Using Science Notebooks To Promote Preservice Teachers' Understanding of Formative Assessment

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The research project described in this article explored how using science notebooks in science methods courses affected preservice teachers' understanding of and predicted use of formative assessment involving science notebooks. The *National Science Education Standards* (National Research Council [NRC], 1996) have called for teachers to continually assess their students' scientific understanding and reasoning and their students' achievement and opportunity to learn. Teachers are encouraged to plan for opportunities where their students can discuss and display their levels of science understanding (NRC, 2001a). In order to implement these recommendations and focus on the learning of each student, teachers need to employ formative assessments: assessing, or helping students assess, current levels of understanding and then helping the students with strategies to reach predetermined learning and performance goals (Sadler, 1989). In a review of research on formative assessment, Black (1998) stressed that "innovations that include strengthening the practice of formative assessment produce significant, and often substantial, learning gains" (p. 41).

Professional development and preservice teacher training should provide instruction in "how students learn and how learning can be assessed" (NRC, 2001b, p. 309). Teachers need to experience how to

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implement assessment tools that can provide them with valid inferences about their students' understanding. Teachers must gather knowledge about a variety of methods to use when assessing science learning as well as the advantages and disadvantages of each method. Black (1998) has concluded that assessment in many classrooms is challenging, for instance: (a) teachers' tests stress memorization and superficial learning even when they say they want to develop students' understanding, (b) assessment methods are not critically reviewed by teachers, (c) in many elementary classrooms "there is a tendency to emphasize quantity and presentation of work and to neglect its quality in relation to learning" (p. 42), (d) grading and competitiveness seem to be over-emphasized while providing useful advice is under-emphasized, and (e) teachers often use feedback to serve a managerial or social role and students' learning needs are left unaddressed.

It is often the case that preservice training programs present a specific assessment tool without allowing preservice teachers a chance to use the tool or the opportunity to be assessed themselves through that tool. According to Sadler (1998), "teachers need to have professional preservice and inservice training for [the] specific requirements of formative assessment" (p. 83). In this era of high stakes summative tests, it is necessary to balance preservice teacher training with experiences of formative assessment which have "the potential to drive changes in teaching that can improve students' conceptual learning dramatically" (Dougherty, 1997, p. 29). A few of the essential ingredients of teachers' formative assessment strategies are features such as (a) the type of feedback needed to guide students' learning, (b) knowledge of the necessary learning goals for the specified content, (c) how to guide students to a clear view of the learning goals and their current understanding of them, and (d) how to move from one to the other (Black, 1998). Ruiz-Primo, Li, Ayala and Shavelson (1999) found that teachers tended to write "great" as feedback for students' written descriptions of procedures that varied drastically in quality, possibly because no clear criteria for procedure description had been communicated to students. The authors stressed that feedback "should be descriptive, not evaluative or comparative" (p.25). In another study (Ruiz-Primo, Li, & Shavelson, 2002), the results showed that in 6 out of 10 classrooms there was no evidence of teacher feedback on students' science notebook entries even though these entries showed poor communication and partial understanding. Certainly, teacher training must include education about the benefits and logistics of providing valuable feedback to students.

Instruction on formative assessment allows preservice teachers to learn about gathering the information they need to guide students toward

learning goals, providing clear and descriptive feedback, and using formative assessment information to improve their own teaching. When feedback is designed to provide students with advice and comments on specific qualities of their work and to provide guidance on ways to improve the work, formative assessment enhances learning (NRC, 2001b). One of the recommendations made by the NRC (2001b) is that "teachers need to understand how to use tools that can yield valid inferences about student understanding and thinking, as well as methods of interpreting data derived from assessments" (p. 309).

There is general agreement that science notebooks are an effective formative assessment tool (Audet, Hichman, & Dobrynina, 1996; Fellows, 1994; Shepardson & Britsch, 1997) that allows teachers to "assess students' understanding and provide the feedback students need for improving their performance" (Ruiz-Primo, Li, & Shavelson, 2002, p. 24). Research has shown that writing-to-learn in science has enhanced students' learning when teachers attend to curricular goals, learners' metacognitive knowledge, and the instructional environment (Hand**,** Prain, & Yore**,** 2001; Rivard, 1994).

