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The Impact Of A Professional Development Program On Teachers' Practice And How Context Variables Influenced Such Practice: A Case Study

Sandra Lynn Yarema
Wayne State University,

THE IMPACT OF A PROFESSIONAL DEVELOPMENT PROGRAM ON TEACHERS' PRACTICE AND HOW CONTEXT VARIABLES INFLUENCED SUCH PRACTICE: A CASE STUDY

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SANDRA LYNN YAREMA

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DEDICATION

This research project is dedicated to my former students and co-workers at St. Dennis School, who shared in many wonderful years of my teaching career, and who provided the impetus to grow and go farther than I ever thought I could.

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CHAPTER 1 INTRODUCTION

Background

Despite the urgent promotion of systemic reform in science education for the past three decades (American Association for the Advancement of Science, 1989; 1993; Next Generation Science Standards- Lead States, 2013; National Research Council, 1996; 2012), science is not yet considered a central part of curriculum and instruction for the early elementary grades in American schools. The federal *No Child Left Behind Act* (NCLB) of 2001, one of the most recently implemented responses to calls for reform, required significantly more emphasis on mathematics and English language arts over science. However, continued changes in the preparation of American students for careers in science, technology, mathematics and engineering (STEM) are advocated based on a lower performance rank of American students compared to students in many other nations on standardized tests in science and mathematics (National Assessment of Educational Progress, 2005; Programme for International Student Assessment, 2006; Trends in International Mathematics and Science Study, 2007).

President Obama declared the need to update NCLB in his 2011 State of the Union Address before Congress:

> Maintaining our leadership in research and technology is crucial to America's success. But if we want to win the future – if we want innovation to produce jobs in America and not overseas – then we also have to win the race to educate our kids. Over the next ten years, nearly half of all new jobs will require education that goes beyond a high school degree. And yet, as many as a quarter of our students aren't even finishing high school. The quality of our math and science education lags behind many other nations. America has fallen to 9th in the proportion of young people with a college degree. And so the question is whether all of us – as citizens, and as parents – are willing to do what's necessary to give every child a chance to succeed. We need to prepare 100,000 new teachers in the fields of science, technology, engineering, and math. (p. 4)

Yet science is still not a significant component of curriculum and instruction in elementary schools despite these pronouncements in support of enhancing school science programs. Adequate Yearly Progress (AYP) is presently the cornerstone of the NCLB for measuring school performance. In many states, AYP is measured by year-to-year student achievement on standardized assessments (NCLB, 2002). Currently, science is not included until the fifth grade level on these tests. Consequently, there may be no formal science instruction in the primary grade levels, as most schools emphasize only the curricular strands that will be assessed.

Problem Statement

At present, most elementary teachers in Michigan are certified to teach all subjects K-5 in self-contained classrooms and are certified for grades 6-8 in a subject major. As a result, unless an elementary teacher has a major in science, he or she may have very little science content knowledge; only 4% of elementary science teachers major in science or science education (Fulp, 2002). Significantly, science is often left out of the curriculum due to the mandated emphasis that most school districts place on reading, writing and mathematics; which are the subjects assessed at the primary level (NSTA, 2011; Watanabe, 2011).

How then, can elementary teachers change their practice, and meet these strident demands for reform? Milner, Sondergeld, Demir, Johnson, and Czerniak (2012) state:

> To increase the probability that student learning will occur in elementary science, federal policy must make elementary science important and it must “count” in the minds of school administrators (i.e., science should be taught and teachers need the proper curriculum, resources and time to teach it). Teacher education programs must prepare elementary teachers to teach science effectively. (p. 129)

Teachers must understand science content as well as how to employ strategies for effective science instruction. Improvement in the teachers' science content knowledge (SCK) and science pedagogical content knowledge (SPCK) is necessary for elementary teachers to implement the reform needed to increase student achievement in science. A teacher's content knowledge is an intrinsic part of the teacher's pedagogical content knowledge (PCK) as affirmed by several studies. (AERA, 2005; Appleton, 2008; Daehler & Shinohara, 2001; Garret, Porter, Desimone, Binnan, & Yoon, 2001; Krebs, 2005; Mishra & Koehler, 2006; Schulman, 1986; 1987; Van Dijk & Kattmann, 2007; Veal & MaKinster, 1999; Wallace, 2009).

Teacher professional development (PD) is considered a foundation for the implementation of standards-based reform (Committee on Science and Mathematics Teacher Preparation, 2001) and is a commonly recognized approach to support practicing teachers' development of standards-based skills such as inquiry-based instruction strategies in science classrooms (Loucks-Horsley, Love, Stiles, Mundry & Hewson, 2003; NGSS Lead States, 2013; NRC, 1996; 2012). PD is particularly important for teachers who do not have a major in science as a means to increase their SCK and SPCK.

In keeping with goals for reform, elementary teachers will need to develop increased science content knowledge, along with the capability to develop scientific literacy in their students. There must be systemic support for planned curriculum and policies that explicitly include scheduled instructional time at the elementary school level, for learning scientific knowledge and processes. Additionally, curriculum must also be expanded to include an emphasis on science content and process knowledge, so teachers can implement this knowledge within their practice. Effective professional development programs are needed to prepare teachers to meet all of these challenges.

Research Objective and Questions

The purpose of this mixed-methods case study was to examine the impact of a state-funded professional development (PD) program on a specific group of teachers' practice. The study also explored contextual variables related to district restructuring and school implementation of district policies and their impact on teacher practice.

The following research questions framed this study:

1. What is the impact of the professional development program (PD) on the teachers' science content knowledge (SCK)?
2. What is the impact of the PD on the teachers' science pedagogical content knowledge (SPCK)?
3. What role does the PD program play in the teachers' classroom practice?
4. What role do contextual variables related to district restructuring and the school's implementation of district policy play in the teachers' classroom practice?
5. To what extent does the program facilitate the development of a professional community among the participants?

Definition of Terms

The following operational terms are utilized in this study:

Contextual Variables are defined as transitory factors that involved the setting in which an interaction occurs; delineated from personal and interpersonal characteristics (Worchel, 1986, p. 2).

Primary grades designate the first three grades at the early elementary school level. Elementary grades are considered to be kindergarten through eighth grades, prior to high school.

Professional Community is a model describing educators working collaboratively to improve student learning (DuFour, 2004).

Professional Development (PD) is " a comprehensive, sustained, and intensive approach to improving teachers' and principals' effectiveness in raising student achievement, and may be supported by activities such as courses, workshops, institutes, networks, and conferences" (Wei, Darling-Hammond, Andree, Richardson & Orphanos, 2009, p.4).

Scientific Inquiry is defined as "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world "(NRC, 1996, p.26).

Science Content Knowledge (SCK) is the body of information that teachers teach and that students are expected to learn in science, including all facts, concepts, theories, and principles that are part of the curriculum.

Science Pedagogical Content Knowledge (SPCK) is teachers' knowledge of how to teach science content; including knowledge of science curricula, of students' understanding of science, of specific instructional strategies, and of how to assess scientific literacy (Magnusson, Krajcik, & Borko, 1999).

Significance of the Study

Capps, Crawford and Constas (2012) conducted an extensive search of the literature and reported that "there is scant empirical evidence to support the effectiveness of teacher PD in the area of inquiry-based instruction" (p. 292). Additionally, they found no targeted review of PD programs focused specifically on scientific inquiry. One of the goals of this PD program was to develop participants' pedagogical content knowledge, in particular skills related to inquiry-based instruction.

The results of this study illustrate the benefits and challenges of implementing a specific PD program as applied to a school targeted for reform and suggest how PD can be a critical vehicle to increase SCK and SPCK for teachers who do not have a major in science. This study also explored connections between changes in teacher knowledge and beliefs and actual classroom practice, which may provide implications for how these aspects of a PD program might be used as a model for the improvement of science education at the elementary level. The study also illustrates the importance of context in efforts focused on fostering teacher change.

CHAPTER 2 THEORETICAL FRAMEWORK

Teacher Professional Development

The term "professional development" is defined by the National Staff Development Council (NSDC) to mean "a comprehensive, sustained, and intensive approach to improving teachers' and principals' effectiveness in raising student achievement, and may be supported by activities such as courses, workshops, institutes, networks, and conferences" (Wei, Darling-Hammond, Andree, Richardson & Orphanos, 2009, p.4). The NSDC further reports that effective PD is essential to school reform because:

> While U.S. policy initiatives increasingly reflect an understanding that effective teaching and school leadership are critical to the quality of education that students receive, there is often less recognition that teacher professional development is a key element of school reform. Without a strategic investment in high-quality professional development, it is unlikely that any effort to improve teacher effectiveness or to turn around low-performing schools will succeed. (Wei et al., 2009, p. 1)

The NSDC conducted a survey that described models for traditional PD experienced by American teachers between 1999 and 2004. The most common form of traditional PD was participation in workshops, conferences, or training sessions; as reported by more than ninety percent of teachers. Greater than twenty percent of teachers surveyed participated as a presenter for such sessions. Approximately thirty percent of surveyed teachers reported completing formal University courses related to teaching as PD. Fewer than 25 percent of the surveyed teachers reported participation in observational visits to schools as a form of traditional PD. (Wei et al., 2009, p. 19).

Traditional models of PD experienced in American schools are of short duration and do not provide the time, regular follow-up, and reinforcement opportunities essential to successful professional development. The teachers surveyed by NSCD reported low ratings of the usefulness of most professional development activities, as well as a desire for further PD in the content they taught, classroom management, teaching special needs students, and other topics. These responses are indicators of the insufficiency of the PD infrastructure in place in most states and communities (Wei et al., 2009, p. 27).

Elements of Effective Professional Development

A framework for designing PD was developed by Loucks-Horsely et al. (2003, p. 12). This included 18 teacher learning strategies clustered within six categories.

Table 1 *Eighteen Strategies for Professional Learning*

Aligning and implementing curriculum
- Curriculum alignment and instructional materials selection
- Curriculum implementation
- Curriculum replacement units

Collaborative structures
- Partnerships with scientists and mathematicians in business, industries, and universities
- Professional networks
- Study groups

Examining teaching and learning
- Action research
- Case discussions
- Examining student work and thinking, and scoring assessments
- Lesson study

Immersion experiences
- Immersion in inquiry in science and problem solving in mathematics
- Immersion into the world of scientists and mathematicians

Practicing teaching
- Coaching

- Demonstration lessons
- Mentoring

Vehicles and mechanisms

- Developing professional developers
- Technology for professional development
- Workshops, institutes, courses, and seminars

Elements from each category of strategies were selected by the provider of the intervention PD program to fit the specific purposes for PD (p. 115): to focus on developing awareness, building knowledge, translating new knowledge into practice, and reflecting deeply on teaching and learning. Detailed elements of the PD design are described in the methods section of this study.

Three research groups (Guskey, 2003; Loucks-Horsley et al., 2003; Thompson & Zeuli, 1999) reviewed recent studies of PD to provide a consensus about the key features of effective PD. These significant components of effective PD are subsequently described. Specific elements of effective professional development (PD) were also summarized in policy statements for teacher educators (AERA, 2005; Wei et al., 2009). The reports evince that PD programs have resulted in significant improvement in students' science achievement when the PD program is sustained over time, encompasses science content and content specific pedagogical content knowledge, allows participants to form cohort groups, and encourages community collaboration.

Visser, Coenders, Terlouw, and Pieters (2010) identified essential elements of a PD program designed to prepare teachers to implement curriculum innovation. Teachers must be given ample opportunities to develop science content, instructional strategies, and assessment methods. Teachers need opportunities to cooperate with colleagues and collaborate in an organized network. They should discuss teaching and learning difficulties, exchange elements of good practice, and address how to obtain equipment and materials.

Capps, Crawford and Constas (2012) compiled a meta-analysis of PD programs focused on Inquiry. They synthesized a list of common features of PD programs that were determined to be effective in promoting scientific inquiry-based teaching from a critical review of reform documents and select PD programs. Structural features included providing extended total time and support designated for the PD program, and authentic experiences to teachers. Core features of these PD programs included coherency with standards, lesson development, inquiry modeling, reflection, transference, and content knowledge.

NSDC listed five of the most frequently mentioned characteristics of effective PD (Wei et al., 2009). Effective PD enhances teachers' content and pedagogical knowledge; it provides sufficient time and other resources; it promotes collegial and collaborative exchange; fourth, it establishes procedures for evaluating the PD experience; and it is conducted within the school or is site-based.

Learning Forward, a non-profit organization formerly known as NSDC, has changed the labeling of Professional development to "Professional Learning" (PL) to signal the importance of educators taking a more active role in their continuous development (Rebora, 2011, p. 4). Learning Forward has also updated the standards for PL that can increase educator effectiveness and results for all students. Such PL occurs within learning communities; requires skillful leaders able to prioritize and coordinate resources; and uses a variety of data to plan, assess, and evaluate learning. It also integrates theories, research and models of human learning; applies research on change; sustains support for long-term implementation; and aligns PL outcomes with curriculum and performance standards (Learning Forward, 2011).

Evidence suggests that PD programs effect changes in teacher practice and in subject specific science teacher knowledge. A long-term mentoring program produced data over two years that showed changes in teacher practice and in subsequent student achievement (Appleton, 2008). A three-year study of professional development involving cases also showed clear evidence of change in teacher practice, and increased student achievement (Daehler & Shinohara, 2001). A survey of teachers who self-reported on their experiences and behavior after participation in PD indicates that increased time span, longer contact hours, specific content focus and coherence have substantial positive effects on teacher knowledge and skills. Coherent PD activities enhance teacher knowledge and skills, and more importantly, have an important positive influence on change in teaching practice (Garret et al., 2001). The results of a long-term PD project (Park-Rogers et al., 2005), suggests that if the ultimate purpose of PD is to improve student learning then PD must take into account the learning needs of students. For this to occur, PD facilitators must instruct teachers on how to use student data to inform their teaching practice. This task requires facilitators to model for teachers how to design appropriate assessments, diagnose student needs from these assessments, and continually modify a standards-based curriculum to address their students' specific learning needs. Such use of data may be considered a form of action research. Action research may be defined as:

> Inquiry that is systematic, intentional, collaborative, and democratic in intent and process. Action research can be an instrument of critical change performed as a careful study by teachers of the conditions and contexts of their work that will help them learn about and change practice in ways that fit their unique teaching settings. (Price, 2011, p. 44)

Action research may impact teachers' instructional behaviors when systematic inquiry about that practice is integrated with the natural classroom practice (Posanski, 2010). The use of action research can thus be a strategy for helping teachers become researchers, thereby an integral component of effective PD.

Science teacher education must foster the development of knowledge and abilities in pre-service teachers. They must learn how to use state and national reform documents and standards (e.g., AAAS, 1993; NGSS lead states, 2013; NRC, 1996; 2012) to inform their choices of developmentally appropriate science content and to begin to practice a set of teaching strategies that facilitate children's learning. Practicing teachers must then collect a curriculum repertoire, to have PCK not only of the substantive content, but also of the syntactical content; knowing how and when to use specific strategies that will reach their students (Smith, 2000).

Developing Content Knowledge and Pedagogical Content Knowledge

PD is considered an established method for building teachers' general knowledge in any content discipline and is a commonly recognized approach to develop teachers' knowledge of specific strategies in science classrooms (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003; NRC, 1996). The integration of science content within explicit pedagogical context is widely considered a successful strategy to increase the ability of teachers to effectively utilize content knowledge gained from PD (Van Duzor, 2012). Shulman (1986) introduced the idea of pedagogical content knowledge as a way to advance thinking about teacher knowledge. He claimed that the emphases on teachers' subject knowledge and pedagogy were being treated as mutually exclusive domains in research (Shulman, 1987). The practical consequence of such exclusion was the production of teacher education programs emphasizing either subject matter or pedagogy. PCK represents the blending of content and pedagogy into an understanding of how particular aspects of subject matter are organized, adapted, and represented for instruction. To characterize the complex ways in which teachers think about how particular content should be taught, he argued for ‘‘pedagogical content knowledge’’ as the content knowledge that deals with the teaching process, including ‘‘the ways of representing and formulating the subject that make it comprehensible to others’’ (p. 9). At the heart of PCK is the manner in which subject matter is transformed for teaching. This occurs when the teacher interprets the subject matter and finds different ways to represent it and make it accessible to learners. This notion of PCK, since its introduction in 1987, has permeated the scholarship that deals with teacher education and the subject matter of education (Ball, 1996; Grossman, 1991; Ma, 1999; Shulman, 1987; Wilson, Shulman, & Richert, 1987). It is valued as an epistemological concept that usefully blends the traditionally separated knowledge bases of content and pedagogy.

Teacher content knowledge is embedded within the structure of pedagogical content knowledge. Multiple studies have documented research on science teachers’ knowledge, its relationships to students' learning in science, and how teachers use students’ conceptions to inform their practice (Anderson & Smith, 1986; Driver, Asoko, Leach, Mortimer & Scott, 1994; Driver, Rushworth & Wood-Robinson, 1994, 2007).

Magnusson, Krajcik, and Borko (1999) developed a model proposing PCK specifically for science teaching. This model includes teachers’ knowledge of science curricula, knowledge of students’ understanding of science, knowledge of instructional strategies, and knowledge of assessment of scientific literacy. Park and Oliver (2008), proposed a "Pentagon model of PCK for teaching science" (p. 816). This model defined PCK as a cycle of integration among five specific-to-science components, which included orientation to science and to teaching, and a knowledge repertoire of instructional strategies, learning assessment, curriculum, and students' understanding.

Improving teachers' PCK for any subject involves learning new skills and putting them into practice. Learning can be viewed as conceptual change as described by Hewson and Hewson (2003). "Conceptual bridging" (p.88), is ideally used, in which learners are able to establish a context to link abstract concepts with meaningful experience gained through experimental evidence. Transforming knowledge into practice is an important element of developing this experimental evidence.

Recent developments relating to the transformation of teacher knowledge into pedagogical practice include the exponential increase of new digital technologies and the requirements for learning how to apply them to teaching. Teachers will have to do more than simply learn to use currently available tools; they also will have to repeatedly learn new techniques and skills as current technologies become obsolete. This is a very different context from earlier conceptualizations of teacher knowledge, in which technologies were standardized and relatively stable (Mishra & Koehler, 2006).

Effective PD is the conventional approach for developing teacher knowledge of science content, as well as instructional strategies, and assessment methods specific to teaching science. Changes in SCK and PCK can be measured by observing changes in teaching practice as compared to self-reported evidence. These changes in practice are also influenced by context, such as mandated curriculum, policies, and procedures.

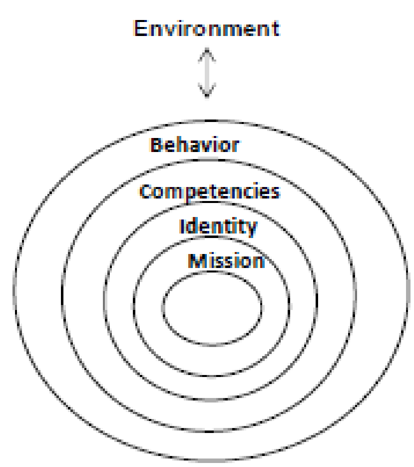
Change in Teaching Practice

Korthagen (2004) proposed an “onion skin model of levels of change” (Figure 1) as a framework to describe different essential elements of a good teacher. Each level of the model can be used as a perspective to look at how teachers function. Only the outermost levels of environment and behavior can be directly observed by others. The inner levels: competencies, beliefs, identity, and mission, can only be recognized through internal reflection by the teacher as motivations for change. Each of these inner levels of the model may successively cause influence on the levels below while simultaneously being influenced by levels from above.

Specific elements of the PD program on the participants’ practice were examined through the lens of Korthagan’s model. The model assisted in the analysis of any effects between the PD and internal changes in teachers that might not be directly observable, but that were discovered through reflection and scrutiny by the teacher and teacher educator. The data collected in this study indicated correlations between observed changes in teacher practice and increases in their own perception of competency in SCK and PCK. A teacher’s belief system guides actions and practice in the classroom (Nespor, 1987; Pajares, 1992; Posner, Strike, Hewson, & Gertzog, 1982). Teacher beliefs about how the PD program influenced their competency and practice became evident through comparison of practice observed by the researcher and statements of self-perception. These views of the change process are used to illustrate the role of context on implementing effective PD and its significance for school reform. Where changes in practice were not evident, the role of contextual factors and the relationship among and between different factors on teacher beliefs were explored. Chen (2010) relates that "requiring teachers to change their pedagogical beliefs can be a daunting task because it may involve challenging fundamental beliefs. Moreover, different contextual factors may combine to affect teachers' beliefs and researchers need to consider the relations among those factors" (p. 67).

In this study, the impact of some contextual factors related to district reorganization were considered. Some of these factors included teacher reassignment, mandated curricular changes, as well as district and building policy decisions.

Figure 1: The onion: models of levels of change (Korthagen, 2004, p.80)



Recognizing Teacher Practice that Promotes Science Learning

Multiple factors must be considered to attempt to characterize a teacher's practice. Direct observations within the classroom, self-reported evidence, and artifacts such as lesson plans and student work can be viewed as cumulative evidence of classroom practice related to inquiry.

Capps and Crawford (2013) described three essential elements for teaching science as inquiry as derived from science education reform documents (NGSS lead states, 2013; NRC 1996, 2000, 2012). First, scientific inquiry might be approached as a content area in which learners develop understandings of how professional scientists do their work. The second element is the learner's abilities in these scientific practices of inquiry, or process skills. Third is the teacher's ability to utilize inquiry-based instruction strategies to address scientific concepts and principles (p. 499).

Five essential features for classroom inquiry are listed by NRC (2000, p. 29).

Table 2 *Essential Features of Classroom Inquiry*

1. Learner engages in scientifically oriented questions
2. Learner gives priority to evidence in responding to questions
3. Learner formulates explanations from evidence
4. Learner connects explanations to scientific knowledge
5. Learner communicates and justifies explanations

Incorporation of these essential components of inquiry was the basis for selection of the Classroom Observation Protocol (Appendix B).

Self-reported evidence, interview questions, and artifacts were all evaluated in comparison to these criteria for evidence of changes in the teachers' practice as a result of the PD program.

CHAPTER 3 METHODOLOGY

Research Design

A mixed-methods case study design was employed as the framework for this research to build an "in-depth, contextual understanding" of the PD experiences and its effect on classroom practice for a participating group of teachers from a single school (Creswell, Hansen, Clark Plano, & Morales, 2007, p. 245). The case study method was chosen as the best way to explore how school and district policies and the focus on a reform agenda served as contextual conditions for the effect of PD on teacher practice, a "complex social phenomena, in which the boundaries between the phenomena and its context are not clearly evident" (Yin, 2009, p. 18).

Context and Participants

The participants in this case study were seven elementary teachers, all assigned to the same urban, neighborhood school. These participants were a subset of a larger sample of teachers participating in the PD program. They registered for the PD program as a cohort group, with the expressed goal of improving their science knowledge base and teaching practice. Two additional teachers from the same school cohort group, both male, a gym teacher and a math teacher, dropped out of the PD program during the first week of the summer workshop, and no other data were collected from them.

Amy and Fran taught first grade, and Wendy, second grade. Their classrooms were self-contained which included teaching of the subject disciplines of reading, English language arts (ELA), spelling, math and social studies. Science, physical education, music and art were taught as separate subjects, by specialist teachers, for 50 minute periods, twice per week. Marie was the primary science specialist, assigned six sections of science each day to rotating class groups of kindergarten through third grade. The fourth and fifth grades were co-taught by subject discipline specialty, for 55 minute periods. Lauren was assigned to teach fourth grade, ELA and Maddy to the fifth grade, ELA and spelling. Jonel was assigned to teach in the upper grade resource room, offering support to students with special needs based on their individualized education plan (IEP). Table 3 describes each of the study participants.

Table 3 *Case Study Participants*

Teacher	Grade level/ course taught	Teacher Background	Additional information
Amy	Grade 1	Second year teacher ELA, Special Ed qualified	Assigned as school's mobile primary resource teacher; no classroom for second school year observed.
Fran	Grade 1	+ 20 years in district, MAT in reading, National Board Certified	Experienced in writing successful grants for technology (Promethean Board, projector, laptop); Assigned Grade 2 for second school year observed.
Jonel	Grade 4-5 Resource room	Third year teaching, special needs support	Assigned to another school in district for second school year observed.
Lauren	Grade 4 ELA	+ 20 years in district, earned Educational Specialist in reading instruction	Retired, as planned, at end of first observed school year observed.
Marie	Primary (1-3) Science	8 years in position, Undergraduate major and state certification endorsement in science	Class periods reduced from 50 to 40 minutes during second school year to accommodate increased reading and math time required by

			district.
Maddy	Grade 5 ELA, spelling	15 years in district, MAT in ELA	Same teaching assignment for second school year observed.
Wendy	Grade 2	+ 20 years in district MAT in reading instruction	Retired, decided at end of second observed school year.

All the participating teachers except for Marie were African-American, Marie was white, non-Hispanic.

The school was located in an aging residential neighborhood in a large mid-western city. The neighborhood was mainly composed of single-family brick bungalows and wood-frame houses, set on small lots. Many of the surrounding houses were abandoned and damaged, and were situated within an area that reported the highest crime and poverty rates in the city (Hackney, 2011).

Over the time period for the study, the school served 456 students, grades pre-kindergarten through five. One hundred percent of the students were of African-American ethnicity; 53 % male, 47 % female; and 90% economically disadvantaged. It was designated as a federal Title I school. The school had not met AYP due to student attendance; all other AYP factors such as student achievement met or exceeded requirements. All the teachers met state certification requirements and the standards for highly qualified elementary teachers (State Department of Education, 2010).

The containing school district continued to endure extensive changes. An emergency financial manager was appointed by the state governor. New state legislation allowed for this emergency manager to assume control over all fiscal matters related to operation of the district, superseding any powers granted to the elected school board and superintendent. As a result, all administrators and faculty in schools that had not made AYP were required to reapply for their positions. A number of administrators and faculty were assigned to different schools, a list of schools were designated for closure at the end of the year, and all contracts for materials and services were re-negotiated (Local Government and School District Fiscal Responsibility Act 4 , 2011).

The school building was constructed in the 1920's; with two floors of classrooms and a multi-purpose room that served as the cafeteria and gymnasium. The building was kept clean, and appeared freshly painted, but wear and tear was obvious through chips and cracks in tile flooring, water stained ceilings, and a missing hand-rail on the stairs. Doors to the outside were kept locked at all times. Entrance at bell-time was supervised by staff at every door. Visitors and late students entering at any other time during the school day had to enter through a single door, monitored by a parent volunteer and a doorbell to the office. The parking lot and adjacent playfield were enclosed by a chain-link fence with an automated locking gate. Administration communicated with teachers through a two-way PA system, with speakers and return-call button mounted within the walls of many of the classrooms. When the system was in disrepair, messages were sent to the classroom with a student, parent volunteer, or another faculty member. Each classroom contained one or two desktop computers. Fran and Marie had *Promethean boards* to project their computers to display instructional materials. The others used overhead transparency projectors to display prepared and handwritten materials. The science classroom had a conservatory attached, but the window vents were broken, and the space was used for storage.

Ethics and Protection of Participants

Permission to collect data was obtained from the school district at the beginning of the PD program. Each participant signed an informed consent document (Appendix K) and approval was granted through the Institutional Review Board and Human Investigation Committee at the partner university.

Data collected in both paper and electronic formats was kept in a secured file cabinet or electronic data base only accessible to the researcher. Audio tapes utilized during interviews were transcribed and then destroyed. Pseudonyms were utilized for reporting all data throughout the study.

Description of the Intervention Professional Development Program

The PD program at the center of this study, titled "Advancing Student Learning Through a Collaborative Partnership for Teacher Education," was the result of a Title II grant from the State Department of Education to provide a minimum of 90 hours of professional development to a group of elementary teachers, who had little science background. Elements of the PD program were designed to match the grant requirements by the principal investigator (PI) and university director for the grant, in coordination with the math-science director of the participating school district. A time-line and the content of each workshop are detailed in Table 3 and in the project overview (Appendix A).

Table 4 *PD Program Intervention Overview*

Session Name	Date	Time Period	Topics Covered	Person Delivering PD
Orientation	5/2009	4:30 – 7:30 p.m.	*Welcome & Introduction *Project overview *Clarification of roles & responsibilities *Pre-program survey *Question & Answer	Program Director
Summer Institute on Pedagogy	Monday 7/27/09	9:00 – noon; & 1:00 – 4:00 p.m.	* Principles of Constructivism & Inquiry	Program Director
	Tuesday 7/28		*Assessment -develop & implement various forms of assessment -use assessment to inform instruction	
	Wednesday 7/29		*Technology -How to integrate various forms of technology in developing and implementing instruction	University Faculty-IT
	Thursday 7/30		*Classroom Management -how to organize & manage the physical instructional environment proactively	Program Director
	Friday 7/31		*Instructional resources -District/State Math/Science Centers -Grants: searching and writing	
Summer Training Workshops	Monday 8/3	9:00 – noon; & 1:00 – 4:00 p.m.	*Using GLCEs & standards -develop curriculum -align inquiry based lessons with specific science GLCES -Integrating across subject disciplines	Program Director
			*Orientation for Outdoor Classrooms-Community Urban Gardening Org.	Community Urban

Tuesday 8/4	*_Project Wild/Aquatic_ -Components of a habitat -Food Chains/Food Webs -Adaptation -Predator/Prey Relationships - Migration -Bioaccumulation -Environmental issues	Gardening Staff Program director
Wednesday 8/5	*_State Environmental Education Curriculum Support_ (-EECS) -Ecosystems & Biodiversity Unit ^Ecosystems basics ^It's All Connected! ^Nature's Recycling ^State Ecosystems ^State Time Machine ^State Web of Life ^Biodiversity survey ^Threats & Protections in state ^Unwanted invasive species ^state threatened species	Certified Program consultants
Thursday 8/6	-Energy ^Types & forms of energy ^Energy Conversions ^State energy generation ^Energy conservation ^Analyzing energy use ^Measurement of energy	
Friday 8/7	-Land Use Unit ^Observing land use ^Measuring land use & land cover ^Classifying land use ^Reflecting on how land is used ^Analyzing land use changes in state & county ^Solving Land use conflicts ^Investigating land use/water/ air relationships	

Earth/Space Science for Elementary Teachers	Fall Semester 2009 (August – December)	Tuesdays 4:30 -7:15 p.m.	*The sky & solar system *Weather & Climate *The Water Cycle *Atmosphere/Hydrosphere/Geosphere /Stratosphere *Rocks & Minerals *Fossils *Natural Resources *Human Impact	University Part-time Faculty-Science Ed
Implement Outdoor Classrooms	Fall Semester 2009	Various-individual schools	Planning & Construction of Outdoor classroom garden spaces at each participating school	Community Urban Gardening Staff
Action Research Academy	Winter semester 2010	Tuesdays 4:30 –7:15 p.m.	*Learn about action research: Inquiry Process Skills, Research design, statistical analysis *Choose topic/issue related to practice for research project *Review literature on topic *Design & implement study *Share results of study in conference style event *Utilize technology to create an electronic portfolio reflecting the effect of the PD program on their practice	Program Director

The original participants in the project were thirty six elementary teachers, working in self-contained classrooms at the third or fourth grade level, who did not have a state endorsement in science, from urban schools that had not made Adequate Yearly Progress. All participants volunteered for the program. Each participant received a stipend and had the option of earning university credit hours for the earth/space science course and the Research Academy. Three of the participants dropped out prior to the Summer session. This case study focused on a sub-group of seven PD participant teachers from the same school who had volunteered for the project as a cohort group with a stated goal of improving their overall school community and individual teaching practice.

The program began with a summer session Institute on Pedagogy that included 25 contact hours over 5 days, from 9:00 a.m. until 4:30 p.m. each day. The teachers participated in activities related to pedagogy, such as understanding of the State's Grade Level Content Expectations (GLCEs) for science and how to use specific GLCEs to develop curriculum, understanding the principles of constructivism, how to develop and implement inquiry-based lessons that are aligned with specific GLCEs for science, how to develop and implement various types of alternative forms of assessment, how to use assessment to inform instruction, how to integrate various forms of technology in the development and implementation of instruction, teacher-grant-searching and grant-writing, and how to organize and manage the physical instructional environment to prevent classroom management issues. Teachers developed and shared lessons incorporating the skills learned in these activities as assessment.

The program continued with five additional summer session days of training in environmental science related curriculum: Project WILD/Aquatic and (State) Environmental Education Curriculum Support (-EECS). Participants received all the instructional materials related to these curricula. Teacher participants were assessed on their practice of identifying specific GLCEs covered in each of these curriculum resources and on how they could integrate some of the activities into lessons to use with their students.

Project WILD/Aquatic is a wildlife-focused conservation education program for k-12 educators and their students. It is available nationwide, sponsored by a network of State Wildlife

Agency sponsors. Project WILD links students and wildlife through its mission to provide wildlife-based conservation and environmental education that fosters responsible actions toward wildlife and related natural resources. Project WILD uses balanced curriculum materials to accomplish its goal of developing awareness, knowledge, skills and commitment concerning wildlife and the environment (Project Wild, 2010). Instructional materials that the participants received included two curriculum activity guide texts.

-EECS are sets of environmental science-based education curriculum lessons and support materials. Each unit was critically aligned to the state curriculum framework standards and benchmarks and was designed to help teachers integrate environmental materials into their classrooms. All materials were extensively reviewed and teacher-tested in state classrooms (-EECS, 2006). -EECS training consisted of separate workshops for each of three units: Land Use and Ecosystems, Biodiversity, and Energy. Each teacher participant received a classroom kit of materials for every unit. Each kit contained: a binder of lesson plans for each unit, posters and worksheets, and a CD-ROM including the electronic version of units, extension lessons, supplemental resources and materials, PowerPoints, and videos, background information for teachers, lesson outlines for hands-on activities and experiments, and pre- / post-tests and unit assessments.

