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ABSTRACT

This study explored how a field-based project involving preservice teachers' development and implementation of science performance assessment tasks in K-8 classrooms affected the preservice teachers' understanding of standards-based assessment and instruction. Participants were 25 preservice teachers in a science methods course. The teachers prepared science performance assessment tasks and then administered them as field tests to students. Researchers analyzed the tasks and student responses. Analysis of the data showed that preservice teachers did come to understand assessment as a formative process, and they also constructed ideas of when performance assessment is useful and when it is not appropriate. The analysis also reflected some areas in need of improvement. Preservice teachers did not develop strong skills in either analyzing children's thinking or in designing inquiry-based science instruction, and preservice teachers also appeared to need more experience with rubrics than the project provided. Findings show that professional development focused on performance assessment is worthwhile, but difficult to implement. An appendix contains the project description given the preservice teachers. (Contains 4 tables and 24 references.) (SLD)

Preservice Teachers' Development and Implementation of Science Performance Assessment Tasks

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Preservice Teachers' Development and Implementation of Science Performance Assessment Tasks

The research project described in this paper explored how a field-based project involving preservice teachers' development and implementation of science performance assessment tasks in K-8 classrooms affected the preservice teachers' understanding of standards-based assessment and instruction. The purpose of this study was to assess the effect of designing and implementing a performance assessment task on preservice teachers' understanding of standards-based assessment.

Performance Assessment

Science reform efforts (American Association for the Advancement of Science [AAAS], 1993; National Research Council [NRC], 1996) have called for students becoming more involved in their own learning based on the philosophy that student understanding is facilitated by active involvement. The science reforms have required that students be assessed on their scientific reasoning and understanding rather than only their discrete scientific knowledge. This type of assessment, often termed performance assessment, may be problematic to define. According to Champagne and Kouba (2000), alternative definitions for the term performance assessment are abundant. They state that performance assessment involves data such as student writing being analyzed "not only on the scientific accuracy of the writing but also on the quality of the reasoning" (p. 226). Stenmark's (1991) definition of performance assessment provides a description of the type of assessment recommended by the NRC (1996) "Performance assessment…involves presenting students with a…task, project, or investigation, then observing, interviewing, and looking at their products to assess what they actually know"

(p. 13). Performance assessment is characterized by students performing concrete, meaningful tasks scored on the reasonableness of the procedure not simply on achieving the correct answer according to Shavelson, Baxter, and Pine (1992). Using students' performances to assess understanding of concepts in science has been recommended by Shymansky, Chidsey, Henriquez, Enger, Yore, Wolfe, and Jorgensen (1997). Well-designed assessment tasks not only assess student understanding but teach concepts and require students to explain and communicate their solutions (Darling-Hammond & Falk, 1997; Shepard, 2000). Performance assessment is well-suited to this purpose because of its focus on the application of knowledge in an authentic context for an authentic purpose. According to Shepard, Flexer, Hiebert, Marion, Mayfield, and Weston (1996), performance assessment is advantageous because it provides the opportunity to examine the process as well as the product and represents a full range of learning outcomes by assessing students' writing, products, and behavior. Performance assessment allows teachers to assess higher order thinking skills and deeper understandings (Firestone, Mayrowtz, & Fairman, 1998). Kelly and Kahle (1999) found that science students who took performance assessment tests were better able to explain their reasoning and conceptions than students who took traditional tests, leading to the conclusion that they had stronger understandings as a result of working through the performance task.

The instructional benefits of using performance assessment strategies seem to be established but it is not clear that teachers can easily or quickly learn to implement these strategies in practice. When Firestone, Mayrowetz, and Fairman (1998) studied the instructional strategies of teachers who were required to use performance assessment in their instruction to prepare students for state tests, they saw little change in the teachers' instructional strategies. Firestone, Mayrowetz, and Fairman identified two major barriers to change: a lack of sophisticated content knowledge necessary for implementation of performance assessment and a lack of rich tasks and problems in the curricular materials necessary to support this approach to instruction. To effectively implement performance assessment, Firestone, Mayrowetz, and Fairman concluded teachers need substantive training opportunities (not just new policies requiring the new assessment approaches) and new curricular materials aligned with performance assessment strategies and a standards-based vision for teaching and learning.