According to Klentschy and Molina-DeLa Torre (2004), students' science notebook writing may be a way for students to strengthen their language skills as they develop an understanding of the world around them.

> The student science notebook serves as an important link between science and literacy when it is utilized in the classroom as a knowledge-transforming form of writing that provides an appropriate opportunity for students to develop voice in the process of constructing meaning from their experiences with the science phenomena. This, coupled with appropriate and timely feedback from the classroom teacher, has strong potential to provide the improvement in student achievement across the curriculum that educators are seeking. (p. 352)

It is important for future teachers to be trained to use science notebooks as an assessment tool; Baxter, Bass, and Glasser (2001) found that the focus of science notebooks in fifth grade classrooms was dependant upon "those aspects of inquiry that teachers attended to" (p. 138). Science notebooks can be a formative assessment tool for both teachers and students to determine: (a) prior knowledge and existing science ideas, (b) how conceptual understanding is being built, (c) procedural understanding, (d) mastery of curriculum goals, and (e) the ability to apply/transfer ideas to new context (Volkmann & Abell, 2003).

Using science notebooks with preservice teachers accomplishes two goals: (1) it introduces preservice teachers to a beneficial assessment tool, and (2) it provides information on preservice teachers' science conceptual

understanding and process skill knowledge. Writing about science in their notebooks is an important step in the development of preservice teachers' science literacy (content knowledge, inquiry skills and disposition toward using critical thinking/science reasoning in decision-making). The study reported here focused on the science notebook as a formative assessment tool in a science methods course and the resultant views held by preservice teachers on the value of this assessment tool for their future practice.

Research Questions

In order to explore the understandings held by preservice teachers about formative assessment and using science notebooks as a tool to find out their students' science understanding, the following research questions were devised:

How do preservice teachers view using science notebooks as a formative assessment tool?

How do preservice teachers develop their own use of science notebooks during a science methods course?

Design and Procedure

Participants

The participants in this study were preservice teachers, both graduate and undergraduate, enrolled in three science methods courses, one each semester for three semesters. The courses were 15 weeks long, met 3 hours weekly, and covered the pedagogical aspects of teaching science as well as physical, life, and earth science content. All students in the methods classes were given the option to participate in the study or not; none opted to refrain from participating. Of the 44 preservice teachers participating, no more than two or three participants in each class had a science background. The remainder of the students had typically completed two science courses during their undergraduate course work. These preservice teachers were planning to teach at the K-8 levels. The preservice teachers had completed a course in assessment in which they were introduced to the term formative assessment, but they had not had prior experiences with the use of science notebooks. These students had also completed a course focused on teaching writing in which they were introduced to ways to improve writing skills and plan effective writing lessons.

Science Notebook Use

Throughout the semester-long science methods courses, the preservice teachers were required to maintain a science notebook. The three methods courses remained similar from the first to the third; the use of the science notebook was consistent across all three. Preservice teachers were asked to provide either a hard bound "composition" book or a spiral bound notebook to be used for the science content parts of the methods course and not to be used for the pedagogy part of the course. The notebooks were likened to research scientists' log books; preservice teachers were encouraged to use them as scientists would before, during, and after all investigations. They were defined as a place where students formulate their own questions, make predictions, record and display data, analyze results, propose explanations, compose reflections, and communicate hypotheses during inquiry investigations.

During the second class meeting the preservice teachers were given a short presentation on using science notebooks, specific excerpts from scientists' notebooks were reviewed and discussed, and recommendations on what to include in a science notebook were given. The expectations for the science notebooks were that the preservice teachers would write about as much as possible during their science content investigations and activities. They were specifically asked to work toward including all observations, questions, relevant ideas, frustrations, and reflections on future classroom applications relevant to the activities and investigations.