The program continued that fall semester with a three credit hour Earth –Space Science course at the partnering university that included thirty-eight contact hours. The course covered the following topics: The Sky and the Solar System, Weather and Climate, The Water Cycle and the Atmosphere, Rocks and minerals, Fossils, Natural Resources, and Human Impact.

Assessment included exams covering the content as well as alternative forms of assessment such as class presentations and building models.

The program also included implementation of an outdoor classroom in the schools of participating teachers, facilitated by a local urban gardening organization. During the spring following the program, a garden was designed and planted on the participants' school grounds, which was to become the source of science related activities in an outdoor laboratory for subsequent school years.

The Program concluded the subsequent winter semester with a thirty contact hour Research Academy during which the participants attended a seminar, once a week, to learn about action research and designed and implemented an action research project related to their own practice. The participants in this study focused their action research project on improving student attendance, which was the main reason for their school's inability to make Adequate Yearly Progress (AYP). They conducted a review of the literature and designed their own research plan. The teachers implemented their study school wide. They collected and analyzed the data, and wrote a final research report. They developed a Power Point Presentation and presented their research project in a conference format to other project participants and faculty at the partner University. The teachers were further encouraged to submit their project for presentation at local and state teacher association conferences. These teachers also created an individual electronic portfolio to develop technological knowledge, highlight their professional development experiences, and document their growth during the program.

A separate cohort subgroup of the participants collaborated to create a curriculum package for use with the outdoor classrooms. This group met for an additional week during the summer following the program to develop a variety of science-based activities that would integrate across curricular areas, and be conducted in the outdoor classrooms. The lessons were organized as a curriculum package, which was distributed, along with a set of materials to implement the activities, to each of the participating schools.

Data Collection

Evidence in this study was gathered from multiple sources including direct observations, surveys, interviews, and artifacts such as electronic portfolios, lesson plans, and submitted assignment responses. The author of this study fulfilled the role of research assistant for the project, responsible for organizing all collected data, and as one of three university faculty members assigned to collect observation data from selected program participants.

Long-term, sustained observations were made during PD sessions and in each teacher's classroom, pre and post intervention. The participant researcher attended twelve different workshop and course sessions alongside the teachers, as an observer, throughout the PD program, and visited each teacher's classroom for the duration of a class period, three separate times. Protocol for observations was selected and adapted from the Oregon Teacher Observation Protocol (2004), (Appendix B) by the PI. All three observers met with the PI prior to data collection to validate their use of the observation protocol.

Extensive field notes (Appendix I) were developed from the observations and from review of the audio tape and transcripts of interviews (Spradley, 1980). Informal interviews served as a member-check to reference evidence and validate accuracy (Lincoln & Guba, 1985).

Two distinct survey sets were given pre and post PD program (Appendices C, D & E) to generate specific data required by the grant. Both of these survey sets included multiple choice, Likert scale, and descriptive responses; and each was intended to elicit demographic information, science content knowledge, teaching experience, and attitudes about teaching science from the teacher participants. Participants rated levels of agreement or chose specific increments of response. For example, teachers were asked about their professional background and science lessons, specific grades taught, the length of a typical science lesson, times per week spent teaching science, and membership in professional organizations. Additional surveys were given for each of the PD program components by the partnering University (Appendix F). These surveys were also a combination of Likert scale and descriptive response for participants to report opinions and evaluate their experiences during each PD session. These surveys included statements such as “The instructor was prepared”, and “The workshop activities stimulated my learning”, with which the participants rated their level of agreement.

A Focus group interview was conducted so that data could be collected simultaneously from all the participants. The participants were encouraged to openly share experiences, and discuss their opinions for each interview prompt. Question prompts are listed in the Interview protocol (Appendix G). This interaction helped to clarify “how ideas and knowledge were developed and operated within the cultural context of the group” (Schensul, LeCompte, Nastasi,

& Borgatti, 1999, p. 52). The interview was scheduled for an afternoon in late July, at the participants' school building, after the summer school session was dismissed for the day. It took place after the PD program workshops, courses, and the first two classroom observation sessions were completed. The interview was audio recorded and transcribed (Appendix H).

Artifacts were collected which included teacher work completed during the PD program, teacher lesson plans and student work, pre and post intervention. The participants produced electronic portfolios to reflect on their practice before and as a result of their PD activities. These electronic portfolios were a significant document of the teachers' reflection on their own classroom practice over a selected time period, and also an illustration of their growth in content and pedagogical knowledge, including applying technology. These portfolios provided a record of the teachers' critical thinking process and revealed their self-reported changes in knowledge and practice. Artifacts such as lesson plans and submitted coursework were also used to compare and corroborate data collected during observations.

Data Analysis

Statistical analysis was performed on survey results to establish the significance of any differences in pre and posttests. Paired sample t-tests were used to identify significant differences in participant survey response between pre and post program at a significance level of (.05).

The observational data record of field notes and the research journal which were derived from direct observations, interview transcripts, electronic portfolios and other artifacts were analyzed using Spradley's (1980) method of semantic structure analysis. Each survey and interview response, observation protocol item, and artifact was categorized by a domain, as determined from each of the research questions. Each of the domains was given a cover term, i.e. science content knowledge (SCK), science pedagogical content knowledge (SPCK), classroom practice, context variables, and professional community. Each piece of data might be categorized by more than one of the cover terms. Themes were identified within and across each domain. Data classified under each theme was then sub-classified and coded using color highlighter to assist in a taxonomic analysis that was used to search for relationships and to identify contextual factors that might have influenced the teachers' practice. For example, an open response to a survey item that had asked for comment related to the Project Wild Workshop stated "It was good to learn about all the issues surrounding the environment and population." This was categorized under the domain of SCK, and coded as "enjoyment" and as "life-science content knowledge". Connections and patterns among and between the data were then identified within and across each theme. A componential analysis of the data was constructed to describe the cultural domain by explicitly defining these relationships and contextual factors and comparing these different levels of analysis with the observations gathered over time (Spradley, 1980).

Establishing Validity and Reliability

A variety of strategies were employed to substantiate a robust strength of results. Lincoln and Guba (1985) described a naturalistic paradigm asserting that trustworthiness and credibility within a qualitative study correspond to the validity and reliability that can be determined with the statistical results of a controlled scientific study. Credibility and trustworthiness was established using the techniques of prolonged engagement, persistent observation, triangulation, dependability, and confirmability. Prolonged engagement enabled the researcher to create relationships with the participants and build trust through repeated contact, over time. This helped the researcher to understand the culture, learn context, and establish validity within the study. The researcher implemented persistent observation to provide for depth, identification of relevant factors, and allow continuous assessment of the study to build credibility. Data were collected through multiple sources to support triangulation as a strategy to build credibility. Triangulation also included the researcher's attempts to verify individual results using different data sources, different collection methods, and cross-checking of the data (Creswell, 2009). Cross-checking was accomplished through peer debriefing, and by discussing findings with peer professionals such as the researcher's committee members. Member checks were also utilized to allow the researcher to discuss findings with study participants to verify accuracy. Member checks and cross-checking also added to the dependability of the results, which is directly related to reliability and trustworthiness. Transferability, the ability to apply the research to similar situations, was developed using rich descriptive data to promote comparisons and advance trustworthiness. Confirmability is directly linked to objectivity and the identification of any bias within the study. Confirmability was established by utilizing an audit trail, a clear description of all paths between all stages of the study. The audit trail was comprised of sequential written field notes, a detailed research journal, and protocol and transcripts for observations and interviews that provided a comprehensive record of the progression of data (Lincoln & Guba, 1985).

CHAPTER 4 RESULTS

The results addressing the impact of the PD program on the study participants' practice were based on data gathered from multiple sources including long-term, sustained observations made over the course of 12 PD workshops and class sessions, and two or three class observations of each participant teacher's classroom (Appendix B), pre and post intervention. Additional information was accumulated from responses to surveys (Appendices C, D, E, and F), a focus group interview (Appendices G and H), and artifacts such as electronic portfolios, the participants' action research project, and other submitted assignment responses. The data were used as evidence to address each of the research questions framed in the study.

Impact of the PD Program on Teachers' Science Content Knowledge (SCK)

Changes in participants' science content knowledge were measured by their perception of their abilities in science using a four-point Likert type survey (Appendix C) in which the teachers rated their own preparedness (from 1 = not prepared to 4 = very prepared) to teach the various science content topics covered in the PD workshops.

The participants' survey responses suggest that the PD program had meaningful impact on the participants' perceptions of their SCK. As displayed in Table 4, comparisons between pre and post surveys indicated a significant increase in participants' ratings of their preparedness to teach each of the specific science topics addressed in the summer workshops. Life and environmental science topics like cells, organization of living things, and ecosystems were addressed by the Project WILD workshop. Topics such as matter and energy were addressed in the -EECS workshops for energy and land use. The earth science course addressed topics like the hydrosphere, geosphere, atmosphere and weather, and the solar system, galaxy and the universe. Topics in physical science such as motion of objects, which were not specifically addressed during the PD program, experienced a lesser increase in participants' ratings.

Table 5 *Preparedness to Teach Science Topics*

		Mean	Mean Change
Cells	pre	2.11	0.45*
	post	2.56	
Organization of Living Things	pre	2.75	0.64*
	post	3.39	
Heredity	pre	2.11	0.43*
	post	2.54	
Evolution	pre	1.93	0.55*
	post	2.48	
Ecosystems	pre	2.63	0.67*
	post	3.30	
Matter and energy	pre	2.64	0.72*
	post	3.36	
Changes in matter	pre	2.71	0.65*
	post	3.36	
Motions of objects	pre	2.64	0.32
	post	2.96	

Waves and vibrations	pre	2.21	
	post	2.89	0.68*
The geosphere	pre	2.04	
	post	2.62	0.58*
The hydrosphere	pre	2.04	
	post	2.62	0.46*
The atmosphere and weather	pre	2.79	
	post	3.21	0.42*
The solar system, galaxy, and universe	pre	2.61	
	post	3.25	0.64*

*$p < 0.05$.

Participants were also asked to rate their level of preparedness to teach science and no-science subject areas, before and after participating in the program. As indicated in Table 5, there was a significant increase in the percentage of participants who felt qualified to teach both science and non-science subjects, a difference of 62%. There was also a decrease of 29% in participants who felt prepared to teach only non-science content areas after attending the PD program. The number of participants who felt prepared to teach only science content stayed constant.

Table 5 *Content Areas Felt Qualified to Teach*

	Pre	Post

Science	14%	14%
Non-science	58%	29%
Both	29%	71%

Participant responses to the open-ended questions about the workshops and course evaluation surveys (Appendix F) also indicated an increase in their perception of the SCK they gained from the PD activities. “I received a lot of information to use in my class, and the activities stimulated my learning,” commented one of the participants about the Project WILD Aquatic workshop sessions.

Participants’ comments in their electronic portfolios also spoke of their enjoyment in learning new skills. As one pointed out, “It was actually fun; I liked learning the technology. I am glad that I learned how to do this and can utilize it for other projects such as a class website” This perspective was also reflected in their evaluation of one of the –EECs units focusing on Land Use and Energy, in which one of the participants wrote, “It was good to learn about all the issues surrounding use of wind and alternative energy”. Other comments mentioned gains in specific content areas including the topics related to land-use data, comprehension of informational text, probing questions, and creating electronic graphs. At the end of the semester-long earth and space science course, one of the participants wrote about the course’s usefulness in terms of increased SCK: “It filled a hole in the amount of information I have about earth science. I feel a lot more comfortable and prepared.”

Observations of the workshops and course meeting sessions provided additional support for the impact of the PD program on the participants' SCK. The first PD session observed was a technology seminar, presented by one of the faculty at the partner university. Specific strategies were shared for using basic tools available in word processing programs, as was a list of resources that might be useful for classroom application. However, there was a great variation in the comfort level of participants' use of technology. While some participants were exposed to a great deal of new information, others were able to share their expertise to assist their peers.

Another observed seminar was intended to introduce the attendees to various educational resources for teachers. The impact of this workshop on the participants' SCK became evident when the first resource, a list of state resource centers for math and science instruction, was shared. Only three of the attendees were previously aware that one of these centers was located within their employing school district and that the center would deliver science and math materials to their individual schools.

Observations were also conducted in the certification workshops for Project WILD/Aquatic and -EECS curriculum units. Detailed descriptions for all the observations were recorded in the field notes (Appendix I). The activities observed during the Project WILD Aquatic workshop provided the participants an opportunity to practice specific science inquiry process skills i.e. public speaking, communication, research, collaboration, critical thinking, modeling of the democratic process, organization, preparation for rational argument, and modeling appropriate behavior for effective respectful civic participation. Specific environmental science content topics were explored such as habitats, bio-magnification, food chains, and adaptations. Most of the activities required active participation, to model effects of specific situations on the environment or habitat of the organisms considered, after which the participants discussed their findings to debrief on the underlying scientific concepts.

In the –EECS workshop sessions, each participant received a binder containing curriculum materials including teacher's guides with content background for all activities, and informational text. The attendees read through the teacher's guide text together, and completed selected activities from each of the contained lessons, to become familiar with the topics and content material. The participants explored content topics on ecosystems and diversity, energy, and land use during these workshops.

Observations of the class meetings of a three-credit, earth/space science course held during the fall semester also suggested that the PD program had an impact on the participants' SCK. During the first class observed, the teachers participated in various activities designed to illustrate science concepts and topics such as matter, materials, and resources. The second session focused on activities that explored tides; weather; and fluid dynamics, while the third observation highlighted science concepts of forces and motion; structure of the earth; rock cycles; and recycling. Scientific practices and the application of scientific inquiry process skills were also addressed during each class session observed.

The electronic portfolios that the participants in this case study created, indicated perceptions of growth in SCK for each individual participant. Amy, Marie, Fran, Wendy, and Jonel each compiled an electronic portfolio to document their growth as a result of the experiences during the PD program. The electronic format was designed to integrate the use of technology with the reflective process. The participants were asked to reflect on their practice, in relation to each major area of the PD program, before and after their participation in the program; to discuss any growth experienced in each of these areas and to provide evidence of such growth. To highlight the PD program‘s influence on her SCK, Amy wrote in her portfolio:

> Before participating in this program my attitude toward teaching science - and science in general - was one of fear and mistrust. Fear of what I didn't know about the subject and mistrust of my own ability to teach it. After my participation in this program I found that my comfort with the subject matter has increased and my fears have abated. I no longer look with terror on my science curriculum. I can enter my classroom feeling secure and confident -- secure in the knowledge that I know and confident that I will be successful at it.

Jonel summed up her growth by stating, “I learned how to do things I had no idea about.”

Observations of each participant’s classroom provided additional evidence of the PD program’s influence on their SCK. Wendy actively attempted to integrate concepts and material from the PD program to reinforce science content in her lessons. This was especially evident during the second observation of Wendy’s class, in which students made ice-cream. She stated that the PD program helped her try something new that would be a benefit to the students, to supplement their science curriculum.

Lauren integrated the science content topic of animal classification, within a reading lesson, during the second observation of her class. She incorporated a graphic organizer to help her students’ visualize their understandings of the concept they were studying.

During the second observation of Fran’s classroom, she integrated science and technology content within a reading lesson. The lesson was enabled by the *Promethean* board to categorize a variety of organisms in which pictures of each were labeled by name, by interactive "drag and drop" into the habitat in which they belonged. This lesson reinforced science concepts taught in science class, along with the goals for the reading lesson.

Notes from the focus group interview (Appendix H) provided additional evidence of the PD program's impact on the participant's SCK. Wendy, who claimed to dislike and know little about science before the program, summarized, "I learned so much. The wind, I mean the turbines were fascinating. There was a lot of information. The information was good. You know, I just might be able to teach science."

Role of the PD Program on Teachers' Science Pedagogical Content Knowledge (SPCK)

Teachers' Science pedagogical content knowledge can be described as a teacher's "knowledge repertoire of instructional strategies, learning assessment, curriculum, and students' understanding specific to teaching science concepts" (Park & Oliver, 2008, p. 816). The impact of the PD program on participants' SPCK was assessed through their perceptions of preparedness to facilitate science related pedagogy and ideas about teaching and learning science in response to survey and interview questions. Additional data were collected through observations of the workshop and class sessions in which the teachers engaged in activities that addressed SPCK and by direct observations of those elements in the participants' classrooms.

The survey responses (Appendix C) suggest that the participants' SPCK increased as a result of the PD program. As shown in Table 6, familiarity with state and national science standards, benchmarks, and grade-level content expectations significantly increased, indicating increased awareness of the topics and content that need to be addressed in a particular year for a particular subject area and grade level. This knowledge of state and national standards and grade level content expectations is an important aspect of SPCK.

Table 7 *Familiarity with Standards*

		Mean	Mean Change
How familiar are you with state science standards, benchmarks, and grade-level content expectations?	Pre	2.57	0.47*
	Post	3.04	
How familiar are you with national standards in science?	Pre	2.17	0.26
	Post	2.43	

*$p < 0.05$

A variety of items in the survey (Appendix C) were used to assess participants' perception of their preparedness to facilitate content related pedagogy. Teachers were asked to rate their agreement with several statements about teaching and learning science on a five-point Likert-type scale (1 = not adequately prepared and 5 = very well prepared). As shown in Table 7, there was a significant increase in the participants' perception of their preparedness in all areas of SPCK addressed in the survey. Participants experienced the greatest growth in three areas of their SPCK: (a) their ability to lead a class of students using investigative strategies, (b) to help students take responsibility for their own learning, and (c) to involve parents in the science education of their students. The least growth, although still significant, was experienced in participants' ability to help their students make connections from science to real-world situations.

Table 8 *Preparedness to Facilitate Content- Related Pedagogy*

		mean	mean change
Problem-solving among students	pre	3.21	0.40*
	post	3.61	
Making connections within and between science concepts	pre	2.93	0.44*
	post	3.37	
Making connections from science to real-world situations	pre	3.19	0.33*
	post	3.52	
Leading a class of students using investigative strategies.	pre	2.85	0.57*
	post	3.42	
Managing a class engaged in hands-on/project-based work	pre	3.07	0.43*
	post	3.50	
Helping students take responsibility for their own learning	pre	3.14	0.57*
	post	3.71	
Recognizing and responding to diverse student learning needs	pre	3.18	0.36*
	post	3.54	
Involving parents in the science education of their children	pre	2.36	0.68*
	post	3.04	

*$p < 0.05$

Teachers were also asked, in another survey item (Appendix C), to rate their level of agreement with several statements about teaching and learning science on a 5- point Likert-type scale (1 = strongly disagree and 5 = strongly agree). The responses are displayed in Table 8. Significant increases were noted in participants' perceptions related to: (a) "I understand science concepts well enough to be effective in teaching science", (b) "it is sometimes productive for students to work together during science class to conduct experiments", and (c) "when teaching science, I usually welcome student questions". In addition, participants' level of agreement with three other items that had been deemphasized during the program decreased: (a) "memorization plays an important role in learning science", (b) "a lot of things in science must be simply accepted as true and remembered", and (c)"you have to study science for a long time before you see how useful it is".

Table 9 *Ideas about Teaching and Learning of Science*

		Mean	Mean Change
Every student should feel that science is something she/he can do	pre	4.85	
	post	4.89	0.04
It is sometimes productive for students to work together during science class to conduct experiments or solve problems	pre	4.63	
	post	4.96	0.33*
You have to study science for a long time before you see how useful it is	pre	2.15	
	post	1.92	-0.23
Memorization plays an important role in learning science	pre	2.81	
	post	2.50	-0.31
A lot of things in science must be simply accepted as true and remembered	pre	2.42	
	post	2.19	-0.23

I understand science concepts well enough to be effective in teaching science	pre	3.37	0.74*
	post	4.11	
Students' achievement in science is directly related to their teacher's effectiveness in teaching science	pre	3.63	0.18
	post	3.81	
I am typically able to answer students' science questions	pre	3.96	0.23
	post	4.19	
When teaching science, I usually welcome student questions.	pre	4.26	0.44*
	post	4.70	

*$p < 0.05$

Participants' comments to open-ended prompts in each workshop's evaluation (Appendices D & E) provided additional details of participants' perceptions of the program's impact on their SPCK. When commenting on the usefulness of the summer workshops that had focused on pedagogy, participants mentioned that they had been particularly useful in helping them be more mindful of their own instructional style. One of them pointed out "Constant self-assessment is needed about one's teaching methods, current professional pedagogical knowledge and adapting it for the development of appropriate strategies for the student learners and classroom."

For others, the workshops helped them uncover the theoretical underpinnings related to their own practice. According to one participant, "The seminar on constructivism was beneficial because I was instructing under that umbrella and wasn't aware of what the methodology was called." Other participants felt the workshops increased their knowledge of science-specific methods and materials as illustrated by the following comment "The workshops helped me become aware of how to find out how to help my students become organized and improve their study skills." Another participant summed up the value of the workshops, stating "The ultimate teaching goal is to help kids get to the point of being able to think/reason independently or in a team to figure out how science works in their lives."

Wendy's definition of good teaching exemplifies how she internalized many of the elements of SPCK addressed by the PD program.

> It's important to guide students, but also to let them think for themselves. Children learn best taking responsibility for their own learning. Hands-on/minds-on activities allow students to learn at their own pace, making self-discoveries. They also solve their own problems which is a learning experience for them, as well.

Observations of the workshops and course meeting sessions illustrated more effects of the PD program on the participants' SPCK. Descriptions of what occurred during the sessions helped identify the pedagogical strategies and methods that were addressed during the PD program (Field notes). The workshop on classroom management explicitly offered strategies for effective science instruction. The participants collectively established some foundations for successful classroom management, as part of this workshop, shown in table 9.

Table 10 *Foundations for Successful Classroom Management*

Teachers' Suggestions
Positive management should be centered on prevention.
Set the tone from the first day
Institute routines for each classroom procedure and practice them
Provide examples of good behavior, and to

Develop rules in collaboration with students so that they take ownership

Create a classroom community

Be consistent

Enforce logical consequences within the classroom

Bring the outside community into the classroom by inviting adult volunteers

Participate with Junior Achievement

Establish beautification projects within the building or school grounds

Use teachable moments to talk with students

Demonstrate how student ideas are valued in real-life situations,

Include children as part of the school community

Help students to see that disrespect to others lessens their own dignity

schedule time to bring current events and real-world issues into the classroom

Differentiate teaching to individualize learning.

The participants also determined that there were some negative management issues that might be caused or exacerbated by the teacher: technology failure, lesson failures, and personality conflicts. To avoid these issues, they proposed that teachers should test all activities and materials before using them with students, plan more than needed, prepare and plan materials and procedures in advance, organize and assign roles for students, define and rehearse routines for specific procedures, transitions, groupings, and use of materials, and concluded that class time should be class business time spent on task.

Participants also generated guidelines for successfully facilitating cooperative group learning. Specifically, students should be assigned to specific groups; roles within each group should be assigned and rotated to accommodate behavior, personality style, gender, ability or other factors.

The Project WILD workshop provided an opportunity for participants to practice some of the SPCK strategies that had been illustrated in prior sessions. Each group chose an activity from the content materials, and prepared a short presentation demonstrating how the activity could be used within a classroom, at a specific grade level. The other groups played the role of students during each presentation, and then provided feedback on the effectiveness of the instructional strategies used, with a focus on development of inquiry process skills and science content knowledge. Participants determined that learners must be given the opportunity, whenever possible, to collect and analyze their own data, and must have enough time to process ideas independently, before contributing to collective conclusions.

During the –EECS session on energy, a number of practical suggestions were made by the presenter, such as local resources for supplying inexpensive materials, and using dried beans or peas in an activity rather than candy, so that the students won't eat the materials. Common student difficulties with specific lessons were mentioned and possible modifications for these were provided. The presenter discussed ways to use the lessons to assist students in preparation for meeting state objectives as measured on standardized tests.

Practical advice was offered during the –EECS session on land use for how to explicitly use and supplement the given curriculum materials i.e. using aerial photographs to identify land use and taking aerial photographs with a camera attached to a kite.

Observations in the earth science course provided more evidence for the PD program's impact on participants' SPCK. The instructor for the earth science course related that there was a major generational difference in general knowledge between the teachers in the workshop and their students; teachers must find ways to teach problem solving skills, knowledge, and may need to integrate and blend subjects in science to reach standards and objectives. A regional professional science teachers' conference was promoted as a great resource for science materials, networking and beneficial information. The instructor pointed out that experiments do not need to be complicated to teach experimental methods and design. Participants received a number of hands-on activities that they could use in their own classrooms. They were able to apply SPCK when they practiced implementing methods and using materials while completing various activities and during assigned mini-lesson presentations made to their peers.

Participants' projects created during the research academy seminar provided additional evidence of the impact of the PD program on their SPCK. The participants were able to authentically experience scientific inquiry, an integral element of SPCK. Seminar participants met once a week, for the first four weeks of the semester, to learn about and practice empirical action research. These teachers formed cohort groups with others from the same employing school or who were interested in exploring the same topic. Each group selected a topic that was related to an issue or problem experienced in their own practice. The group conducted a review of related literature, then designed and conducted an experimental study as their action research project. Each study involved proposing an intervention or action to address the selected problem or issue, identifying and defining experimental variables, implementing the intervention within their own classroom or school setting and collecting pre and post intervention data to determine the intervention's impact. Participants analyzed the data, wrote a formal paper, and put together a presentation. At the end of the semester, each group of teachers shared their study's results with the others through a posters or a PowerPoint Presentation in a conference style event. Portfolio reflections further illustrated changes in participants' SPCK due to the PD program. In her role as the school's science specialist, Marie reflected that one of the most useful aspects of the program was becoming familiar with specific resources, "I wasn't familiar with Project Wild/Wild Aquatics K-12 Curriculum and Activity Guide, or with - EECS. All of these resources have become an integral base for me to further use in my teaching practice."

Wendy's reflection is a good illustration of many participants' perception of the value of the program to their own practice,

> Before this program I taught in front of my class with students sitting in rows and being taught from the textbook. They would read the chapter, copy the vocabulary words, write the definitions, answer the checkpoint questions, and end of chapter questions. During the program I learned lots of fun activities that I implemented in my classroom. Students began liking to come to class and doing hands-on/minds-on activities.

This view was similarly expressed by Jonel,

> I have always believed that if students are having fun, they will learn more. However, I had succumbed to the "old ways" of keeping students quiet and busy, because it's expected by most principals and coworkers. This program has encouraged me to return to my beliefs that school can and should be fun, hands-on, and project oriented. The children respond with great enthusiasm and excitement. They are more involved and I know they are learning by how they interact with purpose and intelligence.

Individual observations of each participant's classroom add further evidence related to the effects of the PD program on the participants' SPCK. Observations in Wendy's class clearly showed increased use of elements of SPCK that had been addressed in the PD workshop sessions. The second observation took place after completion of the PD workshop sessions. Wendy actively attempted to integrate concepts and material from the PD program to reinforce science content about states of matter during a writing lesson. The class made ice-cream by following a recipe, which was displayed on the overhead, and then wrote about the process. The students moved their desks, to facilitate the activity, evidence of advance planning for the physical space. Wendy used cooperative grouping strategies, integrated technology to provide direction for procedures and materials distribution, and used authentic assessment strategies.

Fran's second classroom observation also illustrated how the PD program impacted her SPCK. She planned specific strategies, set up in advance, to welcome a new student to the class, mid-year. Fran had several "new student" packs prepared and stored in a classroom cupboard, each contained a pencil box, containing crayons, pencils, an eraser, safety scissors, and a glue stick, along with a pack of consumable textbooks. When the principal brought the boy to her class, she assigned him a desk, asked the girl seated next to him to be his buddy throughout the day, and gave him one of the packs. Practicing such procedures as a routine was promoted as a strategy to facilitate science learning as part of the PD program.

Marie utilized a number of strategies specific to science instruction during both observations of her classroom. Marie was the lead science teacher for the primary grades at this school. Both observations occurred after the PD workshops. The physical arrangement of her classroom demonstrated elements of SPCK. Tables set up for cooperative groups were arranged in a connected u-shape with the open end facing the projection screen. A large carpeted area was at the back of the room, behind the tables, and there was a stack of small carpet samples the children used as sit-upons. Marie had a bulletin board on the side wall toward the rear of the room, with a section designated for each grade-level group and a portable white board adjacent to the carpeted area. Increased SPCK was also evident in the lesson procedures. First grade students were directed to construct a model of the butterfly life cycle, using a paper plate with different shaped noodles glued to the plate and labeled to represent each phase of the life-cycle. Marie provided written spellings of each life-cycle phase on the Promethean board, and showed a completed example. A stack of paper plates, a container of each type of noodle, a marker, and a bottle of white glue were placed at the end of each table to facilitate group cooperation. After the models were constructed, the children moved to the carpet area and Marie reviewed the concept by reading a word-wall list of vocabulary terms and definitions for each, and read a literature book on butterflies to the students. She then directed the students back to their assigned table seats and projected a film clip depicting the butterfly life cycle on the *Promethean* screen. Marie was awaiting the delivery of a Butterfly eggs- kit, to provide the students with an opportunity to journal their observations for the weeks ahead.

The second observation was of a third grade lesson on seed structure and function. The students began class by sitting in the rug area to review the word-wall list and definitions and listen to a story reading about a seed growing into a plant. The students then moved to the tables, and passed around a magnifier-viewer containing a split seed. They then represented what they observed by drawing those parts of the seed they could identify on a pre-made cut-out paper. Marie drew a sample on the Promethean Board display. She directed the students to color their model with specific colors for labeled parts. She then asked them to write the function of each labeled part, as copied from the display. The curriculum plan of using science as a special class had the benefit of ensuring students attended a science class each week. Marie related that she was also trying to coordinate a plan for all the teachers to integrate science in their daily lessons in other content.

Data from the focus group interview provided additional evidence that the PD program impacted participants' SPCK. Fran shared how she learned teaching strategies from the PD program,

> I think we were allowed to discover things within our groups and were able to always have a chance to work together. We weren't just isolated there with a piece of paper. We were able to sit together and able to work in groups, cooperative groups, which is what they tell us to do with our students. We had to try everything out; it wasn't just a packet of information to put on a shelf.

Their descriptions of what makes a good science lesson support the perception that their SPCK was developed during the PD program. Jonel described,

> Have the kids actively involved, using their hands, manipulating things, building things, or taking apart something, so they can actually get real experience, as opposed to just reading about it in a book. Also exploring too, they can use the internet; that can clear up some misconceptions right away. And having some access to technology will help, too.

Fran added that good science should be "hands-on and minds-on" and that "just being able to see it, by making a model, and then they see the finished product, helps them to have a better understanding."

Role of the PD Program on Teachers' Classroom Practice

Changes in the participants' classroom practice should be an obvious consequence of the PD program's impact on their science content knowledge and science pedagogical content knowledge. Participants' perception of changes in their classroom practice were apparent in their survey responses (Appendix C, D, and E), their portfolio reflections, and from their responses during the focus group interview (Appendix H). Direct evidence of changes in their practice was collected through classroom observations.

Participant responses to the survey (Appendix C) indicated the PD program had a positive impact on participants' perception of their classroom practice. Teachers were asked to rate their frequency of use of selected science teaching practices on a four point Likert-type scale (1 = never and 4 = during almost all lessons). As shown in table 10, participants reported an increase in frequency in the use of all the selected science teaching practices. The largest significant increases were noted for aspects of science-related pedagogy such as encouraging the exploration of alternative solutions; allowing students to work at their own pace; helping students make connections between science concepts and real-world situations; requiring students to explain reasoning when giving an answer; encouraging scientific communication; and embedding assessment in regular class activities. The smallest increase was related to the strategy of introducing content through formal teacher presentation.

Table 11 *Frequency of Use of Selected Science Teaching Practices*

		Mean	Mean Change
Introduce content through formal teacher presentation	pre	3.33	
	post	3.56	0.23
Arrange seating to facilitate student discussion	pre	3.89	
	post	4.15	0.26
Use open-ended questioning strategies	pre	3.78	
	post	4.15	0.37
Require students to explain their reasoning when giving an answer	pre	3.81	
	post	4.41	0.60*
Require students to communicate scientifically	pre	3.23	
	post	3.85	0.62*
Encourage students to explore alternative methods for solutions	pre	3.30	
	post	4.07	0.77*
Allow students to work at their own pace	pre	3.30	
	post	3.96	0.66*
Help students make connections between science and real world situations	pre	3.67	
	post	4.33	0.66*
Use assessment to find out what students know before or during a unit	pre	3.63	
	post	4.07	0.44

Embed assessment in regular class activities	pre	3.48	
	post	3.96	0.48*
Assign science homework	pre	2.96	
	post	3.52	0.56*

*$p < 0.05$

Participants also rated the frequency of their students' engagement in activities associated with science. Teachers were asked to rate each item on a four- point Likert-like scale (1 = never and 4 = during almost all lessons). As indicated in table 11, there was a significant increase in participants' ratings of the frequency in which their students engaged in certain activities that support scientific inquiry as demonstrated through activities and lessons during the PD program. These activities included displaying data in graphical form; developing hypotheses and forming conclusions based on investigative data; using computers as a tool and for learning and practice; participating in discussion with the teacher to further understanding; working in cooperative learning groups; working on solving real-world problems; designing and implementing their own investigations or projects; using data displayed in graphical form to make comparisons; writing reflections; and taking tests requiring constructed response. Participants also indicated that their students engaged less frequently in the following activities, post PD: working independently, reading from a textbook in class, and answering textbook and worksheet questions. These activities were de-emphasized during the PD program because they were associated with teacher-centered instruction.

