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SUSTAINABILITY OF A LONG TERM PROFESSIONAL DEVELOPMENT PROGRAM

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Abstract

Currently, in most school districts, the main form of teacher education comes from professional development (PD) that claims to improve teaching and student achievement. School districts and teachers spend time and money trying to make sure that they are providing the best quality education for their students. Yet, educators are looking for what the most effective form of PD should look like.

Utilizing the methodology of a descriptive case study a long-term PD grant, called *Science Alliance* was evaluated to add to the research on PD and grant program efficacy. Twelve teachers that participated in the *Science Alliance* grant were interviewed, observed, and given a survey to see how and to what degree they were implementing the inquiry methodology three years after the grant ended. The results were compared with previously existing data that were collected by a company that *Science Alliance* hired to complete external research on the effects of the PD.

The findings suggest that the teachers that participated have sustained the utilization and implementation of the methodology learned during the training. School administrators and/or staff developers could utilize the findings from this study to see what effective PD may entail. Future researchers may use findings from this study when reporting about grant program evaluations and/or PD.

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LIST OF ABBREVIATIONS

Abbreviation

PD – Professional Development

LSA - LS Associates

Chapter One

Problem

Currently, in most school districts, the main form of teacher education comes from professional development (PD) to improve teaching and student achievement (Supovitz & Turner, 2000). "Over the past decade, researchers and educators have forged a remarkable level of national consensus about what may constitute effective science professional development" (Supovitz & Turner, 2000, p. 964). Fulp (2002) completed a report on elementary school science teaching. Fulp (2002) summarized her research by stating, "Elementary school science teachers are lacking in content preparation" (19).

Purpose

The purpose of this study was to evaluate a long-term professional development grant, called *Science Alliance* to add to the research on PD and grant program evaluations by utilizing the methodology of a case study based on Guskey's (2002) Five Levels of Professional Development. Creswell (2012) states a case study is an in-depth exploration of a program based on extensive data collection.

An interview based on Guskey's (2002) Five Levels of Professional Development was conducted as the basis of the case study. LS Associates (LSA) was a company that was hired to complete external research on the effects of the *Science Alliance* PD. LSA (2012) reports, "A primary aim of *Science Alliance* is to increase inquiry-based science practices and enhance learning by linking teachers and students with informal science learning institutions (ISI's)" (p. 3). Survey and observation data collected by LSA (2012) was compared to survey and observation data collected for this follow up evaluation

study. The data attempted to support the interview data to find the sustainability of the PD, adding to the research on PD and grant program evaluations in general.

Science Alliance was a new program in this setting. This program was piloted before in one other school. In the fall of 2009, LSA facilitated research of a similarly structured *Science Alliance* grant program. However, this study was completed at a school with much different dynamics than the school discussed in this research.

The school that first participated in the *Science Alliance* program was a magnet school, with 450 children in pre-kindergarten through grade five. The population of students was approximately 62% African American, 28% Caucasian, 6% Asian. Seventy four percent of the students were eligible for free and reduced lunch.

Many positive outcomes were found through LSA's (2009) evaluation of the first *Science Alliance* program. The teachers used inquiry-based teaching strategies as reported by observations by the *Science Alliance* staff. The students showed statistically significant gains in science knowledge as reported by LSA (2009). LSA (2009) reported that the teachers became more confident in teaching specific science content areas. Increased support for the teachers in implementing this new teaching strategy was also reported by LSA (2009). LSA (2009) suggested that *Science Alliance* should be replicated in other schools.

The follow up research reported here investigated to what extent the *Science Alliance* model could be replicated in another school with different dynamics and with sustain the methodology. The school researched in this study had approximately 350 students in grades kindergarten through six. Approximately 55% of the students were

eligible for free and reduced lunch. The ethnicity of the school was divided; 53% of the students were African American, 46% are Caucasian and less than 1% were of other ethnicities. The make up of the researched school differ from the first school that participated in *Science Alliance*. LSA (2009) reported, "…the results of the outcome-based evaluation continue to provide that the *Science Alliance* is a successful educational model that should be replicated in other urban (and non-urban) schools" (pg. 4). The research looked at how and to what extent a suburban school is able to sustain the methodology learned during the three year long PD.

Question

The research question for the study was based on Guskey's (2002) Five Levels of Professional Development (PD). The research question was: How are the teachers that participated in the *Science Alliance* grant using and implementing the inquiry methodology as defined by the Exploratorium?

Inquiry for the purpose of this investigation, accepts the definition of the *Science Alliance*.

Llewellyn (2007) states the Exploratorium defines inquiry as follows:

> Inquiry is an approach to teaching that involves a process of exploring the natural or material world, that leads to asking questions and making discoveries in the search of new understandings. Inquiry, as it relates to science education, should mirror as closely as possible the enterprise of doing real science. The inquiry process is driven by one's own curiosity, wonder, interest or passion to understand an observation or solve a

problem. The process begins by the learner noticing something that intrigues, surprises, or stimulates a question. What is observed often does not make sense in relationship to the learner's previous experience or current understanding. Action is then taken through continued observing, raising questions, making predictions, testing hypotheses and creating theories and conceptual models. The learner must find [his or her] own idiosyncratic pathway through this process: it is hardly ever a linear progression, but rather more of a back and forth or cyclical series of events. As the process unfolds more observations and questions emerge, giving occasion for deeper interaction and relationship with the phenomena—and greater potential for further development of understanding.

Along the way, the inquirer is collecting and recording data, making representations of results and explanations, drawing upon other resources such as books, videos, and colleagues. Making meaning from the experience requires intermittent reflection, conversations and comparison of findings with others, interpretation of data and observations, and applying new conceptions to other contexts as one attempts to construct new mental frameworks of the world. Teaching science using the inquiry process requires a fundamental reexamination of the relationship between the teacher and the learner where by the teacher becomes a facilitator guide for the learner. (p. 5-6)

The question was developed from the information found in the LSA's (2012) executive summary report for the 2010-2011 school year.

The LSA report states:

> The external evaluation of the *Science Alliance*'s first three years found that the program was successful in achieving or making progress toward many of its targeted outcomes, including: 1) Increased teacher understanding of science content and inquiry –based teaching strategies; 2) Increased teacher confidence in teaching science; 3) Enhanced student learning in science at all grade levels; and 4) Increased teacher, family, and student interest in science.

Important Terms

Inquiry has many different meanings depending on the reference. Barrow (2006), states that there is a "lack of agreement on the meaning of inquiry in the field of science education" (265). Barrow completed a small qualitative research study on inquiry and found that the teachers that state they are doing "inquiry" are not fully teaching with that methodology. The teachers were using some aspects of "inquiry". Only one of the three teachers studied showed qualities and behaviors that would be a good model for inquiry education teachers (Howes, Campos, & Lim, 2008).

According to the *Glossary of Educational Reform* (2013) professional development (PD) in the educational field can be used to reference training that is intended to assist educators improve their professional knowledge, competence, skill and effectiveness. The teaching staff from the three informal science institutions provided a

weeklong PD training for the elementary schools teaching staff during the summer of 2010. The training was all day, every day, for one week during the summer at the local botanical gardens. The training immersed the teachers in the methodology of inquiry as defined by the Exploratorium. The teachers were learning as a student in their classes would learn. Basically, the teachers from the three institutions modeled lessons as they were the teachers and the participating teachers were the students. This was to demonstrate to the teachers exactly how the inquiry method could be utilized and taught.

During the first year commitment, in addition to the weeklong training, three staff from the science institutions used the methodology of inquiry in the classroom to train the elementary school staff during the regular school district's scheduled PD days. Misconceptions and questions the teachers had about the methodology were addressed.

Significance

Merriam (2009) defines a descriptive case study, "as an in depth description and analysis of a bounded system" (43). In this study the interview will provide the basis for the in depth description. Interviews and observations will support the interview data. The bounded system in this case is a long-term professional development program called *Science Alliance*.

Horsley & Matsumoto (1999) argue the importance of looking at areas other than student achievement in regards to PD. Changes in teacher knowledge and practice, implementation of new programs, changes in school culture, and development of teacher leadership abilities are just as important to the broad goal of national reform in science

and mathematics education (Horsley and Matsumoto, 1999). Their objective was incorporated in *Science Alliance*.

Science Alliance in this setting, with this particular school and these institutions, is a new program. The program hoped to increase the knowledge base of the teachers and improve their practice. School culture then could change if the teachers are more satisfied with the achievement of their students in the content they are teaching.

Torff et al. (2005, pg. 821) states,

> "Research is needed that investigates the extent to which teachers' attitudes about PD (a) develop as teachers gain classroom experience, in-service training, and teaching expertise; (b) vary across subjects and grade levels; and (c) change as a result of particular PD interventions."

Bryan & Keys (2001, pg. 631) state,

> "…We propose that more research is needed in the areas of teachers' beliefs, knowledge and practices of inquiry-based science, as well as, student learning. Because the efficacy of reform efforts rest largely with teachers, their voices need to be included in the design and implementation of inquiry-based curriculum."

Bryan & Keys (2001, pg. 631) go on to say, "…we propose that particular attention be paid to research on inquiry in diverse classrooms, and to modes of inquiry-based instruction that are designed by teachers."

The staff that underwent the training from *Science Alliance* had various levels of experience. Some of the staff were nearing retirement, whereas others were in their first year of teaching. The study looked at the training across grade levels and, since not each teacher at the school taught science, this study also looked at teachers that teach various subjects in terms of inquiry teaching and their perceptions of the PD. In addition the school is diverse in that the ethnicity of the school consisted of 53% of the students African American, 46% Caucasian and less than 1% other ethnicities. The teachers assisted the *Science Alliance* staff in creating the lessons the first year and the staff then created their own inquiry lessons the second year.

Anderson (2002) explains that inquiry teaching has produced positive results, however this does not tell teachers how to teach using this methodology and what percentage of teachers are successful at it. Anderson (2002) reports difficulties teachers have with using the inquiry teaching method, such as implementation and ease of use. In addition Anderson (2002) states that political and cultural dynamics of the school also play a role in the implementation of inquiry. One of the key roles in reform is collaboration (Anderson, 2002). The PD addressed obstacles of teaching using the inquiry method through the collaboration with other staff members and *Science Alliance* staff.

Limitations

Since this is a long-term grant program evaluation, staff received other training besides what was provided by *Science Alliance*. Therefore, additional PD may affect the results. The guiding questions on the interview attempted to only address this specific

PD. Observation and survey data were collected and compared to observation and survey data collected by LSA (2012).

The researcher conducted all of the interviews of the staff personally to reduce the threat of instrumentation errors. The researcher also transcribed and coded all of the interviews herself. Using one individual to conduct all of the interviews, transcribe, and code all of the interviews should facilitate internal validity of the study.

The researcher works as an instructional coach in the same school district, which could have posed a threat to some of the interviewees. Prior to the interviews, the researcher made sure to share with the teachers that the information collected would not be evaluative of their positions and their names would not be shared. The researcher stated to the teachers that honest answers would help to validate the findings.

Summary

This chapter discussed the purpose of researching *Science Alliance* utilizing the methodology of a descriptive case study with the support of quantitative data. The study attempted to resolve the question how and to what degree did the teachers continue to utilize and implement inquiry based on the definition defined by the Exploratorium learned during the *Science Alliance* training. The following chapter will review literature related to the study.

Chapter Two

Review of Related Literature

The purpose of the literature review is to introduce background knowledge and insights from pertinent literature as it relates to effective professional development (PD). Literature is presented that focused on programs with similar characteristics of *Science Alliance*. This review helped to identify research that is needed in future studies in the area of PD.

Effective Professional Development

Much research has been completed on what effective PD should include. Loucks-Horsley (1999) reported that the issue with ineffective PD arose in the 1960's and 1970's when teachers attended PD institutes. When the teachers returned to their schools they found it extremely difficult to apply the knowledge and skills they had learned. Many reasons were stated for the difficulty of implementation. Some reasons were lack of administrative and teacher support, not enough or the right materials, and lack of support from the parents. Loucks-Horsley (1999) stated, "Many studies of the importance of context to professional development have not focused on science and mathematics teachers, but on teacher learning in general" (265). This case study focuses on science and math teachers in relation to the sustainability of methodology taught in a long term PD program.

Guskey (2002) stated that PD is most likely to be effective when it is evaluated using five critical levels of evaluation. Each level builds on those levels that come before it. "Success at one level is usually necessary for success at higher levels," (Guskey, 2002, p. 46). The first evaluates the reactions of the participants through questionnaires

to measure the initial satisfaction in order to make improvements in the instruction of the program. The second measures the participants learning through paper and pencil instruments, simulations, demonstrations, and/or portfolios. These formative data should be used to improve the content, format, and/or organization of the program. Third, measures the organization support and change through district and school records, follow up meetings, questionnaires, interviews and/or portfolios. The data were used to document and improve organizational support. The data could also be used to improve future change efforts. Fourth, use of the new knowledge and skills are measured through questionnaires, interviews, reflections, observations, and/or video or audiotapes. The data regarding the fourth level assist to improve the implementation of the program content. Fifth, measures the student learning outcomes using student records, school records, questionnaires, interviews, and/or portfolios. The *Science Alliance* program reported addressed all five components.

Supovitz & Turner (2000) stated that PD is most likely to be effective when it includes a set of six critical components. The first states teachers must be immersed in inquiry, questioning, and experimentation and model inquiry forms of teaching. The second states that the PD must be intensive and sustained. Third, PD should not be isolated from the teachers' regular responsibilities. According to Supovitz & Turner (2000), "Fourth, PD must focus on subject-matter knowledge and deepen teachers' content skills" (p. 964). Fifth, PD must relate to PD standards and show teachers how to connect their practice to specific standards for student performance. Lastly, strategies must connect to the other realms of school change.

Science Alliance addresses the first step of the components discussed in Supovitz & Turner (2000). The weeklong PD completed by the teachers over the summer immersed the teachers in inquiry methodology. The teachers learned content through inquiry-based experiences. *Science Alliance* hoped the teachers realized through the initial training how fun and exciting learning can be once they were mentally involved with the topic at hand. During this first week the teachers learned how to question and inquire and how to bring this method back to the classroom and teach using that instructional strategy.

The *Science Alliance* grant program was conducted over a three-year period; the teachers were involved in a PD that was sustained over a long period of time. This addressed second critical component that Supovitz and Turner (2000) stated in regards to effective PD. During the first year of the grant, the staff from the supporting institutions planned "grass roots" model lessons. Their hope was to create inquiry lessons that the teachers will use in subsequent years. Lesson planning occurred once a month. The teachers from the school and the staff from one of the institutions met at the school to plan. After the teacher and the educator from one of the facilities completed the lesson, the staff from the institution taught the lesson with assistance from the teacher. The following year the process remained the same, with the exception that the teacher taught the lesson and the staff member from the institution assisted. This model addressed the sustainability goal of *Science Alliance* in that attempted to make sure the teachers understood the process of inquiry and how to effectively teach utilizing that model.

The third of Supovitz and Turner's (2000) components is also covered in the *Science Alliance* grant. This program representatives came to the school and met with

the teacher to plan to help them successfully teach lessons using the inquiry model. The teachers taught the content they normally would teach, however they planned and received assistance from the staff from one of the non-traditional science institutions to teach utilizing the inquiry methodology. Therefore, the teacher was not diverted from their normal responsibilities.

The forth component mentioned in Supovitz and Turner's (2000) research, is deepening the content knowledge of the teacher, which was covered during the training. During the weeklong training, teachers were introduced to content through inquiry-based lessons. This not only attempted to enhance the content knowledge, it also modeled to the teacher the inquiry model of teaching.

Since this is a "grass roots" planned lesson, the teacher participants were sharing with the staff member from the institution their grade level expectations and required content that was to be taught. *Science Alliance* was attempting to increase student achievement with the lessons that were covered. This includes the fifth step of effective PD.

Since everyone in the school was participating in the *Science Alliance* grant program, the culture of the school was changing. This covers the sixth step. After participating in the *Science Alliance* grant program, which the researcher felt addresses the six components, the staff that participated in the PD would be expected to comfortably teach science and other subject areas using the inquiry based teaching method.

In addition to the research above, the National Science Education Standards (NSES, 1996) propose a vision in which all students have the opportunity to become scientifically literate. This vision means that science educators need to be responsible for their own PD, as well as having the ability to make judgments about the quality of PD. NSES suggests that in order to be an effective science teacher you need to continuously update content knowledge to share, support and guide students.