Typically, the last half of each class (1.5 hours) was spent in making observations and predictions, collecting data, designing investigations, collecting and analyzing data, testing activities, formulating conclusions, and communicating conclusions and results. Any writing, diagramming, graphing, or drawing about these activities was done in the science notebook. The preservice teachers always worked in groups of 3-4 and compared and shared information from their science notebooks throughout their investigations. Often the final communication was a group effort involving combining the members' results. Collaboration among group members and between groups in the class was always encouraged. At the end of the class session, the preservice teachers were asked to review what they had entered in their notebooks, and to reflect on how entries could have been clearer, how entries demonstrated their learning, and how their learning might be assessed by the instruction based on their notebook entries.

The science notebooks were viewed informally by the instructor during every class session with oral feedback provided; the notebooks were collected for non-graded, formative assessment at the mid-semester

point. At the end of the semester, the preservice teachers submitted their notebooks for both feedback and a final grade. The criteria for the final summative grade were presented to the preservice teachers at the start of the course in the course syllabus; the focus of the assessment was on the level of communication achieved, the degree of completeness and organization of the notebook, and the reflections provided by the preservice teacher on the activities and investigations in which he or she had been involved.

During the two class sessions on assessment, the role of formative assessment, science notebooks as a formative assessment tool, the benefits of clear and constructive feedback, and the necessity of students communicating their understanding of science concepts in the notebooks were all addressed. The preservice teachers continually were asked to reflect on their own notebook use and how they would use science notebooks in their own teaching.

Data Collection

Data were collected from a variety of sources in order to answer the research questions. Preservice teachers used science notebooks as they were involved in inquiry-based investigations in the methods classes. These notebooks were collected and photocopied as a primary data source on how the preservice teachers represented their science understanding and reflected on their use of science notebooks. Specifically, one entry from early in the semester and an entry near the end of the semester from each preservice teacher were photocopied in order to collect evidence of growth in notebook use. The preservice teachers received informal feedback from the methods instructor throughout the semester and more formal written feedback on the science notebooks twice during the semester.

The preservice teachers completed an anonymous questionnaire at the end of the science methods course in which they provided information about their use of science notebooks as an assessment tool, their planned future use of science notebooks, and what they had gained through the assessment of their own notebooks in the methods course (Figure 1).

During the methods course, the preservice teachers wrote one formal paper about the uses of science notebooks as a formative assessment tool, wrote a single page reflection paper at the end of the course on their own use of science notebooks, and also designed a rubric to use to assess students' science notebooks (see Figure 2). These were all data sources. Another assignment in the course was writing three lesson plans that each included an in-depth presentation of the planned assessment of the designed lesson. Information presented by the preservice teachers

Figure 1
Notebook Questionnaire

1. What was your reaction to using notebooks in the science methods class? Why?
2. How did using notebooks affect your learning of the science content we have covered?
3. How has using notebooks affected or changed your views of science?
4. How has using notebooks affected or changed your views of yourself as a scientist?
5. How will you use science notebooks in your classroom?
6. How will the students you work with react to using science notebooks?
7. Describe how you might use science notebooks as an assessment tool in your classroom.
8. How might you use the notebook you generated in this class in the future?

Figure 2
Science Notebook Assignments

Formal Paper	Discuss the use of your science notebook during this course. Be sure to include any changes you may have made from the beginning to the end of the semester. How was your science notebook used to for you to assess your own learning or present your learning to others? How might you use your notebook in the future?
Reflection Paper	How might you use science notebooks to assess your students? Include the strategies you would use and the things you would have students include in their notebooks.
Rubric Assignment	Design a rubric for assessing science notebooks. Clearly describe the criteria necessary to achieve each level.

about how they planned to assess future students was a source of data on the views they held about formative assessment and specifically science notebooks. Throughout each of the three methods courses, the researcher collected data in a researcher's log. Any reference to the use of science notebooks or formative assessment made by the preservice teachers during the classes was recorded in the log.