Table 12 *Student Engagement in Selected Activities as Part of Science Lessons*

		Mean	Mean Change
Participate in discussion with the teacher to further understanding	pre	3.83	0.46*
	post	4.29	
	pre	3.64	
Work in cooperative learning groups	post	4.04	0.40*
	pre	3.82	
Work independently	post	3.68	-0.14
	pre	2.70	
Make formal student presentations to the class	post	2.85	0.15
	pre	3.68	
Read from a science textbook in class	post	3.36	-0.32
	pre	3.39	
Answer textbook/worksheet questions	post	3.29	-0.10
	pre	3.15	
Review homework/worksheet assignments	post	3.37	0.22
	pre	3.18	
Work on solving real-world problems	post	3.93	0.75*
	pre	3.54	
Follow specific instructions in an activity or project	post	3.79	0.25
	pre	2.48	
Design or implement their own investigations or projects	post	2.96	0.48*
	pre	3.21	
Perform experiments or investigations that require more than one step	post	3.54	0.33
	pre	2.96	

Display data gathered in lab exercises in graphs, tables, or other forms	post	3.63	0.67*
Create basic tables and graphs from sets of data	pre	2.93	0.82*
	post	3.75	
Locate data points in a simple table or graph and make comparisons between them	pre	2.71	0.65*
	post	3.36	
Formulate hypothesis or prediction related to an experiment or investigation	pre	3.00	0.52*
	post	3.52	
Draw conclusions based on results of an investigation	pre	3.14	0.75*
	post	3.89	
Use electronic monitors/probes to collect data	pre	1.74	0.26
	post	2.00	
Use computers for learning or practicing skills	pre	2.30	0.74*
	post	3.04	
Use computers as a tool (e.g. spreadsheets, data analysis)	pre	2.00	0.61*
	post	2.61	
Write reflections in a notebook	pre	3.33	0.52*
	post	3.85	
Take short-answer tests (e.g. multiple choice, true/false, fill-in-the-blank)	pre	3.36	0.21
	post	3.57	
Take tests requiring constructed responses	pre	3.07	0.57*
	post	3.64	

$^{*}p < 0.05$

The participants' responses to open-ended items on the post PD survey provide further evidence on the impact of the PD program on their classroom practice. Participants spoke of changes in their classroom management strategies, in their use of new technology and curriculum materials, and in greater use of authentic assessments. As Jonel reflected,

> Before, I didn't have specific rules posted for the whole year. After participating in the program, I have learned valuable techniques that have changed the climate of my classroom. Students were more attentive to their behaviors than before. I did less shouting and micro managing of my students. I took two main ideas from the management workshop: to have students complete a "Do Now" at the beginning of every class period and some ideas for creating a point system, which I have implemented.

Amy related how she implemented ideas for technology gained from the PD program,

> After this program, I've been forced to expand my use of technology in the classroom and personally. My students now use the computer to access various science related web sites for the students to explore. Personally, I've learned how to utilize technology tools that will enhance my teaching skills.

Marie expressed changes in practice related to specific curriculum,

> Prior to this program, my resources were limited. I had access to FOSS kits that were old or limited in their materials. This year I used a lot of resources from "Project Wild" and "Project Wild Aquatic" because they fit into the grade-level units on "Animal Adaptations".

Fran commented that, "before taking this program most of my assessments came directly from the science book. Currently, I use more informal assessments."

Wendy's comments centered on the impact the action research academy had on her classroom practice.

> Action research is such a great tool to use for your own problem solving; it helped me take a closer look at issues facing my students. It also helped me design activities for my students to supplement their learning in science.

The action research academy project was another avenue for the PD program to influence teacher practice. They collected base data on a problem related to their school's loss of AYP status (low student attendance) and participants designed an alternative policy to improve student attendance (NCLB, 2002). They arranged with school administration to put their policy into practice school-wide. Their project was eventually incorporated into the administrator's district-required plan for improvement.

Participants used their electronic portfolio to record additional reflections related to the ways in which the PD program had effected changes in their teaching practice. Participants reported changes in classroom management, assessment, and familiarity and use of curriculum materials. Jonel wrote in her portfolio:

> Before this program I've always prided myself on having excellent classroom management skills. When I heard we were going to have a section on classroom management I thought it was going to be a waste of time. Boy was I wrong! In this program there were several things that I learned I could use in the classroom to enhance my classroom management skills. One procedure has become a routine in my class daily. When I'm done teaching a lesson, instead of asking the students, "Do you have any questions?" I ask them "What are your questions?" This is beneficial because the kids know they will have an opportunity to ask their questions and they don't have to interrupt my lesson. Another excellent tool that was provided to us was a list of things to think about in the classroom called, "Keys to Effective Management". The key that I realized I needed to work on was, "Control voice and proximity". During the day I work very hard on controlling my voice level and going over to the students when I see a problem arising. I don't like to be yelled at so how can I expect my students to like it? I've noticed my students are much calmer and quieter and I have less altercations.

In her portfolio, Fran reflected on the impact of the PD program on her assessment approaches:

> My text-series' reading assessments were weekly tests on the selection. Every unit ended with a unit assessment. Math assessments were the chapter tests and performance assessments from the text series. After participating in this program, I put a lot more effort into performance-based assessments. Those performance-based activities often

> came hand-in-hand with a rubric, even if it was just written on the board. The students usually had the opportunity to work in groups, following this I would speak to them individually. This allowed those who had a difficult time with writing skills to explain to me verbally their knowledge of the subject.

Marie's reflection focused on how the resources provided in the PD program affected her practice:

> Before the program, I wasn't familiar with many of the curriculum materials like Project WILD, or with some of the resources for technology, nor teacher tools like the E-portfolio and Action Research. All of these resources have become an integral base for me to further pursue and apply to my teaching practice.

These perceptions were similarly shared during the focus group interview (Appendix H). Participants mentioned program impacts such as providing more connections between science and other curriculum disciplines and with the real world. They also described making lessons more student centered, and as Amy said, "I try to use models for more hands-on."

Fran described changes in her practice as, "making more connections with their everyday life; to require them to do some higher order thinking, constructing responses, and making connections with other parts of the curriculum." Wendy related how her teaching practice had changed after the program:

> I try to integrate more science in with my writing curriculum, like describing the critters in the garden outside. I let their thinking lead a lesson. I try to be more student-centered. I'll let them decide where the learning is going, to a certain extent. I would let them investigate topics that have more of an interest to them, as long as it's still pertaining to the concept that we're learning.

Jonel shared the following changes in her practice, post-PD:

> I use real-world applications like going to the grocery store so they see things, and do things, for themselves, like how to spend money. With a lot of students, that helps, I think that's real life, they get to experience, actually doing things, as opposed to being abstract. One of the things I do more now, as opposed to just testing, is more like an assessment, to

> see what they've learned, what they know, where they are now, as opposed to just memorizing information, over a period of time, more assessing, opposed to just testing.

Inquiry-related skills in teachers' classroom practice. To assess the extent to which the PD program impacted participants' use of inquiry skills in their classroom practice, an observation protocol was used (Appendix B). The observer rated each inquiry related descriptor on a 5-point Likert-type scale, (0 = not observed, 4 = characterized the lesson). Twelve inquiry related descriptors were rated, e.g. "the lesson encouraged students to seek and value various modes of investigation or problem solving", "the teacher encouraged students to be reflective about their learning", "interactions reflected collaborative working relationships and productive discourse among students", "intellectual rigor constructive criticism and the challenging of ideas were valued", and "the teacher used a variety of means to assess student understanding."

Although all content areas can be taught from an inquiry perspective, some of the protocol indicators did not match ELA practices, such as using manipulatives and multiple forms of representation. The school district's high priority for instruction of reading and language arts also made it difficult for all of the observations to involve a science lesson, since the lessons observed involved a range of subject areas. As a result, for each observation it was also important to note the content of the lessons. Three ELA teachers purposefully conducted interdisciplinary lessons, integrating science content into their reading and writing instruction. These observations were compiled, tabulated (Appendix J) and are summarized in Table 12, which displays total scores for the 12 indicators observed during each observation. As indicated in Table 12, Jonel, Wendy, Lauren, Fran, and Maddy exhibited an increase in the inquiry indicators between the first and second observations. However, all the participants exhibited a decrease in their use of inquiry related approaches between the second and third observations. It is believed this decrease might have been the result of a new principal appointed between the second and third observations, with a corresponding change in instructional time schedules. These changes included an increase in the amount of time for instruction of reading, ELA, and math while time allotted for science and cooperative planning was decreased.

Table 3 *Each Participant's Total Score on Inquiry-related Classroom Practices*

name	visit	sum of descriptor ratings	difference
Jonel	1	27	10
	2	37	
Wendy	1	31	10
	2	41	
	3	29	-12
Lauren	1	39	6
	2	45	
Fran	1	43	5
	2	48	
	3	26	-22
Maddy	1	0	39
	2	39	

	3	23	-16
Amy	1	34	-15
	2	19	
	3	18	-1
Marie	2	40	
	3	16	-24

The observation protocol also included non-numeric descriptors that were used to summarize other areas related to each participant's classroom practice of scientific inquiry, such as use of manipulatives, teacher and student roles, and whether the activity or lesson focus was on conceptual understanding or factual knowledge. Based on these descriptors the observer then provided an overall assessment related to whether or not the lesson, as a whole, illustrated the use of an inquiry approach. For example, in the case of Jonel, as shown in Table 13, she did not use manipulatives, assumed the teacher role of facilitator, provided students with an active role, and the focus of the lesson was on conceptual understanding. She was rated as *progressing* in her use of inquiry.

Table 4 *Non-numeric Descriptors*

			Characteristics Observed			Summary
		Use of Manipulatives	Teacher role	Student role	Focus	Use of Inquiry Approach
Name	Visit	Not used Demonstrate	Facilitator	Active	Conceptual Understanding	Not observed Beginning Progressing

		Explore/Test	Expert	Passive	Factual Knowledge	Proficient Accomplished
Jonel	1	Not used	Facilitator	Active	Both	Progressing
	2	Demonstrate Explore	Expert	Active	Both	Progressing
Wendy	1	Not used	Expert	Active	Factual	Progressing
	2	Demonstrate Explore	Facilitator	Active	Factual	Progressing
	3	Explore/Test	Expert	Active	Both	Progressing
Lauren	1	Demonstrate Explore	Expert	Active	Both	Progressing
	2	Demonstrate Explore	Expert	Active	Conceptual	Progressing
Fran	1	Not used	Facilitator	Active	Both	Proficient
	2	Explore	Expert	Active	Both	Proficient
	3	Not used	Expert	Active	Both	Proficient
Maddy	1	Not used	Expert	Passive	Factual	Not observed
	2	Not used	Facilitator	Active	Both	Not observed
	3	Not used	Expert	Active	Both	Beginning
Amy	1	Demonstrate Explore	Expert	Active	Both	Beginning
	2	Not used	Expert	Passive	Fact	Not observed
	3	Not used	Expert	Passive	Fact	Not observed

Marie	3	Demonstrate Explore	Expert	Active	Both	Proficient
	4	Explore	Expert	Passive	Fact	Beginning

The data collected through the observation protocol as well as field notes related to each classroom observation were used to provide an overall rating to each participant's growth in four areas that encompassed the project outcomes: classroom management, use of project resources and technology, assessment, and constructivist and inquiry principles. A Likert-type scale was applied to each set of data (0 = no growth to 4 = great deal of growth). As indicated in table 14, Wendy, Lauren, and Fran exhibited a great deal of growth in their teaching practice; Jonel, Marie, and Maddy exhibited some growth; and Amy displayed very little growth. Of the two teachers who showed the least growth, Maddy was identified as an English-language arts (ELA) teacher and Amy was a probationary teacher in her third year, subsequently reassigned to having no permanent classroom. Despite these challenges, a majority of the participants showed growth on a continuum of inquiry-based science teaching.

Table 5 *Summary of Changes in Observed Classroom Practice*

Name	Evidence for Changes in Areas Addressed by the PD Program				Growth Rating
	Use of Technology & PD Resources	Classroom Management	Assessment	Use of Inquiry Strategies	
Wendy	Science integration with ELA.	Planned transitions, group roles,	Probes thinking, students	Reflective thinking.	4/4 Great deal of growth

		routines	explain Writing to learn	Established meaningful context. Cooperative Groups, management strategies.	
Jonel	Does not teach science	Planned, practiced routines	Students explain problem-solving strategies, reflect.	Student to student collaboration and cooperation. Encourages reasoning: "How can I get this 2 to become an 8?"	3/4 Some growth,
Amy	Does not teach science.	Repeated threats, no follow-up	NO	Students passive, scripted ELA lesson	0/4 little growth
Maddy	Does not teach science.	Planned and practiced routines	NO	Student to student interaction; connects lesson to life experiences; open ended writing	2/4 some growth
Lauren	Science integration with ELA.	Organized for group work, planned, practiced routines.	Reflection/ Explanation; sorting compare/ contrast	Relates concepts, personal connections; active drawing/ diagramming	4/4 Great deal of growth

Fran	Science integration with ELA, Promethean Board.	Planned and practiced routines, consistent	Reflection/ explanation/ defend ideas (oral)	Comprehension in context Much student to student interaction connects art, geography, reading	4/4 Great deal of growth
Marie	Promethean Board, Science Integration with ELA, Planned unit activities, web resources.	Attributes management issues to specialist situation, repeated threats, no follow-up	Constructing models, journals	Some practice of process skills: observations and representing; integration of literature	3/4 some growth

The following two examples are a good illustration of the growth that some of the participants experienced in their classroom practice.

Wendy. Wendy was a second grade teacher with more than twenty years' experience, and an earned master's degree in reading and English language arts. She had not taught science for at least ten years. Changes in practice were very evident comparing the first observation of Wendy's class with the third observation. During the first visit, Wendy was observed teaching a summer school writing lesson that involved identifying nouns and action words in sentences. She called on specific students to respond as part of an example performed using a projected transparency of a student writing workpage. Inquiry strategies were not very evident as students worked independently to complete the rest of the assignment. In contrast, the last observation of

Wendy's class took place during the school year following the PD program completion. Desks were arranged to facilitate small groups. Wendy stated that the class observed was a long time block, with no special classes or prep periods scheduled, so she planned four different activities to be completed at stations set up at separate table locations. The students were organized in groups of four or five and were directed to spend twenty minutes at each station, as part of an English language arts lesson. Wendy worked with the students at the grammar station, using wooden tiles, each labeled with a word or with a part-of- speech, as prompts for students to construct original sentences. An aide worked with another group practicing oral reading, a third group worked independently on practice reinforcement work sheets for identifying nouns and verbs, and a fourth group worked together to complete boxed puzzles as fine- motor coordination practice. The transitions between activities were notably smooth; the students knew exactly what to do next; moved quietly to the appropriate station set up; and performed their tasks with minimal disruption and little off-task talking. Wendy reported that she had practiced the transition routines extensively the first week of school.

Fran. Fran was a first-grade teacher with more than 20 years' experience in the district. She had earned an educational specialist degree in reading instruction, and had also earned National Board Certification prior to participating in the PD program. Fran had not taught science for more than ten years. Changes in Fran's teaching practice were also evident by comparing her first two observations. The first observation was of a summer school third grade reading lesson. Student desks were arranged in traditional rows, facing the projected display. The children were directed to silently read a text section that was displayed on the "Promethean

Board." Probing questions were then displayed, underneath the text. Selected students were asked "to explain why they thought so," and to find passages in the story that supported their opinion. Volunteers were called on to share their responses to each question with the rest of the group. Each student then wrote individual responses to the same questions which were printed on their worksheets. All the children worked quietly on-task, and waited until called on to share responses aloud. The second observation was of a first grade homeroom reading lesson, which took place after the PD program pedagogy institute. The desks were arranged in a u-shape, the open end toward the projector display, with a rug on the floor in the center. The lesson was enabled by the Promethean board to categorize a variety of organisms in which pictures of each were labeled by name, by interactive "drag and drop" into the habitat in which they belonged. Fran used attributes of the student's names, such as beginning with the letter J, or containing six letters, to randomly select participants. Those called on were directed to come up to the projection screen, and physically touch the selected picture and move it into the chosen habitat. About half of the children were able to participate. Every student had a worksheet. They were given directions to use a blue crayon to draw lines matching each given organism to its habitat, on the page. Fran moved around the class and put a sticker on the top of each page, as it was completed. This lesson reinforced science concepts taught in science class, developed reading readiness skills, organization, sorting, sequencing, vocabulary used in context, sight words, art integration, and fine motor skills. Fran stated that curriculum policy requiring specific times for instruction of reading, language arts, and mathematics limited how much teachers might possibly implement from the science-oriented PD workshop sessions, but that she was sometimes able to supplement science content with reading lessons. A number of these contextual variables related to changes in the containing school district and the school administration's implementation of policy played a role in the teachers' classroom practice.

Role of Contextual Variables in PD Program's Impact on Teachers' Practice

One of the open ended questions in the survey (Appendix C) asked participants to list major issues or concerns related to teaching and learning of science before and after the PD program. Pre-program responses centered on lack of facilities, resources, and materials, to provide science instruction. Another common concern was a feeling of inadequate preparation to teach science content. One teacher reported,

> My science background is very general, where I learned a little about a lot of subjects. I would like to be very knowledgeable about several key areas within our curriculum. I would be more apt to teach science if I were more specialized. I don't think that I am adequately prepared to teach science in depth.

The amount of time required to teach science or to integrate science concepts with other subject curriculum that had mandated pacing was also a frequently stated concern.

Participants responded to the same prompt to list major issues or concerns related to teaching and learning of science in the post-program survey (Appendix C). However, their responses no longer included any mention of lacking content knowledge preparation.

One of the post-program survey questions in Appendix E also asked participants to indicate any changes that affected their teaching assignment during the school year. As displayed in table 15, 96% of the participants mentioned changes at the district level, 72% reported changes in school assignment, and 62% reported changes that impacted their teaching.

Table 6 *Changes that Affected Teaching Assignment*

Change Category	%
Changes in school assignment	72.4%
Changes in subject taught	37.9%
Changes in grade level taught	44.8%
Changes have impacted teaching	62.1%
District changes with impact on life	96.6%

Participants were asked to provide some explanations for any of the changes they had indicated in table 15. The participants' explanations for changes that impacted their teaching were categorized by common themes that surfaced in their responses. These themes included district and administrative policies for negotiating contracts, and teacher assignment to buildings and classes; curriculum issues like fidelity to pacing with scripted lessons, and high stakes testing; time and resources allotted to science; poverty; and student attendance. However, not all the changes they reported were negative. One participant wrote, "We have incorporated science fairs, family science night, more displays throughout school hallways. We also began a community garden program, a recycling program, and an attendance incentive program, and lots of professional development."

District and administrative policies. One of the teachers' key concerns included changes mandated by the state-appointed manager that were applied to the whole school district. A number of schools were being closed, causing uncertainty in reassignment of students, teachers, and administrators to other buildings. According to one of the participants, "Leadership disputes created an ineffectual atmosphere between the appointed manager, the administration and school board, and the community. Instructional materials weren't delivered; classroom and building maintenance weren't consistent."

A new contract was imposed, resulting in a net reduction in pay for most teachers. The teachers mentioned higher deductions for health insurance, changes in the pension plan and a freeze on any pay increases. One of the participants also mentioned a perception that "the state wanted 'seasoned' teachers to retire".

The effect that issues and concerns related to district and administrative policy had on participants were made apparent during observations of the PD workshop sessions. During one of the sessions, one of the attendees spoke as the school-district representative and reported that all of the schools in the district were to be re-constituted, which meant that all staff in all schools had to re-apply for every position. Five of the workshop participants related that they had been laid-off. Some participants had received letters of offer from a principal; others reported that their school was being closed. A discussion followed in which participants raised a number of concerns such as: where teachers were to report for duty; legality of a possible strike; legality of lay-offs; and how these issues would affect participation in the PD program.

Some of the changes the participants listed in the survey (Appendix E) were related to district policies that affected the participants' school assignment, such as assignment to a new grade level or another school, and a new principal. One participant related, "I'm not teaching what I enjoy teaching, changing to different schools is disheartening, which leaves me feeling insecure about my future in teaching. I really don't like inconsistency and I feel it's most unfair to the students."

Other teachers related that increased class size and newly shared space with a middle-school embedded in their elementary school created additional challenges. Lauren stated, "These changes put a strain on the teacher and the students. I don't believe the folks who implement/ cause these changes understand how detrimental they are. Or perhaps they don't care-which would be so sad."

Teachers were reassigned, based on enrollment needs, seniority, and at the discretion of the principal. At the start of the school year and before the final classroom observation of participants, Wendy was moved from a second to a third grade class; Fran was moved from first to second grade; and Amy was moved from a first grade to having no assigned classroom as she became the designated resource support teacher. Jonel, who was the special education resource room teacher, was transferred to another school building in the district.

During an observation of an earth science course meeting, one of the PD program participants shared an experience that illustrated a disruptive district policy. The teacher was certified at the elementary level, but her third grade class had been reassigned to a building substitute with bilingual certification. This teacher was now assigned in the morning as the primary science specialist, and had a seventh and eighth grade study hall in the afternoon.

The participants also mentioned new district policies for increased inclusiveness and decreased support for special education students as changes that affected their practice.

Curriculum and assessment issues. Participants described other changes that impacted their teaching. The most frequently listed issue involved an increased focus on mandated fidelity to pacing and scripted lessons. Teacher evaluation and fidelity to pacing charts and scripted curriculum were also mentioned as a concern during the focus group interview (Appendix H). Amy related that "the principal comes in, looking for my lesson plan book, my grade book." Fran added,

> She comes in pretty often, to see what you're doing, but there's usually no comment on it unless she catches you doing what you're not supposed to be doing, and are way off the pacing chart. But none of us have ever been guilty of (laughs). She usually lets us just do our job, as long as she sees evidence that we're doing our job, there's usually not a problem.

Lauren agreed,

> She's very observant. If she comes in and sees something that needs a little tweaking, she might give a little note to; you know if she sees that, for that individual teacher. She's always walking around.

High-stakes testing and administrative pressure to prepare students for the tests were also concerns mentioned in participants' survey responses. As one participant pointed out: "I feel as if I am always teaching to the test and not to the students' capabilities."

During the focus group interview (Appendix H), all the participants agreed that the issue of tests not matching the curriculum was problematic and unfair to the students. Jonel stated, "Our curriculum is almost built towards those (state) tests."

Fran too, expressed her concern about testing,

> When we were giving the district test in the fall, it had time and money on it but we didn't get to those units until late May, but it was on the test. The kids were crying because they didn't know how to count the money.

Wendy added her view on the issue,

> I felt bad for the kids. We hadn't really had a chance to look at this material, and they're getting assessed on it. There might be material at the end of the year; that was on the pacing chart, but we haven't gotten to it yet, but it was on the test.

Fran described what the tests were designed to measure, noting that the district tests were not yet aligned with the present curriculum:

> The state test, yes those are based on the GLCEs. The district tests, they just brought in, those are sort of based on national standards, that's not a state-based test. I'm not sure where this came from, but I know I've heard of other states using them, a standardized test, to increase how they do on the national standards. But I'm hoping they'll make some adjustments so you don't have first graders crying when they don't know how to count money, I haven't taught them how to count money, yet, but it's being held responsible for counting money. That's unfair.

Time and resources. The most frequently listed concern in the post PD program survey responses was still lack of materials. Time was also again mentioned as a concern, as one participant related, "There is not enough time to thoroughly cover the material that will allow the student to develop deep level learning."

Participants also reported that administrative scheduling prevented them from teaching science. "I do not have many opportunities to introduce the various lessons. Pre-K to 3rd grades concentrate on reading more than science," one teacher commented.

Reduced time allotted for science instruction was also mentioned as another issue affecting their teaching practice. Per district mandate, time allocated for science instruction had been reduced to accommodate extended time for reading, ELA, and math instruction. However, the district curriculum still included science for all grades, and state tests assessed science concepts beginning in third grade. Each school building administrator determined scheduling for science. In most district schools, science was scheduled to be taught in a self-contained classroom with all other subjects in the curriculum. In other schools, designated teachers instructed science or social studies. The students changed classes for those subjects two or three times per week, while the homeroom teacher taught all other curriculum areas. In some of the schools, the science instructor was a specialist, responsible for all science curricula for the whole school. At the participants' school, Marie was the primary grade science specialist. However, time reduction meant that class periods that were previously 55 minutes, twice per week, for all the special departmental classes like science and gym, were reduced to 45 minutes, meeting only once per week.

It also became evident that the level of access to technology in schools across the district varied. Fran related that her school had two interactive projector boards. Teachers at her school had been asked to write proposals about their plans to use the equipment in order to be considered for a projector board in their classroom. Fran submitted one of only two proposals and she was able to secure one interactive board for use in teaching language arts. Marie had the other one in her science classroom. Participants at other schools described having only one or two working computers in the building, and having to bring their own laptops for classroom use.

Poverty. Participants mentioned student poverty as another issue affecting their practice. Poverty had a direct impact on the students, and affected the resources available within the school, compared to schools in other nearby districts. Poverty was an issue that permeated the participants' school. The participants' school was designated as a federal title I school with 90% of the students considered economically disadvantaged, and had not met federal AYP due to attendance (NCLB, 2002). Data collected during their research academy project survey indicated that student absences were often due to children not having clean clothing, so they arranged donations and purchased clothing to have at school, for students to wear. Poverty additionally impacted the stability of students' home life. Fran remarked during her second classroom observation that as many as half of her students would be transient throughout the school year, mostly due to financial reasons. She had prepared for new students by having a "welcome kit" that included basic school supplies. Transient students directly affected funding in the containing district. The state's allocation of resources to each school district was based on student attendance on specific "count days." Students who changed schools after the count did not bring those allocated resources with them. Wendy had to secure a grant to pay for students to attend a district-required field trip to a cider mill. Fran noted in her portfolio response:

> This year I became a master grant writer when it came to utilizing the resources available to us through *DonorsChoose.org*. It became my ticket to offering my students the same sort of resources that children in the suburbs have access to learn.

Student attendance. Student attendance was another issue that affected participants' schools. This concern was addressed by Amy, Marie, Fran, Wendy and Jonel in their action-research academy project. They selected the topic of attendance because poor and inconsistent student attendance negatively affected overall performance on state assessments, which resulted in the school not meeting the requirements for Adequate Yearly Progress (AYP) (NCLB, 2002). They collected attendance data from the whole school population of kindergarten through fifth grade. A survey distributed to the parents of their students was also used to gauge student attitudes toward attending school, and get insight from students and parents on some of the reasons why students missed school. Based on the results of their study, the school administration adopted an alternative to using exclusion or suspension from school as a disciplinary measure, and arranged to collect some gently used clothing items to eliminate the issue of missing school due to not having a clean uniform. They also designed an incentive program for teachers to distribute “attendance bucks” for daily attendance. Students were able to spend those in the school’s attendance store each month on snacks, school materials, and small toys. The principal awarded students who had earned one hundred percent attendance each week. Students attending on a half day could participate in a pizza party with the principal. The school’s monthly attendance improved an average of 8% from the previous school year. The limitations to their study were that they were not able to begin the incentive program early enough in the year to make AYP; the teachers used their own money to stock the merchandise in the store because of district budget constraints; and finally, there was no designated permanent space for the incentive store.

Some of the other PD program participants were not able to institute building-wide initiatives due to lack of administration support, or because other faculty were not cooperative. The participants that were most able to alleviate some of the effects of these issues had developed a sense of professional community.

Effect of PD Program on Development of a Professional Community Among Participants

All of the participants in this study had specifically enrolled in the PD program to further develop their sense of professional community and to provide feelings of greater agency among the faculty at their school. Additional data related to the development of community among participants were collected through comments in the surveys (Appendix F); from observations made during the PD sessions (field notes) and during classroom visits. Additional data were collected through participants’ reflections in their electronic portfolios and from participants’ discussions during the focus group interview. The major themes that emerged across these data included: collaboration with peers, sharing resources, creating cross-disciplinary curriculum support, and improving their students' learning experience.

Collaboration with peers. Many of the participants' comments in the PD program evaluation surveys (Appendix F) were positive and related the benefits of cooperating with each other to share ideas, concerns and techniques that affected their schools and students. The study participants chose to work together as a cohort group during all of the program activities, including the summer institute workshops and the earth science course class, and for their action research academy project. Jonel reflected on the collaboration with her peers during the action research academy: "I enjoyed working with my peers on critical issues that affected our school, diagnosing the problem and coming up with solutions; working collaboratively to find strategies and tools that will benefit our students."

One of the focus group interview questions (Appendix H) asked: "How did the program as a whole, affect the sense of community you have at this school?" Jonel remarked, "We had a conversation about the new things learned every day, and all of the new things we could take back to the classroom; and we shared and discussed it."

Wendy replied, "I think we became closer as a staff."

Lauren agreed, "Shared experience."

Amy stated "All of the things we shared together."

Fran related,

> We made it through together, we survived it; we were together for all of the things we did for the school, together, like recycling and the things Marie put together toward building improvements for the garden, and the science rooms, and having a parade.

Shared resources. A sense of community was also demonstrated by the grant applications that the study participants coordinated as part of the summer institute workshop on resources. They applied to multiple sources, as a school group, with the stated goal of repairing the school's greenhouse. The group was later successful with a proposal to *Donors choose,* which they used to purchase additional incentive materials related to their action research project (Field notes).

During the focus group interview the participants also mentioned their community effort to increase resources for their school. Jonel said, "Getting grants. We brought that back to the staff, things like *Donors Choose*. Even bringing back information, other teachers benefitted from the materials we brought back. The kids really enjoyed the outdoor classroom."

Wendy remarked, "There were about five other teachers that participated in *Donors Choose*. And the whole school is interested in the attendance project." Fran related, "Even though only a few of us participated in the PD, we shared with other teachers in the building."

Support for cross-disciplinary curriculum. Working together to supplement the curriculum with cross-discipline lessons also exemplified the sense of community developed as part of the PD program. Their community provided a way for teachers to support each other across the curriculum, even though grade level teachers were not responsible for the whole curriculum.

Wendy actively attempted to integrate concepts and material from the PD program in coordination with Marie, the lead science teacher at the school, to reinforce science content about states of matter in a writing lesson performed during the second observation of her classroom.

Lauren stated that she was glad the PD program provided the opportunity to learn more about science and develop more cooperation with colleagues. Suggestions for subject integration and support across curriculum areas were good for the students. Her second observation involved a reading lesson. The students read a story about animals that lived in urban areas, discussed the definitions of “wild animals”, and “pets” and constructed a table showing examples of each that they might find near their own home. Every student shared his or her table, in turn, and then each made a Venn diagram of the animals found in the story, comparing the categories “wild animals”, and “pets.” Lauren expressed that this lesson provided a good subject discipline integration of science and reading due to the topic of animals.

Fran’s second observation was also a reading lesson which utilized a program for the Promethean board that Marie had suggested. The lesson was designed to focus on reading vocabulary aligned with objectives to integrate science content and technology. Marie also provided cross-subject integration to support the other teachers, in her science lessons, by reading stories and reviewing vocabulary and definitions using a word-wall in coordination with each science content lesson.

Improved student learning. In her electronic portfolio, Fran reflected on the outdoor classroom garden space to highlight student learning experiences as another aspect of an evolving professional community that evolved as a result of the PD program:

> Each grade level created and built its own garden. Our goal was to have each grade level take ownership of their garden. The older students did the heavy building and lifting and the younger students helped plant the gardens. The gardens were beautiful when they were completed and they stayed intact for about a week. Then some vandals came in and ripped out the plants. This turned out to be a great learning experience for the students. They were very angry that their work had been destroyed and they made it their goal to fix the garden and pass the word around that "we want to keep our school beautiful." The gardens are now put back together and just today the students in my class saw a bunny in the garden. They were able to write about it in their journals.

During the focus group interview Lauren also mentioned how the students might benefit from the PD program, "A few classes were doing journaling in the outdoor classroom."

As part of their action research project the study's participants selected the issue of student attendance because poor and inconsistent student attendance negatively affected overall school performance on state assessments, which resulted in the school not meeting the requirements for Adequate Yearly Progress (AYP) (NCLB, 2002). Based on the results of their study, they worked with administration to adopt alternatives to using exclusion or suspension from school as a disciplinary measure, and arranged for a student uniform clothing "bank" to eliminate the issue of missing school due to not having a clean uniform. They also designed and implemented an attendance incentive program for the whole school. The school's monthly attendance improved an average of 8% from the previous year. They planned to continue the incentive program during the subsequent school year. Their strategy became a core part of their school improvement plan.

CHAPTER 5 DISCUSSION, CONCLUSION, AND IMPLICATIONS

Professional Development (PD) is considered an established approach for building teachers' general knowledge in any content discipline (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003; NGSS Lead States, 2013; NRC, 1996; 2012). However, professional development programs vary in their design and effectiveness. Research on professional development indicates that effective PD programs share the following characteristics: the PD is sustained over time, encompasses science content and content specific pedagogical content knowledge, allows participants to form cohort groups, and encourages community collaboration (AERA, 2005; Guskey, 2003; Loucks-Horsley et al., 2003; Thompson & Zeuli, 1999; Wei et al., 2009).

The PD program in this study contained the following elements of effective PD programs as put forth by Loucks-Horsely et al (2003, p. 115):

- "Strategies for aligning and implementing curriculum" in science content areas were addressed by the summer institute workshop sessions including the Project WILD/Aquatic, the –EECS units in Ecosystems; Land Use and Energy; and Biodiversity; and the Earth/Space Science course.
- "Collaborative structures" were fostered through the sponsoring of the community gardening program which established an outdoor classroom at each participating school and through all the cooperative group assignments throughout the program.

- The Action Research Academy provided the participants an “opportunity to examine teaching and learning”, and also provided “an immersion experience” of authentic research in their own school.
- Participants were involved with the PD over the course of more than an entire school year, and also received a variety of resources including lessons, activities, and the materials to implement them as part of the “long-term engagement and support.”

A mixed method strategy of data collection was employed to provide robustness to the findings: quantitative data from various surveys, and qualitative data from open-ended items, portfolio reflections, interview remarks, and observation records, which all occurred during the same phase of the research. These various data sources were used to triangulate findings related to the various program outcomes (Creswell, 2009).

