



Elementary Teachers' Views of their Science Professional Development Attendance: An Expectancy-Value Approach

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Received 26 July 2012; accepted 15 September 2012
Published on 27 January 2013

APA style referencing for this article: Thomson, M.M. & Kaufmann, E. (2013). Elementary Teachers' Views of their Science Professional Development Attendance: An Expectancy-Value Approach. *Eurasia Journal of Mathematics, Science & Technology Education*, 9(1), 45-58.

Linking to this article: DOI: 10.12973/eurasia.2013.915a

URL: <http://dx.doi.org/10.12973/eurasia.2013.915a>

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ISSN: 1305-8223 (electronic) 1305-8215 (paper)

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This study explored primarily the elementary teachers' motivations and expectations for engagement in a science professional development. Participants (N=20) were elementary teachers in two public schools from the United States and were enrolled in a yearlong science professional development; however, due to various factors teachers did not complete the professional development program. We investigated various motivational aspects related to teachers' professional experiences as well as their views about the program. Study results showed that teachers' motivations for this professional development program were strongly influenced by their self-efficacy beliefs about science teaching, their beliefs about what effective teaching means and the types of support provided to teachers by their schools to engage in such program. Additional study results showed that teachers from different grade levels perceived differently the effectiveness of their professional development program involvement because of the relevance (or lack of relevance) of the science content presented in the program relative to their grade level. Implications for classroom practice and future research are discussed in this study along with findings.

Keywords: teacher education, teacher development, motivation, beliefs, values, teaching practices

INTRODUCTION and PURPOSE

For many teachers professional development (PD) involvement provides valuable opportunities to engage in experiences that help improve their quality of teaching in addition to increased students' academic outcomes (Dana, Campbell, & Lunetta, 1997; Desimone, Porter, Garet, Suk Yoon, & Birman, 2002; Seymour, Hunter, Laursen, & Deantoni, 2003). Recent research in science education in particular has demonstrated that effective professional development has a direct impact on students and teachers' development (Abdal-Haqq, 1998; Feldman, Divoll, &

Rogan, 2007; Shymansky, Henriques, Chidsey, & Dunkhase, 1997). Additional studies also show that teachers who participate in professional development programs have been shown to effectively increase their science quality instruction and students' science achievements (Kardash, 2000; Zubrowski, 2007). The PD experiences have a major influence on teachers' thinking about teaching science and their classroom practices (e.g., Buck, 2003; Hanuscin & Musikul, 2007; Pop, Dixon, & Grove, 2010; Smith & Southerland, 2007). Such studies also suggest that participants' choices to implement changes into their teaching practices generally were related to the novelty of the program, and to the degree teachers valued the elements of the program (Dixon & Wilke, 2007; Grove, Dixon, & Pop, 2009).

Reports of the National Research Council (1999) and the NCLB Act of 2001, have stressed the importance of

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State of the literature

- A few studies in the field of science teaching explore elementary school teachers' motivations and expectations for professional development engagement and their views of the professional development engagement
- Teachers' motivations and expectations for professional development engagement are strongly connected with teachers' changes in their thinking about science teaching and changes to their classroom teaching.

Contribution of this paper to the literature

- Teachers' engagement (or lack of engagement) in a professional development program is influenced by various factors such as teachers' self-efficacy beliefs about their science teaching, their perceived relevance of the professional development program and the types of support they receive from school to engage in such programs.
- Providing elementary school teachers with opportunities to enhance their teaching confidence and learn about authentic activities is crucial for their professional growth.

high-quality professional development programs for all teachers, especially in science teaching (Guskey, 2003; Supovitz & Turner, 2002). Policy-makers have begun to emphasize that schools need to use professional development training opportunities that would provide teachers with novel ideas and strategies that would help increase students' science achievements. Elementary school teachers do not always have the chance to participate in high quality professional development programs for science and studies show that they often report a lack of adequate content preparation in science and inability to implement reformed based teaching strategies. Research shows that elementary teachers' reported feelings of low confidence in teaching science and lack of content knowledge compared to their middle and high school counterparts (Lloyd, Braund, Crebbin, & Phipps, 2000; File & Gullo, 2002).

Our study has arisen as a response to the scarcity of research in the field of science teaching for elementary teachers, especially motivational aspects related to their professional development involvement. We embarked in this study to investigate teachers' motivations for attending a science professional development, and professional development experiences. Additionally, we investigated the relationships between motivational aspects for program involvement, teachers' beliefs about elementary science teaching, and teachers' reported uses of PD elements into their classroom practices.

Participants in this study (N=20) enrolled in a yearlong science professional development program, but complete it only partially. The professional development program was initiated by a science education program working at a large national science laboratory hosted by a major university in the United States. The following research questions were addressed by our study:

1. *Generally, what were elementary teachers' views of their science professional development involvement and their motivation for professional development engagement?*

2. *Overall, how did teachers perceive their science professional development experiences and the degree to which their involvement influenced their their science teaching practices?*

Theoretical Considerations

The Expectancy-Value theory (Atkinson, 1957; Wigfield & Eccles, 2000) is one of the major frameworks for explaining achievement motivation and expectancies. Generally, research in this area have regarded success expectancies and task valuation as major elements to determine motivational engagement and subjective values of tasks (Wigfield & Eccles, 2000; Wigfield, Tonks, & Eccles, 2004). We used this theoretical framework in our study to describe participants' motivation for task engagement (i.e., what was valuable in teachers' participation in a professional development program, or engaging in a learning task), and their views about science teaching.

