"This is More About a Book Than About Science!" Preservice Teachers' Perceptions Toward Using Literacy Strategies in Inquiry-Based Science Lessons

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Abstract

The application of literacy strategies in the context of inquiry-based elementary science instruction betokens an expansion of contemporary thought regarding cross-curricular instruction. Yet, in light of the potential and promise of new developments, the perceptions of preservice teachers, who will soon be expected to make use of such cross-curricular instructional strategies, remain largely unexplored. Through the use of structured interviews and surveys, insight was gleaned regarding why preservice teachers did, or, as in most instances, did not make use of literacy strategies during their elementary science field experience, wherein they were tasked with teaching an inquiry-based science lesson. Results indicate that though the vast majority of participants acknowledged the value of using the strategies, most elected not to employ them, as a result of numerous and varied concerns. Implications allow teacher educators to utilize perspective variances to support preservice teachers' abilities to understand and apply novel instructional approaches.

Key words: inquiry-based science, teacher preparation, literacy integration

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Introduction

Although the idea that there is an inherent value in borrowing instructional strategies from one content area, and adapting them for use in another content area, is nothing new, such practices typically involve cross-curricular application of techniques from subjects that are historically viewed as having a high degree of curricular commonality. Social studies, for example, often enjoys a substantial degree of content overlap with language arts, just as mathematics is understood to be more compatible with science, than it is with fields frequently categorized as belonging to the "humanities."

However, recent research takes a stance that considers literacy to be an integral component of scientific inquiry. According to Washburn and Cavagnetto (2013), science can only be presented in the context of both written and verbal language; thus, language is equally important to

mathematics in the development of a strong "scientific literacy." "Scientific literacy" is thought of as being inclusive of more than the simple comprehension of scientific texts and vocabulary. Rather, it is thought of as the ability to comprehend, analyze, and critique texts and engage in the discourse of science (Norris & Phillips, 2003). With this definition in mind, it is plain to see how instructional strategies that are associated almost exclusively with language arts could be advantageous in developing students' understanding of science. Characteristics shared by both science and literacy include the concepts of making predictions, sequencing events, making observations, and drawing conclusions (Washburn & Cavagnetto, 2013). Such ideas provide the groundwork for applying literacy strategies in a science education classroom. Moreover, recent federal legislation including the *Framework for K-12 Science Education* (National Research Council, 2012) and the *Next Generation Science Standards* (NGSS Lead States, 2013) have emphasized the need to integrate literacy and science. Based on these notions, it is concluded that elementary preservice teachers should be exposed to the utilization of literacy strategies within inquiry-based science lessons as well as provided opportunities to incorporate these instructional approaches within elementary classrooms.

Review of Literature

The application of literary strategies that emphasize the organization and interpretation of information demonstrate exceptional potential for enhancing the effectiveness of science instruction (Chen, 2011). The "PONG Cycle," as described by Washburn and Cavagnetto, provides a logical framework for the integration of scientific inquiry into the language arts curriculum. This strategy employs the formation of hypotheses in a literary context, and uses them as a means to make predictions about experiments conducted during a classroom science lesson. According to Washburn and Cavagnetto (2013), this technique has been proven highly successful at building upon the students' abilities to formulate a hypothesis and make conclusions regarding their observations.

Though this doesn't represent the only instance where science and literacy can make use of similar learning practices, it certainly provides an example of the potential for overlapping methods between the two disciplines. Further relevant examples employ both explicit and implicit use of language arts strategies in a science classroom, but still support the concept by virtue of incorporating distinct elements of language arts and scientific content. Fang (2013) depicted the use of literature in the context of a science classroom as a means by which to make science content more relevant to the lives of the students. Fang asserted that the use of literature provides an excellent backdrop for expanding students' discussion of content to include a broader perspective of scientific concepts and how such information can be generalized to fit a given situation. Girod and Twyman (2009) described a comparison between an inquiry-oriented science curriculum and a blended science and literacy curriculum that utilized a hands-on, inquiry-oriented approach. Study findings revealed significant differences in favor of the blended curricula on second graders' identity affiliations about themselves as science learners, understanding of the nature of science, and conceptual understanding. Lara-Alecio et al. (2012) focused on middle level English Language Learners and suggested that the utilization of direct and explicit vocabulary instruction alongside the integration of reading and writing within inquiry-based science lessons enhanced the students' performance on curriculum-based tests of science and reading and standardized tests of oral reading fluency. Cooper, Nesmith, and Schwarz (2011) even discussed the potential for enhancing

elementary science teaching through the use of graphic novels. Their work shows that the use of graphic novels as a foundation for scientific discussion is not only possible, but beneficial to student learning.