In accordance with Firestone, Mayrowetz, and Fairman's (1998) research, Borko, Mayfield, Marion, Flexer, and Cumbro (1997) found that for teachers to effectively use and realize the benefits of performance assessment approaches, they need substantive and sustained professional development. Borko, et al. also indicated that time was a major obstacle to implementing performance assessment approaches. Specifically, teachers were found to need time to plan for implementation of new strategies, employ more complex scoring rubrics, administer the assessment tasks, record observations of students, and interview students before, during, and after the performance assessment.

Field Experiences

Educational researchers and students bound for a teaching career agree that there is a need for more direct, specific, and practical experiences in classrooms prior to student teaching (Anderson & Mitchener, 1994; NRC, 1996). Field experiences early in the teacher training have a lasting effect. Schoon and Sandoval (1997) indicate that more "real-world" opportunities for preservice teachers to practice their skills will help them gain necessary skills faster. Borko, et al. (1997) emphasized the importance of situating preservice teacher learning in classroom practice for professional growth. They found that a key component of their program was their teachers' ability to experiment with and implement the ideas of professional development workshops in their own classroom practice and then to reflect o these efforts in follow-up workshops.

Putnam and Borko (2000) argue that for teachers to construct new knowledge about their practice, the learning needs to be situated in authentic contexts. First, learning needs to be situated in authentic activities in classrooms to support a transfer to practice. Preservice teachers need a combination of university learning for theoretical foundations and school-based learning for a situated perspective. Second, preservice and inservice teachers should participate in discourse communities as part of learning and enculturation in the profession. Preservice teachers, in particular, need to learn about and contribute to a community's way of thinking (Putnam & Borko, 2000).

Spector (1999) recommends having preservice teachers work with inservice teachers to help them better apply newly learned teaching and assessment strategies. This finding is in line with Dickinson, Burns, Hagen, and Locker's (1997) finding that important changes in science teaching can take place with the support of an enthusiastic peer.

As well as providing valuable experiences for preservice teachers, field-based experiences can be beneficial for the inservice teachers who are involved in mentoring the preservice teachers. The inservice teachers have the opportunity to be exposed to new strategies and techniques, share their own strategies and techniques, and collaborate in the evaluation of student work. Learning experiences for both preservice and inservice teachers must include inquiries into the difficulties and questions teachers regularly face

(NRC, 1996). It is essential that teachers, both preservice and inservice, have opportunities to observe, practice, and evaluate appropriate assessment tasks. The National Science Education Standards (NRC, 1996) discuss the need for teachers to be involved in the design and implementation of assessment.

> Teachers must have opportunities to observe practitioners of good classroom assessment and to review critically assessment instruments and their use. They need to have structured opportunities in aligning curriculum and assessment, in selecting and developing appropriate assessment tasks, and in analyzing and interpreting the gathered information. Teachers also need to have opportunities to collaborate with other teachers to evaluate student work-developing, refining, and applying criteria for evaluation. (p. 67)

Methods

This study was interpretive in nature (Strauss & Corbin, 1990); qualitative measures were used to examine perspectives and meanings that preservice teachers formed about teaching and learning. We defined two research questions for this study: (1) When instruction on and use of performance assessment is emphasized in a science methods course, and the task is implemented in a field-based situation, what is the nature of preservice teachers' learning and development toward standards-based assessment strategies? (2) What are the aspects of situating the implementation of the performance assessment task in an authentic context?

Participants

Participants included 25 preservice teachers enrolled in an elementary science methods course at a mid-sized Northwestern University. The students were working on a Bachelors degree in elementary education (including an endorsement to teach grades K – 8). The preservice teachers were in the first year of their prospective programs. Prior to the elementary science methods course, the preservice teachers had been enrolled in an assessment course where they were introduced to performance assessment as an alternative assessment strategy.