NSES (1996) created criteria for all people that design and lead PD activities. PD must include experiences that engage teachers in active learning that builds their knowledge and understanding and ability to reach all students. Basically, PD must model good science teaching. In addition, to create a school wide change, the PD must connect to the teachers' role in the context of the school. "Teachers should have opportunities for structured reflection on their teaching practice with colleagues, for collaborative curriculum planning, and for active participation in professional teaching and scientific networks." (NSES, 1996, p. 58).

Standard A (NSES, 1996) states that elementary science teachers need to have the opportunity to develop a broad range of science content. Since very few science courses are required, the courses that an elementary pre-service teachers take should be designed so the teacher learns through inquiry. Standard B (NSES, 1996) states that teachers need to have a background in theories of how learning occurs and how to facilitate learning through multiple instructional strategies. In addition teachers should reflect on their practice through collaboration with colleagues to choose the best methods to teach content to students. "Some of the most powerful connections between science teaching and learning are made through thoughtful practice in field experiences, team teaching,

collaborative research, or peer coaching." (NSES, 1996, p. 67). Standard C (NSES, 1996) states that teachers should be lifelong learners and enhance their content knowledge through PD. To guide which classes the teacher should take comes from self-reflection and collaboration. Standard D (NSES, 1996) states that PD should be easily able to integrate. The material should be reinforced and practiced. The *Science Alliance* PD addressed the four (NSES, 1996) summarized in this paper.

Most teachers attend professional development because they want to be better teachers, not just because it is in their contract (Guskey, 1986). However, Guskey states that the majority of programs fail because two factors are not taken in account. The first is the motivation of the teacher to engage in professional development. The second is the process by which change in teachers typically occurs (Guskey, 1986). Fullan and Miles (1992) state that teachers hope to gain specific, concrete and practical ideas that relate to the day-to-day operation of their classrooms. Guskey (1986) provided a model to see teacher change. The model has four categories (Guskey, 1986). PD is the first and that leads to the change in the teachers' classroom practices (Guskey, 1986). This leads to change in student learning outcomes, which promotes the change in teachers' beliefs and attitudes (Guskey, 1986). Basically, Guskey (1986) thinks the real change comes from seeing that the new knowledge learned from the PD. Guskey (1986) calls his model the "Model of Teacher Change". Guskey (1986, p. 7) stated, "Practices… that teachers find useful in helping students attain desired learning outcomes- are retained and repeated. Those that do not work or yield no tangible evidence of success are generally abandoned."

Guskey (1986) stated that when planning professional development programs the following characteristics must be present if you want the results of the PD to be significant and sustained. The PD developers must realize that change is gradual and is a difficult process for teachers. The teachers must receive feedback on a regular basis on the effects of their efforts. The PD should provide follow-up, support and expectation of adoption. It is felt that *Science Alliance* had these characteristics.

Teacher Inquiry as Professional Development

Poekert (2010) conducted a qualitative study that examined the pedagogy of facilitation. Six teachers and a veteran facilitator were guided through the inquiry process. The program of study was called the Lastinger Teacher Fellows Program. This was a yearlong PD on inquiry facilitation. Poekert (2010) states that teacher inquiry can be conducted in three ways. One is "teacher research", which will be explained under Poekert's study. Second is a "lesson study", which is explained below under Crockett's study. Last are "collegial study groups", which will be explained under King's (2001) study. These studies are discussed in detail because *Science Alliance* is a mixture of "teacher research", a "lesson study" and a "collegial study group". Based on the literature review there is a need for more research in these areas.

Poekert (2010) stated that "teacher research" is a process in which teachers inquire about their own teaching practice, through the inquiry process. The teacher formulates a question from their reflection of their practice. The teacher then collects and analyzes data related to the question. Action is taken based on the findings. Ideally, the new knowledge is shared with other teachers.

"Little research examines the pedagogy of facilitation" (Poekert, 2010, p. 21). The question posed by Poekert (2010) is: "How can facilitators successfully encourage and support teachers through the process of teacher inquiry?" The study was completed in a qualitative fashion with interviews. It suggests using the "teacher research" methodology of PD enhanced teacher learning and collaboration, in turn assisting with improving teacher practice.

Poekert (2010) found his results unconfirmed the impact of teacher inquiry on teacher practice and student learning. Therefore it is implied that more research in this area is needed. The *Science Alliance* grant used the pedagogy of teacher inquiry during the initial week long PD.

Crockett's (2001) study was conducted over a one year time period. The research attempted to find out if certain activities generated the kind of inquiry that would cause a change in the teacher beliefs and practices. Crockett (2001) described how a one-time workshop tends to be very unsuccessful in changing the beliefs and practices of teachers. A "lesson study" approach to PD identifies the goal of the lesson, plans the lesson, conducts the lesson and assesses the results of the lesson. These steps should be done in collaboration with a team of teachers. The researcher suggests the teachers learn about the content they teach, help find misconceptions, and open dialogue for the teachers that participate. The *Science Alliance* grant assisted teachers in finding the goal for the lesson. A teacher from the institute planned and conducted the lesson with the teacher. Following the lesson a posttest was given and was compared to the pretest. This followed the design described by Crockett (2001).

King's (2001) study attempted to seek understanding and contributions of PD with school wide inquiry. The study also examined the benefits of inquiry to the school-wide professional community through collegial study groups. The teachers in this form of PD reflect and examine their practice and collectively confront issues that arise. *Science Alliance* was conducted school-wide where the teachers reflected with each other and the staff of the presenting institutions to examine their practice. When an issue arose, all parties collaborated together to brainstorm how to address the issue. King's (2001) study was conducted with seven urban elementary schools and suggested that further research can help determine if school wide inquiry plays a significant role in school reform.

The above three studies focused on the teachers going through the inquiry process through PD and reflecting and inquiring about their practice. The information that all these pieces of research provided was valuable to the research in regards to *Science Alliance*. *Science Alliance* required teachers to go through the inquiry process to learn the methodology to teach their students in that form. These appear to be related, as they attempted implementation of PD utilizing the inquiry process for school reform.

Professional Development Programs with Characteristics Similar to *Science Alliance*

PD programs with similar characteristics to those of *Science Alliance* were reviewed to see trends what possible arose from the research. Researchers noted what they felt was needed to be added to research in this field. In addition they provided ideas on how to set up the methodology for the *Science Alliance* research.

Weinburgh and Smith (2008) designed a professional development experience for two urban elementary schools. The goals were to help increase science content knowledge about water issues, to increase the use of inquiry based teaching, and to have teachers become reflective of their practice using the Reflective Teaching Model (RTM). Teachers volunteered to participate in a two-week summer institute, workshops/meetings on Saturdays, and attend RTM sessions monthly. The principal and lead teachers from both schools were very supportive of the program.

The developers of the program conducted research on the program. Through their studies they found, in order to change teaching behavior, teachers need to be given the opportunity to practice and receive coaching (1986).

The Reflective Teaching Model (RTM) involved a pair of teachers, one being the model teacher. The model teacher modeled effective practice, shared authority, and reflected on practice. The teachers had consistent joint planning periods, teaching and reflective sessions.

The research completed in the RTM study was based on a case study that was completed on one teacher in a large urban area in the southwestern portion of the United States. The school was comprised by 65% Hispanic, 25% African American, 10% Caucasian. More than 50% of the students had a limited English speaking background.

Through the study the researchers noticed a theme that they were not expecting. The teacher that was being studied felt alienated by the other members of her third grade team. The other members were also given the opportunity to participate in the professional development and did participate at times, but not to the full extent of the

teacher being observed. The participating students in the research had a significant gain in test scores at the end of the summer workshop. When given the test the second year, the teacher retained the content knowledge learned during the summer training. This teacher felt as though RTM affected the amount of content learned. The confidence level of the teacher improved and the teacher became more interested in making connections between science and other disciplines. As she began to want to change her practice to more of an inquiry-based classroom, her teammates reacted and began to alienate her. This particular case study showed that professional development needs to look at the unwritten structures of the school to see if everyone involved will accept the change and be supportive.

Neathery, Gynn, and Long (1998) investigated a PD program that focused on environmental science content. The program provided opportunities to develop inquiry – based instruction and familiarized teachers with the teaching and learning cycle. The teachers learned through their own actions and reactions to new situations. After participating in new situations, the teachers reflected on how they could apply this to their educational setting.

The participants in the study were elementary teachers that were interested in learning about environmental science, with a commitment to participate in follow up meetings. These teachers also had support of their principals.

The teachers were exposed to a variety of speakers in an eight-day professional development program. The data collected suggest that a hands-on participatory PD

program enables participants to develop the confidence needed to apply what they learned in a classroom setting to their own classroom.

Lumpe, Czerniak, and Haney (1999) researched the first year of a local systemic change (LSC) called Tapestries that was funded by the National Science Foundation (NSF). The purpose of the project was to develop comprehensive school science programs through sustained PD.

The target group included K-6 teachers in a large urban school district and an adjoining suburban school district. Both school districts had large numbers of students that were below the poverty level and their students tended to score low on the state science achievement examinations. The teachers were given a needs assessment in regard to science education. The developers of the program used this information to build their PD program. Summer institutes and sessions during the school year facilitated in implementing inquiry based science curricula and other instructional strategies. Four science programs were adopted by the school districts and were used as the focus of the PD.

Lumpe, Czerniak, and Haney (1999) state that the purpose of the research was to examine support structures and teacher beliefs during the first year of implementation. A variety of qualitative and quantitative research was used to triangulate the data. The data came from teacher and principal questionnaires, observations completed by trained observers, summer institute observations, teacher interviews, reflective journals, district action plans, and teacher belief instruments. Four themes came out of the data (Lumpe, Czerniak, & Haney, 1999, Findings Section):

1. Key support structures are critical to reform success.

2. The quality of the science curriculum materials impacts reform processes.

3. Elementary teachers need well designed professional development in science content in order to effectively use quality science curriculum materials.

4. Teachers' beliefs may be influenced by restructuring efforts.

Lumpe, Czerniak, and Haney (1999) state that researchers should continue to examine the effectiveness of systemic reform efforts in the area of science education. Student achievement, as well as other information, should be examined. Longitudinal studies should be conducted to examine the patterns of support and sustainability.

The PRISM program was a partnership between K-12 teachers with science and math graduate students. The focus was on addressing ways that teachers and scientists could effectively implement inquiry-based teaching methods to help overcome the barriers faced when teaching using the inquiry method (2009).

PRISM was set up in three phases. The first phase was a summer program where the scientist and the teacher participated in learning about inquiry, teaching strategies, and participated in inquiry along the inquiry continuum. Past PRISM teachers and scientists co-planned and taught. They also began to plan for the school year. The second phase was done at the end of the summer. The collaboration team co-planned and developed inquiry–based activities that met state and local standards. The third phase was done throughout the school year. The team continued to plan and co-teach. Meetings discussed barriers and concerns in regards to inquiry. The teams received

support as well as supportive observations (Van Hook, Huziak-Clark, Nurnberger_Haag, & Ballone-Duran, 2009).

Van Hook, Huziak-Clark, Nurnberger-Haag, and Ballone-Duran (2009) explained many barriers in teaching with the inquiry method. Classroom management is one of the main barriers. Teachers were not taught by teachers that used the inquiry method; therefore they did not feel comfortable using the method. Sometimes administrators and parents are not familiar with inquiry teaching and therefore pressure the teacher into not teaching utilizing that methodology. Some teachers feel as though the state tests only require them to know the factual knowledge, therefore they teach to the test. Other teachers do not understand the methodology of inquiry.

Van Hook, Huziak-Clark, Nurnberger-Haag, and Ballone-Duran (2009) imbedded collaboration throughout the study, stating that support is one of the key factors to making inquiry-based teaching successful. The teachers collaborated with scientists and mathematicians throughout the program.

The researchers drew from four main data sources in order to triangulate their findings. These came from an inquiry methods survey, journal prompts, classroom observations, and focus group interviews. The survey was developed by the authors and was tested for internal consistency. The journal prompts were open-ended questions that tried to determine the amount of inquiry exposure the children received. The interviews were all taped-recorded, transcribed, and coded. The researchers, Van Hook, Huziak-Clark, Nurnberger-Haag, & Ballone-Duran, (2009) concluded that a long-term collaboration program can be an effective model to change conceptions about inquiry and

promote inquiry-based teaching in K-12 classrooms. The study suggested that future research about scientist-teacher collaborations will enhance inquiry-based teaching. The long-term effect of participation in programs like this should also be investigated.

The study completed by Furtak (2006) had three participating teachers that had various amounts of experience. However, all three teachers participated in collaboration between the Stanford Education Assessment Laboratory (SEAL) and the Curriculum Research and Development Group (CRDG) at the University of Hawaii. The curriculum written by CRDG is called Foundational Approaches in Science Teaching (FAST). FAST was an inquiry-based program for middle school students. The program was designed so the students build upon lessons they have previously learned.

Furtak (2006, p. 455) asked the following research questions:

- How do teachers describe the role of answers in guided scientific inquiry teaching?
- How do these teachers manage problems with answers during the enactment of a guided scientific inquiry investigation?
- What do the experiences of these three teachers say to policymakers, researchers, and practitioners about guided scientific inquiry teaching?

Furtak's (2006) study stemmed from earlier research that gave mixed results on the effectiveness of scientific inquiry teaching and student performance. Furtak's research stated that inquiry teaching is difficult due to lack of time, lack of pedagogy, and teachers feeling overwhelmed when implementing inquiry.

The three teachers taught using guided scientific inquiry teaching, which on the inquiry continuum is in the middle of traditional or direct instruction and open-ended

scientific inquiry. They were videotaped daily for the first unit of the FAST curriculum. The researcher attempted to capture the teachers' and the students' words. The videotapes from the first investigation were analyzed by coding the comments of the teachers and students. The data were collected from multiple videotapes and interviews.

Faulk (2006) suggested that researchers need to explore what inquiry teaching looks like in average classrooms as well as how to effectively manage problems. Exploration also needs to be done on how motivated students are when they find out that their teacher will not tell them the answer (Faulk, 2006). This raises the question; will this make students want to give up or further investigate (Faulk, 2006)?

Blanchard, Southerland, Granger (2008) explained that inquiry is the central reform of science teaching and learning. However, many teachers do not understand how to teach in this fashion due to the lack of experience. Research experiences for teachers (RETs) allowed teachers to participate in scientific inquiry in hopes that they would transfer these experiences into their classrooms. The research on the effectiveness of this type of program is minimal (Blanchard, Southerland, Granger, 2008).

This study followed four preselected secondary science teachers back to their classrooms after participating in a 6 week long RET focusing on marine ecology. The research was both qualitative and quantitative to address the following questions (Blanchard, Southerland, Granger, 2008, p. 327):

- What were the teachers' initial conceptions and enactment of classroom inquiry and how did they change after the RET?
- How did teachers enact inquiry before the program, and how did the

enactment change after the program?

- What changes were there in the nature and use of questions from pre- to post program, and how do these highlight changes in enactment?
- How were teachers' changes linked to the RET, and were there changes that cannot be explained by the RET experience?

The researchers observed the teachers, conducted interviews, emailed and had phone conversations over a two-year period. The data that they collected were triangulated from six different sources that described the teachers' pre- and post-program understanding of inquiry. The sources were as follows: questionnaires, interviews/conversations, classroom recordings, STIR instrument, and participant observations. The researchers looked at data on the four teachers and determined what commonalities existed.

The commonality among the teachers prior to the PD was that they believed that the teacher was the one who caused inquiry to occur. Following the PD the teachers stated that they were more concerned about what the students were doing, rather than themselves.

Prior to the PD the teachers had a low level of knowledge of how to set up and conduct inquiry lessons. They asked very low-level questions. Much improvement was made following the PD on the amount of inquiry that the students were using per the instruments that the researchers used to measure inquiry. Following the PD the amount of questions asked by the teacher decreased and the amount of questions asked by the students increased in each of the four classes. The amount of student questions increased due to the cognitive level of questions being asked by the teachers.

The interviews showed that two of the four teachers discussed a commitment to modify their teaching practice by using an inquiry method. The other two teachers did not express a long-term commitment to this teaching method. However, each of these teachers changed to be much more student centered. Blanchard, et al. (2007, p. 356) state, "Our findings suggest the need for further research to identify the most effective and appropriate way of weaving together theory, reflection, and the research experience to engender teacher change as described by Kegan (1994) and others."

