Integrating Literacy into Elementary Science: Teacher Concerns and Their Resolutions

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Abstract

Although there is strong support for the use of science and literacy strategies at the elementary level, little research has been conducted on the issues that teachers encounter as they incorporate these new practices into their instruction. This study utilized the stages of concern of the Concerns-Based Adoption Model CBAM framework (Hall and Hord, 2006) to examine questions and challenges that arose as teachers involved in a professional development project began to adopt an integrated approach to science and literacy through the use of science notebooks (Klentschy, 2008). Specific concerns that teachers expressed and ways in which they were resolved are discussed.

Introduction

Current requirements of the No Child Left Behind (NCLB) Act place primary focus for elementary instruction on mathematics and language arts. In many cases, science instruction has been marginalized and the amount of time that teachers are given for science has been limited when high stakes tests focused on the basics (i.e. mathematics, reading, and writing) are implemented (Goldston, 2005; Spillane, Diamond, Walker, Halverson, & Jita, 2001; Tugel, 2004). As a result, many programs across the country have started examining ways of integrating science with other subjects, in particular literacy, in order to incorporate science back into the elementary curriculum (e.g. Klentschy & Molina-De La Torre, 2004; Linking Science, Inquiry, and Language Literacy, 2008). Research on the integration of science and literacy has shown that the integration of these two subjects can enhance student learning in both areas (Amaral, Garrison, & Klentschy, 2002; Vanosdall, Klentschy, Hedges, Weisbaum, & Chicago, 2007).

Although there is strong support for the use of science and literacy strategies at the elementary level, little research has been conducted on the issues that teachers encounter as they incorporate these new practices into their instruction. This study utilized the stages of concern of the CBAM framework (Hall & Hord, 2006) to examine questions and challenges that arose as teachers involved in a professional development project began to adopt an integrated approach to science and literacy through the use of science notebooks (Klentschy, 2008). Furthermore, it describes the ways in which these concerns were addressed by the professional development provider and the teachers themselves. This paper provides important insight into the adoption of an integrated science and literacy approach, the nature of change that occurred as teachers proceeded through this process, and ways in which teachers moved from questions and challenges to solutions and successes.

Review of the Literature

Elementary Science and Literacy

Language is an integral part of science and science learning. Scientists and students use language to make sense of new information and develop new ideas. Reading and writing are fundamental components of scientific literacy (Norris & Phillips, 2003). As Wellington and Osborne (2001) point out, learning science is “in many ways, like learning a new language” (p. 12). The use of language is also integrally involved in the development of concepts (Vygotsky, 1962). Talking, writing, and reading, all play important roles in science learning. As Rivard and Straw (2000) noted:

> Talk is important for sharing, clarifying, and distributing scientific ideas among peers, while asking questions, hypothesizing, explaining, and formulating ideas together all appear to be important mechanisms during discussions. The use of writing appears to be important for refining and consolidating these new ideas with prior knowledge. (p. 588)

The processes of science and literacy also have many similarities that can support student learning in both disciplines. The processes of scientific inquiry, such as questioning, hypothesizing, gathering/organizing data, drawing conclusions, analyzing results, and reporting, are similar to the literacy processes of purpose setting, predicting, organizing ideas, constructing/composing, evaluating/revising, and comprehending/communicating (Baker, 2004; Casteel & Isom, 1994).

In a review of science and literacy, Yore, Bisanz, and Hand (2003) describe a distinction between knowledge-telling and knowledge-transforming models of writing in science. The knowledge-telling model focuses on the technical aspects of science writing and utilizes writing as an evaluative tool for the teacher. Whereas, a knowledge-transforming model views the writing process as a generative process in which students construct understanding as they engage long term memory, short term memory, and sensory-motor activity (Holliday, Yore, & Alvermann, 1994). In this model, "the act of writing in science is seen as a process of constructing understanding and building knowledge: the minds-on complement to hands-on inquiries" (Yore et al., 2003, p. 712).