The Expectancy-Value theory explains that a person's motivation to engage in a behavior is the product of the individual's expectations to perform this task (i.e., meet a goal) and the perceived value of that goal (Atkinson, 1964; Eccles, Kaczala, & Meece, 1982; Eccles, 2005). One's values and expectancies are key motivational components in predicting academic behaviors and choices. Wigfield and Eccles (1992, 2000) researched the concept further to explain that an individual's choice of tasks or goals, their persistence, and their performance can be explained by determining the individual's expectancy and value concerning mastering the task or obtaining the goal. Two key concepts are discussed in the Expectancy-Value Theory: (1) value, which refers to the extent to which the task or the established goal by an individual is meaningful and valuable, so the individual would engage in the task and sustain effort to successfully achieve it and (2) expectancies (expectancies for success or ability beliefs) which refer to the extent that an individual is confident on performing a particular task (Wigfield & Eccles, 1992, 2000).

METHODS

Participants and context

A total of 42 teachers from two Title I elementary schools in the southeast U.S. enrolled in a science professional development program offered by the M. Lab (a major science laboratory hosted by a large university in the southeast U.S.). The administration of the two schools requested help from the M. Lab in finding ways to improve teachers' science content knowledge and the science teaching practices in school as a result of the increasing state demands for improving quality science teaching in elementary schools and high stakes standardized tests on science for the elementary students. All teachers from the two schools were voluntarily involved in an eight month professional development program, consisting of a series of workshops offered once a month (2 hours workshops after school) by a team of science educators from the M. Lab. The content of the workshops included topics such as: The Nature of Science (NOS), Science Process Skills, Observation versus Experiment, Energy, Motion, Climate Change and Measurement. The workshop's design was based on an innovative approach, including a constructivist model of five features adapted from Loucks-Horsley model (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003), such as meaningful learning, active participation, situated learning, problem solving, and social constructivism. The workshop design included monthly sessions on writing in science, online journaling, colloquiums, content lectures, peer mentoring, and share fairs.

We contacted all teachers and the school administration of the two schools and invited them to participate in a study regarding their professional development program experiences. Twenty five teachers completed an online survey about their demographic data, motivation to participate in the professional development program and information about willingness to participate in an in-depth interview (the focus of our study). The purpose of the initial online survey was to collect basic data about participants and also to select participants for the interviews. The interview respondents, participants of our study ($N=20$) completed in the survey all information and completed the form for their interview participation about their professional development experiences (see demographic information in Appendix A).

Data analysis

All interview participants ($N=20$) volunteered for the interview and consented to have their interviews recorded. To protect participants' anonymity, pseudonyms were assigned to each teacher. The in-

depth, semi-structured interviews (see Appendix D for sample interview questions) explored teachers' views about their professional development experiences, their motivations for program involvement and their views of elementary science teaching.

The content analysis technique (e.g., Lincoln & Guba, 1985; Merriam, 1998) was employed to organize, code, and interpret the data gathered through the interviews. Three coders independently coded sample interviews initially to develop a coding scheme (See Appendix C), and compared notes. Three types of codes were used (borrowed from the grounded theory technique, Creswell, 2007), open, axial and selective coding.

RESULTS

Analysis of the interview data revealed three major themes, common views expressed by all interviewed teachers about their PD experiences. These themes emerged as dominant ideas held by all participants; we labeled them as: the theme of beliefs, support, and relevance. We present next the thematic analysis, describing the major themes common for all interview participants, and then we exemplify these themes for three individuals (case studies), three teachers illustrating distinctive experiences and views regarding their PD involvement (see Appendix C).

The Theme of Beliefs

Teachers' self-efficacy beliefs and pedagogical content knowledge in science was directly related to their teaching strategies and motivation to attend science professional development. Negative feelings of self-efficacy science teaching in this study were expressed by teachers in general, and often resulted in low participation in science professional development. Often these negative feelings were expressed by teachers because, according to them, they had minimal exposure to science in their respective university teacher education curriculums. Several teachers talked about themselves as being "not- scientific", and often fearful of teaching science because of the potential unknowns prevalent in science. Barbara, one participant who held this belief, described herself and her science PD experience:

I never really saw myself as a science teacher so when I got hired as a beginning teacher and put in the classroom and science was going to be one of the subjects that I was going to teach I knew I wasn't going to do it badly and I knew I needed to do something to make myself more enthusiastic about the subject and professional development was one way I thought to take care of that.

It is important to note that teachers like Barbara felt increased confidence in their ability to teach science after attending the M. Lab science professional development. Teachers who attended the M. Lab workshops explained that the science activities, not the scientists' lectures, were key in changing their feelings toward science. Additionally, experience in science professional development, specifically workshops provided by the M. Lab was instrumental in transforming teachers' self-efficacy of their science teaching for those teachers who explained that science was boring. Many of these teachers explained that their science teaching was textbook-centered; however, including science activities increased enjoyment with science for both students and teachers and led to connections between science topics and development of meaningful discussions. When asked about the most helpful aspect of the M. Lab workshops Patrick, one of the teachers, explained:

Every teacher at our school can use the textbooks, but that's boring and that makes science boring. The hands on part of the experiments that they [science lab] did for us in the little guide... was more engaging than the textbooks.