Much of the literature on reform efforts with inquiry based science curriculum discusses the challenges for the teacher. Geier, Blumenfeld, Marx, Krajicik, Fishman, Soloway, & Clay-Chambers (2008) discuss challenges students encounter. Inquiry requires students to collaborate with peers, construct usable knowledge by linking past experiences and new experiences, relate new science content to their lives both inside and outside of school and do this in a long or short term time period. Geier et al., (2008, p. 922) state, "There is a lack of credible research on effective science instruction and curricula for diverse student populations."

Geier et al., (2008, p. 922) stated, "implementing standards-based instructional practice in diverse urban school systems presents a particular set of challenges for educators and their partners in reform efforts." Lack of resources, poverty levels, low student achievement, high student turnover, poor student attendance, and recruiting and retaining high-qualified teachers are just a few difficulties.

The University of Michigan and the Detroit Public School partnership was a PD project that was funded by the National Science Foundation Urban Systemic Initiative

and the Urban Systemic Program to provide opportunities for summer and Saturday workshops, technology resources in the classrooms, and for developing a support system.

The researchers studied whether urban student participation in project-based inquiry science curricula led to higher achievement on statewide tests than the basic district efforts of reform. The curriculum was designed as a series of eight to ten week units that incorporated inquiry investigations. Teachers provided feedback on the units and the units were modified based on their suggestions.

The conclusion suggests that an effort is needed in incorporating and aligning the best practices in curriculum, professional development, and learning technology in the context of a systemic reform (Geier et al., 2008). The researchers noted that during the first years of the implementation of the reform the teachers and the students were adapting to the new curriculum and technology. The administration remained supportive of the program.

The researchers suggested that greater amount of opportunities provided for students using the methodology of inquiry during schooling, the higher the achievement scores would be. The researchers hoped to see additional achievement gains for students that experienced a greater number of inquiry-based projects during their middle school years.

The Teacher Research Update Experience (TRUE) is a 7-week long program developed by The University of Florida. Participants were housed on the University of Florida campus during this time and were involved with learning how to transfer research into classrooms. The teachers were immersed in supportive research and application

experiences that would translate into improved classroom teaching and learning (Barnes, Hodge, Parker, Koroly, 2006).

Barnes, Hodge, Parker, Koroly (2006), investigated perceptions of the TRUE participants' experiences in the program. The study addressed the following research questions:

- How do participants perceive their experiences during the 7 weeks in the TRUE program?
- How have these experiences contributed to their professional and personal growth and development during the institute?
- How may their experiences influence their teaching and, hence, their students' learning?

Barnes et al., (2006), stated that TRUE was previously evaluated by survey instruments, program activity visits, and open-ended questionnaires to gather evaluation information and the previous studies were supportive of TRUE, however the researchers in this study wanted to expand their understanding of the teachers' thoughts, feelings, and attitudes and behaviors during the program. The participants were asked questions using an interview protocol to address various aspects of TRUE. Each interview lasted about 35 minutes. They were tape-recorded and transcribed. Barnes et al., 2006 (cited Spradley, 1997 methodology guidelines) coded and analyzed the teachers responses based on Spradley's guidelines. Two of the researchers coded and grouped the responses under 25 headings once patterns and themes from the interviews emerged. The researchers then evaluated the themes and patterns and made inferences in regards to the program. Barnes et al., (2006) stated that deeper information was gained from

interviews. Barnes et al., (2006) stated, "Compared to the survey results, findings from the in-depth interviews provided deeper insights into the thoughts, motivation, and, in some cases, insecurities of the adult learners" (pg. 258). The findings suggested that the participants were satisfied with the program.

Connecting Undergraduates to the Enterprise of Science (CUES) was designed to support science faculty that are early in the career to incorporate inquiry into their laboratory courses, Hutchins & Friedrichsen (2012). The research question was (Hutchins & Friedrichsen, 2012, p. 872): "In what ways, if any, do science faculty belief systems about inquiry-based teaching change within the context of the CUES program?"

The data collection was through three semi-structured interviews, field notes from observations, and a researchers' journal. The analytic approach was a constant comparative method. The transcripts and the observations were analyzed. The researchers coded the analyzed data. They looked for trends and common themes when coding. This data was triangulated by comparing the different sets of data to contribute to the trustworthiness of the study. The findings suggest the importance of contextual experiences in implementing what science faculty learn (Hutchins & Friedrichsen, 2012). The analysis of *Science Alliance* utilized similar methodology as CUES.

The PD programs mentioned above have similar characteristics to *Science Alliance*. Professional Development research needs, as determined by these researchers, were noted. In addition methodology regarding how they conducted their study was noted and incorporated for the *Science Alliance* assessment. The above studies also gave

insight in what other researchers in the field are noticing in regards to long-term professional development.

Desimone (2009, p. 181) states, "Understanding what makes professional development effective is critical to understanding the success or failure of many educational reforms." Desimone questioned (2009, p. 182), "How can we best measure professional development, and its effects on teachers and students, toward the end of improving professional development programs and policies to foster better instruction and student achievement?" Desimone (2009) reported information on matching data collection methods to the research questions. Observation and interviews are most appropriate methods for in-depth reflection. Observations can make distinctions in practice that a survey cannot. Interviews and observations provide narratives, examples, and anecdotes to answer research questions. Survey data lacks detail, but produces statistics to see trends. Desimone (2009) recommends building your measurement around the appropriateness of the research question.

Summary

The information in this chapter provided an overview of evaluation research already completed in regards to programs similarly set up like *Science Alliance*. This review assisted to identify research needs for future studies in the area of PD. In addition, a framework based on Guskey's (2002) Five Levels of Professional Development was explained. Chapter three will describe the methodology utilized in this study.

Chapter Three

Methods

Description of Participants

Science Alliance was a three-year partnership between three local informal institutions and one school located in the same area funded by a major local business. The elementary school at which the *Science Alliance* program was conducted is a public school located in the Midwest suburban area of the United States. Several opportunities arose for the staff, students and parents through the partnership.

The teaching staff from the three institutions provided a weeklong PD training for the elementary schools teaching staff during the summer of 2010. The training was all day, every day, for one week at the local botanical gardens. The training immersed the teachers in the methodology of inquiry as defined by the Exploratorium. The teachers were learning as a student in their classes would learn. The teachers from the three institutions modeled lessons as they were the teachers and the participating teachers were the students. It was demonstrated to the teachers exactly how the inquiry method could be utilized and taught. Conversations arose during the training regarding to concerns of how to teach using the inquiry method with a group of elementary students.

In addition to the weeklong training, the science institutions trained the elementary school staff during the regular school district's scheduled PD days in the inquiry methodology. Misconceptions and questions the teachers had about the methodology were addressed.

Science Alliance also provided ongoing training every month. Each month one of the members from the partnering institution collaborated with a grade level team to provide a "grass roots" type lesson. "After the grade level team and one staff member from one of the institutions met, the staff member from the institution came back to the grade level team with ideas of how to teach the particular content using inquiry-based methodology. Once the lesson was agreed upon, the teacher from the institution typed the lesson and emailed it to the classroom teachers.

During the first year, the role of the institution teacher during the lesson was to teach the lesson via inquiry. The classroom teachers' role during these lessons was to be more like a teacher assistant, basically, this giving the classroom teacher first hand PD on how to teach his/her curriculum in an inquiry based fashion. The team collaborated and discussed the lesson and what improvements could be made if this lesson was taught again.

The goal of the second year of *Science Alliance* was to wean the elementary staff away from dependence on the institution staff. The second year the elementary staff planned the lesson with the institution staff, agreed on the lesson, and taught the lesson with help from the institution staff. The role of the institution for the second year was to support the elementary school by assisting with lesson planning, typing up the lessons, providing materials for the lessons, and assisting with teaching the lesson.

The third year, teachers contacted the institution staff as they needed help.

Another opportunity included hands on contact with the institutions. During the first year each grade level was provided with three field trips; one to each one of the

institutions. The field trip was planned with the institution's staff and the elementary teacher, again with a "grass roots" philosophy.

During the second year, each grade level was provided two field trips. The local science center dropped their commitment to the grant, therefore reducing the trips available.

The third year, the *Science Alliance* grant provided two field trips per grade level, one to each of the institutions.

Six family nights per year were also provided the first year. During a family night event, the school staff, the institution staff, the students and the parents came together in the evening to collaborate and learn in an inquiry fashion. Three family nights were at the elementary school and the remaining three were at each of the institutions. The intuitions and the elementary school staff consulted with each other with regard to the needs of the family nights. Materials and supplies were funded through the grant. For example, during one family night the local botanical gardens set up tables that provided science experiments in which families could participate. At the same time the staff at the school presented information about their classrooms to the parents and students. The families could rotate to the experiment stations as well as attend the teacher presentations.

The second year, four family nights were provided. Two were at the school and one at each of the participating institutions. During one of the family nights at the local zoo, the institution closed its doors to the public and only allowed the families of the *Science Alliance* schools to enter. During the family nights, many of the activities that would usually have cost money, were allowed for viewing and participation at no charge.

During the third year, the school of study was invited to two family nights. One of the family nights was held at the local zoo and the other at the local botanical garden. Family nights at the school were not provided during the third year.

Student teacher ratio met the state guidelines posted on the Missouri Department of Elementary and Secondary Education (2011). The guidelines state that kindergarten through second grade have a maximum of 25 students, grades three and four had a maximum of 27 students, and grades five and six had a maximum of 30 students (Department of Elementary and Secondary Education, 2011).

The elementary school met the qualifications to receive Title I services. Free and reduced lunch was provided for 55% of the students. The ethnicity of the school consisted of 53% of the students African American, 46% Caucasian and less than 1% other ethnicities.

The sample size was 12. Within the sample, the study had three types of participants (extended training, official training, and school year training. These three types of training were broken into two levels (same location and different location). The research participants are described below and are presented in Table 1.

Table 1

Research Participants

	Same Location	Different Location
Extended Training	n=2	n=1
Official Training	n=4	n=2
School Year Training	n=3	n=0

Participants: N= 12

Three participants participated in the summer inquiry training prior to the *Science Alliance* grant. During the data collection period, two of these teachers worked in the building in which the *Science Alliance* grant was implemented, the other taught in a different location. Six participated in the summer inquiry training the year the *Science Alliance* grant was awarded. Four participants taught at the same school and two were at a different school sites during the 2015 school year. One of these teachers still taught within the district and the other was a teacher that transferred out of the district. Three teachers participated in the *Science Alliance* PD throughout the school year. Those teachers continued to practice at the same school during the spring 2015 data collection.

The teachers finalized their intense portion of their PD at the end of the 2011-2012 school year. During the 2012-2013 school year the teachers contacted the institution staff on as needed basis. The researcher collected data three years after the intense portion of the PD ended.

Description of Instrumentation

A research company named LS Associates of St. Louis or LSA conducted research on the *Science Alliance* program. LSA collected data from pre- and posttests from the lessons, pre- and posttests on the teacher's knowledge of science content, teacher surveys, parent surveys, student surveys, and teacher observations. When the researcher spoke to the manager of the *Science Alliance* grant program, she stated that more research could be completed on *Science Alliance* to validate the data.

LSA (2012) published an executive summary report compiling the data collected over the 2010-2011 and 2011-2012 school years in regards to the *Science Alliance* training. The survey data in LSA's (2012) report compared the end of the 2011 and the end of the 2012 school years. This researcher had access to comparing the reported data on three sub-scales. These three sub-scales include how often your students take part in each of these activities during science instruction, the teachers use of assessment strategies and how prepared the teachers felt in teaching particular science topics at the grade level that they taught.

Research was not found investigating the reliably and validity of the survey utilized by *Science Alliance*. To remain consistent and to compare data, the researcher utilized the same survey. The researcher added one statement to the survey. This statement is as follows, "*Science Alliance* was beneficial to my teaching practice." The survey was created and administered by the researcher through Qualtrics. The survey is found in Appendix A.

Science Alliance utilized an observation tool to observe teachers based on similar instruments listed on the copy of the protocol in Appendix B. The observation tool was called the Local Systemic Change Classroom Observation Protocol developed by Horizon Research (2005).

Science Alliance in their final report (LSA, 2012) reported eleven of the twelve sub-scales from the observation protocol. The protocol used a 6-point Likert scale where 0 meant did not occur and 5 meant occurred to a great extent. Each sub-scale had descriptors to align to the sub-scale.

The researcher designed and conducted an interview based on Guskey (2002) Five Levels of Professional Development. The interview questions are located in Appendix C. To assist with reliability and validity the researcher designed questions based on Guskey (2002) Five Levels of Professional Development. The table located in Appendix D states each interview question asked and which of Guskey's (2002) levels of professional development it addresses.

Research Design

A descriptive case study is defined by Merriam (2009, pg. 43), "as an in depth description and analysis of a bounded system". In this study the interview provided the basis for the in depth description. Interviews and observation data from 2012 to 2015 assisted in supporting the data. The bounded system is a long-term professional development program called *Science Alliance*. The researcher collected and analyzed interview, survey and observation data from the twelve participants that made up the case study.

The interviews were conducted at a time and location that was convenient to the interviewees. Each interview was recorded using a handheld recorder. After all interviews were conducted, the researcher transcribed each interview to a Word Document. The responses were read several times. The researcher made notes of key descriptors and patterns in the comment section on a Word Document. To ensure consistency with coding the researcher transferred all interview data to a matrix shown in Appendix F to compare the interviewee's responses. Each question was transferred to the matrix that corresponded with that question. In all there were five matrices, one for each of Guskey's (2002) levels. The researcher reread the responses several times and then began to highlight occurring phrases or words for each question. Themes for each question were considered after reviewing the list of frequently occurring phrases or words. Each coded phrase or word was compared to all of the other participants within that same category. The participants themes were then compared to participants in other categories of participation. All of the questions were compared in the same way. The original plan was to analyze the data with different levels of participation, in two categorical groups. Due to the small size and for the protection of the participant's identity, the researcher reported the data as a full group in chapter 4 and chapter 5.

The *Science Alliance* participants were all given the opportunity to participate in a survey that was distributed by the Qualtrics' website to the teachers' email address. Participants were informed in person by the researcher about the survey when they agreed to participate in the study by signing a consent form. Following the data collection, data were transferred to an excel document to compare the mean scores and

the differences between means. The researcher compared the means of all of the data LSA (2012) reported for spring 2012 to the data from the 2015 Qualtrics' survey.

All participants were asked if they could be observed teaching an inquiry lesson. Appointments were made with the willing participants either via email, by phone or in person. Following the observations, the data were transferred to an excel document to compare the mean scores and the differences in mean scores.

After all forms of data were collected, the descriptive findings, themes, and patterns as noted in chapter four, were placed in matrices to compare common themes and trends. Each was labeled one of Guskey's (2002) Five Levels of Professional Development. A sample of what the matrix looked like is provided in Table 2. This particular matrix is based on Level I of Guskey's (2002) Five Levels of Professional Development.

Table 2

Level 1 Matrix

Evaluation Level	Research Method
Level I: Participants' Reaction	Survey
	Observation
	Interview
	Common Themes

Findings from the qualitative and quantitative research that would align were added to the findings in the matrices to analyze. Due to the sample size of the participants data presented in chapter 4 and chapter 5 were reported as a whole group, rather than in sub-groups.

Description of Procedures

Once IRB approval was obtained, the teachers were contacted and invited to participate in the study and were presented with the consent form. A copy of the consent form is found in Appendix E. Once approval was obtained from all of the participants, the researcher locked the consent forms into a secure location. The survey was then sent

via email though the Qualtrics' website. At the same time attempts were made to schedule interviews and observations with all of the participants.

Ethics and Human Relations

There were no known threats that this study posed for the research participants. This study compared existing data collected by the *Science Alliance* grant program and data collected by the researcher. The study was designed so that identifying information on participants would not be reported. The researcher was the only person with access to any individual data. The data were locked inside a cabinet located in the researcher's home. Data from the Qualtric's website are password protected. The identifying data was shredded once the study was complete.

The *Science Alliance* data were compiled and shared as an aggregate participant group to maintain anonymity.

All staff that participated in *Science Alliance* had the opportunity to assist in the study by participating in a survey, answering interview questions, and allowing observations of their classroom. The participants' information remained anonymous in each of these situations.