Research has shown that integrating reading and writing into content area instruction can lead to improved student achievement in science and language arts. Amaral et al. (2002) found that integrating the use of science notebooks with elementary science curriculum resulted in increased student achievement among English language learners in science, writing, reading, and mathematics. At the secondary level, Wallace and Hand (2007) found that students using the Science Writing Heuristic scored significantly better on higher order conceptual questions of scientific knowledge. Rivard and Straw (2000) found that structured writing activities combined with small group discussion improved the retention of science knowledge over time.

Adopting Integrated Science and Literacy Practices

As described above, many theoretical and empirically based arguments have been made for a science-literacy connection. However, few studies have examined the challenges that teachers face when incorporating literacy into science instruction. Baker and Saul (1994) investigated the issues that elementary teachers considered important when evaluating the value and feasibility of science-language arts connections. Teachers in this study expressed academic, personal, child-oriented, and practical considerations when thinking about the integration of science and literacy. Academic considerations included authenticity, intellectual viability, and commonalities across science and literacy. Personal considerations included feelings of ownership and empowerment, identification with students, and the belief that ideas make sense based on their own experiences. Child-oriented concerns included fostering of self-regulated learning, effects on child's self-system, and the developmental fit. Practical considerations included feasibility, effects on student outcomes, and availability of resources and materials.

Two studies have examined teacher concerns related to the implementation of writing-to-learn strategies in middle school classrooms. Hand and Prain (2002) conducted a case study of two teachers changing perceptions and concerns as they implemented writing-to-learn strategies into their middle school science classrooms. They found that the primary issues for the teachers related to assessment, planning and setup, and their changing roles as classroom teachers. Baker, Barstack, Clark, Hull, Goodman, Kook, Kraft, Ramakrishna, Roberts, Shaw, Weaver, and Lang (2008) surveyed middle school science and writing teachers about common classroom problems they experienced while implementing writing-to-learn strategies in science lessons. Scheduling and time constraints, teacher and student attitudes about writing, and evaluation and feedback were identified as the primary challenges that were encountered.

Framework for Examining Teacher Concerns and the Process of Change

In all educational innovations, teachers go through a process of change as they incorporate new ideas into their instructional practices. The Concerns-Based Adoption Model (CBAM) is "a framework and set of tools for understanding and managing change in people" (Horsley & Loucks-Horsley, 1998). CBAM makes several assumptions about change in educational settings. These assumptions are; (1) Change is a process, not an event, (2) Change is accomplished by individuals, (3) Change is a highly personal experience, (4) Change involves developmental growth in feelings and skills, and (5) Change can be facilitated by interventions directed toward the individuals, innovations, and the contexts involved (Anderson, 1997, p. 333).

CBAM characterizes Stages of Concern (SoC) that people generally progress through as they adopt educational innovations (Hall & Hord, 2006). According to this framework, concerns are identified as the "composite representation of the feelings, preoccupation, thought, and consideration given to a particular issue or task" (p.138). Hall and Hord identify seven stages of concern: stage 0 - awareness, stage 1 - informational, stage 2 - personal, stage 3 - management, stage 4 - consequence, stage 5 - collaboration, and stage 6 – refocusing. These seven stages of concern can also be grouped into four categories of concerns originally proposed by Fuller (1969): unrelated (awareness), self (informational and personal), task (management), and impact (consequence, collaboration, refocusing). These are stages that individuals may experience when adopting an innovation. Although research has shown that there is a quasi-developmental path to the concerns that individuals express as they progress through the change process, the process is not necessarily sequential or linear (Hall & Hord, 2006).

This framework characterizes general components of the change process, which can provide useful information about teachers' overall attitude towards the educational innovation. In addition, each educational innovation also presents its own unique concerns to teachers as they implement new approaches. Examining the general stages of concern and the specific nature of these concerns can provide important insight into ways to support teachers' continued implementation of new instructional practices. This study utilized the stages of concern framework in order to characterize teachers' concerns and the nature of change elementary teachers experienced as they implemented an integrated approach to science and literacy in their classrooms.

