decrease in the number of hands-on activities taught, these instructional changes for science did not influence how teachers reported their use of instructional practices on the teacher survey.

Evaluation Question 2: Sustainability of Perception of Roles of Females

The perception of the roles of females in STEM was captured by three factors in the teacher survey of instructional practices. The use of a variety of assessment strategies, the strategy factor, was an instructional strategy to help teachers deal with classroom diversity (Berry, 2006). According to Berry (2006), "Teachers can use assessment strategies to identify different learning needs and to improve teaching and learning" (p. 1). The diversity factor referred to the level of comfort a teacher reported when teaching students with diverse abilities and students with disabilities. The evaluation factor referred to using video to assess instructional practices. The National Science Education Standards (National Research Council, 1996), specifically the science teaching standard key principle, "science is for all students," is described as:

> This principle is one of equity and excellence. Science in our schools must be for all students: All students, regardless of age, sex, cultural or ethnic background, disabilities, aspirations, or interest and motivation in science, should have the opportunity to attain high levels of scientific literacy (p. 20).

Analyses revealed no statistical difference from 2008 to 2013 for the factors, strategies, diversity, and evaluation. At the individual teacher level, two teachers (Teachers Five and Seven) had statistically significant positive change scores for these factors. Teacher Five's change scores revealed statistically significant positive scores for the strategies and diversity factors indicating a perceived increase in the use of these strategies. Teacher Seven's change scores revealed an increase in the perceived increase in comfort level teaching diverse students.

As a group, teachers, on average, reported being "fairly comfortable" and "somewhat comfortable" for all three factors related to perceptions of females, as reported in Table 11, Chapter Three. District administrator #1 highlighted the focus on equity as being a weakness of the Teaching SMART® professional development program. According to district administrator

#1, "If you look at the classroom of the 70s then maybe you would see that with males really standing out but when you go into classrooms now, it is almost the opposite." For this district administrator, issues of gender equity were no longer relevant today. However, the Next Generation Science Standards (2013) included a section on equity-based instruction, highlighting the perceived continuing relevance. Without buy-in from stakeholders, equity-based instructional strategies may not be implemented or supported through professional development (Datnow, 2002). When asked in their interviews what strategies were used to ensure equity in the classroom, the three teachers stated that they used cooperative groupings of students, assigned students roles to ensure everyone had a job, and discussed different types of careers at the end of lessons. None of the interviewed teachers mentioned using a variety of assessments as a strategy for promoting equity. The strategies described by the interviewed teachers for promoting equity in the classroom were emphasized during Teaching SMART® professional development over the course of the three years of implementation, whereas, the use of a variety of assessments as an equity-strategy was not. As a result, teachers may have retained the use of cooperating groups and assignment of roles in their instructional practices more so than the use of a variety of assessments.

Evaluation Question 3: Sustainability of Classroom Management Techniques

Classroom management techniques included using job roles and cooperative groups to encourage participation of all students, were captured by two items in the empowerment factor in the survey. Other items in the empowerment factor highlighted a range of instructional strategies to "allow students to work at their own pace" including the use of "wait-time" as well as "asking open-ended questions encouraging multiple answers." Together, the items in the empowerment factor captured the importance of being aware that some students may require more time and encouragement to participate. While not prescribed or described as part of the Teaching SMART® professional development program, Culturally Responsive Classroom Management (CRCM) is “a pedagogical approach that guides the management decisions that teachers make” (Metropolitan Center for Urban Education, 2008, p.2). The use of job roles and cooperative groups are classroom management strategies that facilitate student ownership and participation in the class and lessons. Providing students opportunities to connect with the content at a personal, culturally relevant level, as captured in the empowerment factor, is part of the CRCM approach to management. Analyses revealed no statistical difference from 2008 to 2013 for the factor empowerment, as reported on the teacher survey. Similarly, none of the individual teacher’s change scores were significantly different for this factor. The reported use of these instructional strategies in the survey and interview data suggested sustaining the amount and type of management practices through time. Without continued professional development, an increase in the reported use of these strategies cannot be expected. However, sustaining these practices through time suggests that teachers who participated in Teaching SMART® have integrated them into their instruction.

These findings suggest that, on average, teachers reported continuing practices at a similar frequency, “often (once or twice a week)” for the empowerment factor, as reported in Table 11, Chapter Three. The teacher case studies revealed, as presented above for evaluation question 2, that the use of job roles and cooperative groups was discussed as instructional strategies that they continued to incorporate to facilitate participation of all students and classroom management.

Recommendations for Sustainability

Teachers in this school district faced a number of system-wide obstacles to sustainability:

- Economic recession
- Turnover of teachers
- No plan for sustainability
- Shifting reform policies at the federal and states levels

To overcome these obstacles, teacher interview data revealed a number of strategies that were used to continue teaching science:

- Teach inquiry methods and experiments at the beginning and end of the school year to allow dedicated time during the middle of the year to prepare for state assessments, in this case, FCAT and Florida Writes;
- Integrate science readers into 90-minute reading blocks of time;
- Locate materials for experiments and hands-on activities from other teachers or from storage.

The following recommendations to facilitate sustainability were made by the two, key informant, district administrators:

- Identify business partners or other grant funding sources to facilitate sustainability of science resources, consumable and non-consumable. District administrator #2 explained, "I can't think of anything that is more expensive [than science]."
- Create a plan for sustainability of reform practices. District administrator #2 pointed out, "there was a fairly decent professional development [implementation] plan [for Teaching SMART®], but I don't know what happened with that for sustainability."
- Provide on-going professional development to support teachers.

All three interviewed teachers noted the importance of having a site specialist assigned to them to facilitate implementation. Due to the district not being able to support the three Teaching SMART® site specialists after the implementation phase ended, having structures in place, or building capacity at the school level may have helped. To build capacity at the school, district administrator #1 shared his/her ideas:

- Involve the instructional leaders and school administrators at the school during the implementation of the professional development program "so that it would have continued to be a priority for them."
- Have key contacts or key teachers who "would serve as lead teachers at the school site to maintain integrity of the program as it closes out." Internal support, according to Sarriot, Winch, Ryan, Edison, Bowie, et al. (2004), "is critical to sustaining efforts" (p. 12).