The results indicated that the PD program had a significant impact on participants’ science content knowledge (SCK), science pedagogical content knowledge (SPCK), and classroom practice. The program also played a significant role in the development of a professional community among the participants. However, contextual variables related to district restructuring and the school’s implementation of district policy also played a significant role in the resulting changes in participants’ classroom practice. The sections that follow provide a discussion of each of these areas.

Impact of the PD Program on Participants’ SCK

Science Content Knowledge (SCK) is a critical component of science teachers’ practice. In order to help students learn science content, teachers must themselves have a concrete understanding of the important ideas in that discipline (Anderson & Smith, 1986; Appleton, 2008; Ball, 1996; Capps & Crawford, 2013). Enhanced teacher knowledge and skills have an important positive influence on changes in teaching practice (Garret et al., 2001). Science teachers must understand how to use state and national reform documents and standards (e.g., NGSS Lead states, 2013; NRC, 2012) to inform their choices of developmentally appropriate science content for the classroom (Smith, 2000). Teachers must also keep up with continual advancements in the STEM field. Because of the exponential increase of new digital technologies, teachers have to do more than simply learn to use currently available tools; they also will have to repeatedly learn new techniques and skills as current technologies become obsolete (Mishra & Koehler, 2006).

In this PD program a variety of approaches were used to develop participants' SCK for specific content including: constructivism and inquiry; life science topics as part of *Project Wild/Aquatic*; -EECS topics involving land use and energy, biodiversity, and ecosystems; earth/space science topics such as lithosphere, hydrosphere, atmosphere, and the solar system; technology tools and resources; and science inquiry process skills. These experiences aligned with the range of instructional approaches described as necessary to fully develop proficiency in science (NRC, 2012; Michaels, Shouse, & Schweingruber, 2008). These approaches included a "spectrum of scientific investigations" such as: simple investigations using common materials, out-of-school field studies, formal laboratory experiments, and student-designed investigations (NRC, 2012, p. 258). Additional knowledge and experiences to support such investigations were listed as essential for science proficiency. Teachers must know how to prepare, organize, and maintain materials; implement safety protocols; organize student groups; and guide students through the practices of science and scientific inquiry process skills (p. 258). The PD program involved many authentic learning experiences, in which participants applied their evolving SCK by answering questions, solving problems, and using materials in the same ways they would expect of their students. Other sessions involved collaborative small-group investigations, some initiated by the PD program instructors and others by the participants themselves. The action research academy immersed the participants in a long-term investigation that they designed themselves. The participants' electronic portfolios provided the opportunity for them to reflect on their growth, utilizing evidence of changes in their content knowledge and process skills. A study by Capps, Crawford, and Constas (2012) indicated that such PD programs were effective in promoting scientific inquiry-based teaching when they included structural features such as providing extended total time and support designated for the PD program, and authentic experiences to teachers. Core features of these science-specific PD programs were observed to include coherency with standards, lesson development, inquiry modeling, reflection, transference, and content knowledge. Participants indicated their increased understandings of SCK through their survey responses, electronic portfolio reflections, and through direct observations of these materials and topics from the PD program used in their classroom practice.

Results of this study indicate that the PD program impacted participants' perception of their preparedness to teach science content as reflected in the significant increase in their ratings of various aspects of SCK. This included feeling prepared to teach every one of the specific science topics that were addressed in the summer workshops and feeling qualified to teach both non-science and science content areas.

Direct observations of each participant's classroom provided further evidence of the PD program's impact on their SCK. Wendy, Fran, and Lauren each integrated science content with their reading and ELA lessons to supplement the science curriculum. Each of their ELA lessons utilized science process skills and inquiry-related activities. This is significant because even though the instructional time allocated for science was reduced, these participants were able to adapt science content knowledge to inform their practice across another curriculum discipline. It has been established that there is a significant relationship between the amount of time children are engaged in activities to develop academic skills and increased achievement in those skills (Berliner, 2005; Marzano, Gaddy, & Dean, 2000). These participants were able to use time scheduled for ELA instruction to also reinforce student understandings of science concepts.

The results of this study align with research that finds a positive relationship between teachers' confidence in understanding content information, their beliefs about their abilities to influence their students' learning and their increased use of inquiry instructional methods in practice (Garret et al., 2001; Magnusson, Krajcik, & Borko, 1999; Smith, 2000; Wallace, 2009).

Classroom observations, the participants' survey responses, portfolio reflections, and interview discussions were all examined through the lens of Korthagan's (2004) "onion skin model of levels of change" (figure 1). Each level of the model was used as a perspective, to look at how teachers function. However, since only the outermost levels of environment and behavior could be directly observed the inner levels of competency, belief, identity, and mission could only be recognized through internal reflection, and self-report. A number of studies have shown that a teacher's belief system guides his/her actions and practice in the classroom (Nespor, 1987; Pajares, 1992; Posner, Strike, Hewson, & Gertzog, 1982). Bandura (1997) defined perceived self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p.3). Perceived self-efficacy in turn influences the course of action one chooses to pursue (Bandura, 1977). Participants' beliefs that the PD program increased their competency became evident through their survey responses, portfolio reflections, and interview comments. Data from the observations provided supporting evidence that the participants were actually implementing content material from the PD program in their teaching practice, as indicated by their survey and interview responses, and in their electronic portfolio reflections.

Impact of the PD Program on Participants' SPCK

Science pedagogical content knowledge (SPCK) has been recognized as an integral part of a science teacher's practice. "Pedagogical content knowledge (PCK)" was established by Shulman (1987) as a model to advance thinking about teacher knowledge which explains how specific elements of subject matter are organized, adapted and represented for instruction. PCK was represented as the content knowledge that deals with the teaching process, including ''the ways of representing and formulating the subject that make it comprehensible to others'' (p. 9). PCK is valued in teacher education research as an epistemological concept that blends the traditionally separated knowledge bases of content and pedagogy (Ball, 1996; Grossman, 1991; Ma, 1999; Shulman, 1987; Wilson, Shulman, & Richert, 1987). Science teachers must have a curriculum repertoire of both the substantive content and syntactical content, and know how and when to use specific strategies to reach their students. They must know how to use suitable resources to inform their choices of developmentally appropriate science content and also practice teaching strategies to facilitate their students' learning (Smith, 2000). For example, in order to reform science instruction as envisioned in the NGSS (NGSS Lead states, 2013):

> Teachers at all levels must understand the scientific and engineering practices, crosscutting concepts, and disciplinary core ideas; how students learn them; and the range of instructional strategies that can support their learning. Furthermore, teachers need to learn how to use student-developed models, classroom discourse, and other formative assessment approaches to gauge student thinking and design further instruction based on it (NRC, 2012, p. 256).

In response to this need for specialized teacher knowledge, models for PCK have been developed explicitly for science teaching. This Science Pedagogical Content Knowledge (SPCK) includes teachers' knowledge of scientific concepts and orientation to scientific practice; as well as their knowledge of appropriate instructional strategies, learning assessment, science curricula, and student understanding (Magnusson, Krajcik, & Borko, 1999; Park & Oliver, 2008).

In the PD program central to this study, a variety of approaches were used to develop participants' SPCK. Each of the requirements for PD programs that were designed to prepare teachers to implement curriculum innovation, as described by Visser, Coenders, Terlouw, and Peters (2010), were addressed: participants were given ample opportunities to develop science content, instructional strategies, and assessment methods; had multiple opportunities to cooperate with colleagues and collaborate in an organized network to discuss teaching and learning difficulties and exchange elements of good practice; and address how to obtain equipment and materials.

The results of this study also indicated that the participants' SPCK was significantly increased as a result of the PD program. Participants' perceptions of their increased preparedness to facilitate science related pedagogy and ideas about teaching and learning science as indicated in response to survey questions and reflections from their electronic portfolio were corroborated by data from the classroom observations and interviews.

Familiarity with state and national science standards, benchmarks, and grade-level content expectations significantly increased post-PD, indicating increased awareness of the topics and content that must be addressed in a particular year for a particular subject area and grade level. The knowledge of what to teach and when to teach it, found in state and national standards and grade level content expectations, is a crucial aspect of SPCK (Smith, 2010).

Participants authentically experienced scientific inquiry, which is commonly considered an integral element of SPCK (Capps, Crawford, & Constas, 2012; Duschl, Schweingruber, & Shouse, 2007; NGSS Lead States, 2013; NRC 1996, 2012), as they practiced implementing methods and using materials while completing various activities; presented mini-lessons to their peers; and while they created their projects as part of the action research academy. Providing this opportunity for participants to engage in authentic learning activities by learning the research process first-hand increased the possibility that they would subsequently provide their students with similar inquiry-based learning experiences (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003).

A stated goal of the PD program (Appendix K) was to assist elementary teachers who had non-science backgrounds to improve their SPCK. All of the study participants except Marie were primary-grade elementary teachers who had no prior background in science. However, the state and the school district prioritized reading and language arts instruction for the early grades, so the goals of the PD program were centered on constructivist teaching and inquiry approaches that were integral to science, but which could be applied to any content area. Capps and Crawford (2013) described that scientific inquiry could thus be approached as a content area to help learners develop abilities in scientific practices of inquiry, or process skills, and teachers might utilize such inquiry-based instruction strategies for concepts and principles specific to science or in any subject discipline (p. 499). Thus, when content was integrated across curriculum subjects, learners would benefit from the connections made between ELA and science, with a greater likelihood of learning and applying skills in authentic context (Beane, 1991).

The results of this study indicated a significant increase in the participants' perception of their preparedness to facilitate all science-related pedagogical strategies addressed in the survey (Appendix C). Even the area of least growth was still significant; experienced in participants' ability to help their students make connections from science to real-world situations. Applying science concepts to real-world situations is a highly sophisticated skill which is considered part of the practice of science. Michaels, Shouse, and Schweingruber (2008) relate:

> Science practice involves doing something and learning something in such a way that the doing and learning cannot really be separated. Thus, practice encompasses several of the different dictionary definitions of the term. It refers to doing something repeatedly in order to become proficient, as in practicing the trumpet. It refers to learning something so thoroughly that it becomes second nature, as in practicing thrift; and also refers to using one's knowledge to meet an objective, as in practicing law or practicing teaching (p. 34).

Participants were also able to authentically practice scientific inquiry as part of the PD program through the creation of their project for the action research academy seminar. Their project, which addressed student attendance, included authentic practice of the scientific inquiry process skills necessary to design and implement an experimental study. They identified and defined experimental variables, implemented the intervention within their school setting, and collected pre and post intervention data to determine the impact of their intervention. The participants analyzed the data, wrote a formal paper, and put together a presentation to communicate the results of their inquiry project. The process of completing this project aligned with the elements of understanding and applying the science and engineering practices described by the NRC (2012): asking questions and defining problems, planning and carrying out investigations, analyzing and interpreting data, and constructing explanations and designing solutions (p. 42). Such authentic scientific practice helped increase the participants' "knowledge repertoire of instructional strategies that are very specific to teaching science concepts" (Park & Oliver, 2008, p. 816).

Participant responses to the post PD surveys (Appendices C and E) indicated a decrease in their agreement with the pedagogical ideas that memorization has the central role in science learning, and that science is only found useful after a long period of study. These ideas were deemphasized by the PD program as they do not align with scientific inquiry, authentic practice, and constructivist strategies that have been promoted by reform documents for the last several decades (AAAS, 1989; 1993; NGSS Lead States, 2013; NRC, 1996; 2012).

Additional supporting evidence for the impact of the PD program on participants' SPCK was gathered during individual observations of each participant's classroom. Attempts to integrate concepts and materials from the PD program to reinforce science content during English language arts and reading lessons were clearly evident during classroom observations for Wendy, Fran, and Lauren. They each planned and implemented specific classroom management strategies to facilitate science and inquiry learning across curriculum disciplines, e.g. they used graphic organizers with the goal of increasing their students' conceptual understandings (Novak, 1990). Marie was able to directly utilize a number of science-specific strategies such as the physical arrangement of her classroom, distribution of materials and directions to students to enable cooperative groups, and the "cross-cutting concept" of model construction to illustrate scientific content ideas (NRC, 2012, p. 84). Marie also integrated English language arts with the science content in each of her lessons, as a way to connect science with the curriculum expectations for primary grades. This integration of subject content helps learners draw knowledge from a variety of sources that will allow them to create meanings for themselves (Beane, 1991). Marie demonstrated her SPCK to share developmentally appropriate curriculum materials, suggestions for activities, and the use of technology tools with the other participants, to assist her co-workers with the inclusion of science content ideas with daily lessons in other content disciplines.

Impacts of the PD program on the participants' SCK and SPCK were apparent in resulting changes to their classroom practice.

Role of the PD Program on Participants' Classroom Practice

The main goal of this PD program was to assist elementary teachers who had non-science backgrounds, in improving their science content knowledge and pedagogical content knowledge, thereby impacting their classroom practice. However, the school district's priority for early elementary instruction focused on reading and language arts. This focus in turn diminished the participants' opportunity to directly implement science content instruction. As a result, data collection related to the participants' classroom practice centered on constructivist teaching and inquiry approaches which although integral to science, could also be applied to any content area (Capps & Crawford, 2013).

The results of the study highlighted participants' perception of changes in their teaching practice resulting from the PD program. Their perceptions were indicated by their responses to various survey items, in their reflections for their electronic portfolios, and by their comments during the focus-group interview. Participants mentioned changes in their classroom management strategies, in their familiarity with and use of new technology and curriculum materials, and in greater use of authentic assessments. They reported a significant increase in the frequency of their students' engagement in activities associated with science, post PD program. Participants also indicated that their students engaged less frequently in activities that were de-emphasized in the reform documents (NGSS lead states, 2013; NRC 1996, 2012) and subsequently during the PD program because they were associated with teacher-centered instruction, such as: working independently, reading from a textbook in class, and answering textbook and worksheet questions.

These data were used to assess the program's impact on the participants' practice. Perceived self-efficacy was defined by Bandura (1997) as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). Perceived self-efficacy then influences the course of action one chooses to pursue (Bandura, 1977). Thus, the participants;' belief that they had changed their practice made it more likely that they actually had increased the practices related to science.

The essential features for classroom inquiry listed by the NRC (2000) were clearly aligned with the classroom observation protocol (Appendix B) selected to evaluate participants' practice. These essential elements of inquiry included a focus on scientifically oriented questions, giving a priority to evidence in responding to questions, formulating explanations from evidence, connecting explanations to scientific knowledge, and communication and justification of explanations (NRC, 2000, p. 29). Changes reflecting these elements of inquiry in the classroom practice of all the participants' were apparent, even though only Marie was directly responsible for teaching science curriculum.

These direct observations were collectively viewed through the lens of Korthagan's (2004) "onion skin model of levels of change" (Figure 1). Each level of the model was used as a gauge, to examine changes in participants' practice. Classroom observations provided data which represented the outermost levels of environment and behavior. Since teachers' classroom practice is guided by their belief system (Nespor, 1987; Pajares, 1992; Posner, Strike, Hewson, & Gertzog, 1982), these observations supported the participants' perceptions of change in their practice which made the inner levels of competency, belief, identity, and mission more evident.

The action research academy project was another avenue for the PD program to influence teacher practice. Participants collected base data on low student attendance, a problem related to their school's loss of AYP status, and then designed an alternative policy to improve student attendance. They arranged with school administration to put their policy into practice school-wide and this project was eventually incorporated into their school's district-required plan for improvement. Such "action research" can be an instrument of critical change, when teachers "carefully study the conditions and contexts of their work" that helped them learn about and change their practice (Price, 2011, p. 44). This action research impacted participants' instructional behaviors when systematic inquiry about that practice was integrated with the natural classroom practice (Posanski, 2010).

Participants' perceptions of changes in their teaching practice were corroborated by direct observation of each participant's classroom practice of scientific inquiry, such as use of manipulatives, teacher and student roles, and whether the activity or lesson's focus was on conceptual understanding or factual knowledge. Based on these descriptors the observer then provided an overall assessment related to whether or not the lesson, as a whole, illustrated the use of an inquiry approach. It was important to note that the lessons observed involved a range of subject areas besides science, because of the school district's high priority for instruction of reading and language arts. Although all content areas can be taught from an inquiry perspective, some of the protocol indicators did not match practices for ELA instruction. Three participants purposefully conducted interdisciplinary lessons, integrating science content into their reading and writing instruction.

Jonel, Wendy, Lauren, Fran, and Maddy all exhibited an increase in the inquiry indicators between the first and second observations. The second observation took place while the PD program was still ongoing. The positive data indicators that were observed aligned with expectations the characteristics of successful PD programs (e.g., provide extended total time and supporting resources) (Capps, Crawford & Constas, 2012). However, all the participants exhibited a decrease in their use of inquiry related approaches between the second and third observations, which occurred during the school year following the completion of the PD program. Such results are similar to those reported after insufficient support is provided for implementation of PD (Wei et al., 2009, p. 27). This decrease might have been the result of administrative and district changes. These changes included the appointment of a new principal between the second and third observations, who was not part of the learning community that the participants had built during the PD program. This loss of opportunity for community collaboration undermined an essential element of a successful PD program (Visser, Coenders, Terlouw, & Pieters 2010). There was also an increased emphasis on fidelity to curriculum pacing, and a corresponding increase in the amount of time for instruction related to reading, ELA, and math, while time allotted for science and cooperative planning was decreased. Research suggests that allocating more time to reading and math produces higher student achievement in those academic subjects (Stallings, 1980). Conversely, reducing the time allotted for science and cooperative planning will decrease the performance in those areas. The length of time between the end of the PD program and the third observation may also have had an effect on participants' practice, with a return to "business-as-usual" familiar practice in that subsequent school year, because participants had not been able to establish a context to sustain their conceptual change in practice (Hewson & Hewson, 2003).

Despite the challenges of subject material emphasis, and new administrative requirements, a majority of the participants showed growth on a continuum of inquiry-based science teaching. This growth was recognized in four areas that encompassed the project outcomes: classroom management, use of project resources and technology, assessment, and constructivist and inquiry principles.

Contextual Variables Related to District and School Policies

A number of contextual variables related to district and school policies played an important role in the PD program's impact on the participants' teaching practice. Qualitative data from participants' perceptions recorded in their portfolio reflections and interview responses, and observations made during classroom visits were used to elaborate on the quantitative data from the surveys. Korthagen's (2004) model was again utilized to compare the participants' responses and reflections with direct observations to validate some of those self-reported internal factors, like competency and belief (Bandura, 1977; Korthagen, 2004; Nespor, 1987; Pajares, 1992; Posner, Strike, Hewson, & Gertzog, 1982).

A post-program survey item (Appendix E) asked participants to indicate changes that affected their teaching assignment during the school year. Almost all the participants (96%) reported that changes at the district level had impacted their life, 72% reported changes in their school assignment, and 62% reported that changes had impacted their teaching. Another survey item asked participants to explain these reported changes. The participants' explanations were corroborated by reflections in their electronic portfolios, remarks made during the interview, and from direct observations during the PD sessions and classroom visits. Some of these changes were positive, describing new administrators, new programs such as a community garden and recycling, increased parent involvement, and increased opportunities for professional development. However, the participants' responses indicated the majority of the changes had not been positive and were related to financial and management changes in the district, which included alterations to administrative policies for negotiating contracts; teacher assignment to buildings and classes; curriculum issues like fidelity to pacing with scripted lessons, and high stakes testing; time and resources allotted to science; poverty; and student attendance.

District and administrative policies. The most universal concerns reported were the changes mandated by the state's take-over of the school district (PA 4, 2011). The state-appointed manager closed a number of schools, and reassigned students, teachers, and administrators to other buildings. Leadership disputes were reported between the appointed manager, school administration, and the community. All schools in the district were re-constituted, which meant that all staff in all schools had to re-apply for every position. Teachers were reassigned, based on enrollment needs, seniority, and at the discretion of the school's principal. Every participant faced uncertainty about their teaching position and practice. Research suggests that teachers who feel uncertain about their jobs experience a decrease in self-efficacy, and are less likely to implement new teaching strategies (Guskey, 1984). Some participants did not know to which school they would be assigned or what grade level or subject they would teach until a few days before classes began. A new contract was imposed resulting in a net reduction in pay for most teachers, which encompassed higher deductions for health insurance, changes in the pension plan, and a freeze on any pay increases. Apple (2004) suggested that state intervention is part of a generalized political rationale for economic and social welfare reform that is designed to stratify schools by class and justify inequitable support:

> The new objectives in education include the dramatic expansion of that eloquent fiction: a free market; the drastic reduction of government responsibility for social needs; the reinforcement of intensely competitive structures of mobility both inside and outside the school; the lowering of people's expectations for economic security; the "disciplining" of culture and the body; and the popularization of what is clearly a form of social-Darwinist thinking. (p. 15)

By imposing the state take-over, the "culture of power" (Delpit, 1988) seeks to blame the disadvantaged for causing their own distress. The state needed to intervene because the disadvantaged community mismanaged the administration of their children's schools (Barton & Yang, 2000). Research suggests that this is a political strategy designed to avoid solutions that would lead to effective socio-economic reforms (Apple, 2004; Barton & Yang, 2000; Berliner, 2006; Delpit, 1988). This unsettled environment certainly contributed to participants' lowered perceptions of self-efficacy. The state take-over also impacted curriculum and assessment practices throughout the district.

Curriculum issues and testing. Participants also reported an increased focus on mandated fidelity to pacing and scripted lessons, which were used for evaluation of their teaching practice. Pacing and mandated curriculum were also enforced by changes in time allotment for instruction. Extended time was allocated for reading, ELA, and math instruction, reducing the time for science instruction and planning. Research indicates that allocating more time to reading and math produces higher student achievement in those academic subjects, while increasingly marginalizing other subjects (Stallings, 1980; VanFossen, 2005). These changes made it more difficult to implement activities and lessons from the PD program, especially for teachers not assigned to instruct science. Yet, the district curriculum still included science for all grades, and science concepts were assessed by state tests beginning in third grade (MDE, 2010). The participants were mindful of this when they planned to supplement science instruction by integrating some science activities in their reading and ELA lessons, whereas the science specialist integrated reading, ELA, and mathematics concepts with the science lessons.

High-stakes testing and administrative pressure to prepare students for the tests were another concern mentioned. During the focus group interview all the participants agreed that the new district tests were not yet aligned with the present curriculum; which was problematic and unfair to the students. Valli and Buese (2007) relate that an environment of high stakes testing takes a high toll on teachers, and unfortunately does not benefit their students:

> Rapid-fire, high-stakes policy directives promote an environment in which teachers are asked to relate to their students differently, enact pedagogies that are often at odds with their vision of best practice, and experience high levels of stress. The summative effect of too many policy demands coming too fast often resulted in teacher discouragement, role ambiguity, and superficial responses to administrative goals. (p.520)

More disturbing was that these students' test scores would then be part of the evaluation rating for the school's AYP, and consequently determine teacher and administrator assignments (NCLB, 2002; PA4, 2011). Research indicates that such pressure leads to instructional time spent specifically on test preparation to the detriment of curriculum content that is not tested, such as activities and lessons from the PD program (Jennings & Bearak, 2014; Valli & Buese, 2007).

Time, resources and poverty. Lack of materials and resources were among the most frequently listed concerns in the post PD program survey. Access to technology resources was limited; there were only two interactive projector boards in the school, and each classroom only had one or two computers available. Materials like electronic sensors and measuring devices, robotics kits, or individual laptops provided for science classrooms in other districts were not available. The science classroom facilities were not in good repair. The only working sink was outside the science classroom, and the greenhouse was used as a storage space because the vents were not working and several windows were broken and boarded-over.

Administrative mandates for time reduction meant that class periods that were previously 55 minutes, twice per week, for all the special departmental classes like science and gym were reduced to 45 minutes, meeting only once per week. Marie was designated as the primary grade science specialist at the participants' school, and was responsible for teaching the entire science curriculum. Because of the new scheduling, and the mandated curriculum pacing, it was difficult for the other participants to include science lessons or activities they received from the PD program in their classroom practice.

Participants also mentioned student poverty as another issue affecting their practice. Their school was designated as a federal Title I school, 90% of the attending students were economically disadvantaged. Data from the participants' action research project indicated that student absences were often due to children not having clean clothing. As a result, the teachers arranged donations and purchased clothing so that some of their students in most need would have clean uniforms available at the school.

Poverty also impacted the stability of students' home life; many students were transient throughout the school year due to financial reasons. Hartman (2006) reports that "families that are poor move 50 % to 100% more frequently than families that are not poor" (p. 22). "A very large portion of such moves, particularly for low-income and minority students, are triggered or necessitated by factors that are not associated with positive change for the family" (p. 23). Such mobility may be due to divorce, job relocation, homelessness, or a parent's disability or death (Hartman, 2006). These transient students directly affected state funding of the school district, which was based on student attendance on specific "count days." Students who changed schools after the count days did not bring those allocated resources with them. Schools with low student enrollment were vulnerable to be re-organized or closed (NCLB, 2002; PA 4, 2011).

Classrooms were lacking basic supplies like paper and pencils. Apple (2004), mentions a shift in school policy from emphasizing student needs to student performance; accompanied by a shift of resources away from high-need students to marketing and public relations, because high-need students are not only expensive, but also deflate test scores (p. 20). In addition, the district's allocation of resources to their own schools was not equitable. Whereas a new and different reading text was adopted twice within two years, the science text was ten years old. Subject matter not included in assessments became increasingly marginalized (Jennings & Bearak, 2014; Valli & Buese, 2007; VanFossen, 2005). As a result, program participants worked together to secure grants as a means to increase their classroom resources.

The Role of the Program in Facilitating the Development of a Professional Community Among Participants

DuFour (2004) defined a professional learning community (PLC) as a conceptual model that describes how a group of educators might work collaboratively to reflectively examine their daily practice with a mission of ensuring that students learn. Five essential characteristics of a PLC were described by Vescio, Ross, and Adams (2007): (a) Shared values and norms must be developed to prioritize use of school resources and define roles of parents teachers and administrators; (b) there must be a clear, consistent focus on student learning; (c) teachers need to hold an extensive, continuing dialogue about curriculum, instruction, and student development; (d) teaching practices must be made public; and (e) there must be a pervasive focus on collaboration (p. 81).

Data from this study indicated that the PD program facilitated the participants' sense of professional community especially in their perceptions of: collaboration with peers, sharing resources, creating cross-disciplinary curriculum support, and focus on improving their students' learning experience. Comments from the evaluation surveys spoke of the benefits of cooperating with each other to share ideas, concerns, and strategies that affected their school and students. One of the interview prompts directly asked participants how the PD program affected the sense of community at their school; their responses mentioned shared experiences, discussion opportunities, and building closer relationships. The participants also chose to work together as a cohort group for most all of the activities during the summer institute workshops and the earth science course class, and for the action research academy project.

Shared resources. The participants had enlisted in a community effort to increase resources for their school, demonstrating a shared vision to prioritize the use of school resources (Vescio, Ross, & Adams, 2007). They coordinated multiple grant applications during the summer institute workshop on resources. This idea of applying for outside resources was mentioned in participants' survey responses and in the focus group interview as a valuable benefit of the PD program, to share with co-workers at their school. The participants were later successful with a proposal to purchase additional incentive materials for their school-wide attendance improvement project. Other teachers in their school building were able to benefit from the materials and resources the participants brought back from the PD program.

Support for cross-disciplinary curriculum. The sense of community developed as part of the PD program was also exemplified in the participants' collaborative efforts to supplement the curriculum with cross-discipline lessons. This collaborative effort demonstrated all of the characteristics of an effective PLC described by Vescio, Ross, and Adams (2007). Their community provided a way for the participants to support each other across the curriculum, even though grade-level teachers were not responsible for the whole curriculum. Wendy, Fran, and Lauren each integrated concepts and materials from the PD program into their ELA lessons in coordination with Marie, the lead science teacher at the school. Marie suggested technology programs, supplemental activities, and alternative assessments aligned with the ELA lesson topics that would reinforce the science content objectives addressed in the students' science class. Marie also supported the other teachers by providing cross-subject integration in her science lessons, by reading stories and reviewing vocabulary and definitions using a word-wall in coordination with each science content lesson.

Improved student learning. Research supports the use of PLCs as a means to improve student learning and achievement (Vescio, Ross & Adams, 2008). The participants reported how their students benefited from the materials, resources, and activities gained from the PD program that they then utilized in their school and classrooms. In addition to lessons and activities performed by participants in their own classrooms, the PD program had demonstrated impact on the entire school that led to an advantage for the students within the school community, specifically the outdoor classroom gardens, and the participants' action research academy attendance project.

Conclusions

The data in this study provided a case description with explanatory power on the impact of this professional development program on this specific group of teachers' practice. The PD program was specifically designed to help primary grade teachers with non-science backgrounds increase their science content knowledge and science pedagogical content knowledge. The results of this study indicated that the participants' SCK and SPCK were increased significantly as a consequence of the PD program. Their perceptions of increased SCK and SPCK were supported by direct observations of changes in their teaching practice as shown by increased frequency in which they addressed science concepts and elements of scientific practice, such as science inquiry process skills. However, contextual variables related to the district restructuring and the school's implementation of district policy also had a significant role in the participants' classroom practice. While some of these variables such as new administration and policies, new programs, and increased cooperation between staff resulted in positive changes, other variables limited the participants' ability to put in practice the content and skills they had acquired during the PD program. Mandated fidelity to scripted curriculum and pacing, increased testing and assessment, reduced funding, and changes in grade level, building assignment, salary, and job security were issues that negatively affected all the participants. One of the most salient impacts on this PD program was the development of a professional community among the participants. This cohort group of participants had enrolled in the PD program together, and worked collaboratively throughout the program's duration. They shared resources among themselves and with their co-workers at school, and supported one another by sharing cross-disciplinary lessons and technology. Their collaboration also led to their ability to secure funding and materials for instructional projects, and to help their school meet AYP (NCLB, 2002). These results suggest that targeted and sustained PD programs such as this one have significant potential for meeting the challenging goals of reformed science education.

Limitations

This study may have been limited by the small number of participants, who were purposively selected from the relatively larger group of self-selected PD program participants. Further limitations were imposed by restrictions on the type of data collection, such as having no access to video-recording within the participants' classroom. It is also important to note that it was not possible to determine if the teachers' involvement in PD correlated to any effect in student achievement because district policy did not allow access to student data.

Implications

The results of this case study highlighted positive impacts of the PD program on the teachers' SCK, SPCK, on their classroom practice, and on the development of a professional community among the participants. Following the PD program, increases in the participants'

SCK and SPCK were evident in their classroom practice despite constraints caused by contextual variables related to district structure and policy.

The calls for reform of school science have grown more forceful as the country struggles to meet the demands related to advances in science and technology and the low number of students entering STEM majors of study and careers (NGSS Lead States, 2013, p. 4). The National Research Council's *Framework for K-12 Science Education* (NRC, 2012) was developed to serve as the foundation for the Next Generation Science Standards (NGSS Lead States, 2013). The NGSS and supporting framework will change the focus of science education requiring a shift from learning content and inquiry in isolation to building and applying science knowledge in practice. The NGSS boldly proclaims "all standards, all students" to describe the ambitious goals for what students should know and be able to do as a result of their science education (NGSS Lead states, 2013, p.1). Meeting these goals will require many science teachers to change what and how they teach. In order to realize the vision proposed by the *Framework for K-12 Science Education* and the NGSS, schools must invest in effective professional development for their science teachers (Wei et al., 2009).

Lynch and Bryan (2014) synthesized elements of effective Professional Development that support the NGSS from several studies (Elmore, 2002; Garet et al., 2001; Wilson, 2013). These elements must include:

> Professional learning experiences should be sustained over time, ongoing, and of sufficient depth to be meaningful. They should also be embedded in the work of teaching: built on actual instructional and curriculum materials that can be used with students and that support the NGSS with fidelity. Professional learning should be collaborative and designed to engage a critical mass of teachers who are members of learning communities. (Lynch & Bryan, 2014, p. 3)

The characteristics of the PD program at the center of this study aligned well with these recommendations. It was sustained over more than an entire school year, with multiple courses of study addressing SCK, SPCK, and the authentic scientific practices of inquiry. Participants received instructional materials ready for classroom use. Collaborative groups were encouraged and the existing learning community was supported and strengthened.

This study also serves as a reminder for reformers to consider the contextual factors involved in making changes to education at any level. Primary grade curricular focus remains centered on ELA and mathematics. To achieve the greatest impact, professional development to advance the NGSS will still need to accommodate instruction for literacy at the elementary grade levels, and address district administrative concerns as well.

Future Research Directions

The results of this study suggest the value of preparing teachers to teach science in the primary grades. National standards include science in the early elementary grades and the NGSS promote “all standards-all students” (Lead states, 2013, p.1). Young children enter school with a natural curiosity, knowledge of the natural world, and the ability to use a range of reasoning processes (Duschl, Schweingruber & Shouse, 2007). Children in the primary grades are primed for science education, yet their teachers often lack the preparation in SCK and PSCK to readily include science instruction and scientific practices as part of the curriculum. Further research is needed to determine the effect of teacher professional development on their early elementary students’ achievement and interest in science, and if there are continued effects over time.

The results of this study illustrated the role that a number of contextual variables related to district and school policies play on a PD program's impact on the participants' teaching practice. These variables included state take-over of the school district; student poverty; reduced funding and changes to salary; administrative changes to class assignment, grade level, and school building; school closure; curriculum changes and restrictions; testing and assessment; changes to time and resource allotment. Additional research is needed examining the role that district and school administrators can play in the successful implementation of large-scale PD programs. Strategies to alleviate or eliminate some of the most negative variables identified in this study could be explored. Such research might include assessment of changes in the teachers' practice and the subsequent effect on student achievement.

APPENDICES

APPENDIX A: PROJECT OVERVIEW- PD TREATMENT

Number of teachers: 33

Purpose of the Project: To increase teacher content and pedagogical knowledge through a series of professional development activities.

Type of teachers: 3rd or 4th grade elementary teachers teaching in self-contained classrooms, preferably who do not have an endorsement in science and teaching in schools that have not made AYP. Cohorts of teachers from individual schools are preferable.