Despite the fact that existing literature addresses strategies, such as PONG, and the impact on students when literacy strategies are incorporated in science lessons, it does not provide much information as to how well teachers who are already in the profession or those entering the profession will be able to apply such techniques in the classroom. One study involving preservice teachers described a project conducted in Canada, in which preservice fifth and sixth grade teachers had students create picture books that served as a performance of understanding for the science content discussed that day (Gwekwerere & Buley, 2011). The students were encouraged to employ literary elements including plot, theme, and characterization in a way that explains the scientific content to prospective readers. Results indicated that this particular application of literacy skills in an inquiry-based science lesson were effective in enhancing students' understanding of the content, as well as contributing to the generative nature of the content topic. This study, however, focused more on the impact that this activity had on the students and less on the skill and understanding with which the preservice teachers were able to employ the literacy strategies in the classroom. The study assumed that the preservice teachers were already familiar with the practices being implemented and made little mention of any teacher preparation that took place beyond the usual steps involved in planning a lesson.

A 2015 study conducted by Cook and Dinkins focused on preservice teachers' utilization of popular fiction texts within scientific inquiries. Requirements of the inquiry project included: (a) connecting science content standards with a popular text; (b) incorporating strategies for teaching reading, writing, and academic language in tandem with the science content; (c) including nonfiction texts; and (d) utilizing literacy practices. The researchers concluded that the experience supported and enhanced the preservice teachers' disciplinary literacy and legitimized the inclusion of popular culture text within the formal science classroom, yet no findings corresponded to the impact of the experience on the preservice teachers' abilities to utilize literacy strategies within scientific inquiry.

Additionally, the Lara-Alecio et al. (2012) study previously cited further revealed that alongside the significant, positive impact on students, the teacher professional development component of the project impacted the educator participants. The professional development included instruction in ESL strategies and the provision of scripted science lessons aligned with science standards and English language proficiency standards. Based on classroom observations and field notes, it was determined that the experience equipped the participating teachers with strategies to build all students' science academic vocabulary and to integrate speaking, reading, and writing into science lessons, to name a few.

Typically, preservice teachers are exposed primarily to the instructional strategies associated with their particular discipline, and are not consistently encouraged to endeavor beyond the pedagogy of that discipline; this leaves them with little opportunity to explore the possibility of applying strategies from outside their area of specialization (Krajcik & Sutherland, 2010). The opportunity to further develop the skills of preservice teachers is incentive enough to warrant further investigation into how this demographic perceive the use of literacy strategies in the science

classroom, as well as the extent to which they developed their propensity for utilizing these strategies.

The limited amount of literature that focuses on the preservice teacher leads to the belief that this aspect of integrating literacy strategies into science curriculum has been somewhat overlooked; thus, further investigation into the matter is guided by the central question: When elementary preservice teachers are exposed to and given the option of incorporating literacy strategy instruction within their inquiry-based science lessons, what perspectives do they present regarding the instructional strategy?

Methods

Setting and Participants

The study took place in an initial teacher certification program at a private university in the Southwestern region of the United States. Sixty-four elementary preservice teachers were the participants in this study. All participants were seeking their initial elementary (grades pre-kindergarten through grade 6) certification, all were concurrently enrolled in a junior-level science methods course, mathematics methods course, and field-based mathematics and science practicum course, and all were assigned to one of three elementary professional development school (PDS) campuses. Professional development schools are innovative institutions formed through partnerships between professional education programs and P-12 schools. Thirty-five of the participants were enrolled in the required methods courses and field-based practicum course during one semester of the study, and twenty-nine participants were enrolled in the courses the following semester. Though all the preservice participants were in their junior year, 40 were first semester juniors and 24 were second semester juniors who had completed their social studies/English language arts methods and practicum courses the previous semester. All participants in the study were female, traditional students. Fifty-nine of the participants were White, three were Hispanic, and two were African American. These demographics are a representation of the population of elementary preservice teachers at the university.