Context

The science methods course was a three-credit, one-semester course. Classes were held weekly in 3 hour blocks throughout the semester. The majority of the preservice teachers enrolled in the science methods course were concurrently enrolled in a math methods course. Throughout both courses performance assessment instruction was coordinated (i.e. designed tasks could combine math and science content, instruction was not duplicated from one course to the other, and course assignments were similar). The science methods course aimed to help preservice teachers develop (a) a theoretical framework for teaching science at the elementary level, (b) a repertoire of methods for teaching science, (c) favorable attitudes toward science and science teaching, and (d) deeper understanding of some science content area.

Performance assessment activities spanned the semester with the major events as follows: introductory performance assessment workshop held during regular class meeting (week 3); performance assessment topics selected and researched (weeks 3 – 5); proposal for task and written reviews of research-based journal articles on topic submitted (week 5); oral and written feedback on proposals provided by instructor, and mentors assigned (week 6); preservice teachers and mentors met during class time to plan task (week 7); draft of task submitted to instructor and mentors (week 8); tasks revised and then implemented in mentor teachers' classrooms (weeks 9 – 12); reports containing analysis, findings, and reflections on students' work on the task submitted to instructor (week 13); lesson plan based on performance assessment findings submitted (week 14).

For a full description of the performance assessment project assignments, see Appendix A.

Introductory assessment workshop. The workshop was conducted during the regular methods class meeting time for a three hour period. A collaborative team (made up of expert middle school teachers and mathematics and science methods instructors) planned and facilitated the workshop with team members leading different parts of the workshop. It was conducted to (a) briefly discuss general assessment issues, (b) provide an overview of the standards-based assessment program in Washington State (e.g., see Washington Commission on Student Learning, 1998), and (c) introduce the preservice teachers to performance assessment issues and strategies.

To introduce the preservice teachers to performance assessment we asked them to work in groups on a sample performance assessment task that was written and field-tested as part of an assessment program in Washington State. The task required the preservice teachers to design a cereal box that would reduce the amount of cardboard needed and still maintain a specific volume, and then to write a letter to the cereal company describing and defending their design. While we only provided approximately twenty minutes for the preservice teachers to work on the task, they had enough time to identify key issues of the task and key components of task-design. Next, we discussed some of the features of the task (e.g., an open-ended question; the descriptive and persuasive writing component; the multiple entry points and various solution methods possible in performing the task, etc.). Although the main concepts addressed in this sample task were mathematical, the task contained the general features of a performance assessment task such as requiring generation of information, discrimination between relevant and irrelevant information, requiring a written product, and an explanation of work. After a brief discussion of the task, we gave the groups scoring rubrics and samples of ninth grade students' work on the task at various performance levels. Using the scoring rubrics, the groups assigned scores to their sample students' work. Following this group work, we discussed the scoring process, the rubrics, and the task as a class.

Next, we worked to formalize their knowledge of performance assessment by discussing defining characteristics of performance assessment, advantages, and limitations. We concluded the workshop with an introduction of the planning guide (See Appendix B) and provided time for generating ideas for the preservice teachers' performance assessment projects while the expert teachers were available to answer questions.

Researching topics and generating a plan for the task. The preservice teachers worked individually to generate performance task ideas that related to their science content area of study. The performance assessment task was related to earlier student interview and lesson plan assignments centered on the same science content. The preservice teachers selected a range of grade levels for which they would be most interested in designing and implementing a performance assessment task. Preservice teachers then had the option of working individually or in groups of two to three on the project. See Appendix A for the description of the project assignments.

The preservice teachers submitted planning guides (see Appendix B) that outlined the major features of their tasks. An important part of this planning guide was aligning the task with standards for learning. Because the Washington State Essential Academic Learning Requirments [EALRs] (Washington Commission on Student Learning, 1998) were emphasized in this course, our students identified appropriate EALRs for their task. It is important to note that these state learning standards are derived from and consistent with the National Science Education Standards (NRC, 1996).