Sustainability of reform practices can be improved if obstacles occurring district-wide or locally at the school level are addressed. This study has shown that teachers in this study found ways to continue some of the reform practices through time in spite of a number of system-wide obstacles.

Limitations of the Study

There are several limitations of the study. The first limitation was sample size. The second limitation was related to data collection procedures. The role of the researcher was the third limitation. Each limitation is described below.

Small sample size was a limitation in this sustainability study, and may be problematic to others, due to the fact that the focus of sustainability is on those who participate in a specific reform program. Therefore, generalizability outside of this population was not intended. In the case of Teaching SMART®, the possible sample of participants consisted of 95 teachers who responded to the teacher survey in 2008. When applying the inclusion criteria (see Chapter Three) the total possible number of eligible teachers fell to 58, with 37 teachers not meeting the inclusion criteria. The 2013 sample return rate was 40% with 23 of the 58 teachers responding. Teacher turnover has been identified as an obstacle to sustainability in the research literature (Coburn, 2003; Elias, Zins, Gracyk, & Weissberg, 2003; Sindelar, Shearer, Yendol-Hoppy, & Liebert, 2006). Schools and districts with high levels of attrition are at risk of losing commitment to a reform as reform participants depart, so does the ability to deepen the knowledge base and ability to respond to incoming policies in a way that aligns with reform practices. Teacher attrition from 2008 to 2013 in this study stemmed from the economic crisis in 2008 that resulted in non-renewals of contract positions and merging of positions as well as unknown variables. The use of a mixed method approach alleviates some issues associated with small sample sizes. The sequential, embedded, equal status mixed method approach followed in this study where the qualitative sample emerged from the quantitative sample allowed the qualitative interview data to inform the quantitative data by providing contextualized data that were incorporated with the quantitative findings (Venkatesh, Brown, & Bala, 2013). Interviews over-time and with additional teachers who met the inclusion criteria would have provided more depth in understanding and should be considered for future research.

Data collection procedures also limited the study's findings for two main reasons. First, the teacher survey was administered using an online surveying tool (Qualtrics). This method of survey administration was recommended by the school district and non –respondents were mailed a hard copy of the survey to complete if they preferred that format. However, during the

2008 administration of the teacher survey, as part of the RCT study, teachers were able to use time during the professional development training sessions to complete the survey or classroom time while RCT research team members were administering assessments to the students. Having set aside time during their regular schedule is optimal to have a high survey return rate, but was not practical or possible in this study. The use of both online and hard copy survey administration was an attempt to overcome this limitation.

The second limitation related to data collection procedures was the timing of survey administration. On-line survey administration was completed over the course of two weeks in May 2013 with an additional week allocated for hard-copy survey administration. The qualitative research sample depended on the respondents to the survey. The timing of survey administration resulted in inviting every survey respondent to participate in the qualitative research rather than purposively or randomly selecting participants. All 23 of the teacher survey respondents were invited to participate in an interview and observation of their science lesson; however, only three teachers agreed to be interviewed and two of the three did not want to be observed due to timing –the school year was ending and they were no longer instructing science. Had the survey been administered prior to May 2013, additional teachers may have agreed to be interviewed and observed.

My role in the sustainability study, and previously in the RCT, was a limitation. Participants were made aware that the sustainability study was linked to the RCT that they participated in from 2005-2008. Participants may have responded according to how they thought they should on the survey and in the interviews as a form of reactive bias (Gall, Gall, & Borg, 2007). This was evidenced by Teacher One, who was interviewed and observed. During Teacher One's interview, she stated that she reviewed the Teaching SMART® notebook of lessons before my visit, "because I assumed you wanted to see a Teaching SMART® lesson." Even though I communicated that any science lesson Teacher One had planned was fine, she purposively selected a Teaching SMART® lesson and modified it for the observation. To better understand how reform strategies have been sustained or not, repeated observations and the addition of observations in other teacher's classrooms would have helped. To facilitate minimizing this limitation, triangulation of data and member checking with participants were strategies that were conducted. These strategies are recommended by Onwuegbuzie and Leech (2007) to reduce researcher bias. Triangulation of survey and qualitative data utilizes multiple sources of information while member checking allows research participants the opportunity to review and provide feedback to ensure accurate representation.

Recommendations for Future Research

Based on the findings from this sustainability study and the limitations identified, the following recommendations for future research are made. First, the findings from this sustainability study were based on data collected from a small number of teachers who were eligible for participation in this study. This was a limiting factor for these findings. Additionally, the small number of interviewed teachers, three, limited the understanding of how and why practices are maintained or not. Observations of classroom practices are needed to document how teachers implement instructional strategies with their students. To better understand how teachers who participated in Teaching SMART® applied the instructional strategies learned in the program to their classrooms, further research with a larger sample of teachers is needed. Future research on the topic of sustainability should pay careful attention to the number of possible participants to ensure the population is viable for study. Multiple strategies for recruitment and support from administrations are needed to increase the number of participants in the study sample.

One reason for the small number of eligible participants in this study was due to the length of time since implementation: five years. Most sustainability studies occur within a year or two of implementation due to funding, if at all (Coburn, 2003). According to Coburn (2003), "most studies focus on schools in their first few years implementing a new external reform, failing, in our view, to capture sustainability." Coburn (2003) puts forth the challenge to researchers to study reform over time:

> We know a lot about challenges to sustainability in the early years of reform. But how do these challenges differ as reforms mature and initial energy, personnel, and funding dissipate (p. 6)?

As time since implementation passed, teachers who participated in the program left due to retirement, reassignment to ineligible teaching assignments, or promoted to administrative positions. While it is important to study sustainability at various time points, future researchers may consider the effect the passage of time may have on their study sample and identify strategies, such as longitudinal studies with ongoing data collection, to elicit the greatest amount of participation and information.