The practicum course was a full semester (12-week) experience and each preservice teacher was required to plan and teach a one-hour science or mathematics lesson four days each week throughout the semester for a total of 48 lessons. The preservice teachers planned and taught mathematics lessons for nine weeks of the experience and planned and taught science lessons for three weeks of the experience. A university professor was situated at each PDS campus and was responsible for assigning and evaluating all of the field-based practicum course assignments. The practicum course professors conducted regular observations of the preservice teachers while they were actively involved in teaching experiences and met daily with the preservice teachers to provide general pedagogical instruction, support, and feedback relative to their teaching and assignments. The science and mathematics methods course professors met with the preservice teachers in university classrooms twice weekly, provided content-specific pedagogical instruction, and made observations during teaching experiences on the PDS campuses. Some methods course assignments were separate and distinct from the practicum experience and others required the preservice teachers to enact assignment components within the PDS classroom. All preservice teacher participants were assigned to classroom teachers at the Kindergarten through sixth grade levels, and all but two of the teaching placements were in ethnically diverse, self-contained, non-departmentalized classrooms in PDS campuses (two of the preservice teachers were seeking dual

elementary/special education certification and were placed in departmentalized mathematics and science Grade 6 classrooms in a non-PDS campus so as to be placed in classrooms that would allow for meeting their unique certification needs).

During the science methods course, the preservice teachers were exposed to lessons and strategies connecting science, trade books (books published by a commercial publisher), and other forms of children's literature such as poetry. In an early class session during each semester, there was a presentation of seven ways to integrate children's literature, as revised from Welchman-Tischler (1992), including examples for each. These various ways include: (a) provide a context, (b) introduce tools of science, (c) model a creative experience, (d) pose an interesting problem, (e) prepare for a concept or skill, (f) develop a concept or skill, and (g) provide a context for review. Additionally, throughout the semester, several children's books were shared with the preservice teachers and the methods course professor would point out the different ways to incorporate the texts within the elementary science classroom setting. For example, when sharing the way in which literature can be used to pose an interesting science problem, the professor read *Who Sank the Boat* (Allen, 1996), and the preservice teachers built and launched foil boats of different shapes and sizes to better understand the concepts of floating, sinking, density, and buoyancy. These experiences also allowed the science methods course professor to share with the preservice teachers the ways to utilize the strategy in a constructivist manner to guide and support students in communicating their science ideas and making real-world connections.

To enhance the preservice teachers' understanding of the connections between science and literacy, and to provide the preservice teachers with specific literacy strategies, a literacy professor gave a presentation during one scheduled science methods class meeting. During the presentation, the professor shared specific literacy strategies, read aloud pieces of children literature, discussed possible science concepts that could be addressed with the literature pieces, and discussed literacy strategies that could be incorporated to enhance elementary students' understanding of the text and the associated science. Some of the specific literacy strategies shared with the preservice teachers included story map/story face, vocabulary four square, and connections chart.

During both semesters of the study, one specific requirement of the science methods course was to incorporate children's literature within at least one science lessons. Additionally, and though not a course requirement, the preservice teachers were encouraged to incorporate literacy strategy instruction in the science literature lesson. Decisions regarding the content of the science lesson, the corresponding piece of children's literature, and the utilization of literacy strategy instruction were left to the preservice teacher. As with all of the science lessons that the preservice teachers designed and shared during the entirety of the field experience, the classroom teacher provided input as well as final approval of all components of the lesson. The preservice teachers were required to complete a written reflection about the literature integration and literacy strategy instruction experience, and, at the conclusion of the semester, the preservice teachers were invited to orally share their reflections about the experience during a scheduled class meeting time.

Data Sources

The question guiding the study was as follows: When elementary preservice teachers are exposed to and given the option to incorporate literacy strategy instruction within their field-based science lessons, what perspectives do they present regarding the instructional strategy? In order to address this question, preservice teachers' written and oral reflections were utilized. Through these

two data sources, preservice teachers were able to share their perspectives toward the integration of literacy strategy instruction and science.