From this point, the preservice teachers continued developing their tasks outside of class time. While many groups created original tasks, the preservice teachers were permitted to use outside resources (e.g., activity books, journal articles) for ideas for their task. Even in the cases where a problem, activity, or task was used from an outside source, significant work was required to develop the problem into a performance assessment task and meet the assignment requirements.

Matching mentors and preservice teachers. Using the information provided in the preservice teachers' planning guides, we matched each preservice-teacher to a mentor inservice teacher. This matching was done based on the topic, skills, abilities, and level of thinking required for the performance assessment task and the knowledge and grade level of the mentor teachers' students. After the preservice/inservice teams were assigned, they met on their own after contacting one another by phone or email. Mentors were sometimes assigned more than one preservice teacher.

After the mentor teachers had been assigned to groups of preservice teachers, the mentors attended one hour of a methods class. The preservice teachers brought their planning guides and drafts of their performance assessment tasks to this meeting. During this hour, the mentor teachers met with each of their preservice teachers to discuss their ideas and plans for the performance assessment tasks. Additionally, other members of the planning team (Dr. Akerson, Dr. Roth McDuffie, Dr. Morrison) were available to assist groups in designing their tasks.

Submitting the first draft and field-testing the task. On the eighth week of the semester, the groups submitted their first drafts of their performance assessment tasks to their science methods professor and to their mentor teacher. Within a week, both parties provided written feedback and comments for the preservice teachers to consider before administering their tasks to students.

Each group arranged a time to field-test their tasks in their mentor's class. The tasks were designed to be completed in one to three 50 minute class periods. Each mentor teacher decided with his or her groups who would facilitate the task. In some cases the mentor teacher was the primary facilitator and in other cases the preservice teachers facilitated the task administration. However, in all cases, the preservice teachers observed throughout the task administration, talked with students (and in some cases, interviewed students about their thinking), and recorded notes on the process.

Analyzing results and reporting on the task. Following the field-test, the preservice teacher groups scored the students' work and analyzed selected students' work in greater depth. Finally, they prepared a written report of their findings and their reflections on the performance assessment process and project.

Data Sources

To examine participants' understandings and beliefs about standards-based instruction and assessment (research question one) data sources included an open-ended pre and post questionnaire (see Appendix C) in conjunction with a semi-structured pre and post interview. This questionnaire was adapted from Peterson et al's (1989) pedagogical beliefs and knowledge questionnaire with items added for performance assessment. The questions specific to teaching science and performance assessment in science were the questions analyzed for this paper. The questionnaire was given to all preservice teachers enrolled in the methods class at the beginning and the end of the course. Due to some absences during administration of the questionnaires, a total of 23 preservice teachers completed both the pre and post questionnaire. To establish validity and gain greater depth in the responses through additional probing, the questions asked in the 45 minute, semi-structured interviews were the same as those on the questionnaire (See Appendix C). The interviews were administered at the beginning and end of the semester to eight of the preservice teachers. Other data sources included written assignments from all project activities and video recordings of methods class discussions on performance assessment.

To investigate the efficacy of the project in providing meaningful field-based learning (research question two) data sources included: archived email correspondences among instructors, preservice teachers, and mentors, field notes from project planners, and written assignments.

Data Analysis

All data was analyzed by analytic induction (Bogdan & Biklen, 1992). Patterns of similarities and differences in perspectives and approaches and any changes in these perspectives for each of the research questions were sought. Categories created included: assessment of student understanding, analyzing and interpreting students' thinking and understandings; implementing tasks (strategies for planning, set-up, facilitating, closing); and situating the project in classrooms (working with a mentor, being in a classroom, experimenting with new approaches). These categories were used to code and index participants' questionnaire and interview responses, assignments, and written reflections. As patterns were identified, categories were added and/or reduced as the data indicated.

We developed a task-coding scheme (adapted from Fuchs et al., 1999) to analyze the performance assessment tasks and items on the questionnaire/interviews associated with performance assessment in science (See Appendix D). Although the task-coding scheme we used as a model was predominantly designed for math, the scheme used was appropriate for science due to the focus on standard based characteristics. These were characteristics such as requiring students to engage in open-ended, authentic investigations, to obtain and evaluate scientific information, and communicate their results.