Data Analysis

Data were analyzed by analytic induction (Bogdan & Biklen, 1992). Patterns of similarities and differences in perspectives and approaches and any change in these perspectives were sought. The data were systematically organized and reduced using categories such as the following: (a) use of science notebooks as a formative assessment tool, (b) formative assessment to inform teaching and learning, (c) students'

writing in science, (d) logistics of using science notebooks, (e) evidence of growth in preservice teachers' use of science notebooks, and (f) beliefs on assessment in general. These categories were used to code and index participants' questionnaires, lesson plans, researcher's log, individual comments made to the instructor in class, and all written work. The questionnaires completed by the participants were done anonymously and the preservice teachers were asked to be as honest as possible in their responses. These questionnaires were then analyzed for both positive and negative comments regarding the use of science notebooks. The preservice teachers' lesson plans were initially analyzed for any mention of the use of science notebooks as a way to assess student learning and any mention of science notebooks as part of the proposed lesson. Then the lesson plans that mentioned using science notebooks for formative assessment were analyzed for reference to the logistics of using notebooks in the classroom or specific aspects that the preservice teachers planned to have their students include in a science notebook.

The preservice teachers' notebooks were collected early in the semester and reviewed for inclusion of questions, predictions, hypotheses, observations, and conclusions. A sample entry from each notebook was photocopied and then compared to a sample entry from the end of the semester. These sample entries were the same for all preservice teachers in each class and selected from an inquiry investigation that had been completed in the classroom. The early and later entries were compared for any evidence of change in writing style, use of diagrams and data displays, description of procedures, or depth of reflections.

The researcher's log and the record of individual comments made by students were analyzed for any positive or negative reference to the use of science notebooks. This was followed by an analysis of the comments made for statements regarding how the notebooks might be used in the future by the preservice teacher.

Findings

The use of science notebooks by the preservice teachers provided a means to strengthen their understanding of formative assessment. The science notebooks were seen by the preservice teachers as a way to continually gather information from students and as an avenue where constructive feedback to students could be provided. The preservice teachers kept their own notebooks and received feedback from the methods instructor on their growth in science understanding and they also reflected on the use of science notebooks as a formative assessment tool for their future teaching.

Research Question #1:
How Do Preservice Teachers View Using Science Notebooks as a Formative Assessment Tool?

The question, How do preservice teachers view using science notebooks as a formative assessment tool?, was addressed through the preservice teachers' questionnaire responses, assessment plans, rubrics, and a formal paper. When asked to design an assessment plan for the required lesson plans, preservice teachers consistently included mention of science notebooks as a formative assessment tool. They said they would use science notebooks to assess students' understanding of the content presented in the lesson. They often assigned a specific prompt for assessment of specific content, and the majority mentioned that they would be able to find out what their students were thinking through the students' writing. They wrote such things as:

> My assessment plan for this lesson will be based on what they write in their notebooks for homework. The prompt for their notebooks will be "Choose one type of rock out of the three that we studied. If possible, find a rock at home that resembles this type of rock. Based on what you know about this type of rock, write a paragraph saying where you think this rock came from and any questions you have about this rock." When assessing this notebook entry, I will be looking for accurate understanding of the specific rock they picked. Also, I will be looking for creativity when they formulate the questions about the rock. (Melissa)

> There is one clear way of assessing every student's work, their science notebooks. This will be a valuable tool because I am asking to know things that they may be thinking, but the journal gives them space to write it all out. (Candice)

> I will know that everyone has understood the material covered through two different assessment plans. First I will have a conclusion discussion…The second way I will be able to find [student understanding] out is through one of the most valuable assets teachers have, and that is the science notebook. As they will be recording all of their data, then looking back and trying to figure out why some froze and some didn't I will get to see that thought process right before my eyes. (Cary)

These quotes demonstrate the preservice teachers' focus on students' communication of understanding through their writing, the need to use science notebooks as a resource for the students, and the value of the notebook as a venue where the teacher can find out what the student is thinking. Earlier in the semester, all the preservice teachers involved in this study had been required to individually interview a student on a specific science topic. Their feedback was that it is very difficult to know what a student understands or is thinking unless the teacher has time to

sit down and do an individual interview. They saw the science notebooks as a tool to use to get an idea of students' comprehension.