Most teachers had intrinsic motivation to attend the M. Lab workshops; they expressed the desire to learn more science content, and continue their professional development. Moreover, teachers who maintained positive science teaching self-efficacy were more likely to integrate activities presented by the M. Lab into their teaching and take a more progressive approach to their science instruction. One teacher explained:

I don't ever prescribe to my children that they have to follow the scientific method. I definitely don't say that there is a start and a finish that every scientist goes through, but I do try to use the language of science so they are familiar with the words.

Teachers' beliefs about science pedagogical content knowledge influenced their approach to their science teaching as well as their motivation to attend the science professional development offered by M. Lab. Teachers expressed frustration towards the minimal science instruction received in the university education and attributed this factor to their inability to teach science well. Throughout the workshops teachers increased their content knowledge by reading literature on specific topics, internet research, and conversing with colleagues. Yvonne, a 1st grade teacher who does not teach science explicitly stated:

After doing the training it kind of helps you to see how science can be almost anything or sometimes we're covering science or an opportunity to cover science and not really know that we're covering it. It helps you to key in to those teachable moments. So if we're covering a reading lesson and because of the training you have, you can see how that relates to science you can pull in the information there.

Teachers who had strong pedagogical content knowledge primarily attributed this to the years of experience and the professional development engagement they had over years. Interestingly, these teachers were more likely to attend any science professional development than teachers who had low content knowledge. Moreover, strong content-knowledge was associated with their desire for continuous learning. Similar to teachers with low-content knowledge, these teachers did not feel that attending the M. Lab workshops increased their content knowledge, but rather provided engaging activities for teaching science. Upon attending science professional development, these teachers felt a strong desire for more hands-on activities and class discussions.

The Theme of Relevance

Relevance in teaching science played a central role in teachers' motivation to attend the M. Lab science professional development. Regulations on science instruction in the first and second grades impeded teachers' opportunities to teach explicit science; therefore, most teachers either rarely taught science (less than once a week) or integrated science into other content areas. Although some teachers were past attendees of different M. Lab workshops, most teachers felt that this science professional development was not a beneficial use of time for them. Furthermore, teachers in first and second grades often saw the M. Lab workshops as inapplicable in their classroom because of the high science content. These teachers explained that alterations to the activities were almost always necessary in order for them to effectively implement these activities in their classroom teaching. Kelly, a 1st grade teacher explained:

A lot of times, to be honest, it's on a higher level. I think the 3rd-5th gets a little more out of it. Like, for instance, one time it was pulleys and levers and so they had string and different types of things to learn about that kind of stuff and for 1st grade level you could do that as a demonstration, but there's no way 1st graders could do some of the things they were doing. It was good to see and learn about.

Although first and second grade teachers found the application of the M. Lab activities difficult, desires to learn from the experiences of other teachers during the workshops served as motivation for them to attend the PD program. Collaborating with fifth grade teachers helped these teachers to see the necessity of teaching science even if it involved integrating science into other content areas. Teachers' interviews revealed that first and second grade teachers who were willing to attend the M. Lab workshops were already integrating science into multiple areas of their class curriculum and felt they possessed a strong content knowledge of science.

Interestingly, teachers in third, fourth, and fifth grade similarly empathized with first and second grade teachers inability to teach science through discussions at the M. Lab workshops. These discussions led to 3rd and 5th grade teachers increased motivation to teach science thoroughly. One 5th grade teacher explained:

I teach 5th grade so I don't know much about what's going on in K, 1, and 2. To see how they take some of the same concepts and break it down for the kids at their grade level helped me to know what we need to be doing more of up here because this is all they can do down there.

Fifth grade teachers found the M. Lab workshops especially relevant to their curriculum and were easily able to implement the activities into their science teaching. Teachers in third and fifth grades explained that opportunities to integrate hands-on activities provided deeper understanding of the concepts that fifth grade students would be tested on at the end of the school year. Integrations of these activities led to more discussion-oriented science lessons with a reduced amount of focus on the textbook. However, for the first and second grade teachers it was evident through the interviews that their professional development focus was literacy and reading strategies, and less important their science training. An important finding emerged from this theme: negative implications were noted for the K-2 teachers because they overlooked the science professional development. On the other hand, pressure in 3rd, 4th, and 5th grade to teach science lead to less hands-on activities and more fact-based teaching to prepare students for testing which results in less critical thinking opportunities and student interest.

The Theme of Support

The theme of support referred to any kind of administrative support, county and state support, as well as support from the M. Lab team who organized the science professional development program. Support in the form of administration referred primarily to the communication and encouragement teachers received regarding science professional development. Teachers maintained positive attitudes of their respective school administration's support of science professional development; however, it is worth noting that professional development in math and reading almost always took priority over science professional development due to pressure in standardized testing in these areas from grade 3 (opposite to science testing which starts in grade 5th only). Teachers were pleased in general with the partnership between their school administration and the M. Lab; this partnership allowed the M. Lab to provide workshops on the school campus which made it convenient for teachers to attend.