We analyzed tasks for eight features including whether the preservice teachers: (1) wrote detailed, in depth tasks, containing two or more paragraphs; (2) wrote two or more questions; (3) required students to use 3 or more skills; (4) required students to discriminate between relevant and irrelevant information; (5) required students to generate information; (6) required students to explain work; (7) required students to create a written product; and (8) required students to produce tables and/or graphs. See Appendix D for operational definitions of each of the above features. Each feature was coded for: strong presence (2); some presence (1); or absence (0) of the feature. The percentage of preservice teachers that showed improvement (moving from a score of 0 to 1, 1 to 2, or 0 to 2 from pre to post) was determined for both questionnaires and interviews. The percentage of preservice teachers showing no change in the responses given in interviews or on questionnaires were determined as were the percentage that showed a decrease in scores (moving from 1 to 0, 2 to 0, or 2 to 1) from the pre to post interview or questionnaire.

Results

Both the strengths and weaknesses of the project were evaluated. In examining the data we investigated first whether the project positively affected teachers' understanding of performance assessment. Second, we sought to understand the role of the field-based implementation of the tasks in supporting the teachers' learning.

Understanding of Performance Assessment

We wanted to establish that preservice teachers developed their understanding of performance assessment. Prior to intervention, the preservice teachers had very little understanding of performance assessment as indicated by low scores on the questionnaires and interviews. Initially, examples given by preservice teachers included very few of the components necessary to a performance assessment task. Their examples tended to be short, required single answers, and did not provide opportunities for their students to generate ideas. Additionally, few of the preservice teachers said they would require students to generate information or discriminate between relevant and irrelevant information when doing a performance assessment task. Their ideas of performance assessment were not couched in an authentic task. Representative quotes from the pre-questionnaires and preinterviews illustrate how preservice teachers initially described a science performance assessment task.

> What is the boiling point of water? What is the purpose of the ozone layer? These questions could gage (sic) the calaber (sic) of each student and areas of efficiency. (Beth)
>
> Have the children write/describe how a tree gets energy. (Matthew)
>
> Allowing students to perform an experiment while you watch. (Sarah)
>
> Describe a cummulis (sic) cloud. (Ben)

> A test asking for Newton's 3 laws and examples to see if students know and understand them. (Tiffany)
>
> After demonstrating a chemical reaction using two elements, have student take the same two elements and see if they obtain the same results. (Michael)

When comparing the pre and post interview responses (see Table 1), it was seen that the preservice teachers interviewed (n=8) demonstrated the most improvement in the categories of (a) designing a detailed performance task containing two or more questions, (b) providing students the opportunity to apply three or more skills, (c) requiring students to discriminate between relevant and irrelevant information, and (d) requiring students to generate information. Relatively little change was seen in the other features of performance tasks, with a surprising 25% decrease in scores from pre to post interviews on the feature of requiring students to explain their work on a performance assessment task. A very high percentage of the preservice teachers (75%) stayed at a score of zero for the feature of requiring students to produce tables and/or graphs to display their data.

[Insert Table 1 here]

The preservice teachers' responses on the pre and post questionnaires (n=23) were compared to assess improvement in discussion of features of performance assessment tasks (see Table 2). The four features where the preservice teachers demonstrated improvement on the questionnaire were the same features showing improvement in the interviews: (a) designing a detailed performance task containing two or more questions, (b) providing students the opportunity to apply three or more skills, (c) requiring students to discriminate between relevant and irrelevant information, and (d) requiring students to generate information. As in the interview responses, the features showing little improvement were (a) designing a detailed, well developed task, (b) requiring students to explain their work, (c) requiring students to generate a written product, and (c) requiring students to produce tables and graphs. As in the interviews, preservice teachers showed very little change for the feature of requiring students to produce tables and/or graphs to display data.