Children's literature reflections. One requirement associated with the preservice teachers' science lessons which connected literature and literacy strategies was the task of reflecting upon the lessons using a prescribed set of questions. These questions focused the preservice teachers on various elements regarding the planning and presentation of the literature and literacy strategy instruction: (a) What piece of literature did you use within the science lesson, (b) If you incorporated literacy strategy instruction, what strategy instruction did you utilize, and why was this a good choice, (c) If you incorporated literacy strategy instruction, how did you incorporate the strategy, and why was this a good choice, and (d) If you did not incorporate literacy strategy instruction within your lesson, why did you make this choice, and why do you believe this was a good choice? It was noted that all of the preservice teachers prepared and submitted the required reflections. However, two preservice teachers failed to integrate literature within a science lesson, and, instead, completed the lesson reflections by indicating future plans to incorporate literature and literacy strategy instruction within science. Following a review of the submitted reflections, it was determined by the researchers that including the reflections of these two preservice teachers did not impact the overall results of the study.

Class discussions. The sixty-four preservice teachers were invited to orally share their reflections about the experience during a routinely scheduled science methods class. This discussion occurred at the end of each semester, and, though class attendance was required of all preservice teachers, participation in the discussion was not a course requirement. A separate, distinct discussion occurred during each of the two course sections each semester. During the first semester discussions, 33 of the 35 preservice teachers provided oral reflections, and 21 of the 29 preservice teachers provided oral reflections during the second semester discussions.

The same discussion protocol was utilized for all discussions, and the discussions were audio-recorded, transcribed, and verified (See Appendix). During the discussion, the preservice teachers responded to questions about their initial and ensuing perspectives on literacy strategy instruction, future plans with regard to the strategy, and possible reasons for changes in perspectives. The questions were designed to elicit information specific to the preservice teachers' perspectives toward literacy strategy instruction integration within science, because literacy strategy instruction often coincides with the utilization of literature integration, many of preservice teachers spoke in terms of comparisons between the two strategies and provided reflections beyond the scope of the posed questions. Following a discussion regarding this phenomenon, a decision was made by the researchers to include all responses pertinent to the question guiding the research.

The researchers noted the discrepancy between the number of preservice teachers involved in the study and the number who participated in the discussions. However, the research described herein focused on the study and data components consistent for all 64 of the preservice teachers: (a) all participants were required to plan and teach a science focused lesson that incorporated a piece of children's literature, (b) all participants received instruction regarding the utilization of literacy strategy instruction from the same literacy methods course professor, (c) all participants were required to reflect upon said lessons utilizing a prescribed set of questions, (d) all participants received instruction and support from the same science methods course professor, and (e) all participants were invited to participate in a discussion that utilized a common protocol.

Data Analysis

The most appropriate design for this investigation was the qualitative, naturalistic inquiry method because it allows for an investigation relative to how individuals react in and to the world around them as they construct a personalized meaning to that particular world (Lincoln & Guba, 1985). Additionally, a decision was made to utilize grounded theory methodology (Strauss & Corbin, 1998): an inductive methodology where themes, categories, and patterns emerge "out of the data, through the analyst's interactions with the data" as opposed to deductive analysis "where the data are analyzed according to an existing framework" (Patton, 2002, p. 453). This decision was made based upon the fact that the researchers determined that no prior studies provided a framework sufficient to analyze preservice teachers' field-specific perspectives toward the integration of literacy strategies instruction in science.

Each researcher brought a unique perspective to the study: (a) elementary science methods course professor, (b) elementary literacy methods course professor, (c) secondary English education doctoral student, and (d) media literacy education doctoral student. The four researchers were all involved in the teacher preparation program at the same university, but only the science and literacy methods course professors had direct interactions with the preservice teachers. To decrease researcher bias, data analysis did not commence until the conclusion of the second semester. Additionally, to take advantage of the researchers' unique perspectives and to assure validity, each of the four researchers began data analysis by independently extracting data from both written and oral reflections. Researchers were provided with word-processed copies of the oral reflection transcriptions and the preservice teachers' written reflections. The researchers independently read through the transcriptions and reflections and highlighted any verbal or written phrases they believed to be related to the participants' utilization, feelings, beliefs, attitudes, and impressions toward the integration of literacy strategy instruction in science. Researchers then came together to discuss the manner in which the salient, highlighted phrases would be further analyzed. Again working independently, researchers analyzed the data by developing thematic summaries of the preservice teachers' responses to posed written and oral questions. Then, researchers discussed these individual thematic summaries and developed themes and categories that represented the entire data set. In constructing this schematic framework, a grounded theory method utilizing inductive, constant comparative analysis was used to cluster the codes into a progressively more inclusive hierarchical taxonomy (Strauss & Corbin, 1998).