Every preservice teacher said that they would have the students record some aspect of science inquiry (recording data, making predictions, designing investigations, proposing explanations, or communicating conclusions) in their notebooks for the teacher to view and provide feedback on in some form or another. When asked on the questionnaires, they all said that they planned on using science notebooks in their teaching. Representative quotes included:

> Notebooks is (sic) a perfect form of assessment to see if they have understood the concepts being explored. (Wendy)
>
> You can certainly check for understanding & assess their experimental procedures. (Lea)
>
> Great way to note progress, are they completing tasks, are they making conclusions & actually "getting it"? (Jay)
>
> You can not only assess science understanding, but you can assess the writing (Beth)
>
> I will be able to see if my students are putting thought into what they are doing. (Tess)

These preservice teachers had begun to see that the science notebook was a place where both the students' understanding and process skills could be assessed. While it is certainly important to assess understanding, the preservice teachers also saw the science notebook as place where they could learn about their students' writing and science process skills.

One of the preservice teachers commented "I will use this science notebook in my classroom. This would be great for parent conferences." This demonstrated recognition of science notebooks as a product to show parents student progress. Another, commenting that "It will make them feel important," recognized that owning and using their own personal notebook is important to students. The preservice teachers also saw that using science notebooks would be a way to gain feedback from students on their own teaching:

> Great formative assessment on my teaching and students' comprehension levels. (Jana)
>
> I can be sure students did the labs, gauge their thinking & know what I might need to re-teach. (Randy)
>
> One of the best tools! I can reflect on their progress & comprehension, or lack-there-of, & plan my lessons/units accordingly. (Deb)

The preservice teachers designed rubrics (examples available from the author) for assessing their future students' science notebooks and the analysis of these showed that through assessment of the science notebooks, preservice teachers intend to provide students with information on the quality of the work in the following areas: organization, completeness, content understanding, and process skills. The rubrics were most often designed for assessment of a single investigation rather than the whole notebook. The majority of the rubrics for the science notebooks had a focus on assessment of students' communication of their science understanding. Ruiz-Primo et al. (2002) found that many entries in students' science notebooks are simply mechanical copying of definitions and procedures from textbooks. Therefore it was important to note that the preservice teachers planned to assess understanding as well as process skills.

In their formal paper, the preservice teachers wrote about how they planned to assess their students' science notebooks and considered how they might provide feedback other than the rubric scores. They wrote, for example:

> Upon completion of the lesson, the science notebooks could be used to determine what students learned. Each student's understanding would be expressed through the questions they asked before, during, and after a unit. The results of their inquiries and other labs would be included, so the teacher could examine students' abilities to create products. (Cherrie)

> I do like the idea of giving students a rubric or checklist on what to include in their notebooks. I would include things such as writing down their investigation questions, drawing and labeling pictures to record their observations, dating their entries, recording data in an organized format (such as a data table…etc.)writing legibly, writing down conclusions or inferences based on data and recording what the process of the investigation was (unless it's on a separate worksheet or book that they could reference). (Laurie)

> I will not grade the notebook on grammar or spelling errors. If I need to communicate to the students through the notebook, I'll write my notes on post-its to maintain the originality. The inclusion of all the required notebook content will [be] a portion of their grade. One of the most important aspects of the notebook that I'll grade will be the students' questions(s) that they'll be required to ask at the end of each inquiry/ experiment. (Maria)

> Time will be purposely made for writing in the science notebooks and students will be encouraged to "write as they are thinking" and to add any anecdotal commentary as they reflect on what they have already written. Teacher will read notebooks over-the-shoulder (with permis-

> sion) and after experimentation to see that scientific inquiry and discovery is taking or has taken place in order to make verbal or "post-it note" commentary and/or to make teaching (inquiry guide) adjustments. Ideally this will be done during and after each inquiry. (Lisa)

Research Question #2:
How Do Preservice Teachers Develop Their Own Use of Science Notebooks During a Science Methods Course?