First and second grade teachers who did not explicitly teach science felt that the science professional development was secondary to reading or math professional development. In this case, these teachers felt a lack of support from their county in regards to science as well as the science professional development. Many teachers explained that a lack of materials was a hindrance to science instruction because this required teachers to bring materials from home and with time regulations this often was not feasible. One teacher explained:

I think that science is really big for 5th grade and in 4th grade also and they do the science fair and all of that stuff. But for the younger kids it's really not made a priority. When it's not made a priority district wide or school wide then the teachers don't make it a priority.

Teachers explained that reading and/or math was the central focus of their instruction. In addition, teachers who were allotted science instructional time during the day expressed frustration towards reading interventions which typically took place during science instruction. Josephine, one of the teachers expressed her feelings of the support she received from the county and state regulations:

In the last 3 years with the testing, this is awful, with the testing and the pressure we are actually told how much time we have to do things. We are regulated. So, it's almost taken freedom and fun out of teaching because we have to teach reading so many minutes and we have to do so many things but we all bend that our own way to.

Moreover, first grade teachers who did not have a grade level science curriculum held ambivalent attitudes towards attending the M. Lab science professional development. In this case, teachers struggled to connect specific activities learned in science professional development to other content areas. Teachers expressed a desire to have a science curriculum which would provide accountability in teaching science. Kelly, a first grade teacher, explained:

If we had a curriculum I would be more apt to put in my lessons plans and I'd be more adherent to having every Monday, Wednesday, and Friday at 1:20 we are going to do half a chapter or page such and such to page such and such. Then as we went through the different chapters I could be more consistent with experiments or stuff like that. We just kind of hit and miss.

These teachers received support from the county or the state generated reservations towards a strong focus on science and poor attendance and motivation towards science professional development. While this was a common dilemma in first and second grade classrooms, fifth grade teachers felt strongly supported by the school administration. Standardized testing in science

prompted support from the county to attend science professional development.

Activities, science resources and materials were the most valuable support that teachers received from this science professional development. In the M. Lab workshops teachers explained they often implemented the activity the very next day if possible while the content was still fresh in their minds. Additionally, the M. Lab workshops, in particular, gave teachers the opportunity to participate in the activity as if they were students. Participation from this perspective helped teachers consider how to relate meaningfully to their students and the most effective approaches to delivering the activity.

A wide range of levels of support was experienced between teachers in grades first through fifth and appeared to be a strong predictor in science professional development attendance. Although first and second grade teachers were encouraged to focus primarily on reading and math, when science is discouraged teachers are more likely to hold negative perceptions of science leading to less science exposure in the classroom.

Case Studies

Throughout the interview analysis, three teachers, Carry, Frances, and Pam provided unique perspectives and stories regarding their science instruction and professional development involvement. We present their stories below, as illustrative stories.

Carry: "I'm struggling to teach science"

Carry was a fifth grade science teacher in her 7th year of teaching. At Carry's school, fifth grade is departmentalized assigning Carry the role of facilitating four science classes each day as well as an intensive reading class. Prior to her experience as a fifth grade teacher, Carry spent four years teaching at the 3rd grade level which has influenced her approach to teaching science in the fifth grade. It is important to note that the state in which Carry taught mandates fifth grade students be assessed in science through a standardized test making science instruction a top priority in the fifth grade curriculum. In the present study, Carry was one among several teachers who felt their responsibility as educators was to compensate for the dearth of science instruction students received in previous classrooms to either prepare for standardized testing or due to a strong intrinsic motivation for their students to learn science. During the interview Carry shared the struggle and pressures to teach many of her fifth grade students' science resulted from K-4 teachers who did not attempt to teach science. Carry states:

I mean our kids for the most part don't get a lot of science instruction until they get to the 5th grade because science is kind of swept under the rug because it's not tested at every

grade level and some of my kids when they come to me they've fallen through to that teacher at every grade level who doesn't teach science then they get to me and they have no content science background?

What does this mean for science instruction in the fifth grade? Carry expressed the pressure she experiences to "teach five years of science in 180 days". For Carry and other teachers with this perspective, this was one of the chief struggles. One avenue to alleviate the struggle to teach the same content to 5th grade students' with various degrees of science content knowledge was to ability-track students. While this created a heavy workload at the onset of the school year, Carry explained that the ability to differentiate between the groups improved the quality of science instruction the students received.

It's a scheduling nightmare, but once we get it all worked out it's great for the kids because then we know where to start and where we can go. I have one group where we need to move a little slower and do a lot more with starting off with direct instruction, building background before we begin the activities. Then with the TAG (Talented and Gifted) group we can just jump right into the activities because they have the background knowledge.

Instructing science at multiple levels required varied instructional strategies. For Carry the hallmark of science instruction was the real-life applications for her students. When students made real-life connections to science, they found more enjoyment in science. To make this connection, Carry explained she used auditory, kinesthetic, and visual learning aids in teaching. Taking notes, keeping science journals, cooperative learning, and hands-on activities were all avenues Carry implemented in her science lessons as well. Moreover, despite the pressure from standardized testing, Carry explained that she felt spending extra time on topics of student interest held a high priority. Her science professional development involvement played a significant role in her science instruction. Carry referred to science professional development with M. Lab during the interview and further explained that the activities learned at the workshops were an integral part of her science curriculum. Carry explained she and another colleague initiated an after school workshop partnership with the M. Lab.