Results & Discussion

Data gathered from the preservice teachers' surveys and interviews indicate that, as a whole, 23% of the 64 participants chose to make use of a literacy strategy in their instruction. Of the 24 participants who had completed the literacy methods course prior to their science teaching experience, 42% elected to incorporate a literacy strategy into their lesson. Only five participants, or roughly 13% who had not taken the literacy methods course prior to their teaching experience, chose to make use of a literacy strategy in their science lesson.

Though participants from both cohorts expressed a few similar sentiments with respect to the integration of literacy strategies into inquiry-based elementary science lessons, the perspectives of respondents who had received literacy methods instruction prior to their teaching experiences remained consistent with each other throughout the course of the study, just as the prevailing perspectives among those who had not taken a literacy methods course prior to their teaching experience were relatively well aligned. Completing the literacy methods course appeared to have

influenced the participants' willingness and perspectives relevant to the inclusion of literacy strategies within their science lessons, but it in no way guaranteed such incorporation. Analysis revealed that, among those opting not to include a literacy strategy, four overarching ideas are almost wholly representative of the responses put forth by the participants. Issues pertaining to a lack of perceived value toward including the literacy strategies, insufficient time for implementing the literacy strategies, a lack of familiarity with the literacy strategies, as well as a general indifference towards the inclusion of literacy strategies were all encountered.

Initially, most participants lacking the literacy methods course were hesitant to make use of literacy strategies in their inquiry-based science lessons. Reluctance to incorporate literacy strategies also seemed to stem from the absence of expectations regarding the outcomes of the strategies. Both groups of participants appeared to have experienced at least some difficulty in making the distinction between the implementation of children's literature, and the implementation of literacy strategies. These sentiments were echoed and expanded in the focus group interviews, where many participants avoided directly addressing the topic of literacy strategies by replying to related questions with a statement about the general use of literature in science instruction. One participant from the first semester responded to a question concerning the continued use of literacy strategies by stating that "I'll use literature in the future as a way to make lessons fun and not so based on text…like a textbook."

Among all participants, but especially those who had completed the literacy methods course, another important factor behind the participants' decision to exclude the literacy strategy involved the amount of time that would be required for its successful integration. One participant commented that, "actually implementing it during the time that we taught science seemed a little farfetched, just because they do that [reading/language arts] right after science... so it just didn't make a whole lot of sense." Additionally, some participants indicated that the inclusion of a literacy strategy into a science lesson might even be detrimental to the students' comprehension, as a result of poor timing. As stated by one preservice teacher, "I was scared that that [the literacy strategy] was going to take away from the actual science learning." Despite acknowledging that a literacy strategy could be used effectively if the timing is appropriate, one preservice teacher spoke to the potential for issues to arise from using science-related literacy strategies in close proximity to the students' actual reading/language arts instruction. "I just don't think that it would've been appropriate for the students. I think it might have confused them a little bit more to have thrown in an extra chart." The preservice teachers repeatedly expressed concerns about the potential for the literacy strategy to impinge upon their ability to address all necessary science content, as a result of, what was at least perceived as, forfeited time. "I was a little nervous with using the strategies because the class period just isn't very long and I was afraid that it would take up too much time..." Suggestions for addressing issues of timing put forth by preservice teachers included the idea that there should exist "a whole block of time to do literature and science," as this, "would make it ten times easier to incorporate these [literacy] strategies, because I felt like in the small science portion that we were given I don't know if there would've been time and it might have been confusing if you're teaching literature and science together."

A number of participants, specifically those who lacked the course in literacy methods, indicated that they lacked confidence in their ability to adapt literacy strategies for use in a different content area. Both survey and interview data suggested that this may be attributable to a limited

number of specific literacy strategies being modeled to the participants. Several participants noted the effectiveness of having a single literacy strategy modeled for them, "You modeled for us how that works in a lesson; that for me was one of the most important things;" thus, it stands to reason that a wider variety of modeling might have proven beneficial. To these participants, literacy strategies in the science classroom seemingly represented a departure from their own experiences as students in elementary school. "I wish my teachers would have done that when I was in a science classroom and I was, like, my students' age, because I think that would've helped me understand stuff more."