The focus on this sustainability study was on the teachers who participated in the Teaching SMART® professional development program implementation and the district administrators who were knowledgeable about or participated in the implementation too. School level administrators were not included due to their exclusion during the implementation of Teaching SMART®. However, further research involving school administrators is needed. Interviews with additional stakeholders, such as school principals or other instructional leaders in the school, may provide perspectives and insight not collected from the key stakeholders, in this study, participating teachers and district administrators. Future researcher will want to include not only program participants but administrators at both the district and school levels due to their positions of authority and influence on what occurs in schools and classrooms. As noted as a recommendation earlier, school level instructional support is needed for continuation of programmatic practices. Documenting the level of support and/or involvement by administrators will add to the body of knowledge on sustainability. Additionally, in this study, the participating treatment teachers from the RCT were included, not the control or business-as-usual teachers from the RCT that this study was based. Therefore, only the changes in practice from 2008 to 2013 for the participating Teaching SMART® teachers are presented. Recruitment and participation of eligible control teachers from the RCT would allow a comparison between the two groups to determine if survey data and observational data are the same between the two groups, indicating no change, or different.

This research is limited by having only one researcher conducting the study. A strength of mixed method research is triangulation of multiple methods from multiple sources. While this mixed method study aimed to do that, the inclusion of at least one additional researcher would have served as a resource for not only facilitating data collection, and ideally increasing the sample size, but also as a source to check accuracy of data analyses and findings. Additionally, the fact that I served as the only researcher, and was involved in the RCT that studied the implementation of Teaching SMART®, there was the potential for researcher bias (Onwuegbuzie & Leech, 2007). While effort was made to reduce researcher bias, such as the use of multiple methods, triangulation, and member-checking, an additional research team member who was uninvolved in the implementation of the Teaching SMART® program would have helped. While dissertation research consists of one researcher for degree fulfillment, future research on this topic may be better served by multiple researchers.

While this research included audio-recorded interviews, field notes and form completion for observations, and on-line and hard copy surveys of instructional practices, additional methods to document sustainability may be considered. For instance, video of classroom observations is a useful method to document the use of instructional strategies and teacher-student interaction. The survey used in this study may be considered for future research on instructional practices. During this study, the psychometrics of the survey was improved, especially the scales used to address the evaluation questions. Other researchers may benefit from this work and could further document the psychometrics of the survey with other samples. Future researchers may want to consider all possible methods to document sustainability of practices and facilitate triangulation of data.

Lastly, as stated in Chapter One, there is a need for research on sustainability of programs to determine how to facilitate change long-term and in diverse locations. All sustainability studies will be limited in terms of generalizability due to site specific reforms and participants. To combat this limitation, future research that builds on what is known in the literature with additional populations and programs will add to the repository of knowledge on facilitating factors and barriers to sustainability.

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APPENDICES

Appendix A: Copyright Permission

Permission Acknowledgement

Ms. Bridget Cotner,

Based on your agreement to include the following permission acknowledgement statement in your dissertation, permission is granted by Girls Incorporated® of Rapid City, and by its parent organization, Youth & Family Services, Inc., to include the Teaching SMART® Logic Model and the four Mirror Coaching forms in your dissertation:

Copyright use permission statement:

Permission is granted by Girls Incorporated® of Rapid City, a program of Youth & Family Services of Rapid City, South Dakota, to include the Teaching SMART® Logic Model and the four Mirror Coaching forms in this study. These items are not to be reproduced for use without permission from Girls Incorporated® of Rapid City.

David Miller

Associate Executive Director
Youth & Family Services

Teaching SMART
A Program of Girls Incorporated® of Rapid City

Mirror Coaching-Cooperative Grouping

Lesson Title: ____ Date:________________

***Notes to Teacher*:**

- ***A seating chart is needed indicating where students are in their groups.***
- ***Please fill in roles, description, and social skill prior to lesson.***

Roles Assigned	Job Description
____________________________	___________________________________
____________________________	___________________________________
____________________________	___________________________________
____________________________	___________________________________

Social Skill: ____
(Examples: listening skills; sharing tools; writing skills; using manners (thank you, please))

The seating chart will be coded with the following:

SR	Student felt he/she understood his/her role and responsibility.
GS	Group felt they met their social skill.
GW	Group felt they worked well together.

Following are some Teaching SMART components I am always looking for during my visit. It may not be possible to see all the following completed during the time period set aside for mirror coaching; however, notes will be made with what was observed. If you would like more feedback, just ask. Thank you!

Groups:	Teacher's Choice:	Randomly ___________ Non-randomly _______	OR Students' Choice _______
Roles:	Teacher's Choice:	Randomly ___________ Non-randomly _______	OR Students' Choice _______
Recording:	Whole Class _________	Group Recorder __________	Every Student __________

Equity Techniques Used: ____

Scientific Processing Skills Used: ____

Open-ended Questions Used: ____

Careers/Real World Application: ____

Adapted by **Teaching SMART®, Girls Incorporated®** of Rapid City

Mirror Coaching-Equity Techniques/Career Application

Lesson Title: ______________________________________Date: ___________________

Equity Techniques Observed: ____

____

____

____

Some examples: Devising ways for all students to respond (ex. using craft sticks with their names on them); using "wait time" for students' answers; allowing for frustration and "working it out" (during activity); calling all students by their given name (not honey, sweetie, guys); allowing all students to participate (using a method for students to keep track of in their group); allowing students to be in charge of their roles being equally shared; using curricula, bulletin boards, and pictures that include women and minorities; having consistency with rules and procedures.

Career Applications Observed: ____

____

____

____

Some examples: Assigning roles using career titles (such as Paleontologist in place of Reporter; Geologist in place or Materials Manager; Archaeologist in place of Engineer; and Surveyor in place or Recorder); using a career word wall; using curricula, bulletin boards, and pictures that show many different careers (especially unique careers unfamiliar to the students); asking students what careers relate to the experiment or how the experiment relates to real life.

Following are some Teaching SMART components I am always looking for during my visit. It may not be possible to see all the following completed during the time period set aside for mirror coaching; however, notes will be made with what was observed. If you would like more feedback, just ask. Thank you!