Science Alliance attempted to train all teachers in the school in inquiry methodology, regardless of what subject the teacher taught. So, each teacher, regardless of what subject(s) they taught, was given the opportunity to participate in the study. Therefore, if the teacher taught science or not, they were still able to participant in the PD and were eligible to be part of the data pool.

Summary

The purpose of this chapter was to describe the methodology and the research design utilized in this study to answer the research question. The following chapter will present the results of the research.

Chapter 4

Results

Overview

The data for this descriptive case study were collected in three forms. Interview data were analyzed utilizing a comparison matrix based on Guskey's' (2002) Five Levels of Professional Development Evaluation. Mean scores and the differences between means from survey and observation data were compared to support interview data. The research question was: How are the teachers that participated in the *Science Alliance* grant using and implementing the inquiry methodology based on the definition as defined by the Exploratorium? This chapter will provide a presentation of the three forms of data collected organized by data collection.

Qualitative Results

Interview Data

Interview questions were created based on Guskey's' (2002) Five Levels of Professional Development Evaluation. The qualitative data was analyzed to identify themes representing the sustainability of training received through the *Science Alliance* grant. The data were analyzed utilizing a comparison matrix based on Guskey's' (2002) Five Levels of Professional Development Evaluation and the level of participation of the interviewee.

Ten participants were interviewed. Two participated in the summer inquiry training prior to the *Science Alliance* grant. Five participated in the inquiry training the year the *Science Alliance* grant was awarded. Three of those five participants teach in the building in which the grant was awarded. Three participated in the *Science Alliance*

grant, however did not attend the summer training. The three participants teach in the building in which the grant was awarded.

After all interviews were conducted, the researcher transcribed each interview to a Word Document. To ensure consistency with coding the researcher transferred all interview data to a matrix created to compare the interviewee's responses. Each question was transferred to the matrix that corresponded with that question. The researcher highlighted reoccurring phrases or words for each question. Themes for each question were considered after reviewing the list of frequently occurring phrases or words. Each highlighted phrase or word was compared to all of the other participants within that same category. The participant themes were then compared to participants in other categories of participation. All of the questions were compared in the same way.

The original plan was to report the data with different levels of participation, in two categorical groups. Due to the small sample size and for the protection of the participant's identity, the researcher reported the data as an aggregate group. The transcribed interviewees with highlighted common key words and phrases are located in Appendix G. To protect the interviewees' identity, each was assigned a number 1 through 10. In addition, occasionally an interviewee shared identifiable information, such as the grade level they taught. This information was replaced with a X.

Question One:

Question one asked, "What subject area(s) did the *Science Alliance* assist you with?" Nearly all of the participants, nine out of ten replied that science was the subject area that *Science Alliance* assisted them with. However, the teachers that were

interviewed also stated that *Science Alliance* assisted them with other subject areas. Table 3 displays the responses. The participants sometimes indicated that *Science Alliance* assisted them with more than one content area. In that case, their information was counted in more than one of the content areas.

Table 3

Number of Participants that Responded in Regards to Each Subject Area

Subject Area	n
All subject areas	2
Science	9
Writing	1
Math	3
Social Studies	3
Reading	1

Participants *N*= 10

Question Two:

Question two asked, "On a four point rating scale: (4 meaning very prepared, 3 meaning somewhat prepared, 2 meaning not prepared, 1 meaning not prepared at all) Rate how prepared you feel teaching inquiry after participating in the three year long professional development? Please explain your answer." This question addressed the participant's reaction level in Guskey's (2002) model. Seven teachers interviewed rated their preparedness of teaching inquiry as a four. Three teachers rated their preparedness a three.

The participants supported their rating with the two different themes. One theme stated that the professional development gave them the tools and information to teach using the inquiry method. Assistance with math was the other theme and was mentioned in two of the ten interviews. Participants responded as follows:

> Four. I just feel like it gave me the tools to apply this, I mean even though it was directed at science, I was able to take those science examples and apply them to math and social studies, so I feel like it was a four because I was able to apply them even further than what *Science Alliance* had intended it for (Interviewee 1, personal communication, May 2015).

> I would say a 4. I feel like after *Science Alliance* it really kind of prepared me with more questions and knowing the questions to prompt deeper exploration to what the kids had been practicing and learning and their objectives that were met and even hearing the kids using the deeper thinking in the their groups during their learning really helped as well (Interviewee 10, personal communication, May 2015).

> Four, very prepared. Not knowing what inquiry was too much before the *Science Alliance* grant. Having participated in it let me to develop my own lessons using inquiry. Confirming my original thoughts about inquiry and finding out that I was doing inquiry like lessons all along, just did not know that was the term to use with it. But, having the *Science Alliance* grants' lessons and the teachers that came in helped me and prepared me to be able to leaving me to develop them on my own (Interviewee 9, personal communication, May 2015).

Question Three:

Question three asked, "Did your attitudes or beliefs change in regards to teaching inquiry after participating in the *Science Alliance* grant? Explain why or why not." This question addressed the participant's learning level in Guskey's (2002) model. Seven of the ten participants that were interviewed responded with the theme that their attitudes or beliefs changed positively after participating in the *Science Alliance* grant. Three of the ten participants responded with the theme yes and no because they had taught using the inquiry method prior to the training.

Six of the ten participants supported their answers with the theme that *Science Alliance* gave them a better understanding of inquiry and they are able to teach it in other subject areas:

> Well, my belief changed because I did not think I was teaching inquiry and I actually was, but I think I was not doing it with fidelity and since participating in the grant I feel like I carry inquiry into more subject areas other than science. When you think inquiry, you automatically just think science and learning the background and the steps to inquiry, I was able to carry that over into other subject areas (Interviewee 9, personal communication, May 2015).

Two of the ten participants changed the way they begin a lesson by not always telling the outcomes upfront:

> Yes. I don't think I thought too much about giving them the idea, not telling them what I am teaching them. I think I was very objective created. I would say the

> objective and then we would prove the objective right (Interviewee 2, personal communication, May 2015).

One participant did not realize that inquiry could be a short lesson:

> I realized that I could do an inquiry lesson in 5 minutes. As long as I did not tell them what I was doing first. So, that was a pretty big mind change on my part (Interviewee 2, personal communication, May 2015).

Question Four:

Question Four asked, "Do you feel that this PD had any impact on the change of the climate in our building? If so, how? If not, why?" This question addressed the organization support and change level in Guskey's (2002) model. Nine of the ten participants stated they felt that the PD had an impact on the change of the climate in our building.

Five of the ten participants responded with the theme they focused on a new teaching style that the PD changed their teaching practice:

> Yes, I do. At the time, I was more of a new teacher, but the PD strengthened us as a whole because we were focusing on the same teaching style (Interviewee 9, personal communication, May 2015).

Five of the ten teachers supported their answer with the theme stating they became more excited and the PD experiences refreshed their lessons:

> Definitely, I think that it just gave us more time to just be together and to focus and share what worked in our room. The PD gave us a ton of time together to add

> to our lessons and to develop them for the kids. I think it was great (Interviewee 10, personal communication, May 2015).

Two of the ten interviewees mentioned that it would be nice to get a refresher in the PD because there was a turnover in staff during the 2014-2015 school year:

> It would be nice to have a refresher on inquiry more often, because I feel like then it would be more permanent. But, overall I think it did change the climate in our building (Interviewee 9, personal communication, May 2015).

Question Five:

Question Five asked, "Do you feel as though your instructional practice changed due to the *Science Alliance* grant? If so, how? If not, why?" This question addressed the participants' use of new knowledge and skills level in Guskey's (2002) model. Nine of the ten participants were asked and answered this question. Nine participants replied yes.

Three themes arose during the responses to this question.

Three of the nine participants responded that they applied inquiry to other subject areas in their supporting answer.

> Yes, lots more projects. Lots more inquiry based activities and things. I try to bring them into math as frequently as possible. It keeps me conscious and it makes me aware of what I am doing and how I am doing it. So, I did change some of the structures of the things that I am doing (Interviewee 7, personal communication, May 2015).

Five of the nine participants supported their answer with the theme that students were generating a lot more of their own ideas, rather than direct instruction teaching:

> Yes. Before I took the *Science Alliance* program I felt like I was pushing towards the questions that I wanted instead of the questions that they wanted to ask. It felt very teacher guided vs. student-guided questioning. Since the program, I leave it up to the students. Some students need a little push. But, when you make it theirs, there is a lot more leaning going on and they take more ownership of it (Interviewee 4, personal communication, May 2015).

Three of the nine teachers supported their answer to the theme that indicated they were utilizing projects and research to assist the students in attaining the learning targets:

> Yes. I allowed the kids more time to do hands on activities, do research, and talk more guiding them on appropriate questions to ask when researching something and experimenting with the things that we were doing (Interviewee 6, personal communication, May 2015).

Question Six:

Question Six asked, "Did the PD affect student performance or achievement? Explain in what way(s)?" This question addressed the student learning outcomes level in Guskey's (2002) model. Eight of the ten participants responded yes. These answers were explained by two themes.

The first theme focused on the fact that the state we reside in assesses our elementary students in the area of science during the fifth grade school year. Four of the ten participants explained their answer with reasons such as:

> I am not sure. Looking at standardized test scores is hard because you have a different group of students from year to year. With science only being tested in the fifth grade, I don't know the exact results (Interviewee 4, personal communication, May 2015).

The second theme was that the students scored higher on the posttests than the pretests that were given to them when the teachers taught using the inquiry method. Five of the ten participants responded such as:

> Well, I would say students performed well on the tests that we gave them. I think that as they went up into testing grades they kept their knowledge base, which helped them to stay more familiar with it (Interviewee 5, personal communication, May 2015).

> I believe so. The grade I teach is not tested in science. I do know in the pretests and posttests that we gave, they seem to get the big ideas more when we do the inquiry based as opposed to any other style when we teach. So, I do think it has given the kids great gains on the scores. We are just not tested by the state in that grade level (Interviewee 7, personal communication, May 2015).

Question Seven:

Question Seven asked, "Do you have anything you would like to add in regards to participating in the *Science Alliance* grant?" This question could have addressed any of the levels in Guskey's (2002) model. Three common themes arose from this question.

First, seven of the ten participants stated they were glad they participated and thought that it was a great program:

> It was a wonderful program. The coordinators did a great job. I never felt threatened having them in my classroom. I never felt like I was being evaluated by them. They were there as an aid. If I made a mistake, it was OK. They were very helpful. They had all the supplies that I needed. I never had to find anything. I just gave them a list. It was a great program and I think it should be everywhere (Interviewee 3, personal communication, May 2015).

Second, five of the ten participants themes stated they missed the opportunities of the resources and collaboration:

> I did really enjoy the people that came in and gave us the guidance and showed us how to do the lessons. It's always good to have a different approach. The kids really enjoyed those and that part I really kind of miss. I also like the planning piece because you can sit down with them and talk about ideas and they would give you some suggestions and you would kind of come up with a plan together what the lesson was going to look like and what the students were going to look like. That's a strength too (Interviewee 5, personal communication, May 2015).

Third, two of the ten responded with the theme that they would like it if the *Science Alliance* grant was available for the new teachers in the building. Participants responded such as:

> I miss it. I miss that we don't have it anymore. We have some of the activities. The facilitators in the grant were kind enough to leave some materials with us. Those things have gotten old over the years, because we use it so much. So, I wish we still had it. The kids really miss the field trips. We all miss some of the

> opportunities because based on and the restructuring of our lessons it is difficult to replicate. So, I do miss it dearly. I wish we still had it. But, overall I think it was wonderful because it does change the way that we teach. Since then we have gotten some new teachers. It is nice to try to share with them, but it is different because it is not the official training. So, I do greatly miss it. But, it has changed the way that I teach (Interviewee 7, personal communication, May 2015).

Quantitative Results

Survey Data

The researcher had access to the survey data on three sub-scales. These three sub-scales included: how often your students take part in each of activities addressed in the descriptors during science instruction, the teachers use of assessment strategies and how prepared the teachers felt in teaching particular science topics at the grade level that they taught. The difference in mean scores utilizing the 2012 to 2015 data were calculated and analyzed. Eight teachers participated in the 2012 data collection. Ten teachers participated in the 2015 data collection. The survey data supported the research question regarding sustainability of the inquiry methodology as to how and to what degree the teachers continued to utilize and implement inquiry based on the definition defined by the Exploratorium learned during the *Science Alliance* training. The survey data is presented Appendix H.

The first subscale stated, "Click the circle that best describes how often your students take part in each of these activities during science instruction. Please respond based on your teaching experiences during this school year." The difference in the

overall mean score from 2012 to 2015 was 0.3. This data suggests that teachers maintained the activities practiced during the *Science Alliance* PD.

Eighteen of the descriptors either were rated the same score or increased slightly. Three of the descriptors mean scores increased by 0.5 or higher. These included the following descriptors: brainstorming ideas for an investigation, sharing alternative explanations, and writing about their findings in their journals. Four descriptors had a negative difference in mean score less than -0.2. These included the following descriptors: conducting their own science experiment, learning science vocabulary, making connections between experiments and main ideas and watching teachers science demonstrations. Three of the descriptors could not be compared, as data for 2012 was not available on LSA's (2012) report.

The second subscale stated, "Click the circle that best describes your use of each assessment strategy used in science this school year." The difference in the overall mean score from 2012 to 2015 was 0. This data suggests that teachers maintained the assessment practices during the *Science Alliance* PD.

Seven of the descriptors either were rated the same score or increased slightly. Challenging student explanations was the only mean score that increased by 0.5. The remaining six had a difference of mean score that was less than 0.5. Posing questions as students work was the only descriptor that had a decrease in the difference in mean score. The difference for that descriptor was -0.2.

The third subscale reported stated, "Click the circle that describes how prepared you feel in teaching these topics at your grade level." The difference in the overall mean

score from 2012 to 2015 was -0.3. This data suggests that teachers decreased in their feeling of preparedness in teaching science topics at their grade level.

Twenty-four descriptors decreased in their difference of mean scores. The negative difference ranged between -0.1 to -0.5. Four descriptors either remained at the same rating or had a slight increase. The four descriptors include: properties of matter, states of matter, mixtures and solutions, and the water cycle. The greatest difference in mean scores was 0.2.

Observation Data

Science Alliance in their final report (LSA, 2012) reported eleven of the twelve sub-scales from the observation protocol. The difference in mean scores utilizing the 2012 to 2015 data were calculated and analyzed. Sustainability of the inquiry methodology through observation data supported the research question in the attempt to view how and to what degree did the teachers continued to utilize and implement inquiry strategies based on the definition defined by the Exploratorium learned during the *Science Alliance* training. Ten teachers participated in the observation. The observation data is located in Appendix I.

The first subscale stated, "This lesson prepares a community of learners for responsible science learning." The difference in the overall mean score from 2012 to 2015 was 1.4. This data suggests that teachers maintained in the preparation of creating a community of students responsible for their science learning.

Table 4 below displays the spring 2012 mean data to the spring 2015 data with the difference of mean scores. Each of the differences of mean scores in this subscale increased by 1.2 or greater.

Table 4

This lesson prepares a community of learners for responsible science learning

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Uses wait time	3.8	5.0	1.2
Uses constructive, descriptive praise	2.9	4.6	1.7
Is non-judgmental of student responses	3.2	4.6	1.4
Encourages student input and questions	3.5	5.0	1.5
Interacts equitably with students in small groups	3.6	5.0	1.4
Mean score	3.4	4.8	1.4

The second subscale stated, "This lesson encourages students to understand science concepts and science process skills using multiple instructional strategies". The difference in the overall mean score from 2012 to 2015 was 0.5. This data suggests that teachers sustained the practice of encouraging students to understand science concepts and science process skills utilizing multiple instructional strategies.

One of the differences in this subscale decreased in mean scores by -0.1. This descriptor stated, "uses multiple strategies to explain a concept". The remaining three descriptors increased in the difference of mean score by 0.4 or greater.

The third subscale stated, "Instructional decisions are made within the lesson in order to probe and use students' existing knowledge and preconceptions". The difference in the overall mean score from 2012 to 2015 was 0.4. This data suggests that teachers sustained the utilization of probing students for prior knowledge.

One of the differences in this subscale decreased in mean scores by -0.3. This descriptor stated, "allows for exploration of science concept in experiential or discovery activities ". The remaining four descriptors increased in the difference of mean score by 0.3 or greater.