However, those participants who had completed the literacy methods course prior to teaching their science lesson exhibited an increased propensity for not simply integration, but rather meaningful incorporation of literacy strategies into their instruction. Likewise, these participants more consistently allowed for differentiated use of literacy strategies within the inquiry-based lesson; "It was a very easy addition to the lesson plan," stated one preservice teacher. From these participants, even those who chose not to include a literacy strategy in their science lesson, emerged an acceptance and acknowledgement of the potential benefit of literacy strategies in the context of science. In one unique instance, two preservice teachers taught lessons that were almost identical, with the exception that one of the preservice teachers made use of a specific literacy strategy during instruction. The preservice teachers who did not use the strategy observed the preservice teacher who did; in the focus group interview, she commented on the apparent effectiveness of the strategy used by her peer, and lamented her decision to exclude the literacy strategy. "She used literature, and I didn't, and I feel like hers was way more engaging of a launch, and I used videos. So, I think that that was just funny to like be able to sit back and compare that. I was at the back of the room like, 'Man, should have used her book!'"

Additionally, a number of participants indicated that, despite having literacy strategies modeled for them, they still struggled to effectively modify the strategies, insisting that success hinges upon, "the story... and how relevant it is." Another preservice teacher voiced concern by saying, "I was terrified and had no idea how to use literature in inquiry-based science, because I really didn't think they went together at all, reading and inquiry... I thought it was going to be really difficult." Preservice teachers from both groups indicated that they were not familiar enough with the literacy strategies to make effective use of these strategies in their science lessons.

Among those participants who did elect to incorporate a literacy strategy into their inquiry-based science lesson, the majority chose to do so because they believed that the addition of a literacy strategy would make the science content more appealing. This stems from the repeatedly expressed idea that literacy strategies, and the literature that often accompanies them, presented an opportunity to contextualize the science content, thereby increasing its relevance in the eyes of the students. As one participant stated, "I feel like it tied the concepts, um, to like applicable, real-life situations better and I think that it helped them relate, um, the concepts that we were learning to each other…" This notion accounts for the fact that most literacy strategy incorporation took place during the "engage" phase of the lesson, when gaining and maintaining student interest is paramount. Despite a continued belief in the potential for literacy strategies to effectively contribute to inquiry-based science instruction, preservice teachers who considered using a literature strategy in other segments of the inquiry-based lesson reported issues arising from poor timing and implementation, such as one participant's claim that "Since I had limited amount of

time to teach the day's science topic, I came to the conclusion that choosing to incorporate literacy strategy instruction during one portion of the lesson would cut too much time away from the other elements of 5E that I needed to address."

In examining the strategies selected for use by the preservice teachers, it became clear that most participants restricted the use of literacy strategies to a few specific roles. Foremost among these roles are the preemptive discussion of content-specific vocabulary, prior to its being encountered in the context of scientific inquiry, as well as the construction of "K-W-L" or "Know-Want to Know-Learned" charts used to guide inquiry later on in the lesson. The relegation of literacy strategies to an almost exclusively preparatory role can reasonably be construed as suggestive of a lack of familiarity with the literacy strategies, and an inability to envision their competence in effectively enhancing the inquiry-based learning experience; or perhaps, as suggested before, a lack of understanding with regards to how such strategies can be more seamlessly integrated into the lesson.

Regrettably, a small number of preservice teachers' responses on the written reflections revealed that a few participants failed to include a literacy strategy in their lesson as the result of either simple oversight, or a general indifference toward the inclusion of a literacy strategy. However, it is also interesting to note that, despite the small overall percentage of preservice teachers who chose to incorporate literacy strategies, none of the participants expressed sentiments that would indicate a complete lack of faith in the potential to successful employ a literacy strategy within an inquiry based science lesson; in fact, one participant optimistically asserted that, "My future plans would probably be to actually use these things, because I think it's a great way to differentiate…". Many participants who chose not to employ a literacy strategy opted to elaborate upon how they would have incorporated a specific strategy, if given the opportunity to do so again. "I didn't have a chance to use the literacy strategies because, um, Dr. Scott came and talked to us after I had done my book, um, but I definitely would have used it... if you have the concept circles or concept maps, things like that, it really helps them to see and organize their thoughts better."