Since we started the workshops we were going to the workshops because we knew we were going to get excellent information because everything I have ever done with the Science Lab has been awesome. We have fun with P and she put together some amazing activities and things.

The "make and take" aspect of the M. Lab workshops was the primary reason Carry pursued the partnership and became an active participant. Since science is taught every day in the fifth grade and a wide range of content must be covered, Carry would simply

integrate an activity on the day of that topic. During the M. Lab workshop, the teachers created a miniature terrarium. Immediately Carry integrated the activity, by encouraging students to ask questions and make observations and predictions. Carry acknowledged the free resources the M. Lab provided, such as the materials needed for the terrarium, was another strong motivation to attend the workshops. A consistent theme amongst the teachers who held this approach was the assumption that science could be integrated into other subject areas fairly easily. This perspective was expressed in the interview with Carry as an encouragement for teachers of younger grades to begin teaching foundational science. Carry explained her appreciation to the integrated approach to science applied in the M. Lab workshops.

You don't have to kick science to the side because you can integrate it into so many other subjects. A lot of teachers aren't comfortable with that, but when you start showing, "Look, here's a literature book that you can throw into your science lesson," or vice-versa throw some science into your literature lesson. People are more likely to try it and then when they feel comfortable with it, they can move on.

Furthermore, Carry explained a focus of the workshops was to explore science through the eyes of the students. Carry stated:

When they put us in a kid role, they would tell us, "I'm going to treat you guys like you're going to be a class." A lot of people get up there and talk to you like you have no idea what's going on. They talked to us like adults and then they would say, "Act like you're a kid. What would the kids think? What would the kids say about this?" I liked that part because it made you think like your kids. I know some of the silly things my kids come up with and you look at them like, "are you serious?" but that's really what they're thinking. Of course we're not going to think that way because we know more, but it's interesting to be put in that role and know that our kids are probably going to think that this is going to happen even though we know it's going to be something else.

When these approaches to science were encouraged, Carry found a deeper interest in hands-on activities and a desire to make science "more fun and realistic" for her students; however extrinsic factors influenced her opportunity to continue the workshops. As a departmentalized teacher, Carry was involved with another professional development workshop which focused on reaching talented and gifted students. Carry chose to participate in this professional development because of the financial stipend. She mentioned: "With the gifted and STEM training, if you go to all of the meeting you get an extra bonus at the end of the year...the extra money that I get at the end of the year

really helps with daycare so I went to those instead of course."

Carry's story exemplified the motivations and beliefs of teachers who felt obligated to instruct science to compensate for a lack of science instruction in previous classrooms. Carry maintained a positive view of science; however, she expressed pressure and frustration to teach five years of science in a single academic year with the expectation that students would master the state's standardized science test.

Frances: *"I was always passionate about teaching science"*

Throughout the interview with Frances a dedicated passion and love for science permeated the discussion. Frances exemplified teachers who were intrinsically motivated to teach science. This resulted from a variety of factors such as a passionate high school science teacher or a feeling of connectedness with nature. For Frances, her intrinsic motivation for science was shaped by her undergraduate professor's passion for science and her involvement with professional development. Frances taught 4th grade and was in her second year of teaching at the time of the interview. Moreover, Frances held the role of science advocate at her school which required her to inform teachers of science professional development, materials and resources and support teachers in facilitating science in their classroom. Frances explained that she was required to teach science, social studies, reading, and math each day and to her pleasure, science was the first content area of the day. It is important to note that Frances' experience with science at the onset of the day was not a commonality amongst other teachers interviewed. Frances commented:

Science is usually the first thing I teach so the kids are open wide when they come into the classroom and it's the first thing they learn of course so they're more open and more keen to whatever I'm teaching during that time.

Although Frances explicitly taught science, science was integrated into other content areas as much as possible. A common theme during the interview was a desire to integrate science into every content area. Frances commented that her students asked more questions about the environment as a result of the heavy integration. She said: *"Everything is science. Science is one of those subjects that you can almost relate to everything and everything is science happy."*

Science professional development, specifically the M. Lab workshops, shaped Frances' science instruction. Frances described her science instruction as "very hands-on"; therefore, a highlight of the Science Lab workshops were the hands-on activities she could take back to her classroom. Walking through the scientific method was the primary strategy employed to teach science. According to Frances, the scientific method is

an effective avenue for making science relative to the students. Frances explained her initial approach to science was to model experiments rather than letting the students explore for themselves; however, attending the M. Lab workshops has shown her that students made connections when they engaged in the activity. She exemplified this connections approach to science when she implemented an activity in her classroom:

On one of the activities that they did was about, well it was a peanut butter and jelly activity and they would make a peanut butter and jelly sandwich and then the kids would actually have to get up and actually tell you how to make a peanut butter and jelly sandwich and you are the person who is taking it very literal so if they tell you to put the jelly on the bread then you might take the whole jar of jelly and put it on the bread, that type of thing. So I explain to my kids that when you're giving information to people you have to be clear about the information you're giving. With a science experiment when you're actually writing out your steps of your science experiment you want to be very clear, that way if someone was to follow your experiment they would be able to walk through those steps and do it exactly the way you done it.