The forth subscale stated, "The lesson presents inquiry opportunities for students". The difference in the overall mean score from 2012 to 2015 was -0.3. Table 5 displays the all descriptors in this subscale. One of the descriptors increased in the difference of mean score by 0.4. This descriptor stated, "provides choice of tools for investigation."

Table 5

The lesson presents inquiry opportunities for students

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Allows for questions to arise out of the experiential or discovery activities	3.7	2.9	-0.8
Facilitates transition from discovery to investigation	2	1.4	-0.6
Provides choice of tools for investigation	1.3	1.7	0.4
Mean score	2.3	2	-0.3

The fifth subscale stated, "Interactions during the lesson reflect collaboration and productive discourse". The difference in the overall mean score from 2012 to 2015 was 1.3. This data suggests that teachers increased the activities in regards to reflection and productive discourse. Table 6 displays all of the descriptors for this subscale. These three descriptors had an increase in the difference in mean score by 1.2 or greater.

Table 6

Interactions during the lesson reflect collaboration and productive discourse

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Interacts with small groups	3.6	5	1.4
Organizes students for group work	3.7	5	1.3
Provides clear objectives for group work	3.7	4.9	1.2
Mean score	3.7	5	1.3

The sixth subscale stated, "Alternative solution strategies and ways of interpreting evidence are encouraged". The difference in the overall mean score from 2012 to 2015 was 1.5. This data suggests that teachers increased the ways of interpreting evidence with their students. Table 7 displays all of the descriptors for this subscale. These three descriptors had an increase in the difference in mean score by 1.2 or greater. The degree teachers encourage the using of alternative solution strategies and promoting ways of interpreting evidence had a difference in the in mean score of at least 2.0.

Table 7

Alternative solution strategies and ways of interpreting evidence are encouraged

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Accepts multiple responses to problems	3.3	3.6	0.3
Provides example(s) of evidence for student interpretation	3.0	3.6	0.6
Solicits alternative explanations	1.8	4.3	2.5
Encourages discussion of alternative explanations	2.0	4.3	2.3
Encourages multiple representations of the data	1.6	3.6	2.0
Mean score	2.4	3.9	1.5

The seventh subscale involved, "Intellectual rigor, constructive criticism, and the challenging of ideas are valued". The difference in the overall mean score from 2012 to 2015 was 0.4. This data suggests that teachers maintained the activities practiced during the *Science Alliance* PD under this subscale. This subscale had two descriptors. Challenges students' idea difference in mean score increased by 1.4 from 2012 to 2015. Encourages students to challenge the text as well as each other decreased in difference of the mean score by -0.5.

The eighth subscale stated, "The lesson promotes coherent conceptual understanding in the context of clear learning goals". The difference in the overall mean

score from 2012 to 2015 was 1. This data suggests that teachers maintained the activities practiced during the *Science Alliance* PD under this subscale. This subscale had three descriptors. Connects inquiry activities to the main concept(s) had a difference in mean score of 2.3. The other two descriptors in this subscale had a difference in mean scores were between 0 and 0.2.

The ninth subscale stated, "Appropriate connections are made between content and other curricular areas". The difference in the overall mean score from 2012 to 2015 was 0.8. This data suggests that teachers maintained the activities practiced during the *Science Alliance* PD under this subscale. This subscale had three descriptors. Integrates content with other curricular areas had a difference in mean score of 2.4. Applies classroom activities to diverse real-world situations had a difference in mean score of 1. Integrates reading and writing into science had a difference in mean score of -0.9.

The tenth subscale stated, "The lesson includes correct and appropriate content". The difference in the overall mean score from 2012 to 2015 was 0.8. This data suggests that teachers maintained the activities practiced during the *Science Alliance* PD under this subscale. This subscale had three descriptors. As displayed in table eight, each descriptor had a difference in mean scores of 0.4 or greater.

Table 8

The lesson includes correct and appropriate content

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Presents content that is accurate	4.6	5	0.4
Presents content appropriate to students' cognitive levels	4.3	5	0.7
Recognizes students' thinking when vaguely articulated	3	4.3	1.3
Mean score	4	4.8	0.8

The eleventh subscale stated, "This lesson includes reflection about learning". The difference in the overall mean score from 2012 to 2015 was 1.6. This data suggests that teachers increase in the descriptors practiced during the *Science Alliance* PD under this subscale. This subscale had three descriptors. As displayed in table nine, each descriptor had a difference in mean scores of 0.7 or greater. The greatest increase in the difference of mean scores was on the descriptor titled, "allows time for reflection." This descriptor had a difference in mean score of 2.7.

Table 9

This lesson includes reflection about learning

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Encourages students to explain a concept	3.7	5	1.3
Allows time for reflection	2.3	5	2.7
Encourages students to explain how they are learning ("sense-making")	3.7	4.4	0.7
Mean score	3.2	4.8	1.6

Summary

The data provided in this chapter was obtained in order to support the research question. The quantitative data analysis reported from the survey and observation suggest sustainability of the PD provided by *Science Alliance*. The qualitative results provide depth to the quantitative results. The following chapter will attempt to analyze the data and provide recommendations for future research.

Chapter 5

Discussion

The purpose of the discussion is to summarize and conclude the data analyzed from the descriptive case study on a long-term professional development (PD) called *Science Alliance*. This study adds to the research on school wide PD. With proper "buy in" school administrators can utilize a model similar in the implementation of their initiative. Staff developers implementing PD for science and mathematics could utilize the research to make their work more effective. Future researchers may use findings from this study when developing future grant proposals or to aid their research.

Findings and Interpretations

The findings discussed in chapter four were placed on matrices based on Guskey's (2002) Five Levels of Professional Development. The five levels include: reaction of the participants, learning of the participants, organization support and change, participants' use of new knowledge and skills, and student learning outcomes. Each of the findings aligned to a matrix and was copied to the matrix to be analyzed. Key words were highlighted. Due to the sample size of the survey the results were reported as a whole group, rather than in sub-groups of the participants.

Participants' Reaction

The first evaluation level in Guskey's (2002) model is the participants' reaction. Guskey (2002) states that on this level we focus on whether or not the participant was satisfied with the experience. A question that would support this category might include, "Was the leader knowledgeable and helpful?" Guskey (2002, pg. 46). The questions on

this level are typically the most common forms of professional development evaluations. They typically focus on basic human needs. Guskey (2002) states that questions that measure the initial satisfaction of the participants can help you improve the design and delivery of programs. The reaction of the participants was addressed in three of the interview questions.

The second interview question asked, "On a four point rating scale: (4 meaning very prepared, 3 meaning somewhat prepared, 2 meaning not prepared, 1 meaning not prepared at all) rate how prepared you feel teaching inquiry after participating in the three yearlong professional development? Please explain your answer."

Seven of the ten teachers interviewed rated their preparedness of teaching inquiry a four on a four point likert scale. Three teachers rated their preparedness a three. The participants supported their rating by stating that the professional development gave them the tools and information to teach using the inquiry method. Two of the ten participants supported their answer by stating *Science Alliance* assisted them with math inquiry, rather than science inquiry.

Question seven on the interview asked, "Do you have anything you would like to add in regards to participating in the *Science Alliance* grant?" Three common themes arose addressed the reaction of the participants when asked this question. Seven of the ten participants stated in their answer that they were glad they participated and thought that it was a great program. Five of the ten participants stated they missed the opportunities of the resources and collaboration. Two of the ten responded with the

theme that they would like it if the *Science Alliance* grant was available for the new teachers in the building.

The interview data suggests that participants were satisfied with the PD. The participants felt prepared to teach the inquiry methodology as defined by the Exploratorium. This statement is supported with the high number of participants rating the PD a three or a four. When asked to add additional information about *Science Alliance*, many of the participants expressed that they were glad that they participated. Half of the participants stated they missed the opportunities and collaboration of *Science Alliance*. The reaction of the participants' preparedness to teach the methodology of inquiry increased.

Participants' Learning

The second level of evaluation in Guskey's (2002) model is the learning of the participants. Guskey (2002) stated that during this level the focus is on whether or not the participant has learned something. Guskey (2002) states that questions that measure the learning of the participants are used to improve program content, format, and organization. The interview data was supported by the survey and the observation data on this level of evaluation.

The third question on the interview asked, "Did your attitudes or beliefs change in regards to teaching inquiry after participating in the *Science Alliance* grant? Explain why or why not." This question had four themes that arose.

Seven of the ten participants that were interviewed stated that their attitudes or beliefs changed positively after participating in the *Science Alliance* grant. Three of the

ten teachers stated yes and no because they had taught using the inquiry method prior to the training. Six of the ten participants supported their answers by stating that *Science Alliance* gave them a better understanding of inquiry and they are able to teach using that methodology in other subject areas. Two of the ten participants changed the way they begin their lessons by not always telling the outcomes of the lesson upfront.

Three sub-scales within the survey were compared. The third subscale stated, "Click the circle that describes how prepared you feel in teaching these topics at your grade level." The difference in the overall mean score from 2012 to 2015 was -0.3. This data suggests that teachers decreased in their feeling of preparedness in teaching science topics at their grade level.

Twenty-four descriptors decreased in their difference of mean scores. The negative difference ranged between -0.1 to -0.5. Four descriptors either remained at the same rating or had a slight increase. The four descriptors include: properties of matter, states of matter, mixtures and solutions, and the water cycle. The greatest difference in mean scores was 0.2.

The observation data also addressed participants' learning. Many of the sub-scales of the observation indicated a significant difference in mean scores from the spring 2012 to the spring 2015 data collection.

All five of the descriptors in the first sub-scale had a significant difference in mean score of at least 1.4. These descriptors included: uses wait time, uses constructive descriptive praise, is non-judgmental of student responses, encourages student input and questions, and interacts equitably with students in small groups.

The second subscale stated, "This lesson encourages students to understand science concepts and science process skills using multiple instructional strategies". The difference in the overall mean score from 2012 to 2015 was 0.5. This data suggests that teachers sustained the practice of encouraging students to understand science concepts and science process skills utilizing multiple instructional strategies. One of the differences in this subscale decreased in mean scores by -0.1. This descriptor is stated, "uses multiple strategies to explain a concept". The remaining three descriptors increased in the difference of mean score by 0.4 or greater.

The third subscale stated, "Instructional decisions are made within the lesson in order to probe and use students' existing knowledge and preconceptions". The difference in the overall mean score from 2012 to 2015 was 0.4. This data suggests that teachers sustained the utilization of probing students for prior knowledge. One of the differences in this subscale decreased in mean scores by -0.3. This descriptor is stated, "allows for exploration of science concept in experiential or discovery activities ". The remaining four descriptors increased in the difference of mean score by 0.3 or greater.

The forth subscale stated, "The lesson presents inquiry opportunities for students". The difference in the overall mean score from 2012 to 2015 was -0.3. One of the descriptors increased in the difference of mean score by 0.4. This descriptor stated, "provides choice of tools for investigation."

The fifth subscale stated, "Interactions during the lesson reflect collaboration and productive discourse". The difference in the overall mean score from 2012 to 2015 was 1.3. This data suggests that teachers increased the activities in regards to reflection and

productive discourse. These three descriptors had an increase in the difference in mean score by 1.2 or greater.

The sixth subscale stated, "Alternative solution strategies and ways of interpreting evidence are encouraged". The difference in the overall mean score from 2012 to 2015 was 1.5. This data suggests that teachers increased the ways of interpreting evidence with their students. These three descriptors had an increase in the difference in mean score by 1.2 or greater. Three of the five descriptors in the subscale alternative solution strategies and ways of interpreting evidence are encouraged had a difference in the in mean score of at least 2.0.

The seventh subscale stated, "Intellectual rigor, constructive criticism, and the challenging of ideas are valued". The difference in the overall mean score from 2012 to 2015 was 0.4. This data suggests that teachers maintained the activities practiced during the *Science Alliance* PD under this subscale. This subscale had two descriptors. Challenges students' ideas increased in the difference of mean scores by 1.4 from 2012 to 2015. Encourages students to challenge the text as well as each other decreased in the difference of mean score by -0.5.

The eighth subscale stated, "The lesson promotes coherent conceptual understanding in the context of clear learning goals". The difference in the overall mean score from 2012 to 2015 was 1. This data suggests that teachers maintained the activities practiced during the *Science Alliance* PD under this subscale. This subscale had three descriptors. Connects inquiry activities to the main concept(s) had a difference in mean

score of 2.3. The other two descriptors in this subscale had a difference in mean scores were between 0 and 0.2.

The ninth subscale stated, "Appropriate connections are made between content and other curricular areas". The difference in the overall mean score from 2012 to 2015 was 0.8. This data suggests that teachers maintained the activities practiced during the *Science Alliance* PD under this subscale. This subscale had three descriptors. Integrates content with other curricular areas had a difference in mean score of 2.4. Applies classroom activities to diverse real-world situations had a difference in mean score of 1. Integrates reading and writing into science had a difference in mean score of -0.9.

The tenth subscale stated, "The lesson includes correct and appropriate content". The difference in the overall mean score from 2012 to 2015 was 0.8. This data suggests that teachers maintained the activities practiced during the *Science Alliance* PD under this subscale. This subscale had three descriptors. As displayed in table eight, each descriptor had a difference in mean scores of 0.4 or greater.

The eleventh subscale stated, "This lesson includes reflection about learning". The difference in the overall mean score from 2012 to 2015 was 1.6. This data suggests that teachers increase in the descriptors practiced during the *Science Alliance* PD under this subscale. This subscale had three descriptors. Each descriptor had a difference in mean scores of 0.7 or greater. The greatest increase in the difference of mean scores was on the descriptor titled, "allows time for reflection." This descriptor had a difference in mean score of 2.7.

Interview data is supported by survey and observation data. Most of the participants had a positive change in attitude of belief in regards to teaching using the inquiry methodology. A little over half of the participants felt as though the training gave them a better understanding of inquiry and they were able to transfer this methodology into other subject areas. The sub-scale on the survey in regards to the preparedness that the teachers felt teaching science content indicated a slight decrease. The observation data indicated on many of the subscales an increase in the difference of mean scores from 2012 to 2015. Teachers continued the implementation and methodology, which suggests the participants acquired the intended knowledge and skills.

Organization Support and Change

The third evaluation level in Guskey's (2002) model is organization support and change. Guskey (2002) states that on this level we focus on shifts in the organization. A question that would support this category might include, "Did it affect the organization's climate and procedures?" Guskey (2002). The questions on this level are critical in indicating a success of a program. Proper support needs to be on all levels of the organization in order to see change in the organization. Guskey (2002) states that if there are problems with the third level of evaluation, the successes in level one and two could be canceled out. Guskey (2002) states that questions that measure organization support and change could be used to document and improve organization support, but also to inform future change initiatives. Two of the interview questions addressed this level of PD.

Question four of the interview addressed the organization's support and change. The question asked was, "Do you feel that this PD had any impact on the change of the climate in our building? If so, how? If not, why?" Nine of the ten participants stated they felt that the PD had an impact on the change of the climate in their building. Five of the ten participants supported their answer by stating they focused on a new teaching style that changed their teaching practice.

Two of the common themes arose during question seven of the interview that addressed the organization's support and change. The question asked, "Do you have anything you would like to add in regards to participating in the *Science Alliance* grant?" Five of the ten participants stated they missed the opportunities of the resources and collaboration. Two of the ten participants stated they would like it if the *Science Alliance* grant was available for the new teachers in the building.

The two questions on the interview had a large percentage of participants that stated the PD impacted the climate of the building. Common themes did arise during these two interview questions: the participants were focused as a building on a new teaching style that changed their practice, they missed the collaboration of a particular teaching style, they missed the opportunities and resources that the grant provided and they would like for the support to be available for the new teachers in the building. The data from the interview supports the sustainability of the PD in the school, with the exception of the new teachers in the building who did not participate in *Science Alliance*.

Participants' use of New Knowledge and Skills

The forth evaluation level in Guskey's (2002) model is participants' use of new knowledge and skills. Guskey (2002) states that on this level we ask whether or not the participant learned new knowledge or skills that will make a difference in their professional practice. Information at this level cannot be gathered at the end of the PD session. Instead, participants need to be allowed time to practice the new ideas in their settings. The research reported has allowed a three-year time span since the intense portion of the PD.