Groups: Teacher's Choice: Randomly ____ Non-randomly ____ Students' Choice _____
Roles: Teacher's Choice: Randomly ____ Non-randomly ____ Students' Choice _____
Recording: Whole Class _____ Group Recorder_____ Every Student _____

Scientific Processing Skills Used: ___________________________________ _______

Open-ended Questions Used: ____

Adapted by **Teaching SMART®, Girls Incorporated®** of Rapid City

Mirror Coaching-Language Used/Questioning Techniques

Lesson Title: ____ Date:___________________

***Note to Teacher*: This form is best used when processing the activity with students.**

Language Used: (Gender neutral and gender specific language used will be noted.)

Questions Used:

Open Ended Questions	Closed Questions

Following are some Teaching SMART components I am always looking for during my visit. It may not be possible to see all the following completed during the time period set aside for mirror coaching; however, notes will be made with what was observed. If you would like more feedback, just ask. Thank you!

Groups: Teacher's Choice: Randomly ____ Non-randomly ____ Students' Choice _____
Roles: Teacher's Choice: Randomly ____ Non-randomly ____ Students' Choice _____
Recording: Whole Class _____ Group Recorder_____ Every Student _____

Equity Techniques Used: ____

Scientific Processing Skills Used: ____

Careers/Real World Application: ____

Adapted by **Teaching SMART®**, **Girls Incorporated ®** of Rapid City

Mirror Coaching-Scientific Method/ Process Skills

Lesson Title: ______________________________________Date: ____________________

Scientific Method

__ State Purpose- “What do we want to know?” “What is your question to investigate?”
__ Predict Hypothesis- Groups should record prediction or hypothesis prior to starting activity/experiment.

- Prediction- Form an idea of an expected result
- Hypothesis- A tentative explanation based on prior knowledge

__ Think Time- Allow students time to think about how to find the answer to the question. Using materials provided, group should be design their experiment.
__ Try Time (Conduct the Activity)- Allow time to try out their ideas.
__ Using Science Processing Skills, which include:

- ***Observing:*** Noting the properties of objects and situations using the five senses
- ***Classifying:*** Relating objects and events according to their attributes
- ***Measuring:*** Expressing the amount of an object in quantitative terms
- ***Inferring:*** Interpreting or explaining observations
- ***Predicting:*** Forming an idea of an expected result
- ***Communicating:*** Using the written and spoken work, graphs, demonstrations, drawings, diagrams, or tables to transmit information and ideas to others

__ Share Time- Allow groups to share their results; if possible, allow time for each group to try again using ideas generated from other groups during sharing.
__ Realistic Conclusions- Students are asked to draw conclusions from what they have learned.
__ Try Time- Discuss how your group might do the experiment differently. If time is permitted, all groups to retry.
__ Experiences in real life, cultural references, and careers- Students should be able to relate how their activity related to real life. _______

Following are some Teaching SMART components I am always looking for during my visit. It may not be possible to see all the following completed during the time period set aside for mirror coaching; however, notes will be made with what was observed. <u>If you would like more feedback, just ask.</u> Thank you!

Groups: <u>Teacher's Choice:</u> Randomly ____ Non-randomly ____ <u>Students' Choice</u> _____

Roles: <u>Teacher's Choice:</u> Randomly ____ Non-randomly ____ <u>Students' Choice</u> _____
Recording: Whole Class _____ Group Recorder_____ Every Student _____

Equity Techniques Used: ____

Open-ended Questions Used: ____

Careers/Real World Application: ____

USF UNIVERSITY OF SOUTH FLORIDA

End-of Year Teacher Survey

Science Education Questionnaire

Thank you for participating in this research study about sustainability of a professional development reform, Teaching SMART. Your district and school are participating in the study and you were selected to answer questions about your science instruction because you participated in the Teaching SMART professional development program in spring 2008.

Data collection procedures to ensure high-quality data and protect teacher confidentiality are being implemented. Your responses will only be used only for this study. The identification information on this questionnaire is used for study purposes; no information identifying individual teachers or schools will be reported under any circumstances.

How to Complete the Questionnaire

Please mark your answers on the questionnaire by darkening the circles completely. You may use a pencil or pen to complete this questionnaire.

Please return the completed answer sheet and the questionnaire in the provided postage paid envelope.

Class Selection

Part of the questionnaire asks you to provide information about instruction in a particular class. If you teach science to more than one class, select one and respond to all the questions for that class.

If You Have Questions

If you have questions about the study or any items in the questionnaire, please contact Bridget Cotner.

Thank you very much. Your participation is greatly appreciated!

Bridget Cotner, Principal Investigator
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Item #s ***Instructions (1-12)****: Please darken circles completely.*

Item #s						
1.	Please indicate your ethnicity/race *(Mark all that apply)*	① Asian	② Black or African American	③ Hispanic or Latino	④ White	⑤ Other
	Years of Experience	**< 1**	**1 - 3**	**4 - 9**	**10 -15**	**> 15***
2.	How many years have you taught prior to this year? *(Mark one item.)*	①	②	③	④	⑤
3.	How long have you been teaching at your current school? *(Mark one item.)*	①	②	③	④	⑤
	Highest Degree	**BA or BS**	**MA or MS**	**Multiple MA /MS**	**Ph.D. /Ed.D.**	**Other**
4.	What is the highest degree you hold? *(Mark one item.)*	①	②	③	④	⑤
	Semesters of Science	**0**	**1**	**2**	**3 - 4**	**> 4**
5.	How many semesters of college science have you completed? *(Mark one item.)*	①	②	③	④	⑤
6.	Do you have a degree in mathematics or science?	① **No**		② **Yes**		
	Number of Science Lessons per Week	**1**	**2**	**3**	**4**	**5**
7.	How many science lessons per week do you typically teach to this class? *(Mark one item.)*	①	②	③	④	⑤
	Minutes	**< 15**	**15 - 30**	**31 - 45**	**46 - 60**	**> 60**
8.	What is the average length of time for a lesson in this science class? (How much actual time, not just scheduled time.) *(Mark one item.)*	①	②	③	④	⑤
9.	During a lesson, what is the average length of time in minutes that students do "hands-on" activities? (Reading or completing worksheets does not count; **must** include using materials other than paper and pencil)	①	②	③	④	⑤
	Percentage	**< 10**	**10 - 29**	**30 - 49**	**50 - 79**	**> 80**
10.	Approximately what percentage of your science activities requires students to test their own hypotheses? *(Mark one item.)*	①	②	③	④	⑤
11.	What percentage of activities requires students to take measurements, make tables, or make observations of natural phenomena? *(Mark one item.)*	①	②	③	④	⑤
	Weeks per year	**< 6**	**6 – 12**	**13 – 18**	**19 - 24**	**> 24**
12.	How many weeks total will this science class meet during this school year? *(Mark one item.)*	①	②	③	④	⑤

* < is less than; > is more than.