Teacher Remuneration: Free tuition for the Earth/Space Science course (3 graduate credit hours) and a stipend

Timeline for the teachers' professional development activities

Orientation Session

- Welcome and Introductions
- Overview of the project
- Clarification of roles and responsibilities
- Collection of "Pre-survey" data
- Question and answer

Summer Institute on Pedagogy (30 contact hours): Instructor- Program director/ Principal Investigator (PI) and University Faculty technology specialist.

- ***Monday Through Friday (9:00am – Noon and 1:00 pm – 4:00 pm) Teachers participate in activities related to pedagogy, specifically:***
    - Understanding of the Grade Level Content Expectations (GLCEs) for science and how to use specific GLCEs to develop curriculum,

- understanding the principles of constructivism,
- how to develop and implement inquiry-based lessons that are aligned with specific GLCEs for science,
- how to develop and implement various types of alternative forms of assessment,
- how to use assessment to inform instruction,
- how to integrate various forms of technology in the development and implementation of instruction,
- Teacher grant searching and grant writing,
- and how to organize and manage the physical instructional environment to prevent classroom management issues.

Assessment: Teachers will develop and share with each other lessons illustrating the skills learned in these activities.

(9:00am-Noon & 1:00-4:00pm) - (30 contact hours)

Training on Project Wild/Aquatic and State Environmental Education Curriculum Support (-EECS). **Each workshop instructed by certified program consultants.**

- Teachers participate in activities related to their certification in Project Wild/Aquatic and -EECS. The activities related to these curricula resources will cover the following topics:

Project Wild/Aquatic
The following topics will be covered:

- Components of a habitat
- Food Chains/Food Webs
- Adaptation
- Predator/Prey relationships
- Migration
- Bioaccumulation

- Environmental issues (habitat destruction, pollution)

-EECS – Two units will be covered (Land Use and Ecosystems & Biodiversity)

Topics to be Covered (Land Use Unit):

- Observing Land Use
- Measuring Land Use and Land Cover
- Classifying Land Use
- Reflecting on How the Land is Used
- Analyzing Land Use Changes: State
- Analyzing Agricultural/Farm Land Use Changes: County
- Solving Land Use Conflicts
- Investigating Land Use/Water/Air Relationships

Topics to be Covered (Ecosystems & Biodiversity Unit):

- Ecosystem Basics
- It's All Connected!
- Nature's Recycling
- State Ecosystems: What Have They Done for YOU lately?
- State Time Machine
- State's Web of Life
- Biodiversity Survey
- Threats and Protections to State Biodiversity
- Most Unwanted: Invaders of the Great Lakes Region
- State's Threatened Species

Assessment: Teachers will practice identifying specific GCLEs covered in these curriculum resources and integrating some of the activities into lessons to use with their students.

Fall

Earth/Space Science Course (38 contact hours; 3 credit hours), **instructed by University faculty**, **covering the following topics:**

- The sky and the Solar System
- Weather and Climate
- The water cycle and the Atmosphere
- Rocks and minerals
- Fossils
- Natural Resources
- Human Impact

Assessment: Individual and Group Assignments, Class presentations, building models, etc.

Fall

1. **Implementation of Outdoor Classrooms facilitated by Community Gardening Org (8 contact hours)**

    a. Community Gardening Org implements Outdoor Classrooms in the schools of the participating teachers. These outdoor classrooms become a source of science-related activities (outdoor laboratory) throughout the year.

Winter

1. **Research Academy (30 contact hours), instructed by PI/Program director**

    a. Teachers attend a seminar once a week in which they learn about action research.

    b. Teachers choose a topic related to their practice to be the basis for their action research project.

c. Teachers review of the literature on the topic and design and implement their study.

d. At the end of their study teachers share the results with each other through posters and power point presentations in a conference style event.

- Teachers will be encouraged to submit their projects for presentation at local conferences such as the State Science Teachers Association (-STA) and Regional Science Teachers Association (--STA).

Total Contact Hours: 136

APPENDIX B CLASSROOM OBSERVATION PROTOCCOL

Advancing Student Learning Through a Collaborative Partnership for Teacher Education

School Code:______________________________Teacher Code:________________________________

Grade Level:_____Topic(s) Covered:____

Date of Observation:_______Time:_________
Name of Observer:_______________________________

1. Role of manipulatives in the lesson (mark all that apply)

Demonstrate or confirm known concepts/procedures

Explore ideas, test conjectures, look for patterns

Not used in this lesson during the time observed

During the lesson, take notes describing noteworthy aspects of the lesson and then complete this portion of the instrument. Each of the items 5-14 should be rated 'globally'; the descriptors are possible indicators, not a required 'check-off' list.

	Not Observed				Characterizes the Lesson
2. This lesson encouraged students to seek and value various modes of investigation or problem solving. (Focus: Habits of Mind)	N/O	1	2	3	4

Teacher:
Presented open-ended questions
Encouraged discussion of alternative explanations
Presented inquiry opportunities for students
Provided alternative learning strategies

Students:
Discussed problem-solving strategies
Posed questions and relevant means for investigating
Shared ideas about investigations

3. Teacher encouraged students to be reflective about their learning. (Focus: Metacognition – students' thinking about their own thinking)	N/O	1	2	3	4

Teacher:
Encouraged students to explain their understanding of concepts
Encouraged students to explain in own words both what and how they learned
Routinely asked for student input and questions

Students:
Discussed what they understood from the class and how they learned it
Identified anything unclear to them
Reflected on and evaluated their own progress toward understanding

4. **Interactions reflected collaborative working relationships and productive discourse among students and between teacher/instructor and students.** (Focus: Student discourse and collaboration)	N/O 1 2 3 4

Teacher:	Students:
Organized students for group work	Worked collaboratively or cooperatively to accomplish work relevant to task
Interacted with small groups	Exchanged ideas related to lesson with peers and teacher
Provided clear outcomes for group	

5. **Intellectual rigor, constructive criticism, and the challenging of ideas were valued.** (Focus: Rigorously challenged ideas)	N/O 1 2 3 4

Teacher:	Students:
Encouraged input and challenged students' ideas	Provided evidence-based arguments
Was non-judgmental of student opinions	Listened critically to others' explanations
Solicited alternative explanations	Discussed/Challenged others' explanations

Not Observed **Characterizes the Lesson**

6. **The instructional strategies and activities probed students' existing knowledge and preconceptions.** (Focus: Student preconceptions and misconceptions)	N/O 1 2 3 4

Teacher:	Students:
Pre-assessed students for their thinking and knowledge	Expressed ideas even when incorrect or different from the ideas of other students
Helped students confront and/or build on their ideas	Responded to the ideas of other students
Refocused lesson based on student ideas to meet needs	

7. **The lesson promoted strongly coherent conceptual understanding in the context of clear learning goals.** (Focus: Conceptual thinking)	N/O 1 2 3 4

Teacher:	Students:
Asked higher level questions	Asked and answered higher level questions
Encouraged students to extend concepts and skills	Related subordinate ideas to broader concept
Related integral ideas to broader concepts	

8. **Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.** (Focus: Divergent thinking)	N/O 1 2 3 4

Teacher:	Students:
Accepted multiple responses to problem-solving situations	Generated conjectures and alternate interpretations

Teacher:	Students:
Provided example evidence for student interpretation Encouraged students to challenge the text as well as each other	Critiqued alternate solution strategies of teacher and peers

9. Appropriate connections were made between content and other curricular areas. (Focus: Interdisciplinary connections)	N/O 1 2 3 4

Teacher:	Students:
Integrated content with other curricular areas Applied content to real-world situations	Made connections with other content areas Made connections between content and personal life

10. The teacher/instructor had a solid grasp of the subject matter content and how to teach it. (Focus: Pedagogical content knowledge)	N/O 1 2 3 4

Teacher:	Students:
Presented information that was accurate and appropriate to student cognitive level Selected strategies that made content understandable to students Was able to field student questions in a way that encouraged more questions Recognized students' ideas even when vaguely articulated	Responded to instruction with ideas relevant to target content Appeared to be engaged with lesson content

11. The teacher/instructor used a variety of means to represent concepts. (Focus: Multiple representations of concepts)	N/O 1 2 3 4

Teacher:
Used multiple methods, strategies and teaching styles to explain a concept
Used various materials to foster student understanding (models, drawings, graphs, concrete materials, manipulatives, etc.)
Encouraged students to use various means to represent their understanding of the concepts

12. The teacher/instructor used a variety of means to assess student understanding of the concept(s) and/or skills. (Focus: evaluation)	N/O 1 2 3 4

Teacher:	
Used observations Feedback to student questions Paper/pencil practice Applications of the concept Learning logs Lab notebooks Portfolios	Other (describe)

13. The teacher/instructor integrated technology to facilitate instruction and student learning. (Focus: evaluation)	N/O 1 2 3 4

Teacher:

Used power point presentations for lecturing
Calculators
Probes to collect data
Video/DVD clips
Overhead projector
Laser disc
Other (describe)

CAPSULE DESCRIPTION

14. For each pair of statements below, mark the one that best describes what you observed in the lesson

☐ Teacher-as-facilitator ☐ Active student role in lesson ☐ Emphasis on developing conceptual understanding
☐ Teacher-as-expert ☐ Passive student role in lesson ☐ Emphasis on learning factual knowledge, skills/procedures

Comments:

15. Overall, how well did this lesson exemplify effective use of an inquiry approach to mathematics/science instruction?

☐ Not at all ☐ Beginning ☐ Progressing ☐ Proficient ☐ Accomplished

Comments:

Comments on the background/context of the lesson *(e.g., prior and/or future activities related to the lesson and any other information pertinent to the lesson)*

Teacher debriefing method

1. *What method was used to debrief the teacher? (e.g., post observation meeting, follow-up email or phone call)*

2. *Comments related to the debriefing*

(adapted from Oregon Teacher Observation Protocol, L. Flick, P. Morrell, C. Wainwright – 2004)
Available at: http://www2.research.uky.edu/amsp/pub/Sharepoint%20Toolkit%20Documents/OTOP%20adapted%20for%20PEP%202.doc

APPENDIX C PRE/POST SURVEY QUESTIONNAIRE

Pre-Program Survey of Teacher Participants SCIENCE

TEAR OFF THE INSTRUCTION PAGE before returning the completed survey to the session facilitator. The information you provide is strictly confidential. Your name will not be linked to the data. The code below is unique to you and only you know how to complete the code. Evaluators will use the code for analyzing pre/post survey results.

THANKS FOR TAKING TIME TO COMPLETE THE SURVEY!

INDIVIDUALIZED CODE NUMBER

This number is unique to you (no one else will know it). You will be asked to use the same code for the end-of-program survey. Carefully fill in the required information to complete your code number.

[ ]	[ ]	[ ]	[ ]
First TWO Letters Of Your Mother's First Name	First 3 Letters of the Month of Your Birth	LAST 2 Letters of First Name You Go By	2-Digit Number of the Date (Day of the Month) of Your Birth (from 01-31)

PART A: About you.

1a. What grade(s) do you teach? ________ **1b**. Do you teach special ed.? yes no

2. If elementary, how many times per week do you teach science? ________________________

3. About how many minutes is a typical science lesson or science class session? ____________

4. If middle or high school, what science courses do you teach? ________________________

5. How many years have you been a teacher? _______________

6. Are you a member of the Michigan Science Teachers Association (MSTA)? _______________

7. Are you a member of the National Science Teachers Association (NSTA)? _______________

8. Rate yourself on the following on a scale of 1 to 4, with 1 = low and 4 = high.

a. How familiar are you with the science standards and benchmarks from the *Michigan Curriculum Framework*?	1	2	3	4
b. How familiar are you with the national standards for science?	1	2	3	4

9. List the name(s) of the core instructional materials you use to support your science curriculum (textbooks, modules, etc.):

PART B: Science Content

10. How *WELL PREPARED* are you to teach the following science topics at the grade levels you teach? Rate each item on a 4 point scale, with 1 = not adequately prepared and 4 = very well prepared.

	Not Adequately Prepared			Very Well Prepared
a. Cells	1	2	3	4
b. Organization of living things	1	2	3	4
c. Heredity	1	2	3	4
d. Evolution	1	2	3	4
e. Ecosystems	1	2	3	4
f. Matter and energy	1	2	3	4
g. Changes in matter	1	2	3	4
h. Motion of objects	1	2	3	4
i. Waves and vibrations	1	2	3	4
j. The geosphere	1	2	3	4
k. The hydrosphere	1	2	3	4
l. The atmosphere and weather	1	2	3	4
m. The solar system, galaxy and universe	1	2	3	4

PART C: Science Teaching Practices

11. How *WELL PREPARED* are you to facilitate the following at the grade level you teach? Rate each item on a 4-point scale, with 1 = Not adequately prepared and 4 = Very well prepared.

	Not Adequately Prepared			Very Well Prepared
a. Problem-solving among students	1	2	3	4
b. Making connections within and between science topics	1	2	3	4
c. Making connections from science to real-world situations	1	2	3	4
d. Leading a class of students using inquiry strategies	1	2	3	4
e. Managing a class engaged in hands-on/project-based work	1	2	3	4
f. Helping students take responsibility for their own learning	1	2	3	4
g. Recognizing and responding to diverse student learning needs	1	2	3	4
h. Involving parents in the science education of their students	1	2	3	4

12. About HOW OFTEN do you do each of the following in your science lessons? Rate each item on a 5-point scale, with 1 = never and 5 = during almost all lessons.

	Never	Rarely: a few times a year	Some - times: once or twice a month	Often: once or twice a week	All or almost all science lessons
a. Introduce content through formal teacher presentations	1	2	3	4	5
b. Arrange seating to facilitate student discussion	1	2	3	4	5
c. Use open-ended questioning strategies	1	2	3	4	5
d. Require students to explain their reasoning when giving an answer	1	2	3	4	5

Strategy use continued . . .

e. Encourage students to communicate scientifically	1	2	3	4	5
f. Encourage students to explore alternative methods for solutions	1	2	3	4	5
g. Allow students to work at their own pace	1	2	3	4	5
h. Help students make connections between science and real-world situations	1	2	3	4	5
i. Use assessment to find out what students know before or during a unit	1	2	3	4	5
j. Embed assessment in regular class activities	1	2	3	4	5
k. Assign science homework	1	2	3	4	5

PART D: Barriers to Implementation

13. What are the major issues or concerns for you related to teaching and learning of science at your grade level?

PART E: Student Activities

14. About HOW OFTEN DO YOUR STUDENTS take part in each of the following types of activities as part of their science lessons? Rate each item on a 5-point scale, with 1 = Never and 5 = During all or almost all lessons.

	Never	Rarely: a few times a year	Some-times: once or twice a month	Often: once or twice a week	All or almost all science lessons
a. Participate in discussion with the teacher to further science understanding	1	2	3	4	5
b. Work in cooperative learning groups	1	2	3	4	5
c. Work independently	1	2	3	4	5
d. Make formal student presentations to the class	1	2	3	4	5
e. Read from a science textbook in class	1	2	3	4	5
f. Answer textbook/worksheet questions	1	2	3	4	5
g. Review homework/worksheet assignments	1	2	3	4	5
h. Work on solving a real-world problem	1	2	3	4	5
i. Follow specific instructions in an activity or investigation	1	2	3	4	5
j. Design or implement their own investigations	1	2	3	4	5
k. Perform experiments or investigations that require more than one step	1	2	3	4	5
l. Display data gathered in lab exercises in graphs, tables, or other formats	1	2	3	4	5
m. Create basic tables and graphs from sets of data	1	2	3	4	5
n. Locate data points in a simple table or graph and make comparisons between them	1	2	3	4	5
o. Formulate hypothesis or predictions related to an experiment or investigation	1	2	3	4	5
p. Draw conclusions based on results of an investigation	1	2	3	4	5
q. Use electronic monitors/probes to collect data	1	2	3	4	5
r. Use computers for learning or practicing skills	1	2	3	4	5
s. Use computers as a tool (e.g., spreadsheets, data analysis)	1	2	3	4	5
t. Write reflections in a notebook	1	2	3	4	5
u. Take short-answer tests (e.g., multiple choice, true/false)	1	2	3	4	5
v. Take tests requiring constructed responses	1	2	3	4	5

PART F: Ideas about Teaching and Learning of Science

15. Below are several statements about science teaching and learning. Rate the degree to which you agree or disagree with each statement on a 5-point scale, with 1 = strongly disagree to 5 = strongly agree.

	Strongly Disagree				Strongly Agree
a. Every student should feel that science is something she/he can do.	1	2	3	4	5
b. It is sometimes productive for students to work together during science class to conduct experiments or solve science problems.	1	2	3	4	5
c. You have to study science for a long time before you see how useful it is.	1	2	3	4	5
d. Memorization plays an important role in learning science.	1	2	3	4	5
e. A lot of things in science must be simply accepted as true and remembered.	1	2	3	4	5
f. I understand science concepts well enough to be effective in teaching science.	1	2	3	4	5
g. Students' achievement in science is directly related to their teacher's effectiveness in teaching science.	1	2	3	4	5
h. I am typically able to answer students' science questions.	1	2	3	4	5
i. When teaching science, I usually welcome student questions.	1	2	3	4	5

APPENDIX D PRE- PD SURVEY QUESTIONNAIRE

The main goal of this program is to increase the science content and pedagogical knowledge of -PS elementary teachers who do not possess a major or minor in science and who are teaching 3rd or 4th grades in self-contained classrooms.

INDIVIDUALIZED CODE NUMBER

This number is unique to you (no one else will know it). You will be asked to use the same code for the end-of-program survey. Carefully fill in the required information to complete your code number.

First TWO Letters Of Your Mother's First Name	First 3 Letters of the Month of Your Birth	LAST 2 Letters of First Name You Go By	2-Digit Number of the Date (Day of the Month) of Your Birth (from 01-31)

Demographic background

In this part you are asked to give some information about yourself. This information will only be used for survey purposes. Please read each statement carefully and answer accordingly. All information will remain strictly confidential. Thank you for taking your time to respond to this questionnaire.

From the statements below choose the one that applies to you.

1. Your gender ____ Female ____Male

2. Your race/ethnic background:
   ____African American
   ____Caucasian
   ____Middle Eastern
   ____Hispanic
   ____Native American
   ____Multiracial
   ____Other (please describe)_____________________

3. Year in which you received your teacher certification __________

4. Grade levels you are certified to teach ______________________________________

5. List your teaching major(s)__________________Teaching Minor(s)______________

6. Grade level(s) you are presently teaching ___________________________________

7. Content areas (math, science, etc.) you feel well qualified to teach
____
____
____

8. About how many times a week do your students engage in science activities?_____________

9. Your highest level of education: ___Bachelor's ___Master's ___Master's plus 30 __Doctorate

10. List your favorite classes in college
____

11. List your least favorite classes in college
____

12. Which science areas or topics do you feel **most** comfortable teaching? ____________
____
____

13. Which science areas or topics do you feel **least** comfortable teaching? ____________
____
____

For the next statements please circle the answer that best reflects your opinion.

SCALE:

SA = Strongly Agree
A = Agree
D = Disagree
SD = Strongly Disagree

1. The most important subjects in elementary school are language arts and math

SA A D SD

2. I think elementary schools should focus on the 3 Rs (reading, writing, math)

SA A D SD

3. Most of my time is spent teaching language arts and math.

SA A D SD

4. I enjoy teaching science

SA A D SD

5. I rarely teach science in my classes

SA A D SD

6. Good teaching primarily means disseminating facts.

SA A D SD

7. Good teaching involves actively guiding students toward the knowledge they are to learn.

SA A D SD

7. Good teaching involves regular interaction with students.

SA A D SD

9. Good teaching means involving students in projects that interest them.

SA A D SD

10. Good teaching means preparing students to score high in standardized tests such as SAT and/or MEAP.

SA A D SD

11. Good teaching means involving students in decision-making regarding the management/running of the classroom.

SA A D SD

12. Good teaching means helping students become problem solvers.

SA A D SD

13. Good teaching means helping students become critical thinkers.

SA A D SD

14. Good teaching means providing opportunities for student-led projects.

SA A D SD

15. Good teaching means following closely the district's passing charts or curriculum guides.

SA A D SD

16. Good teaching means using state guidelines and benchmarks to develop curriculum and instructional plans.

SA A D SD

How often do you believe the teaching strategies below should be used when teaching science? Circle the degree that best represents your view.

	Never	**rarely**	**sometimes**	**frequently**	**always**
(1) lecture	1	2	3	4	5
(2) class discussions	1	2	3	4	5
(3) teacher demonstrations	1	2	3	4	5
(4) teacher-designed laboratory experiments	1	2	3	4	5
(5) reading	1	2	3	4	5

(6) models	1	2	3	4	5
(7) student-led investigations	1	2	3	4	5
(8) inquiry-based activities	1	2	3	4	5

<u>Circle</u> the one method that you most prefer when learning science.

(1) lecture (2) class discussion (3)teacher demonstrations

(4) teacher designed laboratory experiments (5) reading (text or non-text) (6) student-led investigations

Why do you prefer this one method over the others?
Sequence the following activities in the ORDER you think is the best way to teach science.

Rank (1) for the method you think should be used to introduce a topic, (2) for the method that should be used next, and so on. Leave blank any methods you don't believe should be used.

_____ lecture _____ teacher designed laboratory experiments

_____ class discussion _____ reading (text or non-text)

_____ teacher demonstrations _____ student-led investigations

Why do you think this order is the best when teaching science?

<u>Open-ended question</u>

Please discuss what you believe is good teaching and how children learn best (use another page if necessary).

APPENDIX E POST-PROGRAM SURVEY QUESTIONNAIRE

The main goal of this program is to increase the science content and pedagogical knowledge of -PS elementary teachers who do not possess a major or minor in science and who are teaching 3rd or 4th grades in self-contained classrooms.

INDIVIDUALIZED CODE NUMBER

This number is unique to you (no one else will know it). You will be asked to use the same code for the end-of-program survey. Carefully fill in the required information to complete your code number.

First TWO Letters of Of Your Mother's First Name	First 3 Letters of the Month of Your Birth	LAST 2 Letters of First Name You Go By	2-Digit Number the Date (Day of the Month) of Your Birth (from 01-31)

Demographic background

In this part you are asked to give some information about yourself. This information will only be used for survey purposes. Please read each statement carefully and answer accordingly. All information will remain strictly confidential. Thank you for taking your time to respond to this questionnaire.

From the statements below choose the one that applies to you.

1. Your gender ____ Female ____Male

2. Your race/ethnic background:
    ____African American
    ____Caucasian
    ____Middle Eastern
    ____Hispanic
    ____Native American
    ____Multiracial
    ____Other (please describe)______________________

3. Year in which you received your teacher certification __________

4. Grade levels you are certified to teach ____

5. List your teaching major(s)_______________Teaching Minor(s)_______________

6. Grade level(s) you are presently teaching ____________________________________

7. Content areas (math, science, etc.) you feel well qualified to teach ____
____
____

8. About how many times a week do your students engage in science activities?______________

9. Your highest level of education: ___Bachelor's ___Master's ___Master's plus 30 __Doctorate

10. Which science areas or topics do you feel **most** comfortable teaching? _____________
____
____

11. Which science areas or topics do you feel **least** comfortable teaching? _____________
____
____

12. What changes have you experienced this year (since September 2009) in the following areas:

- Changes in school -
- Changes in subject(s) taught -
- Changes in grade level(s) taught -

13. In what ways have the changes listed above impacted your life as a teacher?

14. What other school/district related circumstances impacted your life as a teacher this past year?

For the next statements please circle the answer that best reflects your opinion.

SCALE:
SA = Strongly Agree
A = Agree
D = Disagree

SD = Strongly Disagree

1. The most important subjects in elementary school are language arts and math

SA A D SD

2. I think elementary schools should focus on the 3 Rs (reading, writing, math)

SA A D SD

3. Most of my time is spent teaching language arts and math.

SA A D SD

4. I enjoy teaching science

SA A D SD

5. I rarely teach science in my classes

SA A D SD

6. Good teaching primarily means disseminating facts.

SA A D SD

7. Good teaching involves actively guiding students toward the knowledge they are to learn.

SA A D SD

7. Good teaching involves regular interaction with students.

SA A D SD

9. Good teaching means involving students in projects that interest them.

SA A D SD

10. Good teaching means preparing students to score high in standardized tests such as SAT and/or MEAP.

SA A D SD

11. Good teaching means involving students in decision-making
regarding the management/running of the classroom.

SA A D SD

12. Good teaching means helping students become problem solvers.

SA A D SD

13. Good teaching means helping students become critical thinkers.

SA A D SD

14. Good teaching means providing opportunities for student-led projects.

SA A D SD

15. Good teaching means following closely the district's passing charts or
curriculum guides.

SA A D SD

16. Good teaching means using state guidelines and benchmarks to develop
curriculum and instructional plans.

SA A D SD

How often do you believe the teaching strategies below should be used when teaching science? Circle the degree that best represents your view.

	Never	**rarely**	**sometimes**	**frequently**	**always**
(1) lecture	1	2	3	4	5
(2) class discussions	1	2	3	4	5

(3) teacher demonstration
1 2 3 4 5

(4) teacher-designed
laboratory experiments
1 2 3 4 5

(5) reading 1 2 3 4 5

(6) models 1 2 3 4 5

(7) student-led investigations
1 2 3 4 5

(8) inquiry-based
Activities 1 2 3 4 5

Circle the one method that you most prefer when learning science.

(1) lecture (2) class discussion (3)teacher demonstrations

(4) teacher designed laboratory experiments (5) reading (text or non-text) (6)student-led investigations

Why do you prefer this one method over the others?
Sequence the following activities in the ORDER you think is the best way to teach science.

Rank (1) for the method you think should be used to introduce a topic, (2) for the method that should be used next, and so on. Leave blank any methods you don't believe should be used.

_____ lecture

_____ teacher designed laboratory experiments

_____ class discussion

_____ reading (text or non-text)

_____ teacher demonstrations

_____ student-led investigations

Why do you think this order is the best when teaching science?

Open-ended question

Please discuss what you believe is good teaching and how children learn best (use another page if necessary).

APPENDIX F EVALUATION OF WORKSHOPS

INSTRUCTIONS

Please rate each workshop that you attended using the scale provided. Your feedback is much appreciated. Thank you!

Workshop on Constructivism; Inquiry; Learning Cycle;
Hands-On/Minds-on; Grade Level Content Expectations
Instructor:
Did you attend this workshop? Yes No

If you attended this workshop, for each statement below circle the answer (strongly agree, agree, disagree, etc.) that best reflects your opinion:

This workshop was well organized.

Strongly agree agree disagree strongly disagree

The instructor was well prepared.

Strongly agree agree disagree strongly disagree

The workshop activities stimulated my learning.

Strongly agree agree disagree strongly disagree

In this workshop I learned valuable information that I will be able to use in my job.

Strongly agree agree disagree strongly disagree

Workshop on Assessment
Instructor:
Did you attend this workshop? Yes No

If you attended this workshop, for each statement below circle the answer (strongly agree, agree, disagree, etc.) that best reflects your opinion:

This workshop was well organized.

Strongly agree agree disagree strongly disagree

The instructor was well prepared.

Strongly agree agree disagree strongly disagree

The workshop activities stimulated my learning.

Strongly agree agree disagree strongly disagree

In this workshop I learned valuable information that I will be able to use in my job.

Strongly agree agree disagree strongly disagree

Workshop on Technology
Instructors:

Did you attend this workshop? Yes No

If you attended this workshop, for each statement below circle the answer (strongly agree, agree, disagree, etc.) that best reflects your opinion:

This workshop was well organized.

Strongly agree agree disagree strongly disagree

The instructors were well prepared.

Strongly agree agree disagree strongly disagree

The workshop activities stimulated my learning.

Strongly agree agree disagree strongly disagree

In this workshop I learned valuable information that I will be able to use in my job.

Strongly agree agree disagree strongly disagree

Workshop on Classroom Management

Instructor:
Did you attend this workshop?   Yes   No

If you attended this workshop, for each statement below circle the answer (strongly agree, agree, disagree, etc.) that best reflects your opinion:

This workshop was well organized.

Strongly agree   agree   disagree   strongly disagree

The instructor was well prepared.

Strongly agree   agree   disagree   strongly disagree

The workshop activities stimulated my learning.

Strongly agree   agree   disagree   strongly disagree

In this workshop I learned valuable information that I will be able to use in my job.

Strongly agree   agree   disagree   strongly disagree

Workshop on District Resources and Grants
Instructor:
Did you attend this workshop?   Yes   No

If you attended this workshop, for each statement below circle the answer (strongly agree, agree, disagree, etc.) that best reflects your opinion:

This workshop was well organized.

Strongly agree   agree   disagree   strongly disagree

The instructor was well prepared.

Strongly agree   agree   disagree   strongly disagree

The workshop activities stimulated my learning.

Strongly agree   agree   disagree   strongly disagree

In this workshop I learned valuable information that I will be able to use in my job.

Strongly agree agree disagree strongly disagree

Which topics in these workshops did you find most useful?

Overall, how would you rate this week's series of workshop?

Excellent very good good poor

Would you recommend these workshops to a colleague?

YES **NO**

Please write any additional comments you wish to make regarding any aspect of these workshops:

THANK YOU!!

APPENDIX G FOCUS GROUP INTERVIEW PROTOCCOL

1. What was your experience in teaching science before participating in the grant program?
2. What training and/or preparation in teaching science did you have prior to this program?
3. Describe what you consider to be the components of a “good science lesson”.
4. How would you describe your attitude toward teaching science, and integrating scientific inquiry in your classroom:
    a. Before participating in the grant program?
    b. After you have participated in the program?
5. Describe any changes (if any), that you believe you have made in your teaching practice based on the workshops and coursework you have done through the grant program. Try to cite specific examples and evidence for these changes.
6. Describe how you plan to use the information and knowledge from the program in your teaching practice in the future.
7. Describe your reasons for your application and participation in the grant program.
8. Describe the science curriculum and structure for teaching science at your school.
9. Describe the involvement of administration on your classroom practice.
    a. What about district policy?
10. Describe how the subject content material that you teach is determined.
11. In your view, how closely does your instruction of the curriculum match what is assessed? Do assessments match GLCEs? Curriculum objectives?
12. Describe your overall opinions about the grant program:

a. What expectations did you have for information/knowledge you would gain

b. Were these expectations met or exceeded?

13. Describe what you consider to be successful professional development. Describe how the grant program compares to your ideal

APPENDIX H TRANSCRIPT OF FOCUS GROUP INTERVIEW

Interview scheduled 07/23 : 12:50 p.m.
Location- Participant's Elementary School
Marie's Science classroom, room 109

Participants: Lauren, Amy, Fran, Jonel, Wendy
Maddy and Marie attending district in-service on technology- *Zangle* web system.

Students had been dismissed from summer school at noon due to intense heat (92°F), no air-conditioning. Interview originally scheduled for 2:00 p.m., participants called the researcher to suggest meeting an hour earlier. Classroom had 2 fans running, lights turned off. Quality of digital recording was tested. Participants each received a book store gift card for their participation.

Researcher: Ok, we are recording. So we're here on Friday, in the terrible heat, (Everyone laughing) July 23, 1:00 p.m. The first question is: What was your teaching experience in Science before participating in the grant program?

Fran: Very limited. We didn't have to do it 'cause we had two science teachers in the building, so we really, I uh, it's been ten years really for me since I've been in the building, to teach science.

Amy: It's been three years for me since I've had to teach science.

Lauren: Mine is about the same, um, it's like Fran said, about ten years. We used to do it in the classroom, but we begged and we got a lower el science teacher and so we had a lower el and an upper el science teacher, which means that we really didn't have to teach the whole curriculum, but one thing that Marie, what she likes to do is to let you know what she's covering, and so sometimes what I would do is just for some supplemental, you know, to back-up what she die, she'll tell me, you know, that that they might need a little more help with this, or that, or matter, or whatever they're doing, so I'll do a little supplement or something like that. But other than that, that was it, we didn't have to do the whole curriculum.

Jonel: I've never taught science.

Wendy: More than ten years, like Lauren said.

Researcher: Ok, um, what training or preparation in science teaching did you have prior to doing this PD program?

Amy: Prior to the program? Nothing.

Fran: We took a course last summer.

Lauren: Well you took a methods course last year. The methods course and district in-service workshops. Other than that, it's been years.

Amy: Oh, I did do the workshops.

Fran: There was a science instruction in the methods last year.

Wendy: We had an opportunity to take a class last summer. We all took that because we wanted to take it.

Lauren: And also the school system offered workshops during summer that a lot of times dealt with science and math and that was it. Oh, also, what was that?

Wendy/Fran: We did in-service.

Lauren: Ok, yeah, in-service, we took advantage of that.

Jonel: The methods course last summer, with Dr.B. and the district workshops.

Wendy: We did do in-service, before this it was at the university, years ago. There was a course last year, a methods course and workshop, before that about 5 years, yeah.

Researcher: Describe the components of what you consider to be a good science lesson.

Jonel: One good component would be to have the kids actively involved, using their hands, manipulating things, building things, or taking apart something, so they can actually get real experience, as opposed to just reading about it in a book.

Lauren: Yes, not too much lecture.

Wendy: Have them predict what might happen in a certain circumstance; then they can do some experiments to align with the curriculum.

Amy: I agree. I think more hands-on activities. They should get a lot of hands-on experience, which is what they need in a lower el classroom. They get a lot of hands-on.

Fran: I think just being able to see it, by making a model, and then they see the finished product, helps them to have a better understanding.

Jonel: Also exploring too, they can use the internet; that can clear up some misconceptions right away. And having some access to technology will help, too.

Fran: Yeah, Hands-on and minds-on.

Researcher: Describe any changes, if any, that you believe you have made in your teaching practice based on the workshops and coursework you have done through the grant program; if you can, try to cite some specific examples, if possible.

Jonel: One thing that I use now, as opposed to asking students, “Do you have any questions? I ask “What questions do you have?” something we learned from (the PD director). I think that it gives the kids the opportunity to um, ask ANY question in any subject, as opposed to just about that one thing, or whatever.