A question that would support this category is, "Did participants effectively apply the new knowledge and skills?" Guskey (2002). Questions on this level can be analyzed to help restructure future programs and more consistent implementation (Guskey, 2002). Interview data is supported with survey and observation data at this level of evaluation.

Question five of the interview addressed participants' use of new knowledge and skills. This question asked, "Do you feel as though your instructional practice changed due to the *Science Alliance* grant? If so, how? If not, why?" Nine participants were asked this question. All participants replied yes. Three themes arose during this question. Three of the nine participants responded by stating that they applied inquiry to other subject areas. Five of the nine participants supported their answer by stating that students were generating a lot more of their own ideas, rather than through direct instruction. Three of the nine teachers supported this answer with the theme that indicated they were utilizing projects and research to assist the students in supporting the learning targets.

At Guskey's (2002) participants' use of new knowledge and skills level the interview data is supported with data from the surveys and observations. During the interview, all participants asked the question that aligned with this level of evaluation responded yes. The survey and observation data is presented in the participants' learning section. Whereas, the second level of evaluation refers to the participants learning, the forth level refers to the application of the learning. The data suggest that teachers are have sustained the use of the inquiry methodology. The survey and observation data compared the 2012 to the 2015 differences of the mean scores. Both forms of data collection either increase or slightly decrease, suggesting sustainability.

Student Learning Outcomes

The fifth evaluation level in Guskey's (2002) model is student learning outcomes. Guskey (2002) states that on this level one should ask how did the professional development affect students. A question that would support this category is, "Did it affect student performance or achievement?" Guskey (2002). Questions on this level can be analyzed to demonstrate the overall impact of the PD (Guskey, 2002).

Question six of the interview addressed the student learning outcomes. It asked, "Did the PD affect student performance or achievement? Explain in what way(s)." Eight of the ten participants responded yes. These answers were supported by two themes. Four of the ten participants supported their answer with responses with, the state we reside in assesses our elementary students in the area of science during the fifth grade school year. Those teachers had not reviewed the high stakes test results.

Five of the ten participants responded with the students scored higher on the posttests than the pretests that were given to them when the teachers taught using the inquiry method.

At Guskey's (2002) student learning outcomes level of professional development the hypothesis is analyzed briefly with an interview question. Though most of the teachers responded with they thought it positively affected student performance, quantitative data is needed to support this level of organizational change.

Summary

The participant's reaction and the participants' learning were the two levels of Guskey's (2002) PD evaluation model that had the most supporting data from the survey and observations. In regards to the participants' reaction, participants responded that they were prepared to teach inquiry and seemed to overall enjoy the professional development. Most of the participants' beliefs about inquiry seemed to change and indicated that *Science Alliance* assisted them with their change in beliefs. In regards to participants' learning science content the results showed a slight decrease in difference in mean scores. One reason might be that is the decrease was due to changes in grade levels that the participants taught. Another reason could be is the decrease is due to departmentalization and not being assigned to teach science content.

The other three levels of Guskey's (2002) model were also analyzed. In regards to the organization support and change, the participants shared that they missed the support and wished that they could get the support again for the new staff in the building. As for the participants' use of new knowledge and skills, participants used the

methodology taught during the PD while teaching learning standards of their state. As for the student learning outcomes, these were not directly supported either positively or negatively. Participants thought that their students scored higher on posttests when they were using the inquiry methodology. Quantitative data were not used to inform this level of PD.

A surprising finding was, no matter where the interview participants taught, they mentioned similar themes on their interviews.

Limitations

Since this was a long-term grant program evaluation, one of the possible limitations may be that the staff received other training besides what was provided by *Science Alliance*. Therefore, the additional PD may affect the results. To reduce the limitation, the researcher compared the data collected with the "*Science Alliance*'s" data. Also, the guiding questions attempted to only address the training received from *Science Alliance*.

The *Science Alliance* data were collected by the *Science Alliance* staff in 2012. The researcher in 2015 was a different researcher than in 2012. In 2012 the survey was given to the participants via paper and pencil, in 2015 the survey was given via a Qualtrics Survey. LSA (2012) did not report all of the data collected from the survey; therefore the researcher could only compare three sub-scales of the survey. Ideally the observer in 2012 would have been able to train or compare observations with the researcher. The observation protocols were the same, however with different observers you may score higher or lower on certain descriptors.

The researcher works as an instructional coach in the same school district with several of the participants. In addition, the researcher was a teacher in the school of study during the PD. This may have affected the responses. To reduce that threat, prior to the interviews the researcher told the teacher respondents the information collected would not be evaluative of their positions and their names would not be shared. The researcher stated to the participants that honest answers would assist with the research.

Ten of the twelve participants that were interviewed were not the same participants as the ten of the twelve that were surveyed. Seven of the twelve participants were observed teaching a lesson. All twelve potential participants participated in some form of the data collection, whether that was the interview, the survey and/or the observation. The difference of participants may have affected the summary.

The sample size of the participants was a small number. The researcher reported the data as a whole group to protect the participant's identity.

Teachers changed grade levels during the professional development as well as following the professional development. Therefore, this was not consistent in developing the teachers in the science content.

The Qualtrics Survey had a mistake on the introduction. It listed the research question with the year 2013, instead of 2012. In addition, on questions two and three on the Qualtrics Survey rated the teachers on a four point Likert scale with the numbers 1, 2, 3, and 4. The survey the teachers took with *Science Alliance* in 2012 also rated the teachers on a four point Likert scale, but with the numbers 0, 1, 2, 3. The researcher adjusted the Qualtrics data to align with the data that *Science Alliance* used in 2012 to

compare with consistent numbers. For example, a 0 of the 2012 survey was a 1 on the 2015 survey. Since the words remained the same in regards to the Likert scale the data should not be affected.

Future Research

Limiting content related research to the areas in which assistance was provided may lead to more productive results. This study only looked at science content, whereas the PD assisted the participants in any content that the participant taught. Some of the participants taught in grade levels that departmentalized and taught only math or social studies, rather than science.

For consistency, the participants could remain teaching the same grade levels and subject area during the time of the PD to get full benefits of the PD. A study of long term PD in which the participants remained teaching the same grade level may be of interest.

A pretest and a posttest was given to the students in this study by the *Science Alliance* researcher. To see if the PD was impacting the students learning outcomes a researcher could pre- and posttest the students using the way the teachers taught before the training to the way they were taught following the training. In addition, a researcher may want to analyze the data from high stakes state tests prior to the training and following the training.

Conclusion

The descriptive case study examined how teachers that participated in the *Science Alliance* grant are using and implementing the methodology learned during the training

since 2012. The findings suggest that the teachers that participated have sustained the utilization and implementation of the methodology learned during the training. With proper commitment school administrators can utilize a model similar in the implementation of their initiative. In addition it adds to the research that could be utilized by staff developers on effective PD. Future researchers may use findings from this study when reporting about grant program evaluations.

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Appendix A

Qualtric's Survey

Q1 Thank you for your participation in the *Science Alliance* Grant! I am following up with the data collected by the grant in order to answer my dissertation question. My question is: Since 2013, how are the teachers that participated in the *Science Alliance* grant using and implementing the methodology learned during the training? This in turn will add to research in regards to professional development. This survey asks about your knowledge, attitudes, teaching practices and comfort levels related to inquiry-based science instruction. The survey is very similar to the one you completed during *Science Alliance*. The individual results of this survey are confidential. The only individual with access to any individual surveys and scores is the researcher. The individual results will not be shared. You may be asked to participate in an interview and/or an observation in the near future. Thank you for your time and support!

Q2 Click the circle that best describes how often your students take part in each of these activities during science instruction. Please respond based on your teaching experiences during this school year.

	Never (1)	Rarely (1 or 2 times per year) (2)	Sometimes (1 or 2 times per month) (3)	Often (more than once per week) (4)
Brainstorming ideas for an investigation (1)	❍	❍	❍	❍
Choosing tools appropriate for investigations (2)	❍	❍	❍	❍
Conducting their own lab/investigation (3)	❍	❍	❍	❍
Discussing a completed investigation/lab (4)	❍	❍	❍	❍
Completing science worksheets (5)	❍	❍	❍	❍
Connecting science to math (6)	❍	❍	❍	❍
Conducting their own science experiment (7)	❍	❍	❍	❍
Explaining finding among peers (8)	❍	❍	❍	❍
Interacting with teacher in small groups (9)	❍	❍	❍	❍
Learning science vocabulary (10)	❍	❍	❍	❍
Learning how to use basic tools	❍	❍	❍	❍

(11)				
Making a visual display of their findings (12)	❍	❍	❍	❍
Making connections between experiments and main ideas (13)	❍	❍	❍	❍
Participating in hands-on science activities (14)	❍	❍	❍	❍
Participating in guided science investigations (15)	❍	❍	❍	❍
Planning an investigation (16)	❍	❍	❍	❍
Problem solving in small groups (17)	❍	❍	❍	❍
Reading the science textbook (18)	❍	❍	❍	❍
Reviewing science homework (19)	❍	❍	❍	❍
Sharing alternative explanations (20)	❍	❍	❍	❍
Sharing what they learned at lesson's end (21)	❍	❍	❍	❍
Sorting and categorizing science content (22)	❍	❍	❍	❍
Writing about	❍	❍	❍	❍

their findings in journals (23)				
Watching teacher's science demonstrations (24)	❍	❍	❍	❍

Q3 Click the circle that best describes your use of each assessment strategy used in science this school year.

	Never (1)	Rarely (1 or 2x per year) (2)	Sometimes (1 or 2 times per month) (3)	Often (more than 1x per week) (4)
Asking planned questions during class (1)	❍	❍	❍	❍
Challenging student explanations (2)	❍	❍	❍	❍
Giving open-ended test questions (3)	❍	❍	❍	❍
Giving short-answer, multiple choice tests (4)	❍	❍	❍	❍
Having students present findings (5)	❍	❍	❍	❍
Observing students (6)	❍	❍	❍	❍
Posing questions as students work (7)	❍	❍	❍	❍
Using student self-assessments (8)	❍	❍	❍	❍
Using textbook tests (9)	❍	❍	❍	❍

Q4 Please tell me about how often you participated in the following professional support activities this school year.

	Never (1)	Rarely (1 or 2x per year) (2)	Sometimes (1 or 2 times per month) (3)	Often (more than once per week) (4)
Shared science material with other teachers (1)	❍	❍	❍	❍
Planned lessons with same grade-level teachers (2)	❍	❍	❍	❍
Received science materials from science institutions (3)	❍	❍	❍	❍
Received support from local science institutions (4)	❍	❍	❍	❍
Received supplies/materials you need for science investigations from your principal (5)	❍	❍	❍	❍
Supported by your colleagues in trying out new teaching ideas (6)	❍	❍	❍	❍
With colleagues, shared new perspectives and ideas (7)	❍	❍	❍	❍
Worked regularly with other teachers on science curriculum or instruction (8)	❍	❍	❍	❍

Q5 Use the grid below to show:1) the number of days per week that you teach each subject2) the approximated number of minutes you spend teaching this subject per day

	No. of days per week you teach this subject (1)	Minutes (per day) that a lesson typically lasts (2)
ELA (1)		
Mathematics (2)		
Science (3)		
Social Studies (4)		
Other (5)		

Q6 Click the circle that best matches your comfort level in teaching that particular subject.

	Not Comfortable (1)	Somewhat comfortable (2)	Very Comfortable (3)
ELA (1)	❍	❍	❍
Mathematics (2)	❍	❍	❍
Science (3)	❍	❍	❍
Social Studies (4)	❍	❍	❍
Other (5)	❍	❍	❍

Q7 Click the circle that describes how prepared you feel in teaching these topics at your grade level.

	Not at all prepared (1)	Not too prepared (2)	Somewhat prepared (3)	Very Prepared (4)
Properties of Matter (1)	❍	❍	❍	❍
Sound (2)	❍	❍	❍	❍
Mass and Temperature (3)	❍	❍	❍	❍
States of matter (4)	❍	❍	❍	❍
Mixtures and solutions (5)	❍	❍	❍	❍
Electrical circuits (6)	❍	❍	❍	❍
change in	❍	❍	❍	❍

position (7)				
investigating motion (8)	❍	❍	❍	❍
forces and motion (9)	❍	❍	❍	❍
laws of motion (10)	❍	❍	❍	❍
work and simple machines (11)	❍	❍	❍	❍
weather (12)	❍	❍	❍	❍
seasons (13)	❍	❍	❍	❍
objects in the sky (14)	❍	❍	❍	❍
observing water (15)	❍	❍	❍	❍
states of matter (16)	❍	❍	❍	❍
rocks an soil (17)	❍	❍	❍	❍
earth, moon, and sun (18)	❍	❍	❍	❍
changes in Earth's surface (19)	❍	❍	❍	❍
water cycle (20)	❍	❍	❍	❍
solar system (21)	❍	❍	❍	❍
parent offspring relationship (22)	❍	❍	❍	❍
characteristics of plants and animals (23)	❍	❍	❍	❍
life cycle of animals (24)	❍	❍	❍	❍
life cycle of plants (25)	❍	❍	❍	❍
food chains (26)	❍	❍	❍	❍

Interactions among organisms and their environment (27)	❍	❍	❍	❍
classification of plants and animals (28)	❍	❍	❍	❍

Q8 Click the circle that best fits you in regards to the following statement:

	Strongly Disagree (1)	Disagree (2)	Neutral Agree (3)	Strongly Agree (4)
Science Alliance was beneficial to my teaching practice. (1)	❍	❍	❍	❍

Appendix B

The *Science Alliance*
Teaching Observation Protocol[1]

Date of observation: (month/day/year)_____

Name of teacher:_____ _____ **Grade**:_____

Start time:_____ **End time:**_____

Observer:_____

Contextual Background and Activities: In the space provided below, please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. Use diagrams if they seem appropriate.

Please rate various aspects of the lesson using a six-point scale in which 0=did not occur at all and 5=occurred to a great extent.

[1] This protocol is based on similar instruments: see Outcomes Research Study, L. Flick, P. Morell, C. Wainright (2002) (http://www.pacificu.edu/academics/ed/resources/OCEPTII/evaluation.html; The Vermont Elementary Science Project (2003) (http://www.exploratorium.edu/IFI/resources/classroom/inquiry_based.html; the Local Systemic Change Classroom Observation Protocol (2003-04). Horizon Research (http://www.horizon-research.com) and J. Sawada, M, Pitburn, K Falconer, J. Turley, R. Benford and I. Bloom (date unknown) Arizona State University: The Arizona Collaborative for Excellence in the Preparation of Teachers.