Context

The Idaho Hands-on Elementary Science (IHES) Project provided professional development for elementary teachers focused on integrating literacy with an inquiry-based science curriculum through the use of science notebooks (Klentschy, 2008). The school district involved in this project had recently adopted Full Option Science System (FOSS) curriculum for grades 1-6. The district adopted two to four kits at each grade level. A few weeks before the start of the professional development project FOSS provided a half-day workshop for each grade level on the curriculum units that they had adopted.

Then the IHES project built teachers knowledge of science content, inquiry-based curriculum, and strategies for integrating science and literacy through six monthly half-day workshops. The first workshop introduced teachers to the project and the relationship between science content, inquiry, and literacy. For the second workshop the teachers were separated into grade-level groups in order to focus on science content and provide examples of science notebook activities that were specific to the units for that grade.

All teachers then attended four additional monthly workshops that introduced new material, addressed specific issues that arose related to implementation of science notebooks, and provided teachers the opportunity to share experiences from their classrooms. These four workshops also provided support for on-going reflection on teaching and learning and the development of a learning community among teachers through the sharing of teaching experiences and the examination of student work. Throughout the project, teachers were also assisted in translating new knowledge into practice through classroom-based mentoring by science and science education faculty. Finally, a project website facilitated communication between teachers and the sharing of resources.

In this project, the educational innovation was defined as the integration of literacy strategies into inquiry based science curriculum using the model of science notebooks developed by Michael Klentschy and the Valle Imperial Project (Klentschy & Molina-De La Torre, 2004). Science notebooks use writing and discussion to support the development of conceptual understanding by scaffolding instruction that supports students in using evidence to form explanations and uses writing as a reflective tool (Klentschy, 2008).

The science notebook model consists of the following science notebook components (Klentschy, 2008):

- Focus Question – student generated with teacher guidance
- Prediction – including an explanation of the reasoning behind the prediction
- Planning – used if students are designing their own procedures
- Data – organization and recording of data/evidence
- Claims-Evidence – structure for scaffolding students development of explanations by focusing on the relationship between claims and evidence
- Conclusions – discussion of what students learned and how it differs from their initial ideas
- Reflection – new thoughts and questions

These components make student thinking explicit and provide a structure to support students in creating meaning from inquiry-based science learning experiences. Although these components have many similarities to typical science lab write-ups, the crucial difference lies in the shift from focusing on conducting the investigation to developing meaning from the investigation:

> The most significant conceptual change occurs when students take a position regarding an investigation and provide evidence for that position: that is when they write about *what they have learned from* the investigation rather than *what they did during* the investigation. Students are now using their observations to support their reasoning. (Klentschy & Thompson, 2008, p. 76-77)

The science notebook model scaffolds student learning through the use of guided inquiry (National Research Council, 2000) and embedded writing prompts. Guided inquiry is used to focus inquiry-based activities on key science concepts and guide students in the development of inquiry skills. Student writing is scaffolded through the use of sentence starters, such as "I think _______, because" and "Today I learned _________" (Klentschy, 2008, p. 16). These scaffolds are gradually removed as students gain experience.

Method

This study utilized a case study approach to conduct an in-depth examination of the issues that elementary teachers experienced when adopting an integrated approach to science and literacy. The case focused on a single professional development project involving 18 elementary teachers and monthly workshops over a span of approximately six months. Consistent with case study design (Merriam, 1998), I utilized multiple data sources including audiotaped discussions, posters of successes and challenges, and workshop evaluations.