Fran: I also think giving them more think time, you know allowing them, just, you know, and not rushing them, letting them think about what they learned, before they get asked another question, giving some thought to it. I think that’s important.

Jonel: I think also, like real world applications, like one of the activities we did about the water, with (the PD director), with how much water we have, use of water, and land, with the apple.

Amy: The model with the apple- cutting up an apple, I try to use models for more hands-on.

Jonel: Like now with teaching math, I use real-world applications like going to the grocery store so they see things, and do things, for themselves, like how to spend money. With a lot of students, that helps, I think that’s real life, they get to experience, actually doing things, as opposed to being abstract.

Wendy: I try to integrate more science in with my writing curriculum. Like describing the critters in the garden outside.

Lauren: I’m retired, it’s all real-world now! (Everyone laughs).

Researcher: Describe how you might plan to use the information and knowledge from the program in your teaching practice in the future.

Jonel: Um, one of the things we learned about this summer was uh, test-taking, types of tests. One of the things I do more now, as opposed to just testing, is more like an assessment, to see what they’ve learned, what they know, where they are now, as opposed to just memorizing information, over a period of time, more assessing, opposed to just testing.

Amy: What I will do involves testing as well. Because with what the district requires now, this kind of coincides with what we were doing, we have to assess the kids quite frequently. Because besides just tests we would give at the end of the year, whatever, or end of the lesson, more assessments to see where the kids are, so we can meet them where they are, so we can improve upon what it is that we need to get.

Wendy: The question is what will I change in my teaching practice? I have to say that I'll allow kids, to let their thinking lead a lesson, the direction, a different approach, a different track, to a certain aspect. I'll be more student-centered. I'll let them decide where the learning is going, to a certain extent. I would let them investigate topics that have more of an interest to them. As long as it's still pertaining to the concept that we're learning, I would let them guide the lesson and where it's going.

Amy: That was one of the things that was most important, step away from direct teaching, allow the kids to learn themselves. Really, everything is geared to them. We can sit back, and see what they're doing, maybe give them a little guidance along the way, and let them actually get into it, play around and see what they come up with.

Fran: They really need to um, a little more as far as making more connections with their everyday life, as well, too. Like Amy said. If you don't give them that time to think, and everything, because they're going to have so many more tests. They're actually going to have a Q1 test the second week after school starts, so we've found with these tests, there are more items on there that require them to do some higher order thinking. You know, constructing responses, making connections with other parts of the curriculum that they have, so it's going to be really important that we really work on that. I think that's important

Lauren: We received some new books and materials to supplement, but I'm retiring, already retired, so I left my materials with Marie, maybe she will be able to use them with students next year.

Researcher: Ok, this question, we've already discussed this, I already know this, but for the record, so I just wanted to know- could you describe the science curriculum and the structure for teaching science here at this school?

Fran: Marie teaches all the lower el science. Curriculum is, I think *Science Anytime*

Jonel: Yes, she uses *Science Anytime*.

Fran: We used to use *FOSS* kits; I don't think we use those any more.

Wendy: She still uses *FOSS* kits for some lessons.

Fran: Uses *FOSS* some, uses the interactive board.

Amy: She uses the whiteboard a lot.

Fran: But I know that they're not downplaying it so much, but um, they didn't increase the hours, the time for science like they did increase the time for reading and math. So I think it's probably going to be more important, even if we're not responsible for it, for us to really address more science, or else the students won't be ready for the testing that is coming.

Jonel: Marie shares a lot of supplement suggestions with all of us. I think the upper el science teacher uses *Science Anytime*, as well. She doesn't share much with us.

Wendy: Along with *Science Anytime*, Marie does a lot of supplemental material. She finds things on the internet and uses them to supplement the curriculum.

Fran: She's gone to a lot of workshops, and she buys stuff for the science room.

Wendy: I know she's done a lot of things with matter, fossils with life cycles, we kind of have to supplement in our reading and writing lessons, to go along with those topics, and just to enhance what goes on in our classroom.

Lauren: The upper el science teacher uses the district curriculum and assigned text series. The older kids don't get as much hands-on in science.

Researcher: How does the science curriculum and course structure differ from grade level to grade level?

Amy: My first graders, they go to science twice a week.

Fran: First grade goes twice a week for 50 minutes each day.

Wendy: My second graders went twice a week, for 60 minutes long. Lower el doesn't get a report card grade in science, until third grade. Science class counts as a prep-time release for grade-level teachers.

Lauren: The fourth and fifth graders go to science four times a week, for 50 minutes. They actually get graded. Third graders go three times a week.

Jonel: I sometimes went to science class with two of Maddy's fifth graders, to give them academic support. Their science class didn't seem as interesting as our PD workshops were.

Lauren: It's too bad the upper el science teacher couldn't do the program with us.

Researcher: Ok, What is the involvement of administration on your classroom practice, and what about district input on what you do in your classroom?

Fran: We have pacing charts for everything, so the district kind of drives our curriculum.

Wendy: Everything is based on GLCEs, the strands, the standards.

Amy: Yes, the standards.

Fran: I know they're going to be leaning toward including the national standards, as well, from the No Child Left Behind, they're driving, you know everything that we do, submitting plans, items have to touch on those standards now.

Wendy: But our administrator, she doesn't really come in and get involved very often.

Amy: The pacing charts, we have to keep up with the pacing charts. Basically, she says, this is November, this is what you should be teaching, and you should be here, and that's what we usually do.

Researcher: So is the administration assessing your work frequently, or not frequently?

Fran: Well no, but she comes around.

Wendy: She does come around (laughing).

Amy: She comes in, looking for my lesson plan book, my grade book.

Wendy: She does look at my lesson plans when she comes in.

Fran: She comes in pretty often, to see what you're doing, but there's usually no comment on it unless she catches you doing what you're not supposed to be doing, and are way off the pacing chart. But none of us have ever been guilty of (laughs). She usually lets us just do our job, as long as she sees evidence that we're doing our job, there's usually not a problem.

Jonel: She's never caught me doing what we're not supposed to do.

Lauren: She's never caught you? Or you only do what you're supposed to?

Jonel: laughs

Wendy: She's observant (laughs).

Lauren: She's very observant. If she comes in and sees something that needs a little tweaking, she might give a little note to, you know, if she sees that, for that individual teacher. She's always walking around.

Researcher: In your view, how closely does your instruction of the curriculum match what is assessed?

Jonel: Well if you're talking about the standardized tests, we test everything.

Fran: No, I don't think the curriculum is very closely aligned. The pacing charts were off.

Lauren: With the Q tests we just started, no they are off.

Amy: We started doing Q 1, 2, 3, 4 tests; I think they are pretty close.

Wendy: I think it's so many things, to me, I felt bad for the kids. We hadn't really had a chance to look at this material, and they're getting assessed on it. There might be material at the end of the year; that was on the pacing chart, but we haven't gotten to it yet, but it was on the test.

Fran: When we were giving the Q2 in the fall, it had time and money on it, but we didn't get to those units until late May, but it was on the test. The kids were crying because they didn't know how to count the money.

Wendy: They didn't know how to tell time on the clock. In that area, it needs to get tweaked a little bit.

Jonel: In upper el it was better aligned.

Lauren: Even in upper el, there were some things tested that we just don't get to until the end of the school year. So when we have the testing meetings, we try to promote that we just introduce it to them earlier, so they know something about it, it might trigger something, so it's not a big shock when they see those items on the test.

Jonel: The State test, or the Q tests, our curriculum is almost built towards those tests.

Amy: But you're right, we don't get to some of those things until the end of the year, and they're testing them on it at the beginning of the school year.

Fran: Yeah.

Researcher: So in your view, the GLCEs are sort of assessed by the state test, and the Qs are, you know, that's what your curriculum addresses, that's what I'm hearing?

Fran: The state test, yes those are based on the GLCEs. The Q tests, they just brought in, those are sort of based on national standards, that's not a state-based test. I'm not sure where this came from, but I know I've heard of other states using them, a standardized test, to increase how they do on the national standards.

Researcher: So these might be used to improve NWEA scores for national comparison?

Fran: Right.

Jonel: Exactly.

Researcher: So is your curriculum kind of tied in to matching that, or not yet?

Fran: For the Q tests, not yet. But I'm hoping they'll make some adjustments so you don't have first graders crying when they don't know how to count money, I haven't taught them how to count money, yet, but it's being held responsible for counting money. That's unfair.

Wendy: Truth.

Lauren: Yes.

Amy: So Unfair.

Researcher: Describe what you might consider to be an ideal successful professional development. Then, if you can, describe how the PD program you experienced matches your ideals.

Jonel: The PD program could be used as an example of an ideal because I liked the hands-on component introduced first. We were hooked by the hands-on experiences, then we were later lectured, and I think that's the way it should be. Hands-on experiences, then lectures, then we go out and practice what we learned. And the attendance project, that was a great way to really develop our school community.

Fran: I didn't think there was that much lecture. I really enjoyed how I think we were allowed to discover things within our groups, we were able to always have a chance to work together, we weren't just isolated there with a piece of paper. We were able to sit together and were able to work in groups, cooperative groups, which is what they tell us to do with our students. We had to try everything out; it wasn't just a packet of information to put on a shelf. I really enjoyed the garden program. I hope we have a chance to fix it for next year.

Amy: Every time we came to class there was something for us to do as soon as we got there.

Lauren: Right. I thought the program was very well done. We had to put something into it as well as getting something from it. I wish I had understood more about the technology to use for the portfolio.

Wendy: Yeah, mmhmm And we were able to take things back to our classroom to really use, even though I still don't teach science, the sessions about classroom management, and how to include more technology were really helpful. Also, there were so many more activities that will help supplement teaching other subjects.

Researcher: Ok, as far as your overall opinion about the grant program, what expectations did you have, and were the expectations met?

Amy: The grant program was pretty nice.

Fran: When we started, and talked about taking classes, and mentioned tests, I'm thinking oh no, essays and everything. But it was a relaxed atmosphere all around, creating games, and boards, and then discussing whatever everyone else had to offer and sharing. That made it nice.

Jonel: It was almost like the make and take- with experiments, we were able to make our own, and share, with ideas of how to teach something, and various methods of how to teach students, with games, and we had the hands-on component. We did the science course, and the instructor had us make a file of everything we did.

Amy: We ended up with thirty activities to take with us, we all shared, and that was very helpful. It was pretty good.

Wendy: I really enjoyed the first workshops. And when we get away from the science components, it's been a really long time since I had science; (laughs) I mean this was in the 70's, science for elementary teachers, so it's been a long time. I learned so much. I really enjoyed the first ten sessions, with the presenters coming in. The wind, I mean the turbines were fascinating. This is probably not new, but when you don't really pay attention to those things every day, then it's new for you. Those days that we met, I really did enjoy those workshops. There was a lot of information, but there were good things. Who was the technology, the lady with the *I-touch*, I still don't know how to use that, and maybe one day I will learn how to use that. But it was just the information was good, because, you know, I'm auditory; I like to see things, and talk about it. I enjoyed the class as well, but those ten sessions, right after school was out, I really learned a lot, I got a lot out of them, it was really you know, just looking at things a little differently. You know, I just might be able to teach science.

Jonel: I think it was the outside resources that (the PD director) used and people came in and talked to us, (Ms. S) from the community gardening organization, the technology person, and the family that talked about the turbines, and alternate sources for electricity. And then the outdoor classroom, we did experiments. It made science seem fun, and not boring.

Fran: You could see how to do activities with the children; they could look at science in a different way, and pick up more information that way. I saw Wendy's class outside in the garden, and it was great to see them using the resources that way.

Wendy: Thank you for noticing, even though the kids were hanging all over the school. It's always nice when you can bring things you learn back into your classroom. That was fun.

Lauren: It wasn't just a bunch of meetings to sleep through and then forget. I learned a lot, personally.

Researcher: In your opinion, how did the program as a whole, affect the sense of community you have at this school?

Jonel: For Wendy, she learned a lot about science, and we had a conversation about the new things she learned every day, and all of the new things she could take back to her classroom and share and discuss it. And a happy teacher is a good teacher, and she was happier after that experience (laughs).

Wendy: (Laughs) I think we became closer as a staff.

Lauren: Yeah we did. Shared experience.

Fran: We made it through together, we survived it; we were together.

Amy: All of the things we shared together, and brought back to our classrooms.

Fran: The things we did for the school, together, like recycling and the things Marie put together toward building improvements for the garden, and the science rooms, and having a parade.

Jonel: Also getting grants. We brought that back to the staff, things like “Donors Choose”.

Wendy: There were about five other teachers that participated in “Donors Choose”.

Jonel: Even bringing back information.

Fran: Yes, even though only a few of us participated in the PD, we shared with other teachers in the building.

Jonel: Other teachers benefitted from the materials we brought back.

Researcher: What About the outdoor classroom?

Jonel: The kids really enjoyed the outdoor classroom.

Amy: Too bad it got destroyed. Again.

Fran: Unfortunately, this time they pulled up all the plants, stole the fencing, and drove tire tracks through the whole area. It will take a lot more effort to repair, if we can replace the materials.

Wendy: The principal mentioned that she thought the community group would come back and repair it. She said there were plans to put a couple of benches out there.

Lauren: A few classes were doing journaling out there. Are the boxes for the journals still out there?

Fran: I do believe the journal boxes are still there, I think the summer school class was using them. That is something we can look forward to, doing that in the fall.

Researcher: Are you planning to utilize your attendance project for next year?

Fran: Oh yes.

Wendy: The whole school is very interested in that.

Jonel: We are doing something similar for the summer school.

Lauren: They've got to be on time. If they're on time, not late, they start right off and can earn rewards.

Jonel: Other teachers are planning to start up the program right when school starts.

Fran: We definitely need to improve our attendance for next year.

Wendy: We need to make AYP.

Lauren: We were so close.

Fran: We have definite plans to use that.

Wendy: We saw a definite increase in attendance toward the end, after we implemented it.

Jonel: So hopefully we make AYP.

Amy: Next time when we do this, we should, if we start right away.

Fran: We need to start at the beginning, in the fall, hit the ground running.

Researcher: Are there any other issues or topics that you can see yourself doing a similar project with your school?

Fran: I would say discipline. From summer school, we've had a lot of fights. A lot of petty stuff, but discipline is an issue. The third graders argue at the drop of a hat. Maybe we could design a program to reward when they don't do that, or if there is a situation and they just step back, maybe we could reward them for that.

Amy: Some kind of behavior modification put in place. And even how important it is to be here in school. We have to do something to involve the parents. Everyone knows I had a student who was absent 80 days over the whole school year. Parents need to understand how important it is. Parent involvement is needed. Especially for lower el. We have to do something for parents to understand how important it is to get them here on time and ready to learn.

Researcher: Anything else anyone wants to share, on how the project has impacted what you do here?

Jonel: At the end of the school year, our principal, she was pretty proud of us. Our project, she was interested, took a copy of our action research report.

Fran: And it's been a core part of our school improvement plan

Jonel: Yes.

Wendy: Attendance is important to our improvement plan.

Researcher: That's it for the questions that I have. Is there anything else you wanted to share for the record?

Wendy: Thank you. I appreciate being included. I got a lot out of it. I learned a lot.

Fran: I really enjoyed the time I spent with the summer workshops. They were very informative. A lot of ways of introducing science to children, to make it more fun, and all that.

Lauren: Our jobs are being changed as we speak; we never know where we're going to end up. This can only help make us more versatile. You never know, you might be put into a science class, Wendy, you never know.

Wendy: (laughs) It's so true, so true.

Amy: Well hopefully, they won't put science back into the general classroom. I think it is so important to have that person, especially with an emphasis on the science curriculum. I think to put it back to the way it was, it won't get as much attention.

Wendy: A specialist is needed, so science doesn't get short shrift.

Fran: Hopefully they won't do that, and we will have the opportunity to give the children what they need. Because I think they do so much better when they do have that person to do just science, and not worry about all the other things.

Researcher: Thank you for coming out on this hot day; I really appreciate your letting me be a part of your school.

Severe thunderstorm with intense downpour commenced as interview finished. All participants, including researcher waited at gym entry for rain to lessen before going to cars in parking lot. Informal discussion of summer plans continued: Amy was recently married, was going on a Caribbean cruise for her honeymoon. Fran shared that she had been on a cruise to Jamaica a few years prior. Lauren was planning to retire effective in September, and was planning a trip to Europe

APPENDIX I FIELD NOTES

Entry 1: Wednesday, July 29, 1:40 p.m. – 3:15 p.m.

Technology Session- Location University Classroom

Class Brainstormed types of technology they were familiar with, categorized home use, classroom use, availability in the classroom, comfort level with use.
Some demonstration/practice with using e-mail, hyperlink feature in word files: assignment- list 3 or more useful inquiry/science/technology websites to share and e-mail to PD director to compile class data bank.
Guest Speaker-University Faculty

I-Tunes
IPod touch-Super resource with wireless.
Radiowillowweb (search itunes for student examples of podcasts)

Uses for student podcasts: review, reports

-ACUL (join organization for tech info, networking)

Audacity.com website includes free set up for recording on windows platform

Zamzar.com free conversion site to change format i.e. AVI to doc., doc to pdf, etc.

Picnik.com

There was a great variation in the comfort level of various teachers with use of technology. Also, noted a great variety in amount of technology hardware available in different schools.
Per discussion with Fran: 2 *SmartBoards* were made available for use at School. Teachers were asked to write proposals for how they would use the equipment to be considered to have one placed in the classroom. Only 2 proposals received by principal. (Fran was one of them, and she has smart board in classroom, used to teach language arts.

Class Participant used ~45 minutes class time to discuss/report on union meeting regarding reconstituting of schools.
At least 5 participating teachers have been laid-off. Questions about where to report for duty in August; how this will affect participation in grant project, legality of strike, legality of lay-offs, are foremost on teachers' list of concerns.

Entry 2: Thursday, July 30, 9:00 a.m. - 3:15 p.m.

Classroom Management- Location University Classroom

State grant coordinator present for site visit, review of grant compliance

Teachers completed "Classroom Management Profile"

Tally scores for Questions:

4,8,11: 10:4, 11:2, 9:4, 12:5, 13:8, 14: 3, 8:2

#6, 10, 12: 4:3, 7:6, 8:11, 6:4, 5:3

#2, 5, 7: 3:4, 4:12, 6:2, 5:6, 7:1, 8:2

Survey: Discussion of answers

If you had a magic wand, what areas related to classroom management would you wish to change? Explain why you wish those changes.

Reduce Teacher procrastination

Students follow rules consistently

Increase student appropriate behavior; reduce disrespect (talking back), off task, etc.

Increase space in classroom

Reduce class size

Reduce external interruptions to teaching time (students pulled out for non-teaching task)

Full time aide

Counseling/Social work support staff more active

Increase student respect for each other

Children would line up peacefully, without concern who is first or last

Never had to raise voice- children would respond to non-verbal signals

More parental support

More administrative support

Access to outside from classroom

Increased learning resources, learning centers, reading area, etc

Improved student attendance

Students prepared to work

Organized classroom with clear jobs that are performed

Increased student pride in classroom & selves

Access to natural lighting

Basic supplies

No use of inappropriate words

Put nurses back

Computers

1. Classroom Management Exercise
    - A. How would you classify your classroom management
        - a. Focuses on prevention
        - b. Focuses on dealing with issues as they happen
    - B. Describe your classroom management approaches
    - C. How effective are these approaches

Cases provided to each group for discussion:

Each group selected one person to read case, and then talked about what their response to the situation would be:

Showing video: 1 student puts coat over-head and emphatically says she is going to sleep, other children throwing pens/pencils. Response: Do Now- redirect pen throwers, remove from classroom if persists; sleeping girl- more attention to find out if underlying physical cause, otherwise, re-focus, or remove girl from class.

Another group- Previous protocol in effect- no coats in class, previous rules no pens allowed during video unless taking notes. Address immediately: Crush behavior call parents, send to office, and take pencil away.

1st day of spring, students are chatting, joking with each other, while teacher addresses questions of student who missed last class. Response: Prevention procedures in place- students know what they are supposed to do. Look at students, Line up, go back outside, and start over.

At presentation of constellations, students researching, students working –involved, not listening, you try to get their attention to make announcement- students ignore and get louder. Response: Need Attention class procedure.(Clapping signal, flip lights, write names on board)

Doing mammals, students interested, and one student in particular shouts out answers even after being asked to wait until called on. Prior set up for sharing- round robin method, talking stick, ask student to teach lesson, teacher behaves in like manner, Student can choose next respondent, or verify correct answers, consequence for blurting, set up silent hand signals.

Covering chemical/physical changes, found activity on internet. Students have difficulty, other groups mess with equipment, don't follow directions, how do you get on track. Response: Students who break rules punished. Group pulled out of lab activity.

Teacher must spend time cleaning up classroom after students leave. Response: Set up "cleaning wizards, students who love cleaning. Mystery trash game- teacher puts out 1 piece of trash- students pick up everything to see if it was the mystery piece, student winner gets treat. Classroom cash- point system for jobs- behavior system, caught being good.

New student transferred into class, not disruptive, does not bring materials, does not turn in work, keeps head down on desk. Response: Check for physical cause, then pair with another student that needs a leader-buddy, face-to-face with parent, provide supplies.

End of unit test handed back, students complain about grades, students come up to ask why, Class gets noisy. Response: Redirect whole class to rubric- look over tests individually. If whole class having difficulty with section, possible re-teach needed,
prior procedure to turn in tests with question attached individually. Return tests at end of class period. If whole class has problem, review prior to handing back, re-teach or adjust as needed. Don't spend class time on whole test with whole class if not needed. Offer extra credit if student can explain why answer missed- corrected.

15 minute break- 10:30- 10:45

Reactive vs. Preventive Management

Prevention is the key to positive management

Set the tone from day One
Establish a Routine
Practice It
Periodically reminding or practicing rules
Giving visual examples of good behavior
Develop rules in collaboration with students (they take ownership)
Develop classroom community
Create a classroom contract with students
Enforce consequences
Try to keep consequences within school/classroom
Be consistent
Rewards???
External
Behavior modification, not always effective
Intrinsic
Works better long term
How do you bring outside community into classroom?
Adult volunteers, open house, Junior Achievement,
Student outreach projects, guest speakers,

Beautification project on grounds, Painting hallway walls (i.e. ecosystems), recycling
How do you develop child's sense of pride in self?
Help children feel part of school/community
Help students see that disrespect to others is a way to lessen their own dignity
Differentiate
Teachable moments to talk with kids- value their ideas in real-life situations
Schedule time for current events- YAK magazine, current concept board

When are issues possibly caused by Teacher?
Technology fails, lesson bombs- prepare enough material, One student gets under your skin, your personality, Positive role model, not testing activities/materials first, Prepare-plan-consider every detail- test, modify, plan more than you think you need, prepare materials, plan more. Organize, prepare roles for students, and define routines, specific procedures, transitions, groupings, materials set up. Class time must be class business time on task. Routines must be established.

Lunch 11:45-12:45

-EECS books arrived

School District Rep Present- Thanked everyone for participating, with uncertainty of situation in school system, you are getting free materials, Professional Development you are being paid to attend, will enrich your classroom. We are in a new day; Accountability is the buzzword- not just a word. PD will be tracked, and implementation in classroom will be measured.
GLCE/curriculum rollout CD available on request.

Review 1st Activity- Handout-Analyze for classroom management styles

High strong agreement scores for # 4, 8, 11= authoritative teaching/management style
#6, 10, 12= laissez faire style
#2, 5, 7 = indifferent style/attitude, No control, lack of updating plans

Reflect on own style- should be a combination of all at different time, be constantly reflective, nurturing growth. (This research also reflects Parenting styles)
Set High expectations, plan and prepare, set up structure and routines from day one.
(On-line resource on handout)

3 Video clips on Classroom Management- Smart Board Display (You-tube videos)

Grade 3 Novice teacher: Attention Class: "Class- Response: yes-yes-yes". "Silly voices". Practice fluoride swish, small group connections. Used physical actions to help students remember abstract rules. High level energy, controlled. Students tell teacher what they like. Respectful, enthusiastic response to children. Children on task. Routines established early on.

H.S. English Teacher introducing students to classroom management system- Keys of Excellence; first week of school. Focus on content, not discipline by using physical keys. Abstract ideas on keys may stay with students as lifelong life-skills. Establish early, be consistent. What questions do you have? In a minute, when I say go, you will…, defined jobs-roles-tasks in each activity. All keys developed on positive attributes.

Cooperative Learning Like inquiry- has mixed research results- depends on how well implemented.

Group Discussion: How do you organize groups, what strategies used to ensure accountability, develop process skills in all students?
Groups I could hear talked about assigning students to specific groups, assigning roles within groups, trying to differentiate learning levels within-among groups (each group has students at each level)

Share with whole class:
Assign students to group, assign tasks within groups, and rotate groups & roles. Try to balance personalities in groups (heterogeneous groups for behavior, personality style, gender, ability, ethnicity- if exists). Each group must assess themselves, keep time log. Mediate with groups as needed.
Handout of strategies: assigning roles for groups of 4: Technician, Facilitator, Recorder, Quality Controller, Reporter

2:10 – 10 minute break

Resource handouts: $0.25 specials at Office Max, free on-line games links

Reference Pages: Classroom Management Don'ts, reminder hints, techniques that backfire

Physical Environment of Classroom
Group discussion to design ideal classroom, then share with larger group for effect of reflecting on ideas to improve own classroom environments by adapting techniques that are possible.
Draw physical classroom on chart paper, share with class.
Interesting to note how adult teachers designated roles within each group, still noticed some people on periphery, or sitting quietly. Some groups made lists first, then drew, other groups made 1st draft on small paper, had one artist, other roles designated, One group had everyone up and drawing on map.

Posters displayed on board- How many of these ideas could you apply to own classroom?
First Group:
Science/ELA/self-contained. Word wall, display area, sink, bookshelves, lab tables, computer stations, demonstration table, teacher area, document camera, space projector, smartboard, carpeted area for reading/ quiet time, separate desks for discipline, student work tables, teacher area.

Second Group:
lockers, desks in groups of 4, reading center, science center, social studies, teacher desk, listening centers, plants, aquarium, windows, smart board, boys & girls lavatory, rolling cart with laptops (technology table- close to teacher's desk), book shelves, carpeted reading area.

Third Group:
u-shaped desk arrangement of individual desks, storage area, reading rug, aquarium, cooperative group tables, 5 computer stations, 6 station writing area, restrooms, white board with LCD projector, DVD/VCR TV, conference room adjacent to classroom.

Fourth Group:
Phone, bulletin boards, rug area- sofa with pillows, bookshelves, many windows, writing center, math center, Listening center, greenhouse with pond & fish, critter area, sink with lab tables, fridge & microwave, laptop cart, wireless internet, smart board, flipdown plasma tv, conference area, storage area

Fifth Group:
Closet (student storage inside class), bookshelves, teacher desk, listening center, outdoor classroom exit, teacher workroom shared with grade partner, math center, cabinets on every wall, student desks in groups, storage area in center, smart board, computer area, wordwall, reading center, laptop cart

Sixth Group:
writing & math center tables (supplies adjacent) smart board, carpeted reading area with beanbags, windows, plants, (a/c unit) Teacher’s desk in cubicle- office area, science center, sink, coat rack, lavatories, laptop at each desk table groups of 4, swivel seats, central printing center

Seventh Group:
restrooms, recycling bins (Go green classroom) Large windows, 2 Terrariums, reading area with seating to look out into terrarium, writing area, library, computer station, desks in groups of 4, slide-out hidden technology LCD flat screen tv-dvd

Entry 3: Friday, July 31, 9:00 a.m. – 3:15p.m.

Educational Resources- Location University Classroom, Presenter- Program Director

Teachers Introduced to District Math/Science Resource Centers- Websites

Only 3 teachers were aware of the location of District resource center, these few were aware that the staff will actually deliver science/math materials to their school.

Teachers took time to explore centers on-line: Lists of resources available.

They will need to visit the center to pick up -EECS kits for next week.

Some confusion because District website published a named high school as center address, (administrative offices), However, actual workshop site is at another location

Hand-Out distributed: Teachers to Search available grant resources, Choose 3 to look at, copy onto word list. These will be compiled into a class data bank for future reference. From their list, they should choose one and put together a proposal for one grant, which will hopefully lead to actual award.

I used Google search, 1,650,000 hits returned.

Several teachers had to be specifically told how to open Word screen, alternate minimize search screen with minimize Word to copy and paste websites from search to save time and effort.

PD director will mention professional organizations later in session, to let them explore.

Some teachers having trouble accessing University wireless- passwords not working.

Various groups displayed differing levels of comfort with accessing on-line resources, and working together to decide on a grant application resource, and on what they were actually trying to fund.

Evaluation Survey

Opinion surveys on this week's workshop were to be distributed, completed, submitted, and grant applications needed to be e-mailed for evaluation. Teachers were given to option to leave early if these tasks were completed.

Entry 4: August 4, 9:00 a.m. – 3:15 p.m.

Project Wild/Aquatic Workshop, Location University Classroom

Presenter- Program Director

Activity I.: Problem Based Learning

Assigned role per table, discussion of situation in groups- Whole group community meeting- debate, argumentation decisions made based on sound argument.

Several roles are county commissioners- need to make argument to advance agenda according to their situation.
Each group prepared their argument during a discussion.
Various groups determined argument early, were discussing personal matters.

Director expressed concern that participant has not attended sessions- would have removed him from program if she knew he would not be present. He is perhaps coming this Thursday (8/6). He did state he would be out of town for most of workshop when I made school visit- I advised him to contact Director to make formal decision. She indicated that she had called him, and he stated he would be present Thursday.

Participant group #1 role: Old Thompson

"County commissioners" asked to bring chairs to front of room, will listen to arguments presented by community members and then make decision based on rational merit. They are running meeting:
Issue: Pleasant Valley – development of a subdivision. Each representative will describe their character role and their point of view on the issue.

1. Snowmobile Association president: argument against because fuel cost will increase for snowmobilers, will displace animals in natural setting, even though it will bring jobs to community.

2. Banker- development will bring loans, investments to area, financial gains for everyone in region.

3. President of Chamber of Commerce- go ahead with project as a way to bring more residents to sustain local businesses. Open land to share with others. Perhaps designate some land to remain natural.

4. Farmers- farm along creek. Would like to buy land, save for rare species of birds and trout in creek, keep zoned for agriculture and forestry, avoid disrupting nature, and conserve resources. This group made signs, made comments out of order, extremely resistant to changes and development.

5. Rancher- owns 800 acre rolling t cattle ranch. Needs to conserve land for cattle grazing

6. Owner of furniture store- wants to conserve land for natural resources. Asks council to develop research team of ecologists to look at the best place to locate development, wants

council to consider using forest area to develop, and give lumber to them at discount to use in furniture manufacturing.

7. Looking at The developers- should consider local developing firm to support local business, instead of outside developers. Reserve land elsewhere for wetlands.

8. Ecology community- what will happen to forest area- when lumber company comes in to use lumber, build and develop land, what restrictions will be made to reforest, control septic systems, runoff into creek, rare species of birds. Consider making area into wildlife preserve, Move development into area already human habitat. “You can’t get no more dirt- once it’s gone, it’s gone.

Open floor Comments:

1. Relocate high-rise away from creek

2. We are still disrupting natural environment with development, and bringing more people in area.

3. Developer concerned that community will face financial ruin because of a few birds and fish. Change is not bad

4. Banker Dislikes idea of high-rise in this area. Individual homes would be more beneficial to local economy that will not ruin view.

5. Farmers/ranchers state that area is not facing financial difficulty

Council asks for any alternate solutions

Ecologist asks if there is a study to determine if present residential zones will support development, if more space is truly needed.

County commissioners briefly meet to make decision: We do appreciate the place we live, we need to encourage new jobs, Need to do research to look at 3 options for development, will table development until best place is determined.

Briefing:

Commissioner decision kind of wishy-washy.
Pro- development argument not very convincing.
Anti-development argument much more reasoned.

How could this activity be adapted to using with students?
Look at neighborhoods, playground development

How could it be adapted to look outside community?
Allow student’s time to research their arguments

Diverse learners?
Explain roles that students can understand

Skills Developed:
Public speaking, communication, research, collaboration, critical thinking, compromise, model of democratic process (civics), organization, preparation for rational argument, modeling appropriate behavior for effective respectful civic participation

10:12- short break, outside activity when we return

Activity 2: Migrating Geese activity: Competition- Loss & Gain of habitat
Using with students- provide background info on migration, habitat before, allow students to suggest organism to model.
Diverse needs- More explanation for adding/removing plates; ask students to choose situation that would increase/decrease habitat.
Talk about wildlife impact on humans (beach closings)

Discussion- Adaptations
Vaccines develop *antibodies*

Antibiotics- kill bacteria

Virus- not living organism (no independent function, no cell), they reproduce using cell structure of host. Flu virus mutate within each host, so human immune response not triggered by same markers, get infected by mutated version of same virus.

Activity 3: Fashion a Fish- Project Wild Aquatic

Handouts distributed- discuss adaptations chosen, then draw fish on chart paper to share.

Adapted Characteristics need to be chosen: Mouth, body shape, coloration, reproduction

The deer crossing activity generated the most creative response from the male participants- cutout of front and behind of deer under crossing.

Participants very engaged in drawing their fish.

Sharing fish:

- Bubba – a big fish. Large duckbilled mouth to grab larger prey, Humpback- stable in fast moving water, and catch prey, horizontal stripes to hide in vegetation from prey and predators (fisherman), floating eggs in HIGH numbers

- Duckbilled, mottled color to hide in rocks, flat belly (near bottom), live bearer to keep them hidden in rocks as well (Participant group)

- Amegalystomaus- Extra-large jaws, vertical disk shape, eggs deposited, hidden on sea floor, may defend nest, dark on top, light on bottom, eats a lot.