In order to determine how the preservice teachers developed in their own use of science notebooks during the methods course, their science notebooks were analyzed, observations of their use of notebooks were made, and their reflections written in a paper on their own use of notebooks. Observations of the teachers revealed that they became more and more dependent upon their notebooks as the semester progressed. At the beginning of the semester, many were concerned about the "right" format for their responses in the notebook. Many asked how data were supposed to be recorded or how the conclusions were to look (the preservice teachers were not given any specifications on these points but were told to decide for themselves what was necessary). By the end of the semester, all the teachers had become more comfortable with the idea that there was not one "right" way to record information in their notebooks and had created individual formats. At the beginning of the semester, two to three preservice teachers in each class would write all their observations, predictions, data collections, hypotheses, and conclusions on loose notebook paper. When asked why they were doing this, the usual reply was that they wanted to make sure it was right or correct before putting the information in their notebooks.

> At first, I wanted everything in the notebook to be perfect, clean, and complete and I labored over each page, writing carefully and adding drawings. That became too time consuming so I settled for less than perfect, which I'm sure a real scientist would have eventually done as well. (Jan)

> In the beginning I was too concerned about making it too perfect. I was writing the information down on pieces of paper and then transferring it to my journal. A couple weeks of this proved to be too tedious, so I changed my strategy. I also started adding more diagrams and sketches. These strategies illustrated my observations and made them more beneficial to me in the future. (Karin)

These preservice teachers were used to being assessed on the neatness of work they did; they had difficulty doing rough writing and drawing in the notebook even though they had been told that they would not be assessed on neatness, spelling, or punctuation. By the end of the

semester most, but not all, were able to let go of their focus on neat work and write with more freedom.

> I don't believe that I used my notebook how it was intended. Instead of putting the activity information directly into the notebook, I would write out the topic, procedure, observations, questions, answers, etc. in a regular spiral notebook. Then I would transfer the information into the notebook. I don't think I ever transferred all of the information from the spiral notebook. Maybe I missed some important details or inquiry prompts by doing it this way. (Craig)

> I will admit that I transcribed large parts of my notebook into a new book. I did this for three reasons. First, it was messy, difficult to read and organized randomly. Second, I did not leave enough space for a table of contents. Third, was that I got it wet and anywhere there had been ink was running on the surrounding pages. I'm sure that in grade schools, I should expect to see notebooks that look like that and I would probably not hold it against the students so long as I could understand it. (Beth)

As the semester progressed, the preservice teachers used their notebooks as a reference for the investigations they had already conducted. They seemed to do this in order to assess their own science process skills, content understanding, and communication abilities. The following quotes demonstrate that preservice teachers used the notebooks to communicate their understanding to others when working together in small groups as well as a form of self-assessment of their own growth.

> By the end of the semester, I was drawing more conclusions because throughout the activities I tended to think of the results and procedures more thoroughly through all the experience I was gaining. I used my science notebook to assess myself by going back and seeing if I could understand what I was trying to communicate and also that I could follow the procedure. (May)

> The science notebook started out as a way to present my learning to the instructor. As I began to write my reflections on the classroom inquiries, I realized this notebook could be a tool for me to refer to in the future as a teacher. So, I tried to use the reflections as a way to convey how the inquiries can be applied to a classroom. (Cherie)

> [The science notebook} broadened and deepened my learning especially the section used in class when small group discussion was taking place. (Craig)

> I was able to regenerate my thoughts and ideas by looking back through my notebook. (Chris)

The preservice teachers came to value their notebooks as a resource to use to reflect on their own science learning and also to use in their own

teaching as a model for students' science notebooks. When the preservice teachers were asked to reflect on the activities and investigations they conducted, the science notebook was the source of information they used to remind themselves of what occurred and how their ideas had changed.

Conclusions

Implications

The use of science notebooks as a formative assessment tool allows teachers to embed assessment into instruction and to retrieve information about students' competence in order to make decisions on adapting instruction to meet students' needs. The preservice teachers in this study came to understand formative assessment as a tool to use in their classrooms and as an avenue to receive information about their own growth in science understanding. They were asked to reflect on the use of science notebooks as a formative assessment tool in their own future classrooms. Because they had been involved with science notebooks in the methods course, being assessed on their notebook entries and also predicting their use of notebooks as a teacher, the preservice teachers began to see that this form of assessment is a valuable method to assess students' scientific understanding.