In this study, I acted as the researcher and the professional development provider. This provided me an insider perspective on the issues the teachers were dealing with as they engaged in the professional development. My goal in this study was to better understand the nature of teacher change and the ways in which teacher concerns related to the integration of science and literacy could be resolved. Due to my role in the professional development, I was not an objective observer on the process, but rather a participant in the process whose primary concern was to better understand how to support teachers in the process of change. Although this perspective provided me with a deeper understanding of the goals, approach, and activities of the professional development, it also influenced my interpretations of the findings.

Due to the focused nature of this case study and the single context in which it was conducted, care should be taken in generalizing the findings discussed here and assuming that other teachers will necessarily go through the same stages, experience the same issues, or find the same solutions effective. However, teachers and other professional developers may find the issues and their resolutions identified in this study useful to consider when engaging in or supporting others in adopting new integrated science and literacy practices.

Participants

Eighteen elementary teachers from a school district in a small northwestern town participated in the project during 2007. The teachers were from three different elementary schools in the district. The teachers, 17 females and one male, taught grades two through six. All of the teachers participating in the professional development had volunteered to participate in this project.

Data Sources

Data sources for this study consisted of workshop evaluations, posters of successes and challenges, and audiotaped discussions from the last four follow-on workshops. At the end of the February, March, and April workshops, teachers completed an evaluation that asked them to describe what they had learned, what they found most/least valuable, and to identify any concerns or questions that they had regarding the project. At the end of the May workshop they completed an expanded evaluation that asked them to describe (a) what they had learned, (b) how the project had impacted their knowledge of science content, scientific inquiry, and strategies for teaching science, (c) how the project had impacted their teaching this year and how they believe it would impact their teaching in the future, (d) how the project impacted their feelings about science and science teaching, (e) what they found most/least valuable, and (f) any concerns or comments they had regarding the project. These evaluations were submitted anonymously and allowed teachers to individually express their comments regarding the project.

At the beginning of each follow-on workshop teachers were asked to share successes, challenges, and needs/desires. Teachers were allowed approximately fifteen minutes to share in grade level groups and then the grade level groups shared with the whole group. Teacher comments were recorded on poster board during these discussions. Discussions during three of the four follow-on workshops were audiotaped. Due to a technical difficulty the March workshop was not recorded, but all other artifacts were collected. The researcher listened to all of the workshop recordings and characterized the nature of the discussions that occurred throughout the workshop. Discussions that related to teacher reflections on the project or implementation were transcribed for further analysis. All names used in the presentation of the data are pseudonyms.

Data Analysis

The various data sources for each workshop were simultaneously examined and statements that referred to teachers' concerns were coded using three layers of coding. The first layer of coding distinguished between nature of concerns. These statements were identified as concerns expressed as either challenges and questions or concerns that were expressed as successes and sharing of things teachers had learned or tried. This was done in order to examine the interplay between concerns that may act as barriers (questions, challenges) and concerns that signaled resolution of these barriers (successes, solutions).

The second layer coded statements using an initial code list based on the seven SoCs (Hall & Hord, 2006): awareness, informational, personal, management, consequence, collaboration, and refocusing concerns. Once the data statements were categorized into Hall and Hord's seven SoCs, the patterns that emerged aligned more holistically with Fuller's (1969) four categories: unrelated, self, task, and impact concerns. The statements were therefore combined into these four categories for further analysis and discussion of findings.

The third layer of coding involved inductively coding the statements to more specifically describe the type of concern. For example, task concerns were found to include concerns related to notebook organization, implementation with students, and time management. This was done to better understand the specific issues that teachers were dealing with.

In order to examine patterns related to the nature of the change process that occurred as teachers began to implement science notebooks a matrix was created (Miles & Huberman, 1994). In the matrix the concern statements from the various data sources were organized sequentially by workshop. Additionally, the concern statements were organized into rows based on the second and third levels of coding related to the concerns framework. Finally, a table was created that combined the concern statements from the various data sources to show the presence of the various concerns in each of the workshops and whether the concerns were expressed as questions and challenges or as sharing of successes and lessons learned. Data was then re-examined to check for confirming and disconfirming evidence of the themes that emerged from the matrix.