- Wio (work it out) Large fish, large jaws to swallow whole prey, torpedo shape, vertical stripes, eggs attached to vegetation

- (Participant group)- Fish of the future, sucker shape mouth, torpedo shape, mottled coloration, hides on bottom when not moving, floating eggs- high numbers
- Striper snapper- sucker-shape mouth, torpedo shape, light-color belly, vertical stripes, live bearer
- Elongated Eddie- sucker shaped mouth- elongated, torpedo shape, lives in salt & fresh water, vertical stripe to hide in vegetation, deposits eggs on bottom and also live young depending on environment
- Veggie fish- duck-billed, large jaws, vertical disk to feed above & below, vertical stripes, flat belly? To develop ability to get food on land, lays eggs attached to plants

Modifications for students:
Use cutouts of features for students to use
Similar to video games
Skills developed: Creativity, teamwork, decision making, appeals to artistic strength in students

Comments/questions

Lunch 12 – 1:00
After lunch- time to work on activity presentations;
Presentations (10 – 15 minutes each)

(Participant Group #1) Comparison- What do Pets/People/Wildlife need to live. Examples of pets and wildlife listed. Then needs for each was listed. (Grand discussion). Exotic animals kept by some families make this more challenging, would need to discuss where most examples of these species live. Learning differentiation: Use pictures, make collages.

(Other Participant Group) Presented typed plan to Director. Created color illustrations from clip art. Posted on board. Everyone Needs a Home. (p. 59) gr k-4.
Major concept: Habitat is composed of many integrated components including food, water, shelter/cover, space and suitable arrangement of these in relation to each other (HN11A1), HN11A: Good habitat is key to survival of humans & wildlife.
Integration: Science, Lang Arts, Environmental Ed
1. Show pictures of habitats, ask “what do these have in common?
2. Ask “What do Habitats need?”
3. Have students draw floor plan of home. Include what is needed for survival. Group provided these as done previously to save time.
4. Ask “how these are similar to animal homes?”
5. Put all floor plans together, and describe neighborhood>community: define.
6. Show pictures of animal habitats again, discuss similarities and differences among the different homes.
7. Select an animal’s habitat and compare it to where they live (Venn diagram and sentences.
8. Then take students outside and look for animal habitats. Write a paragraph to describe how habitat meets the animals’ needs for survival

Group B: Gr 5-8 activity adapted. People depend on plants as a food source directly and indirectly. Diagram on board of food chain segment to assess prior knowledge of energy flow. Dinner mats and plates distributed children directed to list everything they ate for dinner last night on place mat. (One teacher claimed she didn't eat dinner last night) Draw picture of where food item came from on plate, and then draw web to show energy transfer. Suggestion: Choose only one item to draw food web, to show its origin- less confusion. All food should be able to trace back to plants (producer).

Group C- What Bears Go Where? (118) K – 4. Major concepts: building a habitat, different regions. Integration: social studies, ELA, science, art.

Types of North American Bears: polar bear: black bear, brown bear, and polar bear. One teacher read thru background info on bears. Then did pass-read activity from Project Wild text. Vocabulary words listed on board. Students make min-fold books. (Rather complex instructions- teachers having difficulty with directions. Also make word wall with vocabulary. What are major, basic habitat needs of animals? Food, water, shelter, air, space. Students will build a habitat for given bear that includes the major needs for that bear.

Director commented on teacher's conception of time limitations. This group also Gave all information to students, rather than helping students build it themselves.

Plastic Jelly-fish: (Aquatic book).Clean, plastic refuse was collected for activity. Objective- To identify harmful effects of plastic waste on aquatic wildlife. Prepared team chart on board, word chart. Items shown and identified that animals might mistake for food. Students asked which items might cause animals to become entangled. Materials distributed to each table: container of soil, plastic spoon, colored beads, paper towel. Directions- count beads and tally on chart: groups calling colors that were not on prepared chart, more than one person collecting data for chart also confusing. Then directed to pour beads into soil trays, cover with soil to bury. Then, each group directed to recover and count as many beads as possible in 60 seconds-children would have more time. (Per Director: Would have worked better for students to fill in own individual table, then compile as group later). Concluding journal writing about effects of plastic on wildlife, and what they could do to prevent/improve.

Too Close for Comfort (p 300) Negative consequences of people and wildlife in crowded conditions. 2 volunteers-, rest of class asked to predict, in cm, how close 2 volunteers can get before feeling anxious: 3 feet, 12 inches, 30 cm. then students approached until one said she was uncomfortable: 24 cm, 58 cm

Students asked to predict how close they could get to a squirrel- 20 cm,: dog- 20 ft; cat -5 ft. Then asked to describe animal behavior when too close: Squirrel- run, climb, warning noise. Dog- bark, growl, chase, bare teeth. Cat- hiss, run. Volunteers asked to role-play animal behavior. (Show pictures for bilingual students). Causes of animal behavior- injury, protective of homes. Getting too close, mating season. Keep safe distance. Draw life-size outlines of animal, and indicate zone of safe approach.

Objective posted on board. (192) Cartoons and Bumper Stickers. KWL chart: especially political cartoons. Issues affecting natural resources/environment, and how humor and slogans affect our ideas about these issues. Cartoon displayed on screen, copies distributed. Students asked to explicitly describe the ideas conveyed within cartoon. Students would find cartoons in magazines to address some of the issues from activity: group found and provided. Ideas could be assigned to different groups (class mgmt). Students asked to share which cartoons match with specific ideas. Extension- since kids don’t drive, they could use 1.5 inch mounting tape, and design shoe stickers.

First Impressions. Distinguish between reactions to an animal based on myth or stereotype and those based on factual information. Recognize animal’s contributions to ecosystems. (178). PowerPoint- (students asked to choose 1 recorder per group) Recorder will write down group’s emotions conveyed when they look at each picture. 1. 2 kittens, spider, snake, puppies, bat, fish, shark, tiger, raccoons, prairie dog, anteater, slug, kangaroo, seals, whale, hyena, baby chimp. Descriptive words written on board. Then, students asked to tell which animals they related with these descriptive words, record in science journal. Identify benefits of each animal to ecosystem. (Reading material distributed to groups that describes one of the animals- groups was to read, and share their idea of benefit of that animal to ecosystem.

Project Wild Evaluations
Overall Grant Evaluation for Director
Certificates distributed

Entry 5: Thursday, August 6,   9:00 a.m. – 3:15 p.m.

-EECS Energy Workshop, Location- University Classroom

Presenter Certified –EECS Program Trainer

Also County Science Olympiad Regional Director- (grades 6-12; coaches clinic Oct 3-4, $120)
Funding available for regional fees.
Meeting for all County coaches: Oct. 29, 4:30 p.m., Location- local university, FREE

Units designed to be done in one semester, could be done in two weeks, or used selectively.

Energy Use Now & Then (Unit I) Presentation:
-EECS curriculum designed to supplement text with state-specific material- notice text talks about energy in California, or East Coast.
Teacher Participants worked through activities, given suggestions for using in their own class.

Lesson One Energy use survey.
Question asked: Do we answer this as ourselves, or as one of our students would?
Response- answer as yourself- good exercise for adults.
Baby food jars: *Local store* – Inexpensive supplies for science.

4 different phones not turned off, interruptions, one participant tried to bring infant to sessions, was told by Program Director she could not attend today, Someone came picked up baby, then brought back just before lunch- she went out because we heard baby cry out in hallway.

Activity p. 6: Use dried beans/peas, can re-use, kids tend to eat candy.
Counted amount of beans in bucket represents energy (oil) available on earth.
Every 10 seconds, volunteer takes out 1 pea, when someone says “consume”, every 30 seconds, another volunteer comes up and takes out 1 pea when leader says “add”, and this repeats.
Competition develops.
Eventually, all peas will be used up.
ALL of us consume energy.
Correlate activity with survey results. (# People in home, # cars, method of transportation, energy use for cooking, cleaning clothes, home heating, appliances - compared with self, parents, grandparents).
Survey data shown for State, entire USA (good for State Test practice), and residential use, in graphical form. This data compared with population data.
P. 18: My environmental diary- Send home activity- Letter to parents included for children to gather data and learn how to read meter. Kids then read meter over period of days. Then, they can turn on an appliance for a period of time, and read meter before and after use of appliance. Then they answer questions to analyze their data collection.
P. 23: Analysis to decide how personal actions affect family meter reading.

Lesson 2- State’s Energy Resource Mix (Renewable/Non-renewable)
Provided card packet to separate into renewable /non-renewable sources.
This task is among questions asked on State Test; even high school students have difficulty.

2 definitions read, then participants given time to swap any piles. (30 sec)-*No fair looking at Key!*

Renewable- replenish themselves naturally within a human lifespan.

Non-renewable- finite, or take millions of years to replenish.

Each table group asked to share one of their choices for renewable, then repeat process for non-renewable.

Graphical representation of US energy consumption 1635 – 2000.

Lesson 3 Generating State's Electricity

p. 41 – Presenter Advises what she does not do: Make a steam turbine: 1. Steam really hot, she ends up burning herself, 2. set off fire-safety system.

There is a really fun lab to do: p. 49- build a turbine and test it.

Materials mostly junk, except multi-meter, (usually ~$10.00), magnets (plastic coated, from Ward scientific), toilet paper tubes, 22 gauge wire, straws, index tabs, scissors.

Given rudimentary directions- told to play with materials to see what works. (Lots of adult humor, regarding generation of electromagnetic energy thru wire coil).

Classroom Mgmt hint- Students are part of Presenter's Laboratories, do experiments for "classroom cash:, wear lab coats, must wear safety goggles, get performance reviews- class activities simulate professional experience.

Fill in lab sheets- predict and test

Disk includes data, suggested alternative materials/activities for teachers who cannot access these in their classrooms.

Presenter described visit to nuclear reactor, coal plants. May be possible to visit with students for field trip, in future, when security concerns are met.

Locale of state is very industrial, main reason for alternative energy push.

Clean-up before break.

– Program Director distributed material for those participants earning credit for workshop, discussed that she was still unable to contact participant (08/04/10, FN3, 11-15).

Lesson 4 Non-Renewable Energy Choices

Charts in Packet, Use Blue cards and place in appropriate places by description and advantage as a group. Blue cards describe situation that needs to be discussed and categorized.

Distinguish with kids- differences between oil, gasoline, natural gas. Teachers share their responses.

p. 73: Zip code profiler to determine how specific types of energy are generated in specific area, and also emission report. For some reason, Regional state reports are never on line and not publishing testing results.

Lesson 5 Renewable Energy and the State

p. 75 Same kind of card on chart matching situation on chart activity. Groups shared their decisions and discussed. (Advantages, disadvantages, availability of renewable energy resources). Clean up cards.

Close book. Short Quiz on Lessons 1-5- Renewable/ Non-renewable energy sources in State. Answers reviewed together at end of morning session. – Participants read answers together out loud. and reviewed concepts from morning lessons. Some follow up activities (p.87, 84) noted, definitions and keys found in book.

Lunch: Noon – 1:00
Ate lunch with 2 participants, both of whom have undergrad degrees in science content, later certified as teachers, now working on Master's credits. Their school participates in Local robotics program

Lesson 6
p. 109 Energy Conservation and Efficiency
-There is math integrated with these lessons. By going over the material, working with students, they should be able to handle it.
Chart showing Energy use of typical Home Appliance. – Students might need help to tally these and analyze data to calculate how much energy they personally, use.
Next page- Energy Star Label, have students do a search for these at home.
p. 111 list of ways to conserve energy (define conserve with them) - Participants will think of 3 additions to given list, and then share.
Graphical Representation of Sources of Air leaks in home. (Edison will actually come out and do an energy audit.) Kids can learn to caulk, directions included in kit. (p.112)
p. 114- air leak indicator- to do a self-energy audit.
May not have facilities for Enlightening Investigations Lab. Comparison between Compact fluorescent bulb and incandescent bulb temperatures/ energy output. Might need to do as a demo, because middle grade kids always grab hot bulb, and CF bulbs are expensive. (p. 125) explains reasons for differences on graphical chart. Very old wiring may blow CF bulbs- older homes may have difficulty using in light fixtures.

Lesson 7
p. 127 Using a Product's Life Cycle
Kids don't understand cycles. This idea was applied to CD- which many kids understand.
Life cycle of a CD: First activity: self- assessment. Groups will do together.
Basic steps of a life cycle assessment
design
Materials acquisition
Materials processing
Manufacturing
Packaging
Distribution
Use
Re-use/recycling
Disposal

Examples for discussion:
What do we do with clothes- buy, wear, give to charity- throw out.

Soft drink cans/bottles
Newspapers
Packaging material for electronics

CD made of plastic, metals, ink. Non-renewable. To make one, you would need to design, buy machine, actually build it, package it, and sell it, people buy, use, and dispose of. Cards distributed for activity. (Statements on the cards are in the book; Kathy cut them apart and put on cards for convenient use). Use poster to help answer life cycle assessment work page. Discuss answers. Lesson 8 Leaving Smaller Footprints

p. 171 Student difficulties- calculating area of home in square feet, vehicle's fuel efficiency, how much of family food packaged v. bought fresh at market. Then, need computer access: www.myfootprint.org complete as a class, or individually. Go back and change some of the input data to make a comparison of how much power would be used i.e. different country, size of home, location of home, use of land, how energy is used in many places.

Review/summarize concepts covered during workshop. All displayed posters are included in kit. (Photo showing light visible from space, renewable v. non-renewable resources, State electricity generation, Oil production/consumption graph) Remember to Laminate all supplies to re-use! Also, if moving classrooms, schools- take materials with you, especially if you wrote grant to get.

Director returned with forms Outdoor Ed planning form, evaluations.

Entry 6: Friday, August 07, 10:00a.m. - 3:00 p.m.

-EECS Land Use Workshop, Location- University Classroom

Presenters: Certified –EECS Program Trainer and husband

Energy Educator, Husband is civic planner (Township Planning Commission), pioneer wind turbine users, Biomass boiler, school grows soy beans for residential boiler,
Will make copies of anything needed

Participants introduced themselves- describing teaching assignment (school, grade level).

Three participants are H.S. level- resource (special ed) teachers, several teachers unsure of fall assignment due to school closings, restructuring/pink slips. 5 teachers certified or assigned as science teachers (building specialist)

Will pick out pieces of Land-Use booklet, *hands-on*, and will supplement with on-line sites, to focus on, how to address GLCE's using materials (Talked about dichotomy of meeting standards, and using hands-on activities to stimulate real learning)

Land Use is applicable to any grade level

Activity: A Slice of Planet Earth: Apple to represent Earth
5 volunteers needed, to cut into apples while story is read
can be done as a demonstration, or one apple per small group of students
Covers fractions.
apple represents Earth,
slice apple into 1/4ths,
Hold out ¾ th, these represent the water (oceans in the world)
What fraction is left? ¼. This represents all the land on the earth.
Slice this in ½; this represents land that is not usable.
Hold the 1/8 that is left. Slice this into 4 equal pieces.
Hold up one of these = 1/32. The 3/32 are too rocky, too steep, or developed as cities so that is not usable for food growth.
Peel the 1/32, and hold up. This peel represents the part of the earth's crust that is available for growing food around the world. It is less than 5 feet deep, and takes thousands of years to form one inch of this layer.
Eat this peel and state-"If you don't take care of this precious resource, it will be gone."

Aerial Photos shown, try to identify:
Photo shown on screen: Aerial photo of trailer park- labeled letter A, top of electrical substation= B, C= cemetery, D= sewage treatment plant, E= church, F=fields with rolled bales of hay, G = planting pattern of a cereal crop field, H = self-storage units, I= Dam and fish ladder.
Photos available on-line thru University website

Observing Land Use p. 10
Photos taken with camera attached to kite
Same activity as above

One teacher (A) always shares: discussed "Open Court" lesson on urban wildlife. (Other participants grumble- comment about her "brown-nosing")

p. 26- pictures with worksheets

p. 24 Measuring Land Use and Land Cover- designations labeled for photo & sketch

Suggestion to "hit vocabulary hard"

"Planometer" (Planometer) – transparencies in kit

p. 33- Using Planometer

figure what percent of photo is forest- using transparency overlay- use dots to count and calculate

count only dots inside of the line.

Then figure % of water

Can also develop map skills- symbols, also graphing skills- (p. 36)

p. 46 -47 Classifying Land Use-

Interpreting graphical data: using measuring stick

Paper provided so that kit provided measuring stick can be used for duplicating in class, along with crayon for colorful representation

Think about how this might be applied to grade level you teach, is it worthwhile, what skills & concepts will students develop thru this activity?

Hint: Do activity first to gauge how much time students will take to complete

p. 49 match photos with land use

Technology difficulty to try to play CD

Kit reading and discussion

Use of Google Earth Map

Discussion of how things are used

Using local produce

A talked about CSA's- comment from other participants: "the talker has spoken"

Other participants talked about growing in own back yard.

Farmer's market- most locally grown in Urban garden in local city *(A said it's called Agricultural Urban Gardening Network)*

Presenter stated that many grants available to start school garden, also legislation to use MI grown produce in school lunch programs

A says district won't allow home grown produce to be used in school due to contract

Lunch time: noon – 1:00

Potluck buffet, gift for PD director

Marie, teaches science k-3 as specialist at her elementary – prefers lower el, wishes upper el science teacher had been part of program, described as being very old school, makes her feel that some of her effort goes to waste

Presenter- invitation for participants to visit their School System:
Wind turbine field, solar array, superintendent’s home owned & operated by school system, biodiesel fuel system, biomass boiler, waiting to purchase new buses- EPA/fuel efficient compliant
Describes “KidWind”- pvc turbine kits, built by kids, hooked to “logger pro” sensor device to test efficiency, power output, wobble, etc., develops enthusiasm in kids
Biomass- corn, sugar-beet pellets, wheat sprout – seed that has sprouted, “muck” form lake- being collected, dried into fuel pellets
Tours available, hands-on science lab for visiting groups, hoping to develop “green” career technical center programs
Described conversation with kindergartner about noticing rain water, and suggesting it be collected for use on plants
Discussed how farm subsidies are used because American farmers need to compete with foreign growers
Suggested having speaker come in to discuss land use from civil planning commission
Presenter explained what Master plan for county jurisdiction is, and how it is developed, and how zoning ordinances are derived. *(A digressed about why Canada has more wind farms visible)*
Turbines average income generated $10,000 per year (per turbine) leased for 20 years on signed contract, which is useful for collateral, adding to sale value. Land use must be rural/agricultural- future use is likely not to be urban/residential development.
Land use is a very personal issue, Commercial energy provider planning multimillion dollar project to develop wind-farm

Copies available of: web links, land use jeopardy game, land use-opoly, Apple earth activity

Lesson 5: Agricultural lands
Table shows less land used for agricultural use. Discuss with students reasons
Students can construct graph of this data.
Look at same data for industry to compare- process skills and critical thinking development
p. 86 Table of urban, built-up land use; shows increase, graph- again develops measurement, graphing, comparison, drawing conclusions etc.
discussed website for ecological footprint

Teachers beginning to get restless, some quiet talking, lots of getting up and taking individual breaks, drooping eyelids, bobbing heads.

Lesson 6 County Land Use Data
Tables showing data by counties, use for comparison, population patterns, economic ideas
p. 102- have students graph changes over 4 years, extrapolate trends
p. 103-105 Data from specific areas, again look for changes over time in these areas
p. 106- Extension activities- compare 2 communities, extrapolate data
p. 116-117 Pictorial map representation of land use in counties (forested, developed, rural)
Participant question- wants a definition of what “forested land” means
Presenter offers list of grant resource websites: (State)gal, grants.gov, State energy office

Lesson 7 Resolving Conflicts in Land Use
p. 127 Case of parking spaces – role playing activity (Problem based learning)
very similar to Project Wild activity
p. 134 Questions to answer about role-play activity to analyze elements of conflicts, discusses core democratic values
2:15- undertone of talking becoming widespread

Lesson 8 Land-opoly Game
website available (State University)- google land-opoly, university site pops up:
develop land use decision making skills
each decision card gives situation, tells how many spaces to move- indicates good/bad choice made
Look at questions

Additional Activity: State Trivia Jeopardy- set up to put on ppt, 10 different games with variety of questions about conservation, land use
Website for “Land Policy Institute”- source of jeopardy questions

Entry 7: Tuesday, September 22, 5:00 – 7:30 p.m.

Earth Space Science Course, Class Meeting 3
Instructor University Faculty, Location University Classroom

Homework from last week: (Scavenger Hunt) Given 5 “geo cards”, students were to bring 5 small items (or photos of) from home that originated from earth- and describe where they came from: mineral, plant, animal product.
Students had a variety of materials including jewelry, everyday objects like pencils, pens, cook pots, one person brought in horseshoe, hay, horse hair; paper, match (wood, magnesium, sulfur), chalk, condiment spices, (salt), petroleum jelly, spoons. Talked and discussed each other’s’ choices for display.

As students arrived, they were to put their items on display, look at others’ collections, and sign-in with instructor.

Program Director stopped in to discuss adding students to class list through *course management system* (with instructor), so that they can access internet and other University resources.
One student shared her opinion of having class on no-credit/stipend basis, without access to internet, and other benefits of off campus access. She weighed credit hours for coursework that might not have relevance to her degree or planned program with stipend- immediate payment gratification, she now somewhat regrets not taking the class for credit.

Instructor brought a sample of edible amber insects (gelatin encased gummy insect).
Class officially began with discussion of homework assignment- what did class think? Level of difficulty? Only a few students volunteered response.
Plastics = petroleum product, which are mined.
What is human impact on earth materials?
What did we do before Plastics? How did we bring meat home? (In paper tied with string)
Milk – in glass bottles, (Milk chutes on houses)
How many times do you eat out? 5 times or less/month?
(A is still at it- interjecting with every question, Jonel & Amy, at another table, made faces)

Instructor comment: How are computers discarded? Sent to 3rd world countries and burned.
Computers made with rare earth metals- Many of these mined in China, China has stated limits on amount of these they will continue to export.

Many materials radioactive- fiesta ware, smoke detectors.
Students were given plastic spoon coated with material last week, asked to observe: When asked what they found out: 4 responses- used a microscope, put water in it, vinegar, and sank to bottom in alcohol. Substance was “silly sand”, glued to plastic spoon. This sand has property of hydrophobic.
Attendance updated, and then students asked to look over the collections and make observations in table form. They were asked to look for themes of types of materials. There were lots of interpretations of assignments.

Students discussed a number of things besides the assignment- sitting at their tables (black widow spider found in grapes, day's events at school, etc…), 3 students walked to back of classroom and conducted cell phone conversation.

Follow up Instructor lead discussion: Pennies not actually made of copper: now zinc composite. Can look at different years of pennies, and graph the mass of pennies of different years, to show how their composition has changed. Pencil leads are made of graphite.
What happens if we run out of petroleum? No new manufactured plastics.
Nail polish is made of coal, fish scales in lipstick; whitewash in toothpaste, carmine red dye is made of ground beetle shells. Lots of spices are mineral, not just plant product: salt, alum, turmeric.
Where do we put radioactive waste? NIMBY: Yucca Mountain.

Major generational difference in general knowledge between our students and the teachers in the workshop. Their life experiences seem limited to digital experience. Everything comes from the store- they have no concept of origins of these items.
We need to find ways to teach problem solving skills, knowledge- we may need to integrate and blend subjects in science to reach standards/objectives (AYP/NCLB nonsense).

Activity:
Cookie Mining
Teacher has cookie mining money (each person gets $19) You will pay $3 for a cookie, graph paper, instructions. Available Tools: paper clip, coffee stirrer, toothpick, prices are listed.
Shows how everything is connected- integrates with Math

Class seems teacher talk centered. Sharing encouraged, but activity is shown having a definitive procedure.
Two identical sheets of paper, one made into cylinder lengthwise, and the other widthwise.
Question: Which holds more volume?
Process skills are scientific. Teachers need to provide opportunities for students to practice these process skills.

Next activity- fossil activity found in calendar distributed during first class session.
Materials included 3 slices bread, pile of multi-colored goldfish crackers, 2 Swedish fish.
place fish in between bread slices, add pressure, fish leaves imprint in bread.

Next week: Coal flowers
End of class: variety of word search, crossword puzzles, article from Kappan, Activity: What's Mined is yours. What would the world be like without minerals?
If they can eat it, they will do it.

Discussion with Instructor- Impressions:

Instructor ran a teacher centered class, inquiry activities were presented by direct instruction- mostly as activities that could be taken as is and used in the teacher's classrooms. Little reflection or theoretical discussion took place. Did not hear much student input except for singular questions or comments directed at something the instructor introduced. Activities performed in cooperative groups, but no method for collective reflection was noted. The instructor made comments to summarize, but students had little input- not much opportunity for reflection on science content, reasons for particular methods (pedagogical theory not really addressed). Final exam is planned; instructor said it is to be “authentic assessment” of process/content covered within the course, not a multiple choice type exam. No study guide provided.

Entry 8: Tuesday, November 17, 5:00 – 7:30 p.m.

Earth Space Science Course, Class Meeting 11
Instructor University Faculty, Location University Classroom

Misconception Presentations- last week
Written work handed back with peer suggestion comments and instructor feedback. Peer suggestions helpful to share ideas with others, some people a little critical.

A private universe- (website) lists Harvard Grad misconceptions. It is very difficult to change misconceptions.
"Stop Faking It" Series for science teachers

Teacher D presented tonight because last week administration "cleaned classroom" to prevent loss of materials. Related story of being a "collector", administration required clean-up, did later when she was on field trip.
"Size of the sun"- looked at misconceptions, on line. Shared Pre-conception inventory- significant number of students thought earth bigger than the sun. It just "*appears*" smaller because it is farther away. She noted need to verify on-line sources when looking for resources. Instructor requires vetted sites for student work- not Wikipedia. Teacher's job is to teach critical thinking which includes ability to evaluate resources.

Today's activities:
Handouts on children's books with science errors. Many misconceptions in media, movies, books.
Lunar phases info.
Time line
Activities on raindrops (3 presentations from last week)
Pressure activity: balloon, nail, board; force per unit area= high heels: Volunteers: take turns to break balloon.
Interactive activity. From Exploratorium: *Iron Science Teacher*: given materials, create as many activities with materials as possible within given time frame.
Discussed *MythBusters* as a science resource.
Life After People Series
United Streaming- Discovery Education resource

Note on Board: Pick up your -EEC materials: Address of District Math/Science Center provided

Sharing Activity: Each table come up with ideal Earth Science Lesson, and then share ideas with larger group.

1. Recycle, Reuse, and Reduce: 3 prongs of use, show video, look at how long it takes garbage to decompose. Make items from recycled paper/materials. Benefits behind reusing. How are recycled materials classified? Conservation and use of natural resources.

2. Sediment, Glaciers, Fossils, Erosion, Geological Time- Timeline. Students find rocks outside, classify

3. Food waste analysis in lunchroom. Arts N Scraps- great resource for recycled materials
4. Growing own plant, label parts of plant, *Tops and Bottoms* resource book: how we use plants.
5. Tectonic plates using Milky Way candy bars: cut thru candy bar to see layers in crust, then smash together to see how landforms are created. Label diagram with parts. Identify ring of fire, put together Pangea.
6. Types of rocks. KWL/KNL identify student knowledge. Groups given rock samples, sort using graphic organizer, compare & contrast types of rocks, peer evaluation of sorting, teacher evaluation (assessment: students explain sorting, see if done correctly).
7. Rock cycle: KWL/KNL, students identify questions, how rocks formed, how changed. Food models for types of rock, compression, erosion, rock cycle. Fill in rock cycle in proper order- graphic organizer.(Used cream cheese instead of peanut butter)
8. Water quality. KNL/KWL. Compare water samples. Draw & label observations, look for organisms. Visit water treatment plant. Research water borne diseases.

Teacher E- misconception presentation (missed last week). Does Air take up space? Included handout with activities to demonstrate correction.

Entry 8: Tuesday, October 20, 5:00 – 7:30 p.m.

Earth Space Science Course, Class Meeting 7, Instructor: University Faculty, Location: University Classroom

Beginning- games assignments left in car, along with tonight's planned activity

Discussion of Saturday's regional professional conference at local university- grants, rock shop, ideas $55 registration fee, ($35 student rate) Just follow directions for grant proposals

(25 teachers present).

The King of Tides Web Quest activity- discussed web quest: PBL task

Excerpt from Weather coloring books: *Billy & Maria learn about Winter Weather*, *Billy & Maria visit the NWS.* (NWS online resource) Coloring works really well to introduce topic, reinforce ideas & concepts

Today's activity: competition- prize will be brought next week.

Challenge for teachers: completing and reporting on experiments. A good way to share & compare data

Mini board to be completed: tools, expectations. Everybody does same experiments follow up with discussion of variables, controls, model of a true experiment Enough materials for 8 groups from resource:

Shubkagel, J.F. (1993). *Show me how to write an experimental science fair paper: a fill-in-the-blank handbook*. Independence, MO: Show Me How Publications.

About 5 teachers MUST participate in science fair- students not really enthused,

2 teachers participate who don't have to.

Instructor commented on poor quality of most projects judged last year: duplicate projects, lack of evidence, poor topic choices. Also discussed *Exploravision* national competition- electronic submission (Web design)

Discussion of experimental design: What happens when you put an ant in the microwave?- not enough water in ant- nothing appears to happen. What happens when you put Ivory soap in microwave? Billows up , 99% water. LG contributed with her daughter's participation in school science fair- testing paper towels for strength

Teachers looked at instructions, Wrote out the given problem/question that they could use the available materials to answer, made a hypothesis, listed procedures they used to test their hypothesis, conducted experimental tests, recorded data, and put together a mini-board on a file folder to report on their evidence. Teacher groups were very engaged in the inquiry activity, and seemed to self-select roles: experimenter, leader (reader), recorder, data collector, etc… More guidance on how to apply these ideas with specific methods might have been appropriate, especially for lower grade teachers. Activities seemed to have been completed rather quickly, board construction took a little longer, but discussions seemed to be off task, for the most part after the initial activities were finished.

Display boards are well done. Lots of variation between each group's boards. Creative approaches to titles (De Plane De Plane, A Clip too far; I Believe I can fly) One group modified the question to ask whether the material constructing the plane made a difference in flight distance. Experiments do not need to be complicated to teach experimental methods & design.

Discussion: Went through a process in the past hour, now you have a model of science project.

Wendy took 2/3 grade to Westview apple orchard (State curriculum approved field trip), tractor ride out to orchard, picked apples, toured cider mill, had donuts & cider, lunch outside, each child brought back bag of apples and a pumpkin ($9 per child). Used *Target* field trip grant.

B teaches science to lower el all morning, and then has 7^{th}/8^{th} grade "study hall" at end of day. Her self-contained 3^{rd} grade was reassigned to a building sub that was certified bilingual. Other teachers told her to file grievance. She was looking for ideas for the 7^{th} graders to do: Teacher C suggested an engineering workshop. She was eager for ideas, when C gave her some ideas: Spaghetti Bridge, balloon-paper rocket sleds, 2liter air pressure rockets- she seemed a little unsure of how to conduct these, and of the procedural and science concepts to do them.

Teachers are getting a lot of "practical" activities that they can take into their class, but I'm not seeing much scientific content knowledge being transferred. There doesn't seem to be a systematic plan or defined content outline in practice. The weather activity that was planned was re-scheduled for next week. Last week's activity was a reflective project to construct a game, and then evaluate games that classmates constructed. Science Process skills seem to be addressed, and some general ideas about the "nature of science", but the "nitty-gritty on basic earth/space science concepts has not really been covered while I observed. The first class I observed on 9/22 did address matter, and how natural resources are the basis for all the products we use. Syllabus consists of list of activities, not themed content topics.

Entry 9: Tuesday, November 17, 5:00 – 7:30 p.m.

Earth Space Science Course, Class Meeting 7,
Instructor: University Faculty, Location: University Classroom

Misconception Presentations- last week
Written work handed back with peer suggestion comments and instructor feedback. Peer suggestions helpful to share ideas with others, some people a little critical.
A private universe- (website) lists Harvard Grad misconceptions. It is very difficult to change misconceptions.
"Stop Faking It" Series for science teachers

Teacher N presented tonight because last week administration "cleaned classroom" to prevent loss of materials. Related story of being a "collector", administration required clean-up, did later when she was on field trip. "Size of the sun"- looked at misconceptions, on line. Shared Pre-conception inventory- significant number of students thought earth bigger than the sun. It just "*appears*" smaller because it is farther away. She noted need to verify on-line sources when looking for resources.
Instructor requires vetted sites for student work- not Wikipedia. Teacher's job is to teach critical thinking which includes ability to evaluate resources.

Today:
Handouts on children's books with science errors. Many misconceptions in media, movies, books.
Lunar phases info.
Time line

Activities on raindrops (3 presentations from last week)

Pressure activity: balloon, nail, board; force per unit area= high heels: Volunteers: take turns to break balloon.

Interactive activity. From Exploratorium: *Iron Science Teacher:* given materials, create as many activities with materials as possible within given time frame.
Discussed *MythBusters* as a science resource.
Life After People Series

United Streaming- Discovery Education resource

Note on Board: Pick up your -EEC materials: Address & contact for district math/science center

Sharing Activity: Each table come up with ideal Earth Science Lesson, and then shared ideas with larger group.

1. Recycle, Reuse, Reduce: 3 prongs of use, show video, look at how long it takes garbage to decompose. Make items from recycled paper/materials. Benefits behind reusing. How are recycled materials classified? Conservation and use of natural resources.

2. Sediment, Glaciers, Fossils, Erosion, Geological Time- Timeline. Students find rocks outside, classify
3. Food waste analysis in lunchroom. Arts N Scraps- great resource for recycled materials
4. Growing own plant, label parts of plant, *Tops and Bottoms* resource book: how we use plants.
5. Tectonic plates using Milky Way candy bars: cut thru candy bar to see layers in crust, then smash together to see how landforms are created. Label diagram with parts. Identify ring of fire, put together Pangea.
6. Types of rocks. KWL/KNL identify student knowledge. Groups given rock samples, sort using graphic organizer, compare & contrast types of rocks, peer evaluation of sorting, teacher evaluation (assessment: students explain sorting, see if done correctly).
7. Rock cycle: KWL/KNL, students identify questions, how rocks formed, how changed. Food models for types of rock, compression, erosion, rock cycle. Fill in rock cycle in proper order- graphic organizer.(Used cream cheese instead of peanut butter)
8. Water quality. KNL/KWL. Compare water samples. Draw & label observations, look for organisms. Visit water treatment plant. Research water borne diseases.