Integration and a desire to make science relative to students' lives developed out of both intrinsic and extrinsic desires. Intrinsically, Frances had a deep love for science. However, she explained that by teaching in a Title 1 school she knew her students would not have exposure to science and her responsibility as a teacher was to instill a curiosity and awareness of science. This extrinsic desire drove her to continually engage in professional development to provide the quality activities for her students. Frances stated:

I can take something like peanut butter and jelly, something you know your kids want to learn and relate it to science and I think that's the main thing in teaching is that you have to make what you're teaching to the students relative to them. So, take something like that and put it into the classroom and have students engage in it. That just shows that what they're learning in science is relative to them and I bet you anytime they're writing out instructions on how to do something they'll think about that peanut butter and jelly because it's something they can relate to.

An intrinsic desire to be a lifelong learner was held by several teachers interviewed. Teachers expressed their responsibility to attend professional development as professional educators, but also to be continuously informed of advances in science education, technology, and effective teaching practices in science. Frances expressed this motivation as "trying to expand my horizons and learn more about science and how to teach and then gain interest." Furthermore, Frances discussed the impact of an open atmosphere at the M. Lab workshops such that she was able to ask questions

of more experienced teachers and process her own science teaching practices verbally. The impact of science professional development including the discussions with fellow teachers gave Frances an increased desire to teach science as well as more confidence in her ability to relate science to her students.

Pam: *"Teaching science is not a priority for me"*

Pam was a first grade teacher with over 30 years of teaching experience (out of which 8 years as first grade teacher). District and state-wide mandates restricted the teaching of science and social studies in the first grade curriculum to simple integration into reading and math. Moreover, many teachers who maintained a similar perspective expressed vexation towards the lack of time and constant interruptions experienced during science time. Most teachers taught science at the end of the day and when most interventions and school-wide programs occurred.

For Pam, science instruction was never taught explicitly rather it was integrated into the reading curriculum. Pam explained that she was able to teach approximately 20-30 minutes of science each day; however, it was woven into the students' reading curriculum. For many other teachers who held this approach, science was taught only once or twice each week. Nevertheless, Pam felt that science should be an integral part of students' education and made the integration of science into reading a high priority. Pam explained:

What I like to do is pull in the science along with the reading and just try to open minds and think about things and just bring things into the classroom while I'm teaching reading. I'm a big lover of the Promethean board and so in my classroom I put the whole lesson on the Promethean board, but I add a lot of science to it. I find the kids are just fascinated by it. They love hearing the real things.

Along with limited science instruction time, the first grade teachers expressed a lack of resources and curriculum standards appropriate for first grade. Pam explained that she must bring in her own supplies such as personal photos; however, she also utilized the library as an avenue for resources. Encouraging her students to explore science through literature has led to a heightened curiosity in science. Often times students brought in materials from home or that they found while on the playground that sparked class discussions and observations. Pam said:

They'll bring back whatever we're working on. Not just for science. If we were doing little critters in the classroom, they would go and get all of the little critter books. When we did frog and toad they went to get all of the frog and toad books to bring in. My kids have always kind of bent on the library more than other classes I think, but I encourage them to do that. I like seeing the spark of

interest where they relate to things we are doing in the classroom. That has been really rewarding to me.

Although Pam did not follow a science curriculum, she was motivated to prepare her students for science in the upper grades and held specific expectations for her students. Creating a curiosity to learn more was Pam's fundamental purpose in science instruction. This required modeling how to ask questions and how to research an area of interest. Pam explained that when her students brought in an object from home she guided her students in asking questions and making observations about the particular object.

Science professional development was not a high priority for Pam; however, she explained she attended the M. Lab workshops held at her school because she felt like it was her responsibility to attend. Moreover, although external restrictions were placed on the science and social studies she felt guilty for not incorporating more science into instruction. Knowing her students enjoyed science activities motivated her to attend the M. Lab workshops. Through attending the M. Lab workshops, Pam saw a larger perspective of integrating science. Pam commented on her experience:

It was always nice to have that time just kind of be a refresher course to remember, "Oh, I need to focus on that." You tend to be so overwhelmed with everything that you are supposed to be teaching that you tend to lose focus on things that you know should be done, but you tend to overlook because of time.

Unlike teachers who explicitly taught science in the upper grades, the first and second grade teachers explained the activities presented at the M. Lab were not applicable to their students. This factor caused many teachers to choose to not attend. In addition, teachers at this grade level expressed a lack of support from administration towards science professional development. These teachers often felt attending science professional development was not an advantageous time investment and preferred attending reading professional development. Although Pam held similar beliefs and feelings towards science professional development, she was an exception because she was committed to attending the M. Lab workshops at the very least. Pam approached the M. Lab workshops as an opportunity to converse with teachers of various grade levels to obtain ideas and voice her struggles in science instruction. She expressed feelings of loneliness throughout the day and opportunities to share were invaluable.

I would say almost always when we did something it was more of a higher level than the 1st grade, but it's just always good to be reminded where the kids need to be later on anyway. I realized that I've got to start the foundation for them so when they get to the other grades they will be

able to work on those concepts. I'm always trying to figure out how I can present this at a first grade level.