INSTRUCTIONAL ACTIVITIES IN SCIENCE

Item #s

Use categories of: **1. Never**; **2. Rarely** (e.g., a few times a year); **3. Sometimes** (e.g., once or twice a month); **4. Often** (e.g., once or twice a week); **5. All or almost all** science lessons.

Instructions (13-35)*: About how often do* ***students*** *experience each of the following as part of their science class?* *(Mark one item for each line.)*	**Never**	**Rarely**	**Sometimes**	**Often**	**Almost all**
13. Listen to the teacher explain something to the whole class.	①	②	③	④	⑤
14. Read other (non-textbook) science-related materials.	①	②	③	④	⑤
15. Work **individually** on science assignments.	①	②	③	④	⑤
16. Write about science in a report/paper on science topics.	①	②	③	④	⑤
17. Do a hands-on activity, investigation, or experiment.	①	②	③	④	⑤
18. Watch the teacher demonstrate a scientific activity.	①	②	③	④	⑤
19. Use mathematics as a tool in problem solving.	①	②	③	④	⑤
20. Work in cooperative learning groups.	①	②	③	④	⑤
21. Do a class science activity **outside** of the classroom.	①	②	③	④	⑤
22. Use computers, calculators or other technology.	①	②	③	④	⑤
23. Write their reflections in a notebook or journal.	①	②	③	④	⑤
24. Follow specific instructions in science activities.	①	②	③	④	⑤
25. Use science equipment or measuring tools.	①	②	③	④	⑤
26. Record, represent, and/or analyze data.	①	②	③	④	⑤
27. Design or implement their **own** investigations.	①	②	③	④	⑤
28. Participate in student-led discussions.	①	②	③	④	⑤
29. Answer textbook, workbook, or worksheet questions.	①	②	③	④	⑤
30. Hear guest speakers illustrating diverse career roles.	①	②	③	④	⑤
31. Review homework, assignments, or prepare for a test.	①	②	③	④	⑤
32. Engage in performance tasks for assessment purposes.	①	②	③	④	⑤
33. Discuss/consider real-world careers related to activities.	①	②	③	④	⑤
34. Conduct science projects lasting longer than a week.	①	②	③	④	⑤
35. Write up results or prepare a presentation from a hands-on activity, investigation, experiment or project.	①	②	③	④	⑤
Instructions (36-45)*: About how often do* ***you*** *do each of the following as part of your science instruction in this class. (Mark one item for each line.)*					
36. Encourage all students to participate in a variety of tasks.	①	②	③	④	⑤

37. Use “wait-time” when asking questions.	①	②	③	④	⑤
38. Ask open-ended questions encouraging multiple answers.	①	②	③	④	⑤
39. Encourage students to explain concepts to one another.	①	②	③	④	⑤
40. Use media illustrating women and minorities in science.	①	②	③	④	⑤
41. Allow students to work at their **own** pace.	①	②	③	④	⑤
42. Emphasize connections among disciplines.	①	②	③	④	⑤
43. Evaluate my practice for subtle biases or stereotypes.	①	②	③	④	⑤
44. Show enthusiasm about science activities.	①	②	③	④	⑤
45. Encourage student-led inquiry or investigations.	①	②	③	④	⑤

TEACHER OPINIONS

Item #s	***Instructions (46-69)**: Please indicate how much you agree or disagree with each statement below. (Mark one item for each line.)*	**Strongly Disagree**	**Disagree**	**Neutral / Uncertain**	**Agree**	**Strongly Agree**
46.	Students learn science best in classes with students of similar abilities.	①	②	③	④	⑤
47.	The state/district testing program dictates what science content I teach.	①	②	③	④	⑤
48.	All students can learn challenging content in science.	①	②	③	④	⑤
49.	It is important for students to learn basic scientific terms before learning underlying concepts and principles.	①	②	③	④	⑤
50.	I really enjoy teaching science.	①	②	③	④	⑤
51.	I am **not** very effective in monitoring science experiments	①	②	③	④	⑤
52.	I have support from my colleagues to try new ideas in teaching science.	①	②	③	④	⑤
53.	Teachers in this school regularly share ideas and materials for teaching science.	①	②	③	④	⑤
54.	Given a choice, I would **not** invite the principal to evaluate my science teaching.	①	②	③	④	⑤
55.	Teachers in this school regularly observe each other teaching science classes.	①	②	③	④	⑤
56.	I routinely link science activities to real-world experiences or science careers.	①	②	③	④	⑤
57.	I receive little support from the school administration for teaching science.	①	②	③	④	⑤
58.	I have adequate time during the regular school week to work with my peers on science curriculum/instruction.	①	②	③	④	⑤

TEACHER OPINIONS

Item #s	***Instructions (46-69)**: Please indicate how much you agree or disagree with each statement below. (Mark one item for each line.)*	Strongly Disagree	Disagree	Neutral / Uncertain	Agree	Strongly Agree
59.	I do **not** know what to do to turn students on to science.	①	②	③	④	⑤
60.	Most teachers in this school actively contribute to decisions about the science curriculum.	①	②	③	④	⑤
61.	I use guest speakers from local organizations, institutions, and/or businesses.	①	②	③	④	⑤
62.	I have adequate materials available for science instruction.	①	②	③	④	⑤
63.	I am continually finding better ways to teach science.	①	②	③	④	⑤
64.	Even when I try very hard, I do **not** teach science as well as I teach other subjects.	①	②	③	④	⑤
65.	I know how to teach science concepts effectively.	①	②	③	④	⑤
66.	I understand science concepts well enough to be effective in teaching elementary science.	①	②	③	④	⑤
67.	I find it difficult to explain to students why science experiments work.	①	②	③	④	⑤
68.	I am typically able to answer students' science questions.	①	②	③	④	⑤
69.	When teaching science, I usually welcome student questions.	①	②	③	④	⑤