Findings

This section is organized by general categories of concerns. For each category of concerns, the general trends in how these concerns changed over time are presented; then specific concerns and the ways in which they were resolved are discussed.

Self Concerns: Learning about the Innovation.

The self concerns that teachers expressed focused primarily on informational issues related to the use of science notebooks. The self concerns initially focused on wanting more information about the nature of the innovation and how it differed from what they already did. These concerns then progressed to desires for information about how to assess the innovation and how to differentiate the innovation for students of different ability levels.

Science notebooks were introduced during the initial content workshops. However, the process of learning about them evolved over a number of follow-on workshops. In addition to requesting additional information regarding science notebooks and their purpose, the key question for the teachers that arose in this learning process was, *how is it different than what we already do?*

Initially, the teachers saw the innovation as merely a way of bringing more writing into their science instruction and some teachers didn't see the difference between the types of writing that were already included in the FOSS handouts and the writing that is involved with the science notebooks. In addition, the science notebooks required additional prep for the students and were of a form that the teachers were not familiar with. As one teacher stated, "I mean I can do a lot of writing on the pages that come with the FOSS but I tried one of those, you know, the big questions, and I felt like I was giving them too much information" (Donna).

This concern was addressed in a later workshop by highlighting the differences between the two forms of writing. The teachers were asked to do a side-by-side comparison of a handout from FOSS and a sample of a science notebook from the same unit. As the teachers did this, they began to identify that the FOSS handouts focused primarily on having students make observations. During this discussion, one of the teachers stated:

> The predictions. We don't have any. No predictions, and no claims or evidence, it's very spotted. It's kind of hit or miss. You get mostly, they're asking for observations. There is nothing before it or after it so this is finding how to put that before and after piece in. (Sarah)

Teachers began to identify the components of the science notebooks that were different than the writing components included with the curriculum. In addition, they recognized the value of adding those components in because they required students to explain their thinking about the underlying concepts that the students were investigating. For example, the FOSS handouts often had students make predictions prior to investigations and observations during their investigations, but did not always have students explain their predictions or what they learned from their observations. On the workshop evaluations, teachers' comments showed how this discussion led to clarification of their understanding of the key components and purpose of science notebooks, "I think I am finally understanding the science notebook and the use of focus questions and prediction versus data collection" (anonymous) and "I cemented what a science notebook is – its purpose" (anonymous).

In later workshops, teachers began to express concerns related to how to assess student learning. Assessment concerns related to how to use the assessments that came with the science curriculum and how to evaluate student writing that was being produced with the science notebooks and associated writing components of the curriculum.

Teachers also expressed concerns about how to support students that struggled with writing. One teacher expressed her struggles with supporting these students:

> This was hard and it felt in some ways for some of my kids it made science not as fun. There's this writing component and I couldn't have them dictate everything to me, because I'm setting up the labs and doing the instruction so I, that was a struggle. (Sarah)

This teacher then expanded on this and discussed how she would like to examine ways of differentiating for these students in future workshops:

> I just didn't know how to do that. That's where I thought maybe we could end up next year, how do we then differentiate this because we are all having our kids do the same thing and we know they can't all do the same thing. (Sarah)

During the workshop discussions, other teachers shared ideas for differentiating such as pairing up students, providing more sentence starters, and more supports for students who struggle with writing. One teacher described how one of her successes came from utilizing a suggestion another teacher had made about having students who were struggling with their writing talk about their ideas with her first:

> So I did, conference with a couple of my kids that were struggling on those, ahead of time, to see where their understanding was because there's a few of them just their writing skills just are not there, so when I conferenced with them, they really knew what they were going to write down. And so 'Great job, go write exactly what you told me' and I think that really did help them. (Donna)

Although teachers expressed informational concerns throughout the project, the nature of these concerns changed over time. Initially, informational concerns focused on desires to better understand the nature of the innovation and how it differed from their current curriculum. As the workshops progressed, these concerns focused increasingly on issues related to assessment and differentiation. Resolutions to the informational concerns came from directly addressing these issues in follow-on workshops and by allowing the teachers time to share ideas and ways they had resolved their concerns with other teachers.