The interview with Pam voiced concerns with the lack of science professional development at the K-2 level. Many teachers expressed feelings of discouragement towards science instruction and a belief that science was not important. Although personal experiences with science influenced teachers' perceptions of science and their confidence in teaching science, state mandates on teaching science perpetuated this ideology. Pam's response to mandates appears to make the most of science in a restricting environment.

DISCUSSIONS

The major themes and case studies presented in this study reveal a multiplicity of explanations of teachers for their science instruction and science professional development experiences. In general, teachers expressed as motivations for engaging in a PD their self-perceptions (i.e., science self-efficacy beliefs), relevance of the PD program for their instructional needs and the type of support they received from administration to engage in PD workshops. With respect to teachers' beliefs, those teachers who expressed positive self-efficacy regarding science teaching were more likely to attend PD; additionally, their desire to attend science professional development was even more obvious amongst teachers who held both positive science self-efficacy and high pedagogical content knowledge. When educators develop science professional programs they need to think about various ways to bring teachers professional opportunities that will increase their science teaching self-efficacy beliefs. For example, teachers who attended the M. Lab workshops expressed that meaningful activities increased their self-efficacy of science stating that science could be fun and engaging. For some teachers, negative self-perceptions were the result of a mandated regulation or a lack of support from school administration. This was a common perspective held by teachers in the first and second grades although, it is important to note, some teachers' positive self-efficacy was not diminished due to low support.

Research shows that generally science professional development programs are predominantly designed for and encourage the support of more middle and secondary teachers than elementary teachers. As a result of this, elementary teachers are exposed less to science PD, and very often they display low confidence about science teaching and/or more negative attitudes toward teaching science compared to their secondary school teacher peers (e.g., Hanuscin & Musikul, 2007; Smith & Southerland, 2007). This is extremely important to become aware of and acknowledge for the science

education in general and for the professional development programs trainers. The power and intensity of the negative emotions experienced by the teachers can be responsible for triggering individuals' motivation to learn and succeed in a program if they have support for their learning (Pop, Dixon, & Grove, 2010). In the long run, participants' negative emotions (such as fear, anxiety) can develop into positive emotions and finally positive outcomes. Contributions from this study may be considered therefore for educators and professional development programs regarding the role of motivations, emotional involvement (both positive and negative emotions) and changes to teaching practices as related to improving the quality of teaching and consequently student achievements.

Another aspect mentioned by the teachers regarding their motivations about the PD program were related to the science curriculum and regulations, communication expressed by administration often aids in the construction of the belief that science is not important in first and second grade. Teachers who developed this mentality were less likely to teach science and attend science professional development. Furthermore, this mentality led to increased pressure from 3rd, 4th, and 5th grade teachers to compensate for the dearth of science instruction in the younger grades. Although reading and math hold a higher priority in first and second grades, it is important for administration to encourage science instruction even if it means integrating science into reading and/or math. In doing this, teachers are more prone to hold a positive view of science which leads to more effective science instruction. In regard to professional development, reading and math professional development which integrates science into the activities and instruction promote the importance of science instruction.

An interesting finding from our study was the intermix of motivations, emotions and cognitive elements (i.e., reported changes to teaching practices) expressed by the participants. Our study results suggest that what teachers valued about their PD experiences greatly influenced them to change their thinking about science teaching and their classroom teaching. In our study, the lack of involvement in novel and authentic science environment activities (such a laboratory) and the emerging in a real science setting made teachers feel that this PD was less important. Research (i.e., Dixon, & Wilke, 2007; Guskey, 2003) suggests that most teachers change their science teaching instruction and their attitudes to science teaching because of the novelty of the professional development program they attended and because of the relevance (applicability) of the program content to their classroom teaching. Also, being involved in an authentic learning environment (i.e., a science laboratory) and for longer durations

showed that teachers learn best and more solid the science content and pedagogy (Pop, Dixon, & Grove, 2010). Previous research show that longer professional development are more effective and show more in-depth changes to teachers' thinking, planning and delivering instruction compared to short term professional development (i.e., 2-3 days), which are commonly developed for teachers due to lack of time and resources (Akerson & Donnelly, 2008 ; Dixon, & Wilke, 2007; File & Gullo, 2002).

Future research directions could explore science programs developed to address these aspects: providing an engaging and authentic science learning environment, providing mentorship programs to best facilitate and scaffold elementary teachers' science learning and teaching, and providing relevance for all teachers in a PD program. Creating science professional development programs for elementary teachers that will engage them in meaningful learning and provide scaffolding for their science learning is extremely important in changing the quality of teachers' science classroom instruction.