1. ***This lesson prepares a community of learners for responsible science learning.***

Teacher/instructor…	**Did not occur at all**					**Occurred to a great extent**
a. Uses wait time	0	1	2	3	4	5
b. Uses constructive, descriptive praise	0	1	2	3	4	5
c. Is non-judgmental of student responses	0	1	2	3	4	5
d. Encourages student input and questions	0	1	2	3	4	5
e. Interacts equitably with students in small groups	0	1	2	3	4	5

2. ***This lesson encourages students to understand science concepts and science process skills using multiple instructional strategies.***

Teacher/instructor…	**Did not occur at all**					**Occurred to a great extent**
a. Uses a model or demonstration	0	1	2	3	4	5
b. Uses multiple strategies to explain a concept	0	1	2	3	4	5
c. Provides more than one material and/or tool to foster student understanding (drawings, graphs, concrete materials, manipulatives, etc.)	0	1	2	3	4	5

3. ***Instructional decisions are made within the lesson in order to probe and use students' existing knowledge and preconceptions.***

Teacher/instructor…	**Did not occur at all**					**Occurred to a great extent**
a. Pre-assesses students for their ideas and knowledge	0	1	2	3	4	5
b. Allows for exploration of science concept in experiential or discovery activities	0	1	2	3	4	5
c. Connects experiential and discovery activities to previous knowledge	0	1	2	3	4	5
d. Helps students explore/challenge misconceptions	0	1	2	3	4	5
e. Refocuses lessons based on student ideas or questions	0	1	2	3	4	5

4. The lesson presents inquiry opportunities for students.

Teacher/instructor…	**Did not occur at all**					**Occurred to a great extent**
a. Allows for questions to arise out of the experiential or discovery activities	0	1	2	3	4	5
b. Facilitates transition from discovery to investigation	0	1	2	3	4	5
c. Provides choice of tools for investigation	0	1	2	3	4	5

5. Interactions during the lesson reflect collaboration and productive discourse.

Teacher/instructor…	**Did not occur at all**					**Occurred to a great extent**
a. Interacts with small groups	0	1	2	3	4	5
b. Organizes students for group work	0	1	2	3	4	5
c. Provides clear objectives for group work	0	1	2	3	4	5

6. Alternative solution strategies and ways of interpreting evidence are encouraged.

Teacher/instructor…	**Did not occur at all**					**Occurred to a great extent**
a. Accepts multiple responses to problems	0	1	2	3	4	5
b. Provides example(s) of evidence for student interpretation	0	1	2	3	4	5
c. Solicits alternative explanations	0	1	2	3	4	5
d. Encourages discussion of alternative explanations	0	1	2	3	4	5
e. Encourages multiple representations of the data	0	1	2	3	4	5

7. Intellectual rigor, constructive criticism, and the challenging of ideas are valued.

Teacher/instructor…	**Did not occur at all**					**Occurred to a great extent**
a. Challenges students' ideas	0	1	2	3	4	5
b. Encourages students to challenge the text as well as each other	0	1	2	3	4	5

8. The lesson promotes coherent conceptual understanding in the context of clear learning goals.

Teacher/instructor…	**Did not occur at all**					**Occurred to a great extent**
a. Lesson purpose is clear	0	1	2	3	4	5
b. Focuses and sustains inquiry on 1-2 concepts	0	1	2	3	4	5
c. Connects inquiry activities to the main concept(s)	0	1	2	3	4	5
d. Facilitates the extension of a concept	0	1	2	3	4	5

9. Appropriate connections are made between content and other curricular areas.

Teacher/instructor…	**Did not occur at all**					**Occurred to a great extent**
a. Integrates reading and writing into science	0	1	2	3	4	5
b. Integrates content with other curricular areas	0	1	2	3	4	5
c. Applies classroom activities to diverse real-world situations	0	1	2	3	4	5

10. The lesson includes correct and appropriate content.

Teacher/instructor…	**Did not occur at all**					**Occurred to a great extent**
a. Presents content that is accurate	0	1	2	3	4	5
b. Presents content appropriate to students' cognitive levels	0	1	2	3	4	5
c. Recognizes students' thinking when vaguely articulated	0	1	2	3	4	5

11. This lesson includes reflection about learning.

Teacher/instructor…	**Did not occur at all**					**Occurred to a great extent**
a. Encourages students to explain a concept	0	1	2	3	4	5
b. Allows time for reflection	0	1	2	3	4	5
c. Encourages students to explain how they are learning ("sense-making")	0	1	2	3	4	5

12. This lesson effectively engaged students in inquiry-based science learning.

Students…	**Did not occur at all**					**Occurred to a great extent**

a. Are enthusiastic and interested in the lesson	0	1	2	3	4	5
b. Sharing findings from an experiential or discovery activity with the class	0	1	2	3	4	5
c. Identify concepts unclear to them	0	1	2	3	4	5
d. Respond to the ideas/contributions of other students	0	1	2	3	4	5
e. Listen to others' ideas or explanations respectfully	0	1	2	3	4	5
f. Make connections between science and everyday life	0	1	2	3	4	5
g. Respond accurately to teacher content questions	0	1	2	3	4	5
h. Participate actively in discussions with other students	0	1	2	3	4	5

COMMENTS:

Appendix C

Interview

Each question was developed with Guskey's five levels of PD in mind. (Initials behind each question represent the level of Guskey that the question aligns to.)

Say before each interview:

I am currently working on my dissertation in the area of science education. My dissertation is to see how are the teachers that participated in the *Science Alliance* grant using and implementing the methodology learned during the training? The *Science Alliance* grant ended for our school at the end of the 2012-2013 school year.

I am going to ask you a few questions. When you answer the questions I would like you to think about a couple of things. Think about the 2014-2015 school year. Also think about the subject area that you were assisted with during the *Science Alliance* program.

None of these answers will be used to evaluate you in teaching. The answers are to assist me with my dissertation.

During the *Science Alliance* program and recently you were given surveys in regards to the PD. My interview is going to be compared to the surveys that we filled out as participants to see if the data that *Science Alliance* collected correlates with the data I am collecting. Your interviewed will be recorded so that I can transcribe your information. From the transcriptions I will code the data with a scoring guide to compare it to their data.

(Show consent form) I have a signed copy of the consent form the beginning portion of my study. Do I still have your permission to continue with the interview?

1. What subject area(s) did the *Science Alliance* assist you with?

2. On a four point rating scale: 4 meaning very prepared, 3 meaning somewhat prepared, 2 meaning not prepared, 1 meaning not prepared at all

Rate how prepared you feel teaching inquiry after participating in the three yearlong professional development? Please explain your answer. (PR)

3. Did your attitudes or beliefs change in regards to teaching inquiry after participating in the *Science Alliance* grant? Explain why or why not. (PL)

4. Do you feel that this PD had any impact on the change of the climate in our building? If so, how? If not, why? (OS&C)

5. Do you feel as though your instructional practice changed due to the *Science Alliance* grant? If so, how? If not, why? (PUONK&S)

6. Did the PD affect student performance or achievement? Explain in what way(s)? (SLO)

7. Do you have anything you would like to add in regards to participating in the *Science Alliance* grant?

Appendix D

Interview Questions and the Evaluation Level

Question Asked	Evaluation Level
1. What subject area(s) did the *Science Alliance* assist you with?	General question
2. On a four point rating scale: 4 meaning very prepared, 3 meaning somewhat prepared, 2 meaning not prepared, 1 meaning not prepared at all Rate how prepared you feel teaching inquiry after participating in the three yearlong professional development? Please explain your answer.	Participants' reaction
3. Did your attitudes or beliefs change in regards to teaching inquiry after participating in the *Science Alliance* grant? Explain why or why not.	Participants' learning
4. Do you feel that this PD had any impact on the change of the climate in our building? If so, how? If not, why?	Organization support and change
5. Do you feel as though your instructional practice changed due to the *Science Alliance* grant? If so, how? If not, why?	Participants' use of new knowledge and skills
6. Did the PD affect student performance or achievement? Explain in what way(s)?	Student learning outcomes

7. Do you have anything you would like to add in regards to participating in the *Science Alliance* grant?	General question

Appendix E

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Informed Consent for Participation in Research Activities
Sustainability of a Long Term Professional Development Program

Participant _____

Principal Investigator Christine E. Ries PI's Phone Number 314-409-3012

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1. You are invited to participate in a research study conducted by Christine Ries, Dr. Wilson, and Dr. Granger. The purpose of this research is to add to the research on Professional Development (PD). This research will also add to the research on grant-funded programs.

2. a) Your participation will involve:

    1. An online survey that will be sent to you via email.

    2. A short interview that will be scheduled at your convenience.

    3. A scheduled observation of an inquiry lesson taught in any subject area.

    Approximately 11 teachers may be involved in this research.

    b) The amount of time involved in your participation will be approximately 10 minutes for the survey and 10-15 minutes for the audio-recorded interview. The scheduling of the observation will be about 5 minutes. The observation will occur during your normally scheduled class. You and your students will not be recorded

during the observation. I will use an observation protocol looking for specific areas in regards to teaching using the inquiry methodology. A total of 30 minutes of your time would be needed.

3. There are no anticipated risks associated with this research.

4. There are no direct benefits for you participating in this study. However, your participation will contribute to the knowledge about PD and grant program evaluations and may help design PD.

5. Your participation is voluntary and you may choose not to participate in this research study or to withdraw your consent at any time. If you want to withdraw from the study, you can contact me at: cherr1us@yahoo.com or 314-409-3012. You may choose not to answer any questions that you do not want to answer. You will NOT be penalized in any way should you choose not to participate or to withdraw.

6. By agreeing to participate, you understand and agree that your data may be shared with other researchers and educators in the form of presentations and/or publications. In all cases, your identity will not be revealed. In rare instances, a researcher's study must undergo an audit or program evaluation by an oversight agency (such as the Office for Human Research Protection). That agency would be required to maintain the confidentiality of your data. In addition, all data will be stored on a password-protected computer and/or in a locked office.

7. If you have any questions or concerns regarding this study, or if any problems arise, you may call the Investigator, Dr. Granger at 314-516-6220. You may also ask questions or state concerns regarding your rights as a research participant to the Office of Research Administration, at 516-5897.

I have read this consent form and have been given the opportunity to ask questions. I will also be given a copy of this consent form for my records. I consent to my participation in the research described above.

Participant's Signature	Date	Participant's Printed Name	
Signature of Investigator or Designee	Date	Investigator/Designee Printed Name	

Appendix F

Interview Matrix

Evaluation Level	Participation	Same location	Different location	Participation Summary
Level I: Participants' Reaction	Full			
	Partial			
	Extended			
Location Summary				L X P Dimension Summary

Evaluation Level	Participation	Same location	Different location	Participation Summary
Level II: Participants' Learning	Full			
	Partial			
	Extended			
Location Summary				L X P Dimension Summary

Evaluation Level	Participation	Same location	Different location	Participation Summary
Level III: Organization Support and Change	Full			
	Partial			
	Extended			

Location Summary				L X P Dimension Summary

Evaluation Level	Participation	Same location	Different location	Participation Summary
Level IV: Participants' use of new knowledge and skills	Full			
	Partial			
	Extended			
Location Summary				L X P Dimension Summary

Evaluation Level	Participation	Same location	Different location	Participation Summary
Level V: Student learning outcomes	Full			
	Partial			
	Extended			
Location Summary				L X P Dimension Summary

Appendix G

Transcribed Interviews with highlights of keywords and phrases

1. What subject area(s) did the *Science Alliance* assist you with?

Math and Social Studies
Science
Basically this was for science but I use it in a lot of other areas… Social studies, reading, um, just for more inquiry based lessons.
I feel it helped me in all subject areas in regards in the fact that we made our kids more inquiry based. So even in math I could use that kind of strategy to understand problems. At the time I was only teaching social studies and it helped me out in that and we figured out a way to use inquiry in history as well as in science.
Science, we worked on weathering and erosion and we also did the water cycle. And I am going to try to think of something else… I am going to say those two core areas are what I recall right now, I might think of something else.
I would say that it helped me with all of the subject areas because when we did units of teaching that we based our units off of science so our writing and math was based on what we were working on in science and we tied in community aspects for social studies.
Science Alliance assisted me with a little bit with science and a little bit with math, but we were departmentalized so I primarily teach math, so that is where they supported me the most.
XXX grade science
Science
Science

2. On a four point rating scale: 4 meaning very prepared, 3 meaning somewhat prepared, 2 meaning not prepared, 1 meaning not prepared at all Rate how prepared you feel teaching inquiry after participating in the three yearlong professional development? Please explain your answer. (PR)

4, Um I just feel like it gave me the tools to apply this, I mean even though it was directed at science, um I was able to take those science examples and apply them to math and social studies, so I feel like it was a 4 because I was able to apply them even further than what the *Science Alliance* had intended it for.
Um… I would say, um a 3. It was hard to decide because, they gave us the information and I would have to go back and redo, you know what they did. I guess I was prepared to teach it and they gave me the foundations you know but I needed to go back and insert it into what I had to do. They could have just given me all the lessons, but they didn't, which is fine cause I would have changed it anyways to my grade, I think.
4, Um it really went through a really step-by-step process. The 1st year we observed them teaching a lesson and then the next year we taught while they were in the classroom. So, it was a long time that we got to use the process. They were there to assist us with everything that we needed, so it was teacher friendly. They gave us feedback. The staff as a whole talked together and it was just was a very comfortable situation and it wasn't one of those.. you are going to watch a lesson and then they left you a lone. It was ongoing for 3 years, which was helpful.
4, Well you said 4 meant very prepared. I feel like every time I do my lessons I am looking for the kids to ask inquiry based type questions and question what we are learning and instead of just teaching and telling them what to do and how to do it. They are doing more of the work, than the teacher asking all the questions and telling the answers.
3 – science has never been my strongest area, so I learned a lot and I was able to transfer a lot and I have taken a lot of other science classes, but I still don't feel 100% clear, so that's why I would say a 3.
4, I felt very prepared. I thought going to the botanical gardens and doing the training there, hands on was very helpful for me to use the inquiry process.
About a 3, only because the inquiry model works better with science. There are some things that I can apply to math, but there are sometimes that I have to go back to a little bit of direct instruction to expose the concept or the content to the student. Then after they get it, we can jump into the inquiry.
3, time issues, I guess. Too much to teach. It did not have anything to do with the program.

4, very prepared. Not knowing what inquiry was too much before the *Science Alliance* grant. Having participated in it let me to develop my own lessons using inquiry. And confirming my original thoughts about inquiry, and finding out that I actually was doing inquiry like lessons all along, just did not know that was the term to use with it. But, having the *Science Alliance* grants' lessons and the teachers that came in helped me and prepared me to be able to leaving me to develop them on my own.
I would say a 4. I feel like after the *Science Alliance* it really kind of prepared me with more questions and knowing the questions to prompt deeper exploration to what the kids had been practicing and learning and their objectives that were met and even hearing the kids using the deeper thinking in the their groups during their learning really helped as well.

3. Did your attitudes or beliefs change in regards to teaching inquiry after participating in the *Science Alliance* grant? Explain why or why not. (PL)

Absolutely, I definitely used.. Again, I applied it to other subject areas and I saw learning improve and kids excitement improve about learning. They got more excited about what they were doing. They had better understandings about the concepts that I taught using inquiry.
Yes. So, I don't think I thought too much about giving them the idea, not telling them what I am teaching them. I think I was very objective created. I would say the objective and then we would prove the objective right. I know we have the hypothesis and things but I thought if I am doing a science experiment and I am doing a science fair experiment, I get that and then there is the hypothesis and then I am going to prove that I am going to check it out for 2-3 weeks and we are going to do the data on it and then look and match it to our guess. But, I don't think that I pulled it down and matched it to each individual lesson. Being inquiry I realized that I could do an inquiry lesson in 5 mins. Not as long as I did not tell them what I was doing 1st. So, that was a pretty big mind change on my part, after that.
I always tried to do inquiry learning. But, they gave me more ideas and so, I really science and social studies I do a lot of inquiry but I tried to filter it into more of the other content areas.
Yes and no. I always felt like that was an important thing I just did not have like all the pieces together to teach it correctly. I knew its importance and this helped me like be able to do it in my classroom.

Definitely, it helped me with my approach to how I would go about science vs. just having a plan always. It is approaching the kids in a more inquiry way vs. to just telling them what to do.
Yes, I would definitely say yes, because it made me change the way I frontloaded the way I was teaching. Before I would tell the students a lot more answers and the vocabulary instead of letting them to more research and finding things out for themselves and I did not realize how much I was giving them until we did the training and until I actually started using inquiry. It definitely changed the way I teach.
Yes. It increased. I enjoyed it more. *Science Alliance* made it a little bit more accessible for me and a little bit more enjoyable for me and it helped me to see how easy it is to do and how to make lessons more interesting for kids.
No because I liked it before. I took inquiry at the zoo before.
Well, my belief changed because I did not think I was teaching inquiry and I actually was, but I think I was not doing it with fidelity and since participating in it I feel like I carry inquiry into more subject areas other than science. When you think inquiry, you automatically just think science and learning the background and the steps to inquiry, I was able to carry that over into other subject areas.
Definitely, I think that um I was kind of; I was very unprepared and more nervous about teaching science before *Science Alliance*. I did not really know how deep to get with those prompting questions. And I think with the *Science Alliance* people come in a model for you and gradually let you go and just made you feel a lot more comfortable and gave you a lot more of a background and understanding of how deep and how much prompting and inquiry to go into for a science experiments that we do.