Task Concerns: Applying the Innovation.

Teachers' task related concerns focused on management of students and materials, adapting current curriculum to incorporate the science notebooks model, implementing the innovation with students, and time management issues. The majority of the task concerns appeared to lessen over time. However, concerns about time continued throughout the extent of the project. As the workshops progressed teachers shared more and more ways that they were addressing the time issues.

Initially, teachers had concerns about how to organize the notebooks and what materials to use to make them. Some teachers had students do their writing in a spiral notebook, others created handouts that were stapled into a packet, whereas others put handouts in a folder so that students could add pages as they went. A second grade teacher also discussed how she printed the labels for the different sections of the notebooks on sheets of blank sticker paper so that students could just stick them into their spiral notebook. This gave students a guide for what to write and limited the amount that they had to write themselves.

Teachers also expressed concerns related to classroom management of students and science materials. Initially, teachers discussed challenges with managing the materials in the science kits and sharing the materials among teachers. Teachers also discussed challenges related to the messiness of the investigations and maintaining student focus on activities. In the evaluation for the last follow-on workshop one teacher described how she had learned to let go of her need to control the classroom during scientific inquiry activities, “I feel like I know how to let go of the control more and let kids explore” (Anonymous).

The science notebook model as described by Klentschy (2008) provides a template that outlines components that students should write about when conducting science investigations, but it does not provide specific guidance for adapting current curriculum to align with this model. Once teachers identified the key differences between their current curriculum and the science notebooks, the teachers began modifying the curriculum to incorporate key components of the science notebooks model. One teacher described her process for doing this:

> We’ve had a lot of success taking those investigations and adding the focus question and prediction piece to that and then setting up the data collection real similar to what they have, but adding those pieces as their science journal component. (Sarah)

In addition to modifying the curriculum, teachers also discussed how this new model was a learning process for the students, but that once students understood the terminology and were use to the format it became much easier. One teacher stated:

> The first couple of lessons were tough, getting the wording down. But you know what? I’m not kidding that lesson was just like clockwork, and I really think now I’m actually incorporating a little bit more per lesson now only just because only because I know that they know it. (Lori)

Finding time to teach science and incorporate the science notebooks into the science curriculum was a major concern for many teachers. At the beginning of the project teachers struggled to find time to conduct the science investigations and incorporate the reading and writing components during the time they generally allotted for science. In order to address this, a number of teachers began to incorporate aspects of the science curriculum into their language arts instructional time. One teacher used the science readers included with the FOSS curriculum during reading groups rather than the basals in an attempt to focus on the science topics throughout the curriculum. Another teacher described how she never had time to finish the science lessons in the 45 minute period at the end of the day, so she started using some of the language arts time during the following day to allow students to finish up their writing from the previous science lesson:

> So, I introduce the lesson at the beginning of our science period which is at the end of our day, gives us 40 to 45 minutes tops but then the following day as part of my language arts block I set up one center rotation so they can go back and revisit, follow through with the writings and actually they have an additional 20-30 minutes to add to that with a nice extension so I don’t have to give up another full science day so I’m able to go a little further, so that helps. (Mary)

Resolution of time management concerns also occurred as teachers began to implement the science notebooks and fully incorporate them into their instruction. Over time some teachers found that the use of the science notebooks actually made their science instruction more successful and efficient. In the May workshop one teacher stated that, "I am finding that I am finding more time now in my science curriculum. They are going fast …" (Lori). Then another teacher at the same school continued on to say "… and more efficiently. More learning gets done. Less stress about hurry hurry recess starts in 5 minutes" (Janet).