The science notebook was presented as a form of assessment that supports individualized instruction, allows for student interaction, contains rich diagnostic data, and provides timely feedback—all criteria for assessment that enhances student learning (NRC, 2001b). Having been assessed through this method themselves, the preservice teachers all predicted they would use science notebooks for formative assessment in their future classrooms. The preservice teachers involved in this study had been exposed to much discussion on assessing students' understanding. They had conducted an individual interview and read current research on students' misconceptions in science. Their use of science notebooks and the discussion of formative assessment using science notebooks gave these preservice teachers a valuable tool to use to assess their future students' understanding.

As stressed by Ruiz-Primo et al. (2002), teachers need to select notebook entries in which students can demonstrate their understanding, improve their performance, and explore scientific inquiry rather than mechanically record data. The preservice teachers in this study explored the use of science notebooks to the extent that they began to see the value of the notebook as a window into students' thinking rather than simply a place to record data.

The value of science notebooks as a method for improving students'

literacy skills was stressed throughout the methods courses. The preservice teachers consistently commented that by requiring students to write about what they are doing and knowing in science, the students' literacy skills and their science understanding can be improved. As many school districts increasingly place instructional and assessment focus on language arts and mathematics in order to comply with standards, to the detriment of science, educators are recommending linking science and literacy instruction (Hand, Prain, & Yore, 1999; Klentschy & Molina-De La Torre, 2004; Saul, 2004).

Limitations

The preservice teachers in the science methods courses in this study all spoke positively about their future use of science notebooks when teaching science. It is certainly possible that some of these teachers felt that in order to succeed in the course they needed to "pretend" to be interested in science notebook use. Due to the fact that the notebooks were an underlying theme of the course, many of the preservice teachers could have become caught up in the instructor's enthusiasm and their comments about using notebooks may have been insincere. In order to attempt to get honest comments about the use of science notebook use, the questionnaire was administered anonymously and the preservice teachers were specifically asked to be as frank as possible. The researcher also purposely looked for any mention of science notebook use in assignments and conversations in which notebooks were not the topic being addressed. The ongoing nature of this project will allow these preservice teachers to be studied in their own classrooms in order to determine their actual use of science notebooks.

Recommendations

In order for preservice teachers to be ready to teach when they enter their own classrooms, they must be provided with strategies that make sense to them and that they have had experience using. Providing them with lists of strategies without adequate preparation or experience could result in the preservice teachers putting these strategies on a back burner until they gain assurance and confidence as a teacher. To ensure immediate use of a strategy, i.e. using science notebooks for formative assessment, it is crucial to provide preservice teachers with experiences using the notebooks themselves as students and to require them to visualize and evaluate the positive aspects of the use of notebooks in their future classrooms.

It is also essential to provide preservice teachers with experience and instruction on assessment practices other than the summative assess-

ment methods stressed by federal policies. Formative assessment practices have shown evidence of significant learning gains when teachers are provided with thorough professional development on the effectiveness of formative assessment practice such as appropriate feedback, use of feedback to improve teaching, and the ways assessment can motivate students. According to Black (1998), "the improvement of formative assessment cannot be a simple matter. There is no quick fix that can be added to existing practice with promise of rapid reward" (p. 46). Black stressed that the substantial rewards of formative assessment will only "happen relatively slowly, and through sustained programs of professional development and support" (p. 46).

Future Research

In order to determine if these preservice teachers have in fact implemented science notebooks in their teaching of science, it will be crucial to follow up on the specific teachers involved in this study. Are they using science notebooks in their classrooms? How is the science notebook used as an assessment tool? How are the notebooks viewed by the students? The next research step will be to conduct classroom observations of the preservice teachers in their own classrooms to determine their use of science notebooks as a formative assessment tool. Also, interviews with these teachers will need to be conducted when they are beginning teachers in their own classrooms to provide information about their attitudes toward using science notebooks as well as other forms of formative assessment.

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