Teacher S presented misconception presentation (missed last week). Does Air take up space? Included handout with activities to demonstrate correction.

Entry 10: Action Research Seminar Observations

Saturday, June 19, 9:00 a.m. – 1:30 p.m.
Location: University Classroom, Instructor: PD Program Director

Announcements by School District Representative: Please save designs for Outdoor Classrooms for 20th anniversary of local gardening organization's displays. She is retiring at the end of the school year.

Group Presentations for Action Research

- Provides Agency for Teachers
- Inquiry in Action

1. How Student Organization & Study Skills Affect Academic Performance

Two teachers in group presenting, from two schools. Study targeted classes in grades 4 & 5.
Problem/Issue: Students demonstrated lack of organization/study skills by late/missing work, observations by teachers.
Question: Will improved study habits affect-effect academic performance?
Lit. Review: Surveyed possible solutions/strategies for teacher intervention, routines for students
Purpose: Create systems/process to promote student organization.
Site A- 30 fifth graders, 60% female, 40% male, magnet language immersion school
Site B- 44 fourth graders traditional elementary school
Procedures: 5 week program- pre/post treatment survey
Treatment: Direct instruction of organization skills, note-taking, text function & structure, listening skills.
Results: Not what was expected
No change in organization skills seen. Possibly end-of-year timing of treatment affected results,
No significant change in academic grades. Some small improvements i.e. when to start studying for test, putting date on paper.
Conclusion: Systemic process over course of year must be repeated.

2. How Can Student Attendance Be Increased?

Five teachers in group presenting, from two schools.
Problem/Issue: Student Attendance caused failure to make AYP.
Questions: Will Rewards Increase Student Attendance? How Can Schools Motivate Parents to Bring/Send Children to School?
Lit Review: National Problem, rewards recommended, poor attendance leads to future social problems. Looked at school history for 3 prior years.
Purpose: Increase Attendance, especially on Fridays, with early dismissal, and scheduled ½ days which have start time at 7:30 a.m. in contrast with regular school days starting at 9: 00 a.m.
Procedures: Setting 1100 students in 2 buildings, Prekindergarten – grade 6. 96% African American. Random sampled 2 classes to pilot, then randomly sampled 15 classes for data, used interviews and survey parent reasons for absences. Treatment plan was to issue raffle tickets to

students for prizes, a class store only open on Fridays, individual teachers assigning points for attendance, and special recognition. Limitations were the duration of program, implementation did not start until the end of May, and also, not all teachers in both buildings were involved.

Conclusion: Administration needs to contact the district director for policy to discuss adjusting start times and ½ day scheduling, Treatment needs to involve entire school, and be implemented systemically all year.

3. Effects of Classroom Management Strategies on Behavior of Elementary Students

Presented by teacher B. Study targeted second grade class.

Problem/Issue: Children shouting in Arabic and Spanish, interpreting instructions to one another, out of seats, delays start of class.

Lit. Review: Characteristics of good classroom management, scaffold instruction with English language learners, use visual aids, vocabulary previews, peer tutoring.

Purpose: Changing classroom management strategies to affect student behavior for this traveling teacher.

Procedures: Tallied behaviors for week prior to treatment and 4 weeks after. Treatment plan: begin class with board work, earn a class party for participation, use more visual aids, scaffold English language learners, positive expectations, not talking above noise, not repeating, changed teacher attitude to calmness.

Results: Intervention strategies had positive effect.

4. Exploration of Parental Involvement in Three Urban Elementary Schools

Presented by four teachers from three schools.

Problem: Decline of parent participation.

Question: How do we Create Relationships Between School and Home?

Lit Review: 3 factors according to state department of Ed. For parent involvement, Epstein's 6 types of parent involvement, 7 steps to implement, issue invitations.

Purpose: Determine ways to increase parental involvement to form a community.

Procedures: Three schools with 45 teachers, using 4 classrooms, 124 parents, 200+ students. Pre-treatment survey assessed teachers' parents', and students' perspectives of parent involvement. Implemented strategies based on survey results.

Results: Very few volunteers, parent attendance at parent/teacher conferences varied.

Conclusions: Treatment needs to begin at start of school year, create avenue for direction, communicate expectations, and provide intrinsic motivation.

5. Higher Return Rate on Homework

Presented by teacher H.

Problem: Many student not turning in homework, many students repeat offenders.

Questions: How do I motivate students to complete and submit homework? Is assigned homework pertinent to class study?

Purpose: Determine ways to increase homework submission.

Lit. Review: 1986 study showed low-middle level students do benefit from Homework. 1994 report showed positive correlation between homework and academic performance. 2006 training

parents to be involved leads to higher completion rates.
Procedures: Questionnaire, observed results, followed by letter to parents.
Result: All parents returned letter.
Conclusion: Need to begin process at start of school year.

6. Middle School Behavior Management Plan

Presented by two teachers from one k-6 building.
Problem: Students don’t follow teachers’ rules, students physically and verbally abusive; endanger safety, no fear of consequences. No whole school program in place.
Question: What effects do discipline strategies have on student behavior?
Purpose: Private Christian school transitioned to charter school management this school year, goal to institute a whole school discipline and behavior management program.
Lit Review: Harry Wong’s procedures, KIPP system.
Procedures: Fifth and sixth grade classes, 32 boys, 23 girls. Pre/post intervention teacher surveys and discipline detention/suspension records. Checklist of student behaviors.
Results: Detentions increased. Not much change in behaviors, but consequences are consistently applied.
Conclusions: Detentions increased due to consistent enforcement. Teachers want to be more positive for upcoming school year, individual commitment to change own practice based on research, will try positive methods rather than punishments.

7. Improving Comprehension of Informational Text Through Instructive Intervention

Presented by Teacher A.
Problem: Students’ difficulty comprehending informational texts.
Questions: Do strategies improve comprehension scores for informational text?
Purpose: To increase scores on district reading comprehension tests.
Lit Review: Graphic Organizer strategies, state department of education
Procedures: #0 third grade students, 12 boys, 13 girls, diverse ethnicity. District curriculum and mid-study DIBEL assessments- Pre/post intervention strategies
Conclusion: Explicit instruction which scaffolds learning will improve reading comprehension scores.

8. Classroom Management for Team (Together Everyone Achieves More)

Presented by Teacher N.
Problem/Issue: Learning time lost to behavior management issues, number of disruptions to learning time. Because of transient population, every week there are first days of school.
Purpose: Reduce disruptions to learning time.
Lit Review: Harry Wong, *First Days of School*, “Its’ your problem to fix your problem- students need to self-manage”. Love & Logic, *Tools for Teaching Beyond Discipline*. Haim Ginott, “I make the weather in my classroom.”

Results: Improving transition time, self-directed individual student behaviors, fewer disruptions the ongoing goal.

Entry 11: Action Research Seminar Observation
Tuesday, June 22, 4:30 p.m. – 7:45 p.m.
Location: University Conference Room, Instructor: PD Program Director

9. The Impact of Incentives on Student Attendance

Presented by Amy, Fran, Jonel, and Marie. Researcher was provided with copies of the presentation and report for this research project.

Problem/Issue: poor and inconsistent student attendance negatively affected overall performance on state assessments, which resulted in the school not meeting the requirements for Adequate Yearly Progress (AYP).

Purpose: Increase student attendance, and overall performance on state assessments, improve rating for AYP.

Questions: Will incentive and reward programs influence students to come to school more often? Will our school attendance percentage increase as a result of these programs?

Lit Review: Several articles from professional and scholarly journals on the topic of strategies for increasing student attendance.

Procedures: They collected data from the whole school population of kindergarten through fifth graders, two special education classes, and also from the results of an initial survey distributed to the parents of their students. Initial surveys were used to gauge student attitudes toward attending school, and get insight on why students and parents found it necessary to miss school. Based on the survey data, administration adopted an alternative to using exclusion or suspension from school as a disciplinary measure, and arranged to collect some gently used clothing items to eliminate the issue of missing school due to not having a clean uniform. They designed an incentive program for teachers to distribute “attendance bucks” for daily attendance. Students were able to spend those in the school’s attendance store each month on snacks, school materials, and small toys. Students were able to earn awards for daily attendance from each teacher. The principal awarded students with one hundred percent attendance each week. Students attending on a half day could participate in a pizza party with the principal.

Results: The school’s monthly attendance improved an average of 8% from the previous year. The limitations to their study were that they were not able to begin the incentive program early enough in the year to make AYP; the teachers used their own money to stock the merchandise in the store because of district budget constraints; and finally, there was no designated permanent space for the store.

Conclusions: Start the procedures at the beginning of the school year, implement all year.

Entry 12: Individual Presentations of Electronic Portfolios

Monday, June 28, 4:30 – 7:30 p.m.
Location: PD Director's University Office Instructor: PD Program Director

Presenters: Amy, Fran, Jonel, and Marie.
Wendy, Lauren, and Maddy attended but did not present.
Portfolios contained Lesson plans, photographs of their classroom and student work, video clips, and written reflection demonstrating how they put inquiry into practice in their classrooms.
Limited access to portfolios and contained documents was granted by the participants.

APPENDIX J CLASSROOM OBSERVATION RATINGS SUMMARY FROM OBSERVATION PROTOCCOL

Observer rated each descriptor from the Classroom Observation Protocol (Appendix B) on a 5-point scale, 0 = not observed, 4 = characterized the lesson.

		Descriptor number											
Name	visit	1	2	3	4	5	6	7	8	9	10	11	12
Jonel	**1**	2	2	3	2	3	4	2	3	4	0	1	1
	2	4	4	4	4	4	4	0	1	4	3	2	3
Wendy	**1**	0	4	4	3	4	3	0	4	4	1	2	2
	2	1	4	4	4	4	4	4	4	2	4	4	2
	3	2	3	4	1	3	1	2	1	4	4	3	1
Lauren	**1**	3	4	4	4	4	3	3	4	4	4	2	0
	2	4	4	4	4	4	4	4	4	4	4	4	1
Fran	**1**	4	4	4	4	4	4	2	4	4	3	3	3
	2	4	4	4	4	4	4	4	4	4	4	4	4
	3	2	4	2	2	3	3	1	3	4	0	1	1
Maddy	**1**	0	0	0	0	0	0	0	0	0	0	0	0
	2	2	4	4	4	4	4	4	3	4	1	3	2
	3	1	3	2	3	3	2	1	2	4	0	2	0
Amy	**1**	3	4	4	2	4	4	1	2	2	4	4	0
	2	0	2	2	1	3	0	0	4	3	2	2	0

	3	0	2	3	1	1	1	0	2	3	0	3	2
Marie	**1**	4	4	4	1	4	4	0	4	3	4	4	4
	2	1	1	0	0	1	1	0	4	2	2	2	2

Descriptors with Ratings Scale from Observation Protocol (Appendix B)

Observer rated each descriptor from the Classroom Observation Protocol (Appendix B) on a 5-point scale, 0 = not observed, 4 = characterized the lesson.

1. This lesson encouraged students to seek and value various modes of investigation or problem solving. (Focus: Habits of Mind)

2. Teacher encouraged students to be reflective about their learning. (Focus: Metacognition – students' thinking about their own thinking)

3. Interactions reflected collaborative working relationships and productive discourse among students and between teacher/instructor and students. (Focus: Student discourse and collaboration)

4. Intellectual rigor, constructive criticism, and the challenging of ideas were valued. (Focus: Rigorously challenged ideas)

5. The instructional strategies and activities probed students' existing knowledge and preconceptions. (Focus: Student preconceptions and misconceptions)

6. The lesson promoted strongly coherent conceptual understanding in the context of clear learning goals. (Focus: Conceptual thinking)

7. Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence. (Focus: Divergent thinking)

8. Appropriate connections were made between content and other curricular areas. (Focus: Interdisciplinary connections)

9. The teacher/instructor had a solid grasp of the subject matter content and how to

teach it. (Focus: Pedagogical content knowledge)

10. The teacher/instructor used a variety of means to represent concepts. (Focus: Multiple representations of concepts)

11. The teacher/instructor used a variety of means to assess student understanding of the concept(s) and/or skills. (Focus: evaluation)

12. The teacher/instructor integrated technology to facilitate instruction and student learning. (Focus: evaluation)

APPENDIX K: RESEARCH INFORMED CONSENT

Purpose

You are being asked to be in a research study examining the effectiveness of the project -------, because you are an elementary teacher in --Public Schools, teaching 3rd or 4th grade in a self-contained classroom and you do not possess a major or minor in science. The project is supported by a grant from the --Department of Education and is being conducted at - University. The estimated number of study participants to be enrolled at --University is about 30. **Please read this form and ask any questions you may have before agreeing to be in the study.**

In this research study, 30 -PS elementary teachers, who do not possess a major or minor in science and who are teaching 3rd or 4th graders in self-contained classrooms, will participate in a series of professional development activities intended to increase their science content and pedagogical knowledge. The professional activities include: (1) two weeks of workshops; (2) an earth/space science course and (3) additional workshops. The purpose of the study is to examine the effectiveness of these activities on the teachers' practice.

Study Procedures

If you agree to take part in this research study, you will be asked to participate in the professional development activities and the evaluation that will be used to determine whether or not these activities positively impacted your practice. First, you will be asked to attend a two-hour orientation session where you will be asked to fill out the attached survey. Then you will attend two weeks of workshops. After that you will enroll in a 3-credit hour earth/space course and in the following semester will attend a series of workshops on the use of action research in teaching. At the end of this final semester, you will be asked to fill out the survey again.

Classroom observations of your teaching will also take place. There will be 3 classroom observations, one at the beginning of the study, one in the middle, and one at the end. The classroom observations will be 50-60 minutes each. The classroom observations are intended to determine if participating in the professional activities influences your teaching: (1) the type of science activities you use with your students; (2) whether or not you integrate inquiry in your teaching; (3) whether or not you integrate technology in your lessons; and (4) any changes in the types of assessment you use.

Your personal identity and that of your school will be protected. We will use a number or name code for you and your school and only such code will be used in the data.

Benefits

There may be no direct benefits for you; however, information from this study may benefit other people now or in the future. The possible benefits to you for taking part in this research study are an increase in your science and pedagogical knowledge resulting from your participation in the professional development activities. This in turn might result in greater motivation and learning in your students. Research shows that students of good teachers are more motivated to learn and are less likely to drop out of school and as a result have a greater chance of becoming positive contributors to society.

Additionally, information from this study may benefit other teachers and lead to additional professional development opportunities for teachers in -Public Schools.

Risks

There are no known risks at this time to participation in this study.

Study Costs

Participation in this study will be of no cost to you.

Compensation

For taking part in this research study, you will be paid for your time and inconvenience. You will receive a $1,800.00 stipend as follows: $500.00 for each week of workshops, and $800.00 for the workshops during the final semester. You will also receive free tuition and fees for the 3-credit hour earth/space science course.

Please note that if you are not a U.S. citizen and/or a U.S. tax payer 30% of the compensation will be withheld by --- before the check is disbursed.

Confidentiality

All information collected about you during the course of this study will be kept confidential to the extent permitted by law. You will be identified in the research records by a code name or number. Information that identifies you personally will not be released without your written permission. However, the study sponsor, the Human Investigation Committee (HIC) at --University, or federal agencies with appropriate regulatory oversight [e.g., Food and Drug Administration (FDA), Office for Human Research Protections (OHRP), Office of Civil Rights (OCR), etc.) may review your records.

When the results of this research are published or discussed in conferences, no information will be included that would reveal your identity.

Voluntary Participation/Withdrawal

Taking part in this study is voluntary. You have the right to choose not to take part in this study. You are free to only answer questions that you want to answer. You are free to withdraw from participation in this study at any time. Your decisions will not change any present or future relationship with --University or its affiliates, or other services you are entitled to receive.

The PI may stop your participation in this study without your consent. The PI will make the decision and let you know if it is not possible for you to continue. The decision that is made is to protect your health and safety, or because you did not follow the instructions to take part in the study

Questions

If you have any questions about this study now or in the future, you may contact ---or one of her research team members at the following phone number ----. If you have questions or concerns about your rights as a research participant, the Chair of the Human Investigation Committee can be contacted at --- If you are unable to contact the research staff, or if you want to talk to someone other than the research staff, you may also call ---- to ask questions or voice concerns or complaints.

Consent to Participate in a Research Study

To voluntarily agree to take part in this study, you must sign on the line below. If you choose to take part in this study you may withdraw at any time. You are not giving up any of your legal rights by signing this form. Your signature below indicates that you have read, or had read to you, this entire consent form, including the risks and benefits, and have had all of your questions answered. You will be given a copy of this consent form.

_______________________________________ ________

Signature of participant Date

_______________________________________ ________

Printed name of participant Time

Signature of person obtaining consent Date

Printed name of person obtaining consent Time

REFERENCES

American Association for the Advancement of Science (AAAS). (1989). *Science for all Americans: Project 2061.* New York, NY: Oxford University Press.

AAAS. (1993).*Benchmarks for science literacy: Project 2061.* New York, NY: Oxford University Press.

AAAS. (2001). *Atlas of science literacy: Project 2061.* Washington, DC: AAAS-NSTA Press.

American Educational Research Association. (2005). Teaching teachers: Professional development to improve student achievement. *Research points: Essential information for education policy, 3*(1), 1-4.

Anderson, C.W., & Smith, E.L. (1986). *Teaching science.* Research series Number 168. Institute for Research on Teaching, College of Education, Michigan State University. Lansing, MI.

Apple, M. W. (2004). Creating difference: Neo-liberalism, neo-conservatism and the politics of educational reform. *Educational Policy, 18*(12), 12-34. DOI: 10.1177/0895904803260022

Appleton, K. (2008). Developing science pedagogical content knowledge through mentoring elementary teachers. *Journal of Science Teacher Education. 19*(6), 523- 546.

Ball, D. L. (1996). Teacher learning and the mathematics reforms: What we think we know and what we need to learn. *Phi Delta Kappan*, *77*(7), 500-08.

Beane, J. (1991). The middle school: The natural home of integrated curriculum. *Educational Leadership, 49*(2), 9- 13.

Berliner, D. (2006). Our impoverished view of educational research. *The Teachers College Record, 108*(6), 949-995.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W.H. Freeman.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavior change. *Psychological Review, 84*, 191-215.

Barton, A. C., & Yang, K.(2000). The culture of power and science education: learning from Miguel. *Journal of Research in Science Teaching, 37*(8), 871-889.

Capps, D.K., & Crawford, B. A. (2013). Inquiry-based instruction and teaching about nature of science: Are they happening? *Journal of Science Teacher Education, 24*(3), 497- 526.

Capps, D.K., Crawford, B.A, Constas, M. A. (2012). A review of empirical literature on inquiry professional development: Alignment with best practices and a critique of the findings. *Journal of Science Teacher Education, 23*(3), 291-318.

Chen, C-H. (2010). Why do teachers not practice what they believe regarding technology integration? *Journal of Educational Research, 102*(1), 65-75.

Committee on Science and Mathematics Teacher Preparation. (2001). *Educating teachers of science, mathematics, and technology: New practices for the new millennium.* Washington, DC: National Academy Press.

Cope, C.J. (2009). *Beneath the Surface: the experience of learning about information systems.* Informing Science Institute. Retrieved from: WTgC&oi=fnd&pg=PP10&dq=Beneath+the+Surface:+the+experience+of+learning+about+information+systems+By+Christopher+J.+Cope&ots=kkoQfNUonN&sig=l5oGeCAcRNx-uq1-lBat1Foo5RA#PPP1,M1

Creswell, J.W., Hanson, W. E., Clark Plano, V.L., Morales, A. (2007). Qualitative research design: Selection and implementation. *The Counseling Psychologist, 32*(2), 236-264. DOI: 10.1177/0011000006287390

Creswell. J.W. (2009). *Research Design*. 3rd Ed. Thousand Oaks, CA: Sage Publications.

Daehler, K. R., Shinohara, M. (2001). A complete circuit is a complete circle: Exploring the potential of case materials and methods to develop teachers' content knowledge and pedagogical content knowledge of science. *Research in Science Education, 31*(2), 67–288.

Delpit, L.D. (1988). The silenced dialogue: Power and pedagogy in educating other people's children. *Harvard Educational Review, 58* (3), 280-298.

Driver, R., Asoko, H., Leach, J., Mortimer, E., & Scott, P. (1994). Constructing scientific knowledge in the classroom. *Educational Researcher, 23*(7), 5-12.

Driver, R., Squires, A., Rushworth, P., Wood-Robinson, V. (1994, 2007). *Making sense of secondary science: Research into children's ideas.* Reprinted. New York, NY: RoutledgeFalmer, an imprint of Taylor & Francis Group.

DuFour, R. (2004). Schools as learning communities. *Educational Leadership, 61*(8), 6-11. Retrieved from: http://www.ascd.org/publications/educational-leadership/may04/vol61/num08/What-is-a-Professional-Learning-Community%C2%A2.aspx

Duschl, R.A., Schweingruber, H.A., & Shouse, A.W. (Eds.), (2007). *Taking science to school: Learning and teaching science in grades k-8.* Washington, DC: National Academies Press.

Flick, L. Morrell, P., Wainwright, C. (2004). *Oregon teacher observation protocol*. Available from: `
http://www2.research.uky.edu/amsp/pub/Sharepoint%20Toolkit%20Documents/OTOP%20adapted%20for%20PEP%202.d0c

Fulp, S.L. (2002). *The status of elementary school science teaching.* Retrieved from Horizon Research, Inc.: http://www.horizonresearch.com/reports/2002/200)survey/elem_sci.php.

Garret, M. S., Porter, A. C., Desimone, L., Binnan, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915-945.

Grossman, P. L. (1991). The Selection and organization of content for secondary English: Sources for teachers' knowledge. *English Education*, *23*(1), 39-53.

Guskey, T.R. (1984). The influence of change in instructional effectiveness upon the affective characteristics of teachers. *American Educational Research Journal, 21*(2), 245 -259. DOI: 10.3102/00028312021002245.

Guskey, T. R. (2003). Analyzing lists of the characteristics of effective professional development to promote visionary leadership. *NASSP Bulletin*, *87*(637), 4-20.

Hartman, C. (2006). Students on the move. *Educational Leadership, 63*(5), 20-4.

Hewson, M. & Hewson, P.W. (2003). Effect of instruction using students' prior knowledge and conceptual change strategies on science learning. *Journal of Research in Science Teaching, 40*(S1), S86-S98.

Jennings, J.L., & Bearak, J.M. (2014). "Teaching to the test" in the NCLB era: How test predictability affects our understanding of student performance. *Educational Researcher, 43*(8), 381 -389. DOI: 10.3102/0013189X14554449

Korthagen, F.A.J. (2004). "In search of the essence of a good teacher: Towards a more holistic approach in teacher education". *Teaching and Teacher Education*, *20* (1), 77-97.

Krebs, A. S. (2005). Analyzing student work as a professional development activity. *School Science and Mathematics, 105*(8), 402-411.

Learning Forward (2011). Standards for professional learning. Retrieved from: http://www.learningforward.org/standards/standards.cfm

Lincoln, S.Y., Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park: Sage Publications.

Local Government and School District Fiscal Responsibility Act, 4 (PA 4) Michigan Compiled Laws ("MCL") §§ 141.1519 (2011)

Loucks-Horsley, S., Love, N., Stiles, K.E., Mundry, S., & Hewson, P.W. (2003). *Designing professional development for teachers of science and mathematics* (2nd ed.). Thousand Oaks, CA: Corwin Press.

Lynch, S., & Bryan, L. (2014). *Supporting the implementation of the Next Generation Science Standards (NGSS) through research: Introduction to NARST position papers.* Retrieved from https://narst.org/ngsspapers/

Ma, L. (1999). *Knowing and teaching elementary mathematics: teacher's understanding of fundamental mathematics in china and the United States*, Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Magnusson, S., Krajcik, & J., Borko, H. (1999). Nature, sources, and development of pedagogical content knowledge for science teaching. In Gess-Newsome J., Lederman, N.G (Eds.), *Examining pedagogical content knowledge: The construct and its implications for science education.* Dorerecht, The Netherlands: Kluwer. p. 99.

Martin, M.O., Mullis, I.V.S., & Foy, P. (with Olson, J.F., Erberber, E., Preuschoff, C., & Galia, J.). (2008). *TIMSS 2007 international science report: Findings from IEA's trends in international mathematics and science study at the fourth and eighth* *grades.* Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College. Retrieved from http://timss.bc.edu/TIMSS2007/mathreport.html

Marzano, R., J., Gaddy, B., & Dean, C. (2000). *What works in classroom instruction.* Aurora, CO: Mid-Continent Research for Education and Learning.

Michaels, S., A. Shouse, & H. Schweingruber. (2008). *Ready, set, science!: Putting research to work in K–8 science classrooms.* Washington, DC: National Academies Press.

Michigan Department of Education (MDE) *AYP Reports.* (2008). Retrieved from http://www.michigan.gov/mde/0,1607,7-140-22709_22875---,00.html

MDE (2010). *Education Performance Reports.* Retrieved from http://normessasweb.uark.edu/Michigan/

Milner, A. R., Sondergeld, T.A., Demir, A., Johnson, C.C., & Czerniak, C.M. (2012). Elementary Teachers' beliefs about teaching science and classroom practice: An examination of pre/post NCLB testing in science. *Journal of Science Teacher Education, 23*(2), 111-132.

Mishra, P., & Koehler, M.J., (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108* (6), 1017-1054.

National Assessment of Educational Progress. (2005). National Center for Educational Statistics, U.S. Department of Education, Institute of Education Science. Retrieved from http://nces.ed.gov/nationsreportcard/science/

National Research Council (NRC). (1996). *National science education standards.* Washington, D.C.: National Academy Press. .

NRC. (2000). *Inquiry and the national science education standards: A guide for teaching and learning.* Washington, D.C.: National Academy Press.

NRC. (2012). *A framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press.

National Science Teachers Association. (2011). What you're saying: Elementary teachers getting less time for science. *NSTA Reports, 23*(1), 17.

NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States.* Washington, DC: The National Academies Press.

Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies, 19* (4), 317–328.

No Child Left Behind Act of 2001 (NCLB) 107 Congress. Pub. L. No.107-110 § 115 Stat. 1425 (2002). Retrieved from http://www.ed.gov/policy/elsec/leg/esea02/index.html

Novak, J., D. (1990). Concept mapping: A useful tool for science education. *Journal of Research in Science Teaching, 27*(10), 937 -949.

Obama, B. (2011). *Remarks by the president in state of union address January 25, 2011*. Retrieved from http://www.whitehouse.gov/the-press-office/2011/01/25/remarks-president-state-union-address

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research, 62*(3), 307–332.

Park, S., & Oliver, J.S. (2008). National board certification (NBC) as a catalyst for teachers' learning about science: The effects of the NBC process on candidate teachers' PCK development. *Journal of Research in Science Teaching, 45*(7), 812-834.

Park-Rogers, M., Abell, S., Lannin, J., Wang, C-Y., Musikul, K., Barker, D., Dingman, S. (2005). Effective professional development in science and mathematics education: Teachers and facilitators' views. *International Journal of Science and Mathematics Education, 5*(3), 507-532.

Posanski, T. J. (2010). Developing understanding of the nature of science within a professional development program for in-service elementary teachers: Project nature of elementary science teaching. *Journal of Science Teacher Education, 21*(5), 589 -621.

Posner, G.J., Strike, K.A., Hewson, P.W., & Gertzog, W.A. (1982). Accommodations of a scientific conception: Towards a theory of conceptual change. *Science Education*, *66*(2), 211-277.

Price, J.N. (2011). Action research, pedagogy and change: The transformative potential of action research in pre-service teacher education. *Journal of Curriculum Studies, 33*(1), 43-74. DOI: 10.1080/00220270118039

Programme for International Student Assessment. (2006). Organisation for Economic Co-operation and Development. Retrieved from http://www.pisa.oecd.org/pages/0,2987,en_32252351_32235731_1_1_1_1_1,00.html

Rebora, A. (2011). Guidelines on teacher learning revamped. *Education week teacher PD sourcebook: Advancing student learning, 4*(1), 4.

Schensul, J.J, LeCompte, M.D., Nastasi, B.K. & Borgatti, S. P. (1999). *Enhanced ethnographic methods, ethnographer's toolkit volume 3.* Lanham, MD: Altamira Press.

Shulman, L.S., (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(4), 4-14.

Shulman, L.S., (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57(*1), 1-22.

Smith, D.C. (2000). Content and pedagogical content knowledge for elementary science teacher educators: Knowing our students. *Journal of Science Teacher Education, 11*(1), 27-46.

Spradley, J.P. (1980). *Participant observation.* Belmont, CA: Wadsworth/Thomson Learning.

Stallings, J. (1980). Time revisited, or beyond time on task. *Educational Researcher, 9*(11), 11-16.

Thompson, D. L., & Zulich, J. (1990). A Decade of career development research: Implications for theory, practice, and research. *Journal of Employment Counseling*, *27*(3), 122-29.

Valli, L., & Buese, D. (2007). The changing roles of teachers in an era of high-stakes accountability. *American Educational Research Journal, 44*(3), 519-558. DOI: 10.3102/0002831207306859

van Dijk, E.M., & Kattmann, U. (2007). A research model for the study of science teachers' PCK and improving teacher education. *Teaching and Teacher Education, 23*(6), 885–897.

Van Duzor, A.G. (2012) Evidence that teacher interactions with pedagogical contexts facilitate chemistry-content learning in a k-8 professional development. *Journal of Science Teacher Education, 23*(5), 481-502.

VanFossen, P.J. (2005). Reading and math take so much of the time: An overview of social studies instruction in elementary classrooms in Indiana. *Theory and Research in Social Education, 33*(3), 376- 403.
DOI: 10.1080/00933104.2005.10473287

Veal, W.R., & MaKinster, J.G., (1999). Pedagogical content knowledge taxonomies. *Journal of Science Education, Electronic Edition, 3*(4) Retrieved from http://wolfweb.unr.edu/homepage/crowther/ejse/vealmak.html

Vescio, V., Ross, D., & Adams, A. (2008). A review of research on the impact of professional learning communities on teaching practice and student learning. *Teaching and Teacher Education, 24*(1), 80-91. DOI: 10.1016/j.tate.2007.01.004

Visser, T.C., Coenders, F.G.M., Terlouw, C., Pieters, J.M. (2010). Essential characteristics for a professional development program for promoting the implementation of a multidisciplinary science module. *Journal of Science Teacher Education, 21*(6), 623-642.

Wallace, M.R. (2009). Making sense of the links: Professional development, teacher practices, and student achievement. *Teachers College Record, 111*(2), 573-596.

Watanabe, T. (2011, October 31). California teachers lack the resources and time to teach science. *Los Angeles Times On-line.* Retrieved from http://www.latimes.com/news/local/la-me-science-20111031,0,3957251.story

Wei, R. C., Darling-Hammond, L., Andree, A., Richardson, N., Orphanos, S. (2009). *Professional learning in the learning profession: A status report on teacher development in the United States and abroad.* Dallas, TX: National Staff Development Council.

Wilson, S. M., Shulman, L. S., & Richert, A. (1987). 150 different ways of knowing: Representations of knowledge in teaching. In J. Calderhead (Ed.), *Exploring teacher thinking*. Sussex, England: Holt, Rinehart & Winston.

Worchel, S. (1986). The influence of contextual variables on interpersonal spacing. *Journal of Nonverbal Behavior, 10*(4), p. 230-254.

Yin, R.K. (2009). *Case study research: Design and methods. Fifth edition.* Thousand Oaks, CA: Sage Publishing

ABSTRACT

THE IMPACT OF A PROFESSIONAL DEVELOPMENT PROGRAM ON TEACHERS' PRACTICE AND HOW CONTEXT VARIABLES INFLUENCED SUCH PRACTICE: A CASE STUDY

by

SANDRA LYNN YAREMA

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Advisor: Dr. Maria M. Ferreira

Major: Curriculum and Instruction; Science Education

Degree: Doctor of Philosophy

This case study investigated how context variables influenced the impact of a state-funded longitudinal professional development (PD) program on the participant teachers' practice. Data was collected to compare differences in Science Content Knowledge, Science Pedagogical Content Knowledge, and the teachers' practice over the course of the PD program. Contextual variables related to district restructuring and school implementation of district policy evidence a direct effect on time spent on science instruction, specific instructional strategies used, and on the development of a professional community among the participants. This case study substantiates the implication that districts and school policies must provide adequate support for teachers to implement what is learned in professional development to enact any effective science education reform at the elementary school level.

AUTOBIOGRAPHICAL STATEMENT

Sandra Yarema is a science teacher educator with over twenty years' experience as a middle-school science teacher. Her career focus has been on the effective teaching of science concepts, content, and scientific practice at the elementary school level. Sandra is currently a research assistant for the W. K. Kellogg Foundation- W.Wilson MI Teaching Fellowship, an alternative graduate teacher certification program at Wayne State University. She is also adjunct faculty instructing science methods and content for pre-service teachers, College of Education at WSU, and for practicing teachers as part of the Master of Science Education Program at Lawrence Technological University.

Sandra has been published in *Science and Children*, *The MSTA Journal*, and *The School Community Journal*, and has presented at regional and national conferences. Sandra has served on the board of directors for the Michigan Science Teachers Association Board of Directors for the past 4 years. She is also the state membership director for the *Society of College Science Teachers*, and is an active member of the *American Educational Research Association*, the *Association of Science Teacher Educators*, the *Michigan Science Education Leaders Association, MI Sci* (Michigan Science Education PLC), the *National Association for Research in Science Teaching*, and the *National Science Teachers Association*.