Throughout the project the teachers struggled with a variety of task related concerns. Initially, these concerns focused primarily on logistical issues, such as how to organize the notebooks, how to manage students and materials when conducting science investigations, how to adapt their current curriculum to incorporate the science notebooks model, and how to introduce students to this new approach. In addition, task concerns related to time management issues were present throughout the project. Through the discussion of successes during the follow-on workshops, teachers shared various examples of ways that they had addressed these logistical and time issues in their individual classrooms and provided ideas for other teachers to consider.

Impact Concerns: Seeing the impact on students and extending the use of the innovation.

As teachers incorporated the science notebooks into their instruction, their discussion of successes during the workshops began to focus on the impacts that the science curriculum, and in particular the use of the science notebooks, was having on students. The impacts included increased enthusiasm of the students, improved learning, higher levels of student engagement, and mutual benefits to science and literacy. During the workshops, teachers shared stories of how their students were much more enthusiastic about their learning of science. One teacher shared a story of how she had asked a student of another teacher, "What did you do at school today?" and the student went into great detail about the water experiment that they had done in class. Another teacher described how her students wanted to extend a classroom investigation beyond what was described in the curriculum. She stated, "So that was pretty cool to watch them take that knowledge and extend it a little bit by themselves and really push through and beg me to do it" (Rachel).

Teachers also identified multiple ways that the use of the science notebooks with inquiry lessons was impacting student learning. One teacher stated that, "I feel that this is helping to focus it a lot and connect it with the previous lessons and then get them ready for the next lessons. … It's a lot more of a learning thing than just entertainment" (Janet). Teachers also described how the science notebooks required more from the students by requiring them to explain their thinking. One teacher described how "it actually put on a little bit more responsibility on their thinking and learning and it's been a great way to see what ideas they come into an investigation with and how that changes" (Sarah).

One revealing illustration of the impact of the science notebooks on students came from a teacher who had taught the same unit the previous year. This year she taught the same unit with the addition of the incorporation of the science notebooks. She described an activity from the unit in which only 3 of her 5 groups last year could even complete the project. This year all of the groups completed the project and completed it more efficiently than the year before. As she stated, "It was just so exciting to see it go so quick and I was thinking this is like half the time as last year and way more efficient and effective. The kids didn't even have to think twice about how to solve it" (Lori). This teacher further described how she was so impacted by the influence that the science notebooks had on her students' learning that she discussed with her students how proud she was of what they did this year. She shared with them how her teaching had improved and how what they were doing with science notebooks this year was different than last year "we actually looked at the little journal from before and it's really quite pathetic and compared it and it was interesting for them to make that connection that there's valuable learning" (Lori).

Other teachers described how the students became more engaged in the lessons. One teacher described how she had seen her students become more willing to share ideas with the rest of the class. She stated that, "They've become a little bit more risky to come up with inferences for things. That's been a big impact. They feel more open about sharing" (Carol). Still another teacher described how her students had started to ask more questions. During the final workshop, she said:

> One thing I think is a success, is these kids will ask, they question, they question everything. … And it's exhausting to be honest, because you don't get through anything without questions being asked, but it's also very cool because you see them learning constantly. (Brenda)

Teachers also noted that the integration of literacy and science was not only impacting students' science learning, but also their writing skills. One teacher described how she was getting more voice in students' science writing on the response sheets than in their journal everyday writing. When asked why she thought that was, she explained that, "I think they enjoy doing it" (Mary). Other teachers asked why she thought they enjoyed doing it and she stated that, "It's an experience, it's connected, they just did it, so they are having to think about it. They have the information and the facts to back it up" (Mary).