Item #s	***Instructions (70-91)**: How comfortable/confident do you feel **right now** about the following? (Mark one item for each line.)*	Not at all comfortable	Uncomfortable	Somewhat Comfortable	Fairly Comfortable	Very Comfortable
70.	Encouraging the participation of females in science.	①	②	③	④	⑤
71.	Doing hands-on science activities with your students.	①	②	③	④	⑤
72.	Helping students document and evaluate their own work.	①	②	③	④	⑤
73.	Having a staff member visit your classroom to observe science lessons.	①	②	③	④	⑤
74.	Teaching students with disabilities.	①	②	③	④	⑤
75.	Visiting another teacher's classroom to observe science lessons.	①	②	③	④	⑤
76.	Teaching classes with students with diverse abilities.	①	②	③	④	⑤
77.	Modeling science activities for other teachers.	①	②	③	④	⑤
78.	Teaching students from a variety of cultural backgrounds.	①	②	③	④	⑤

Item #s	***Instructions (70-91)**: How comfortable/confident do you feel **right now** about the following?* *(Mark one item for each line.)*	**Not at all comfortable**	**Uncomfortable**	**Somewhat Comfortable**	**Fairly Comfortable**	**Very Comfortable**
79.	Learning about equity techniques for female and minority students.	①	②	③	④	⑤
80.	Developing an interdisciplinary/cross curricular lesson that included a variety of curricular areas.	①	②	③	④	⑤
81.	Being videotaped conducting an interdisciplinary lesson.	①	②	③	④	⑤
82.	Doing a self-assessment of the videotaped lesson (above).	①	②	③	④	⑤
83.	Teaching science at your assigned level.	①	②	③	④	⑤
84.	Using/managing cooperative learning groups in science.	①	②	③	④	⑤
85.	Integrate science with other subjects.	①	②	③	④	⑤
86.	Encouraging participation of minorities in science.	①	②	③	④	⑤
87.	Providing science instruction that meets standards.	①	②	③	④	⑤
88.	Using a variety of science assessment strategies.	①	②	③	④	⑤
89.	Accounting for students' prior conceptions about natural phenomena when planning curriculum and instruction.	①	②	③	④	⑤
90.	Teaching students who have limited English proficiency.	①	②	③	④	⑤
91.	Involving parents in their child's science education.	①	②	③	④	⑤

PROFESSIONAL DEVELOPMENT ACTIVITIES IN SCIENCE EDUCATION

In answering the following items, consider all the professional development activities related to science content or science education that you have participated in ***during the past year****. Professional development refers to a variety of activities intended to enhance your professional knowledge and skills, including in-service training in your school, teacher networks, course work, summer institutes, committee work, and mentoring.*

Item #s	***Instructions (92-110)****: Thinking about all your professional development activities in science* ***during the past year****,* ***How often have you****: (Mark one item for each line.)*	**Never**	**Once or twice a year**	**Once or twice a term**	**Once or twice month**	**Once or twice a week**
92.	Participated in workshops or in-service training related to science or science education.	①	②	③	④	⑤
93.	Participated in summer institutes related to science or science education.	①	②	③	④	⑤
94.	Attended conferences related to science or science education.	①	②	③	④	⑤
95.	Participated in a teacher network, or collaborative of teachers supporting your professional development.	①	②	③	④	⑤
96.	Acted as a coach or mentor to other teachers or staff in your school.	①	②	③	④	⑤
97.	Participated in a committee or task force focused on curriculum and instruction.	①	②	③	④	⑤
98.	Explored strategies to improve student-led inquiry.	①	②	③	④	⑤
99.	Practiced what you learned and received feedback.	①	②	③	④	⑤
100.	Observed demonstrations of science teaching techniques.	①	②	③	④	⑤
101	Developed curricula or lesson plans reviewed by others.	①	②	③	④	⑤
102.	Participated in activities that make science fun.	①	②	③	④	⑤
103	Developed performance assessments or scoring rubrics.	①	②	③	④	⑤
104.	Received coaching or mentoring in the classroom.	①	②	③	④	⑤
105	Aligned science instruction to curriculum standards.	①	②	③	④	⑤
106.	Used cooperative learning activities with role assignments for students.	①	②	③	④	⑤
107	Interpreted assessment data for use in science instruction.	①	②	③	④	⑤
108.	Used technology to support student learning in science.	①	②	③	④	⑤
109	Shared experiences with other teachers in my school or department who did **not** attend the activity.	①	②	③	④	⑤

Item #s	***Instructions (92-110)****: Thinking about all your professional development activities in science* ***during the past year****,* ***How often have you****: (Mark one item for each line.)*	**Never**	**Once or twice a year**	**Once or twice a term**	**Once or twice month**	**Once or twice a week**
110.	Discussed how to improve parents and community involvement in the classroom.	①	②	③	④	⑤

Thank You for Your Assistance!
Please place the questionnaire in the stamped envelope provided and mail to Bridget Cotner.