Conclusions & Implications

In examining the results of the study, the manner in which preservice teachers perceive their ability and desire to successfully incorporate literacy strategies into inquiry-based science lessons hinges primarily upon two key factors. The fact that participants from the group of preservice teachers who had taken the literacy methods course used literacy strategies in their lessons with almost double the frequency of the participants who had not taken the literacy methods course, suggests that preparation plays a vital role in the development of preservice teachers' feelings towards the integration of literacy strategies into the science curriculum. Likewise, the remorse expressed by many of the participants who chose not to use a literacy strategy seems indicative of a willingness on the part of these participants to explore such integration, should adequate encouragement and preparation be provided. The consistent use of literacy strategies in a similar role from one participant to the next, coupled with the conclusion drawn by some participants that a literacy strategy would not have substantively contributed to the science lessons, shows that the preservice teachers were, perhaps, either not exposed to enough variety of literacy strategies, or felt that they lacked the ability to modify these strategies in such a

manner as to suit their particular lesson. Explicit instruction with respect to the adaptation of literacy strategies might be of use in remedying such an issue.

Aside from preparation, preservice teachers from both groups made it apparent that the integration of literacy strategies into a science lesson represents a questionable return on the investment of time and energy that it requires. Whether it stemmed from classroom teacher pushback, or personal intuition, preservice teachers, especially from the group who had not taken the literacy methods course, were reluctant to jeopardize the already limited time that had been allotted to science instruction. However, as addressed by one aforementioned participant, the issue of time can potentially be remedied through either additional allocations made for science instruction, or the dedication of a specific time slot for cross-curricular instruction.

Pertaining specifically to one class section from the second semester, it is interesting to note that very few students made mention of literacy strategies during the course of the interview; rather, these students reflected almost exclusively on the use of children's literature without the application of a formal literacy strategy. The inability of these participant to distinguish between the two concepts indicates a lack of vision with respect to the transfer of actual literacy strategies to the science content; it would appear that, at least to some of the participants, integrating literacy strategies into inquiry-based science lessons involves little more than reading a book in the context of an existing science lesson.

Taken collectively, the study findings provide implications to teacher educators when considering the manner in which preservice teachers are taught and asked to apply instructional strategies. First, there is a great need to encourage preservice teachers to use literacy strategies in order to bridge understandings for difficult concepts. Literacy strategies such as Venn Diagrams, Info Boxes, and K-W-L charts help students to further comprehension and higher order thinking skills. Additionally, teacher educators should be willing and adaptable in providing resources for integrating cross-curricular instructional approaches so that preservice teachers can be prepared to integrate literacy strategies in science content.

Second, and in consideration of utilizing literacy strategies in science content, teacher educators should be cognizant of the variability in which these strategies can be taught. Preservice teachers should be taught how to modify, and in some cases, apply differentiation techniques. Models of inquiry-based instructional approaches, such as 5E (Biological Sciences Curriculum Study, 1989) provide ample opportunities for students to utilize literacy strategies, so it becomes imperative that teacher educators model the flexibility that should occur in science lessons. For example, preservice teachers could use a Venn Diagram to "Explore", "Explain", or "Evaluate" similarities and differences between a grasshopper and a cricket.

Finally, there is a need to consider the time implications for integrating literacy strategies in science instruction. One of the most prevalent markers as to why preservice teachers did not integrate literacy strategies in science instruction was the notion that "it would take too much time." In this sense, teacher educators should stress to preservice teachers the intentional act of helping students to apply such strategies across subject areas in order to increase their understanding and development of the content, thereby enhancing scientific literacy.

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Appendix

Focus Group Interview Protocol

1. What do you recall as your first feelings/impressions/attitudes towards integrating children's literature in inquiry-based science lessons?
2. What do you recall as your first feelings/impressions/attitudes towards utilizing literacy strategy instruction in inquiry-based science lessons?
3. Now that you've utilized the instructional strategies of literature integration and literacy strategy instruction, what are your feelings about the strategies?
    a. Impact on students
    b. Impact on you within the course requirement of planning/teaching inquiry-based science lessons
    c. Impact on you as a future educator
4. What are your future plans with regard to the strategy of integrating children's literature in science?
5. What are your future plans with regard to the strategy of utilizing literacy strategy instruction in science?
6. If your feelings/impressions/attitudes towards these strategies changed from your initial feelings/impressions/attitudes, how did they change, and to what do you attribute the change?