4. Do you feel that this PD had any impact on the change of the climate in our building? If so, how? If not, why? (OS&C)

Absolutely, at least especially with the teachers that participated in it and even those that didn't because we came back and shared what we learned, so absolutely it did.
I think that you bring back all the science experiments and just revisit all those ideas. Absolutely, I think we got more excited about our. We rechecked the old and revised the lessons and made it fresh again. That's how it was with me.
Yes. I just think that more teachers are more frightened to do the inquiry. I am a very

organized teacher and I like my classroom run smoothly and sometimes if you go that way you wonder if they are going to be to loud and are they going to learn and you know. Some teachers think I am just supposed to stand up in front of the room and tell you what to know so they know what they need to know for the test. But, I think this gave them a real comfortable way to look at teachers another way and to try it. I think more teachers tried it than if we had not had that PD.
I don't know. I don't want to say yes, I don't want to say no. You are always going to have those that are stuck in their ways and those that are open minded and flexible seem to encourage this kind of stuff. I don't really think it changed the climate though, because we have always have had that.
Yes, I do think that more teachers use more inquiry based approach where the students were doing a lot more with the hands on and playing a part in how they learned their science, than just being instructed directly.
Yes, I do, I think that. At the time I was more of a new teacher but the Pd it strengthened us as whole because we were focusing on the same teaching style and then also with going back to the previous question, it changed the way that were actually teaching.
I think it did. I think it made people more excited about inquiry-based learning. I think it changed the structure of a lot of the lessons. I think that there are a lot more hands on things going on, a lot more inquiry projects going on as a school as a whole and it is crossing curriculum subjects. For me personally, I did not get to participate in 100% of the training because some of it was in the summertime and I was teaching summer school and taking summer classes. That was the only downfall about it. So, I did not get to participate in 100% of it. But, the things that were available to us that were not in the summer, I did participate in it and I did enjoy it thoroughly and I was able to get things from it and able to get things that were usable and applicable and use it the very next day in the classroom.
Yeah, probably. It is just a general feeling. I can't really explain why.
Yes and No. I believe it created an awareness of what needs to be taught. I feel like under the grant, more teachers stuck with the inquiry. But, since then with teachers leaving, I think the climate of teaching inquiry has changed because the teachers that were originally trained are not here anymore. So, I feel like the pressure, not pressure, but under the grant we learned how to do it and we stuck with it. It would be nice to have a refresher on inquiry more often, because I feel like then it would be more permanent. But, overall I think it did change the climate in our building.

Definitely, I think that it just gave us more time to just be together and of a focus to be together and share what worked in our room and give examples and gave us a ton of time together to add to our lessons and to develop them for the kids. I think it was great.

5. Do you feel as though your instructional practice changed due to the *Science Alliance* grant? If so, how? If not, why? (PUONK&S)

Yes, definitely. Um.. Like I said, I applied it to math and I taught it for so many years and came up with a new way to teach the same concepts that I had been teaching
Yes, cause again I would only think about it if it was going to be a long drawn out what I thought experiment. My instructional thought changed for each lesson, as best as I could. Not ever lesson, but as many as made it fit.
Skipped question 5
Yes, before I took the *Science Alliance* program I felt like I was pushing towards the questions that I wanted instead of the questions that they wanted to ask. It still felt very teacher guided vs. student-guided questions. After that, I leave it up to the students. Some students need a little push. But, when you make it theirs, there is a lot more learning going on and they take more ownership of it.
Yes, once again, I did a lot more in trying to include the kids in their own learning and more exploring for them, than me just directly guiding them in the instruction. Their was always hands on experiments and things like that, but their were times when they created their own experiment, which was really neat because I think they learned a lot more that way than just giving them the experiment that I wanted them to do.
Yes, I would say, kind of going back to question 3, I allowed the kinds more time to do hands on activities, do research and talk and more guiding them on appropriate questions to ask when researching something and experimenting with the things that we were doing.
Yes, lots more projects. Lots more inquiry based activities and things. I try to bring them into math as frequently as possible. It keeps me conscious and it makes me aware of what I am doing and how I am doing it. So, I did change some of the structures of the things that I am doing.
I guess. I did teach inquiry before.

Yes, because learning the steps. I feel like I was a pretty strong science teacher and then learning the steps to inquiry led me to investigate how to do it in math and in reading and social studies and even in writing. I feel like my instructional practice in other content areas changed.
Definitely, I feel like, not just with the deeper prompting and exploration, and the prompting and the questions, but just getting an idea of just how to organize labs. How to take advantage of free resources in our community. I think part of it is trying to find all the materials and you don't want to use all the money out of your own pocket. So, finding all these different ways that you can do really cool experiments and not have to spend money for it. To be able to take advantage of different resources just for free out the there. I feel like it helped me relax during science because that was the one area that I am just not as comfortable with and um it kind of made it more enjoyable. The kids enjoyed it. To see how much they learned and how much they carried over was really exciting.

6. Did the PD affect student performance or achievement? Explain in what way(s)? (SLO)

Absolutely, um, I mean the last year that I taught the XXX graders that I taught, made the highest gains I think in the district. They made much bigger gains.
Um, I do. Yes, because I know that's how the tests are written. Um, they have to prove their thought 1st. So, I definitely think it changed their performance. Yah, it definitely changed it in they way they know that I am not going to just first ahead of time, you know.
Oh, I believe absolutely. I believe our map scores increased, especially in the area of science, so yes and the kids enjoy it.
I am not sure. Looking at test scores, it is hard because you have a different group of students, I think. Not teaching science, and it only being tested in 5th grade, I don't know the exact results on achievement on performance. However, I feel that on the assessments that I give they do better when it is theirs. They understand the questions that they are asking and you just hope they questions that they ask cover what you wanted them to learn and what they have to have moving from grade level to grade level. I hope it has.

Well, I would say students preformed well on the test that we gave them. I think that as they went up into testing grades they keep their knowledge base and helped them to stay more familiar with it.
Yes, I would say, kind of going back to question 3, I allowed the kinds more time to do hands on activities, do research and talk and more guiding them on appropriate questions to ask when researching something and experimenting with the things that we were doing.
I believe so. XXX grade is not tested in science. I do know in the pre test and post that we give, they seem to get the big ideas more when we do the inquiry based as opposed to any other style when we teach. So, I do think it has given the kids great gains on the scores. We are just not tested by the state in that grade level.
I am not sure.
I think students were more motivated because it made the teachers get away from textbook like lessons. Even though the text books have experiments in them it allowed them to be more hands on with their students and be more of a facilitator and let the students lead their learning and that's how it should be done.
Yeah, I think it did. Because if you are going to spend more time planning and trying to get a deeper understanding to get to be able to talk to higher level grades and to find out what the kids need to come in knowing. It's kind of neat to overlap it to your planning and instruction. Just having time to share and to and get valuable information for other teachers is really important.

7. Do you have anything you would like to add in regards to participating in the *Science Alliance* grant?

I am just glad that you talked me into doing it. It was awesome. Like, it totally makes you think about teaching a different way. It's always nice to think about it a new way, you know?
No, I am just glad that we did it. I don't think I would have pulled up a book and read it. If I would have read it, I would not have put it into practice like we did. You know, like watching practice lessons or those kinds of things. I know I would not have. Just personally, I know I would not have done it the way we did it.

Um, Oh it was a wonderful program, um; the coordinators did a great job. They did not, I never felt threatened having them in my classroom. I never felt like I was being evaluated by them. They were there as an aid, if I made a mistake, it was ok . They were very helpful. They had all the supplies that I needed. I never had to find anything, I just gave them a list, so um, it was a great program and I think it should be everywhere.
No, I encourage all teachers that are open minded and flexible to at least give this a try and see that it is a wonderful program. And the people ran it were awesome and were very creative and had awesome ideas. Anybody who is a teacher has to be open for a new way for students to learn it is just, if you cant to that then what are you in this business for?
No, I did really enjoy though the people that came in and gave us the guidance and showed us how to do the lessons. It's always good to have a different approach. And the kids really enjoyed those and that part I really kind of miss. I also like the planning piece because you can sit down with them and talk about ideas and they would give you some suggestions and you would kind of come up with a plan together what the lesson was going to look like and what the students were going to look like. That was a strength too.
When you asked about the PD affecting student performance, I think that one of the biggest changes that I have seen between last year and this year is with the writing curriculum. The new XXX curriculum did not allow for you to integrate different subject areas as much. So, the students were not able to apply concepts that they were learning in different subject areas in writing. Which, I thought that was a neg. impact on their performance.
I miss it. I miss that we don't have it anymore. We have some of the activities. Like the facilitators in the grant were kind enough to leave some materials with us. Those things that we have gotten old over the years, because we use it so much and so, I wish we still had it. The kids really miss the field trips. We all miss some of the opportunities because based on and the restructuring of our lessons it is difficult to replicate. So, I do miss it dearly. I wish we still had it. But, overall I think it was wonderful because it does change the way that we teach. Since then we have gotten some new teachers and the last couple of years since the program has ended. It is nice to try to share with them, but it is different because it is not the official training. So, I do greatly miss it. But, it has changed the way that I teach.
Not really, no.
I would like to have it back. I think the tie with the community was incredible for our

school. It brought families out that were not coming out to see what happening in our school. Not just here when they came to our building, but when we went to those places too. I think that the since of community in our school was really enhanced by having those 3 institutions with us. I think students were having scientific conversations on a daily basis and I think that it was a great program and great pd for teachers to grown in their learning too.
I think it was highly beneficial. I feel like I learned tremendous amount in teaching science, not just science but in all areas you can over lap. The consentient questioning, like right now I teach map focus and that very high level question based. Just question after question to get the kids to explore and to get a deeper understanding and I feel like doing the SA really helped with um kind of getting more comfortable with that and having the resources. The instruction coming in, I think was very valuable to our school. It's a shame that its not around anymore, but I think that it would highly affect kids scores especially in the area of science.

Appendix H

Survey Data

Based on your teaching experiences during this school year

	Spring 2012	Spring 2015	Difference in Mean Scores
Brainstorming ideas for an investigation	1.9	2.6	0.7
Choosing tools appropriate for investigations	2	2.2	0.2
Conducting their own lab/investigation	2.1	2.1	0
Discussing a completed investigation/lab	2.2	2.5	0.3
Completing science worksheets	1.8	2.2	0.4
Connecting science to math	_	2.3	_
Conducting their own science experiment	2	1.9	-0.1
Explaining finding among peers	2.4	2.5	0.1
Interacting with teacher in small groups	2.2	2.5	0.3
Learning science vocabulary	2.9	2.8	-0.1
Learning how to use basic tools	2.5	2.5	0
Making a visual display of their findings	_	2.3	_
Making connections between experiments and main ideas	2.5	2.3	-0.2
Participating in hands-on science activities	2.5	2.5	0

Participating in guided science investigations	–	2.4	–
Planning an investigation	1.6	1.9	0.3
Problem solving in small groups	2.6	2.8	0.2
Reading the science textbook	0.9	1.3	0.4
Reviewing science homework	1.4	1.4	0
Sharing alternative explanations	2.1	2.6	0.5
Sharing what they learned at lesson's end	2.5	2.7	0.2
Sorting and categorizing science content	1.9	2	0.1
Writing about their findings in journals	1.8	2.5	0.7
Watching teacher's science demonstrations	1.9	1.8	-0.1
Mean Score	2	2.3	0.3

Best describes your use of each assessment strategy used in science this school year

	Spring 2012	Spring 2015	Difference in Mean Scores
Asking planned questions during class	–	2.5	–
Challenging student explanations	2.1	2.6	0.5
Giving open-ended test questions	2.1	2.2	0.1

Giving short-answer, multiple choice tests	2	2.3	0.3
Having students present findings	2.3	2.5	0.2
Observing students	2.9	2.9	0
Posing questions as students work	3	2.8	-0.2
Using student self-assessments	1.4	2	0.6
Using textbook tests	1.1	1.1	0
Mean Score	2.3	2.3	0

Describes how prepared you feel in teaching these topics at your grade level

	Spring 2012	Spring 2015	Difference in Mean Scores
Properties of Matter	2.6	2.6	0
Sound	2.3	2	-0.3
Mass and Temperature	2.7	2.5	-0.2
States of matter	2.7	2.8	0.1
Mixtures and solutions	2	2.2	0.2
Electrical circuits	2.1	1.9	-0.2
change in position	2.6	2.1	-0.5
investigating motion	2.6	2.2	-0.4
forces and motion	2.6	2.5	-0.1
laws of motion	2.3	2.2	-0.1
work and simple machines	2.6	2.5	-0.1

weather	2.7	2.4	-0.3
seasons	2.6	2.3	-0.3
objects in the sky	2.6	2.2	-0.4
observing water	3	2.6	-0.4
states of matter	3	2.8	-0.2
rocks an soil	2.3	2.1	-0.2
earth, moon, and sun	2.7	2.5	-0.2
changes in Earth's surface	2.9	2.6	-0.3
water cycle	2.7	2.7	0
solar system	2.9	2.4	-0.5
parent offspring relationship	2.7	2.3	-0.4
characteristics of plants and animals	2.9	2.7	-0.2
life cycle of animals	3	2.7	-0.3
life cycle of plants	2.9	2.6	-0.3
food chains	3	2.8	-0.2
Interactions among organisms and their environment	3	2.7	-0.3
classification of plants and animals	2.9	2.5	-0.4
Mean Score	2.7	2.4	-0.3

Appendix I

Observation Data

This lesson prepares a community of learners for responsible science learning

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Uses wait time	3.8	5.0	1.2
Uses constructive, descriptive praise	2.9	4.6	1.7
Is non-judgmental of student responses	3.2	4.6	1.4
Encourages student input and questions	3.5	5.0	1.5
Interacts equitably with students in small groups	3.6	5.0	1.4
Mean score	3.4	4.8	1.4

This lesson encourages students to understand science concepts and science process skills using multiple instructional strategies

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Uses a model or demonstration	2.7	3.7	1
Uses multiple strategies to explain a concept	3.5	3.4	-0.1

Provides more than one material and/or tool to foster student understanding (drawings, graphs, concrete materials, manipulatives, etc.)	4.3	4.7	0.4
Mean score for each topic	3.5	4	0.5

Instructional decisions are made within the lesson in order to probe and use students' existing knowledge and preconceptions.

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Pre-assesses students for their ideas and knowledge	3.6	4.3	0.7
Allows for exploration of science concept in experiential or discovery activities	4.4	4.1	-0.3
Connects experiential and discovery activities to previous knowledge	4	4.3	0.3
Helps students explore/challenge misconceptions	2.9	3.6	0.7
Refocuses lessons based on student ideas or questions	2.6	3.3	0.7
Mean score	3.5	3.9	0.4

The lesson presents inquiry opportunities for students

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Allows for questions to arise out of the experiential or discovery activities	3.7	2.9	-0.8
Facilitates transition from discovery to investigation	2	1.4	-0.6
Provides choice of tools for investigation	1.3	1.7	0.4
Mean score	2.3	2	-0.3

Interactions during the lesson reflect collaboration and productive discourse

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Interacts with small groups	3.6	5	1.4
Organizes students for group work	3.7	5	1.3
Provides clear objectives for group work	3.7	4.9	1.2
Mean score	3.7	5	1.3

Alternative solution strategies and ways of interpreting evidence are encouraged

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Accepts multiple responses to problems	3.3	3.6	0.3

Provides example(s) of evidence for student interpretation	3	3.6	0.6
Solicits alternative explanations	1.8	4.3	2.5
Encourages discussion of alternative explanations	2	4.3	2.3
Encourages multiple representations of the data	1.6	3.6	2
Mean score	2.4	3.9	1.5

Intellectual rigor, constructive criticism, and the challenging of ideas are valued

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Challenges students' ideas	2.9	4.3	1.4
Encourages students to challenge the text as well as each other	1.2	0.7	-0.5
Mean score	2.1	2.5	0.4

The lesson promotes coherent conceptual understanding in the context of clear learning goals

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Lesson purpose is clear	_	_	_

Focuses and sustains inquiry on 1-2 concepts	5	5	0
Connects inquiry activities to the main concept(s)	2.7	5	2.3
Facilitates the extension of a concept	2.7	2.9	0.2
Mean score	3.5	4.5	1

Appropriate connections are made between content and other curricular areas

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Integrates reading and writing into science	3.5	2.6	-0.9
Integrates content with other curricular areas	1.6	4	2.4
Applies classroom activities to diverse real-world situations	3.9	4.9	1
Mean score	3	3.8	0.8

The lesson includes correct and appropriate content

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Presents content that is accurate	4.6	5	0.4
Presents content appropriate to students' cognitive levels	4.3	5	0.7

Recognizes students' thinking when vaguely articulated	3	4.3	1.3
Mean score	4	4.8	0.8

This lesson includes reflection about learning

Teacher/instructor descriptors	Spring 2012	Spring 2015	Difference in Mean Scores
Encourages students to explain a concept	3.7	5	1.3
Allows time for reflection	2.3	5	2.7
Encourages students to explain how they are learning ("sense-making")	3.7	4.4	0.7
Mean score	3.2	4.8	1.6