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Appendix A. Interview Participants Demographics (N=20)

Name	Gender	Ethnicity	School	Grade Level	Years Teaching	PD attendance
Lisa	F	Caucasian	White Oak	4 th	1-5	0
Yvonne	F	African American	Ramsey	1 st	11-15	0
Pam	F	Caucasian	Ramsey	1 st	Over 25	4
Carry	F	Caucasian	Ramsey	5 th	6-10	0
Patrick	M	Other	Ramsey	3 rd	16-20	4 +
Josephine	F	Caucasian	Ramsey	4 th	Over 25	2
Brittany	F	Caucasian	White Oak	5 th	1-5	0
Tricia	F	Caucasian	White Oak	4 th	6-10	3
Erica	F	Caucasian	White Oak	5 th	1-5	4 +
Frances	F	African American	Ramsey	4 th	1-5	0
Natalie	F	Caucasian	White Oak	3 rd	1-5	0
Kelly	F	Caucasian	Ramsey	1 st	11-15	0
Jenny	F	Caucasian	White Oak	2 nd	1-5	0
Mary	F	Caucasian	Ramsey	5 th	16-20	4
Kay	F	Caucasian	Ramsey	2 nd	1-5	2
Dan	M	Caucasian	Ramsey	4 th	6-10	3
Bianca	F	Caucasian	Ramsey	3 rd	6-10	2
Deborah	F	Caucasian	Ramsey	3 rd	1-5	3
Liz	F	Caucasian	Ramsey	4 th	1-5	3
Bonny	F	Caucasian	Ramsey	4 th	1-5	3

Appendix B. Major Categories and Themes

Categories	Themes	Observations
Teaching science strategies	Hands-on inquiry-based science Science journals Direct Instruction Textbook (mainly in grades 3-5) Science Weekly (1 st grade) Worksheets Vocabulary Videos Cooperative learning/Centers	Varied methods amongst teachers (e.g., engaged students in activities before using textbooks, worksheets, and experiments).
Obstacles to teaching science	Time Standardized Testing Scheduling disturbances Pressure to teach writing Outdated curriculum and textbooks No science curriculum (1 st grade)	Time, standardized testing, and an outdated curriculum were significant obstacles
Expectations/roles of students	Know vocabulary and concepts Practice scientific method Performance tasks (activities & discussions) Develop questions	Expectations for students to perform higher level activities and assessed students' based on performance assessments
Teacher self-efficacy	Confident with grade level content Dislike of science Confidence gained through PD	Teachers felt confident with grade-level science content
Motivation to attend PD	Free materials and resources New ideas and perspectives Hands-on demonstrations Increased content knowledge Encouragement from administration Student interest in activities	Free resources and inquiry based activities were strong motivational factors
Obstacles to attending PD	Time and location conflicts Poor attendance Disinterest in teaching science Same activities as previous year Not applicable to grade level	Time and location conflicts were consistent among most teachers. 1 st grade teachers were not able to apply activities
Application of PD into science class	Hands-on activities Allow students more discovery opportunities Integrate into other content areas Activities allow for more discussions	Introduced more hands-on activities and allowed students more ownership over class discussions

Appendix C. Summary of Three Teachers' Motivational Approaches (Case Studies)

Name	Description	Science Instruction	Motivations PD	Obstacles PD	Overall Experience
Carry	Pressured to prepare for testing	Departmentalized and ability-grouped science instruction in the 5 th grade; The end result of science instruction is real-life application; Utilizes note-taking, hands-on activities, and cooperative learning	To provide more hands-on activities for the classroom; Opportunities to share ideas with colleagues; Ideas on ways to integrate science into other content areas	Other workshops she attended impeded the M. Lab attendance however Repeated lessons presented in M. Lab PD were not a good use of time	Feels responsible to teach science to prepare students for standardized testing Believes students learn best through hands-on activities Motivation to attend science professional development to provide more meaningful activities for her students
Frances	Intrinsic motivation to teach science	First content area taught each day; Scientific method is method of choice; Strives to integrate science into other content areas to increase students' awareness of science	Love for science and a desire to be a continuous learner were the primary motivators; Opportunities to broaden science instruction	Other teaching responsibilities and obligations that were held at the time of science PD	Intrinsic motivation to teach and learn about science She particularly enjoys integrating science into other content areas to increase awareness of science in her students
Pam	Focused on reading instruction	Does not teach explicit science; however, integrates science into reading curriculum; Uses spontaneous opportunities to teach science; Science is a not a high priority	Feels responsibility to attend as a professional educator; Opportunities to share with colleagues; Exposure to higher-level science	Science is not a focus in the 1 st grade, science PD not important PD activities are too complex for 1 st grade	Teaching students to read is Pam's primary focus; therefore, she has little time to teach science. Nevertheless, Pam does feel a responsibility to teach science through integration to prepare students for the next grade level.

Appendix D. Sample Questions of the Interview Protocol

1. Please tell me a little about yourself and your science teaching experience. What grade do you currently teach? How long have you taught?
2. In what kinds of science professional development programs have you participated?
3. Why did you choose to participate in these programs?
4. To what extent do you believe professional development programs are useful to attend?
5. In what ways does your school support your participating in professional development programs?
6. Did you attend any Science Lab professional development workshops? If so, how many?
7. What reason led you to participate in the workshops initially?
8. What reasons led you to stop attend the workshops?
9. Do you feel that the workshops you attended affected the way you teach science? If so, can you describe how?
10. Do you think about science differently after attending the workshops?
11. What was the most helpful aspect of the Science Lab workshops?
12. Were you able to integrate any of the information presented at the workshops into your classroom? If so, how?
13. In general, what kinds of things do you expect your students to know or be able to do as a result of your science lessons?
14. How do you generally conduct science in your class?