Appendix G: List of Items by Factor

Factors	Items
Hands-On	17 Do a hands-on activity, investigation, or experiment.
	25 Use science equipment or measuring tools.
	26 Record, represent, and/or analyze data.
	24 Follow specific instructions in science activities.
	18 Watch the teacher demonstrate a scientific activity.
	35 Write up results or prepare a presentation from a hands-on
	27 Design or implement their own investigations.
	34 Conduct science projects lasting longer than a week.
	21 Do a class science activity outside of the classroom.
Empowering	38 Ask open-ended questions encouraging multiple answers.
	37 Use "wait-time" when asking questions.
	41 Allow students to work at their own pace.
	39 Encourage students to explain concepts to one another.
	43 Evaluate my practice for subtle biases or stereotypes.
	42 Emphasize connections among disciplines.
	36 Encourage all students to participate in a variety of tasks.
	44 Show enthusiasm about science activities.
	45 Encourage student-led inquiry or investigations.
	20 Work in cooperative learning groups.
Inquiry	30 Hear guest speakers illustrating diverse career roles.
	33 Discuss/consider real-world careers related to activities.
	16 Write about science in a report/paper on science topics.
	40 Use media illustrating women and minorities in science.
	22 Use computers, calculators or other technology.
	19 Use mathematics as a tool in problem solving.
	14 Read other (non-textbook) science-related materials.
	28 Participate in student-led discussions.
	32 Engage in performance tasks for assessment purposes.
Traditional	29 Answer textbook, workbook, or worksheet questions.
	31 Review homework, assignments, or prepare for a test.
	15 Work individually on science assignments.
	13 Listen to the teacher explain something to the whole class.
Efficacy	65 I know how to teach science concepts effectively.
	66 I understand science concepts well enough to be effective in teaching elementary science.
	50 I really enjoy teaching science.
	68 I am typically able to answer students' science questions.
	67r I find it difficult to explain to students why science experiments work.
	59r I do not know what to do to turn students on to science.
	64r Even when I try very hard, I do not teach science as well

	as I teach other subjects.
	51r I am not very effective in monitoring science experiments.
	69 When teaching science, I usually welcome student questions.
	54r Given a choice, I would not invite the principal to evaluate my science teaching.
Collegiality	55 Teachers in this school regularly observe each other teaching science classes.
	60 Most teachers in this school actively contribute to decisions about the science curriculum.
	53 Teachers in this school regularly share ideas and materials for teaching science.
	58 I have adequate time during the regular school week to work with my peers on science curriculum/instruction.
Strategies	88 Using a variety of science assessment strategies.
	87 Providing science instruction that meets standards.
	83 Teaching science at your assigned level.
	71 Doing hands-on science activities with your students.
	72 Helping students document and evaluate their own work.
	85 Integrate science with other subjects.
	84 Using/managing cooperative learning groups in science.
	73 Having a staff member visit your classroom to observe science lessons.
	91 Involving parents in their child's science education.
	89 Accounting for students' prior conceptions about natural phenomena when planning curriculum and instruction.
	77 Modeling science activities for other teachers.
	80 Developing an interdisciplinary/cross curricular lesson that included a variety of curricular areas.
Diversity	78 Teaching students from a variety of cultural backgrounds.
	76 Teaching classes with students with diverse abilities.
	79 Learning about equity techniques for female and minority students.
	86 Encouraging participation of minorities in science.
	74 Teaching students with disabilities.
	70 Encouraging the participation of females in science.
	90 Teaching students who have limited English proficiency.
	75 Visiting another teacher's classroom to observe science lessons.
Evaluation	81 Being videotaped conducting an interdisciplinary lesson.
	82 Doing a self-assessment of the videotaped lesson (above).

Appendix H: District Administrator Interview

District Administrator Interview (Spring 2013)

School District Information

1. Please describe your position and responsibilities in the school district.
    a. How long have you been in this position?
    b. In what ways has your position changed since you started until now?
2. Describe what elementary level reforms are currently being implemented at the school district?
    a. What types of professional development reforms? (for science)
    b. What instructional strategies are being emphasized in the reforms? (inquiry)
    c. What other types of reform? (bullying)
3. Describe the level of turnover of elementary school leadership (principals, assistant principals) that has occurred in the last five years (and this school year).
    a. What are some reasons for turnover?
    b. What are some reasons for continuity?
4. Describe the level of elementary teacher turnover and re-assignment that has occurred in the last five years (and this school year).
    a. What are some reasons for turnover?
    b. What are some reasons for continuity?

Retrospective View of the Implementation of the Teaching SMART® Professional Development Program

Thinking back to when Teaching SMART® was being implemented:

5. What were the main strengths of the program?
6. What were the main weaknesses of the program?
7. What are some outcomes that resulted from having the Teaching SMART® program?

8. If you were able to implement the program again, what would you do differently?

Plan for Sustainability

9. When the implementation of Teaching SMART® was ending in 2008, what did you want to see continued?

10. What plans or ideas were in place or discussed at the district level to continue the program?
    a. Who were involved in making these plans or discussing ideas?
    b. Were these plans implemented?
        i. If yes, what was implemented and how?
        ii. If no, what stopped the plans from being implemented?

11. What plans or ideas were in place or discussed at the individual school levels to continue the program?
    a. Who were involved in making these plans or discussing ideas?
    b. To what extent were these plans implemented?
        i. What was implemented and how?
        ii. What stopped the plans from being implemented?

Support from Leadership and Stakeholders

12. At the district level, what practices were implemented to support sustainability of the program?
    a. Were positions created or maintained (PD specialists)?
    b. Was funding reallocated to support the program (PD workshops, materials replenished)?

13. At the school level, what practices were implemented or continue to support sustainability of the program?
    a. Were positions created or maintained (PD specialists)?
    b. Was funding reallocated to support the program (PD workshops, materials replenished)?

Ongoing Professional Development

14. Describe what science professional development opportunities are available to elementary teachers (upper intermediate).

    a. How often are they offered?

    b. What is the focus of these offerings?

15. To what extent are PD offerings aligned with current reform programs?

    a. In what ways are these opportunities in alignment with the Teaching SMART® professional development program?

    b. In what ways are these opportunities not in alignment with the Teaching SMART® professional development program?

Closing Questions

16. Is there anything you'd like to share?

17. Would you like to receive an electronic draft of this interview transcript to review?

    a. If yes, email address: ____

Thank you for participating in this interview.

Appendix I: Teacher Interview

End of Year Teacher Interview (Spring 2013)

Teacher Information

1. Please describe your current teaching assignment. (grade levels, the content areas, and if team teach).

2. Have there been any changes in your teaching assignment (change schools, grade levels or content areas), certification, or other changes affecting your science instruction in the last five years (since 2008)?

3. Thinking back to when you participated in Teaching SMART®, are there teachers at this school that also participated in TS? In what ways do you work with them if at all?