Teachers also recognized that many of the skills that students were developing in their use of the science notebooks, such as questioning skills and supporting claims with evidence, crossed over into other subject areas. One teacher described how she incorporated the use of the term "focus question", which comes from the science notebooks into her language arts instruction:

> In my language arts we're doing this, we're talking about questioning as they're reading. And in my language lately has been, we all come together and list our questions for the story and what's our focus question. That's the term I've been using. I said let's really use that question. Let's reread the story tomorrow and let's use that focus question and it worked perfectly if you were doing it at the same time, using that strategy. (Tammy)

Still another teacher described how the focus on claims and evidence also crossed over into other subjects, "And that claim thing how it carries over to other subjects, 'I claim this because …'" (Donna). The teachers began to see that the incorporation of science notebooks into the curriculum was increasing critical thinking in all areas.

Examination of the teachers' discussions during the workshops suggested that the impacts that the science notebooks were having on students affected how they saw the value of the innovation and encouraged them to continue to use this form of instruction. For example, one teacher described how the impact on students' learning had encouraged her to continue to modify future lessons:

> And using that language 'I know this because …' or 'I'm predicting this …' and explaining why they are making that prediction so that whole piece of pushing their understanding and having to verbalize it a little bit more has been a real success. So, I really enjoy looking for lessons and figuring out how can I tweak this so that it puts students back in charge of that learning rather than just collect their observations and that's it. (Sarah)

When asked about ideas that the teachers had for continuing the project next year, they expressed an interest in getting other teachers in their district involved in the project. Donna stated that, "This is night and day from what we've had in the past and we're actually learning something and we're getting organized and it's useful and I do think we could bring a lot more teachers aboard."

Conclusion

Previous studies have identified issues that elementary teachers consider when evaluating science and literacy approaches (Baker & Saul, 1994) and challenges that middle school teachers experience when implementing writing-to-learn strategies in science lessons (Baker et al, 2008; Hand & Prain, 2002). This study extends this work by examining the concerns that elementary teachers experienced as they engaged in the process of incorporating a new approach to integrating science and literacy and the ways in which teacher concerns were resolved during teachers' involvement in professional development.

Similar to previous studies (Baker & Saul, 1994; Baker et al, 2008; Hand & Prain, 2002), this study found that teachers expressed concerns related to time constraints, assessment, and effects on student outcomes. In addition, this study provides insight into the initial challenges that elementary teachers encountered when learning about and beginning to implement an integrated science and literacy approach. Teachers in this study initially struggled with identifying how the use of writing in the science notebooks model differed from the writing components already included in their science curriculum. Specific focus on this concern highlighted the differences for teachers and allowed them to begin modifying their curriculum to incorporate the specific literacy strategies emphasized in the science notebook model.

Teachers also struggled with how to incorporate the science notebooks into their current curriculum. This included issues related to teaching students to use the notebooks, mechanics of what formats to use for the notebooks, and issues related to time management. Teachers in this project experienced time related management issues that are commonly seen with the adoption of educational innovations. However, the teachers' resolution of this concern was unique to their context and the nature of the innovation. In order to address the need for more instructional time, teachers extended the level of curriculum integration that was occurring in their classroom. Teachers began to integrate science into their language arts instruction as well as integrating language arts into their science instruction. Some teachers also noticed that once students were use to the science notebook approach students became more successful and efficient in completing science lessons.

During the project, teachers increasingly described the positive impacts that the integration of the science notebooks into their science curriculum was having on students. When teachers began to see the impacts that the science notebooks were having on students, there was an increased enthusiasm to continue to utilize this approach. Experiencing changes in student outcomes is a crucial component to changing teachers' beliefs about their instructional practices (Guskey, 2002). Discussions of student successes encouraged teachers to continue to move the change process forward.

Adopting new educational approaches involves a process of change where teachers often encounter questions and challenges related to the incorporation of new approaches with current practice. In order for change to occur, teachers must either accept or resolve the concerns. In this study, the professional development workshops facilitated the sharing of teachers' concerns in a safe environment where professional development staff and other teachers could share possible solutions and stories of related successes. By examining the nature of teachers' concerns and their resolutions in specific cases, guidance can be provided to others pursuing similar types of change.

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