Science Instruction

4. How <u>often</u> do you currently teach science to your students? (number of times per week, how long are lessons)

5. What strategies do you consider to be your greatest strengths in teaching science?
    a. Weaknesses?

6. When teaching science, what strategies do you use to encourage student inquiry?

7. When teaching science, what strategies do you use to ensure that there is an equitable opportunity for all students to learn science?

8. When teaching science, what strategies do you use to support student collaboration?

9. When teaching science, what strategies do you use to make connections between science and the real-world your students may experience?

10. What assistance (from colleagues, district, school admin) do you receive to enhance your science instruction?

Attitude toward Science

11. Please describe how comfortable you feel when teaching science. (what makes you feel comfortable)

12. What makes you feel uncomfortable when teaching science?

Professional Development

13. What professional development activities have you participated in for science over **this school year**? In the **past five years**?

    a. What types of PD are most attractive to you (makes you want to go)?

    a. Who provides the PD?

14. What do you consider the greatest strength of the science professional development that you have received?

15. What do you consider the greatest weakness of the science professional development that you have received?

16. In what ways have the professional development activities influenced your science instruction?

Retrospective View of the Implementation of the Teaching SMART® Professional Development Program

Thinking back to when Teaching SMART® was being implemented:

17. What were the main take-aways for you? (what did you learn? What were the strengths)

18. What were the main weaknesses of the program? (what did you want to learn and didn't or learn more of?)

19. Have you seen any changes in the way you teach science today because of Teaching SMART®? Please give examples.

20. Have you seen any changes in students since using Teaching SMART®? Please describe. (student interest in science, involvement, scores on tests)

21. What has influenced whether or not you use the strategies learned in the TS professional development? (resources, completing reforms, isolation from other teachers, support)

Closing Questions

22. Is there anything you'd like to share about your science instruction or Teaching SMART® that I have not asked?

23. Would you like to receive an electronic draft of this interview transcript to review?

    b. If yes, email address: ____

Thank you for participating in this interview.

UNIVERSITY OF SOUTH FLORIDA

RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-7091

5/2/2013

Bridget Cotner, M.A.
College of Education
4202 East Fowler Ave., SOC 107
Tampa, FL 33620

RE: **Expedited Approval for Initial Review**
IRB#: Pro00011550
Title: Sustainability of a Professional Development Program

Study Approval Period: 5/2/2013 to 5/2/2014

Dear Dr. Cotner:

On 5/2/2013, the Institutional Review Board (IRB) reviewed and **APPROVED** the above application and all documents outlined below.

Approved Items:
Protocol Document:
BormanAccessToDataLetter.docx
BridgetCotnerDissertationProposalCh1,2,3_April 10_2013.docx
Consent Document*:
Adult IC minimal risk Interviews and Observations April 29 2013.docx.pdf

Consent Script:
Adult IC minimal risk Waiver of Documentation Survey April 26 2013.docx

*Please use only the official IRB stamped informed consent/assent document(s) found under the "Attachments" tab. Please note, these consent/assent document(s) are only valid during the approval period indicated at the top of the form(s).

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110 and 21 CFR

56.110. The research proposed in this study is categorized under the following expedited review categories:

(6) Collection of data from voice, video, digital, or image recordings made for research purposes.

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your study qualifies for a waiver of the requirements for the process of informed consent (retrospective data from 2008) as outlined in the federal regulations at 45CFR46.116(d) which states that an IRB may approve a consent procedure which does not include, or which alters, some or all of the elements of informed consent.

Your study qualifies for a waiver of the requirements for the documentation of informed consent as outlined in the federal regulations at 45CFR46.117(c) which states that an IRB may waive the requirement for the investigator to obtain a signed consent form for some or all subjects.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval by an amendment.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

John A Schinka, Ph.D.

John Schinka, Ph.D., Chairperson
USF Institutional Review Board

Appendix K: Qualitative Code Book

Code	Definition	Examples
Assessments	Federal, state, district, or classroom assessments	FCAT, Florida Writes, class project, class presentation
Class size	Number of students in a class	
Coaches	Individuals who are trained as coaches to work with teachers on instructional practices or content	District provided, reading coaches, TS coaches
Curriculum	Science curriculum or text books used	
District	District administrator interview	Use this code in ALTAS to allow analysis at the district level
District reorganization	Superintendent and other district positions that have been changed in some way	New regions in the district
Inquiry	Science inquiry method	Cooperative learning/grouping, hands-on, experiments
PD	Professional development opportunities from the past, present or future	Trainings, workshops, inservice at the school, district coaches
Policy	Any policy mentioned	Common Core, Student Success Act, Class size, etc.
Quotable	A phrase that captures the essence of the thought perfectly	
Resources	People, places or things that are available to teachers to use and support their instruction	Other teachers, science lab, science materials
Standards	Science standards	Any mention of federal, state, or district science standards
Strength TS	Identified strengths of Teaching SMART® by participants	
Sustainability of TS	Practices identified by participants as being sustained, or not	
Teacher	Teacher interview	Use this code in ALTAS to allow analysis at the teacher level
Teacher evaluation	Evaluation of teaching practices	Teacher self-evaluation, principal or district level evaluation
Technology	Technology used in science instruction	
TS outcomes	Outcomes of the Teaching SMART® program identified by participants	
Turnover	District or school leadership, teacher turnover	
Weakness TS	Identified weaknesses of Teaching SMART® by participants	

ABOUT THE AUTHOR

Bridget Cotner has been a qualitative researcher on mixed method studies for over 15 years. She received her B.A. from Ball State University with a double major in Anthropology and French in 1998. She earned her M.A. from University of South Florida's Applied Anthropology program in 2001. During her Master's program, she began her research career by working on large-scale, mixed method education research and evaluation studies funded by the National Science Foundation, U.S. Department of Education, Florida Department of Education, and the Spencer Foundation.

While pursuing her Ph.D. at the University of South Florida, Bridget became a research faculty member with the Department of Anthropology and continued her research to improve teaching and learning. In 2011, Bridget began working at the U.S. Department of Veterans Affairs in Tampa, FL as a qualitative researcher.