[Insert Table 2 here]

A comparison of the improvements made from pre to post interviews and the improvements from pre to post questionnaires (see Table 3) demonstrates that the four features where the preservice teachers showed improvement were consistent both when the preservice teachers were discussing performance assessment tasks in interviews and writing about them on the questionnaires. The four features where less improvement was seen were consistent from interviews to questionnaires and the area of least improvement (requiring use of tables and/or graphs) was seen to be the same in both interviews and questionnaires.

[Insert Table 3 here]

When the preservice teachers were asked in their post interviews or questionnaires to describe an example of a science problem that might be categorized as an example of performance assessment, their answers demonstrated that they had greatly improved in their ideas of what constitutes a performance assessment task. Representative quotes from the post interviews and questionnaires are provided below.

> "Produce a brochure for a nature walk which describes at least three different species likely to be encountered in the given habitat. Describe the species' appearance, life cycle, nutritional needs, etc." Produce a product scored against a rubric, and conveying topics which students have some exposure to already. (MaryBeth)

You have built a scale model of our solar system. You have worked with proportions to build this model for both size of planets and sun, and the distances of the planets. It is now your job to write a proposal to the museum and to address their question of whether or not this model is realistic to put in a museum? Why or why not? If not, what suggestions can you give to the museum to make the exhibit fit? (Matthew)

Four years ago the Department of Ecology reported that 15 different species of birds lived in Columbia Park. This year that number has dropped to only 11 species. It is your job to go to Columbia Park (class field trip) and collect water samples, leaf samples, and oil samples in order to find out why the number may have dropped. Provide an explanation of why you think the number may have dropped with the following details 1) the pH of the water 2)pH of the soil 3) observations of leaves 4) any other observations. (Tiffany)

Have the students simulate an oil spill and create waves and wind. Then after they record how the oil spread after each simulation (oil, wind) have them write in their journal what impact an oil spill has on the real world. (Wendy)

When the preservice teachers' final performance assessment tasks were analyzed using the task analysis scoring guide (Appendix D), the scores showed that the majority of the preservice teachers were able to incorporate the required features into their tasks (See Table 4). As stated earlier, the preservice teachers were required to submit an initial draft of their task. The task was analyzed by the instructor and then feedback was given about missing or incomplete features. The preservice teachers were then able to revise their tasks and resubmit the tasks for their final evaluation. Therefore, we expected more features to be addressed in their tasks than were mentioned in their interviews or questionnaires. Due to the fact that with support the preservice teachers were able to produce high quality tasks suggests that they had internalized many of the features of performance assessment. The feature that seemed to be most difficult for the preservice teachers to include in their tasks was a requirement for students to produce tables and/or graphs to display data.

[Insert Table 4 here]

The preservice teachers were asked to reflect on what performance assessment is during their post interview and questionnaire. The following quotes from the preservice teachers' post-interviews are representative of their views of performance assessment after their performance assessment task implementation. The preservice teachers show that they were beginning to see performance assessment as an authentic task that requires students to communicate what they understand.

> ...performance assessment is a task which has a real world problem to assess students' understanding of a topic. It is most appropriate to assess what someone already knows, like at the beginning to see what someone already knows about it, or at the end to evaluate what they have learned and how your teaching has helped them to understand that concept. (Tara, post-interview)

> Performance assessment I would define as sort of an assessment project that engages the students to use all they have learned to solve a problem that kind of involves all they know. (Karin, post-interview)

> An examination of a process the student uses to achieve an answer or a product. It's based on tasks that are authentic, worthwhile, and real-world problems. Obviously, it has to be. It's not used if you want to assess for norms. The performance assessment task administered was a hypothetical situation that could have been used to see where my teaching is going or what direction it's going to take, based on what they know. Or it could be an afterward, was my teaching effective, did they "get it"? (Matthew, post-interview)

> Performance assessment I think is...What I understand performance assessment to be. I think that it's a task that has a tie, is authentic and has a tie to the real world, so the students have a certain purpose for completing it. When I believe it's not appropriate to use? Well you're not going to be able to use it everyday, because there is so much that goes into implementing it and planning it, you're probably only going to be able to do it a few times a year. But it is a chance for you to develop a concept a little more broadly to see if students understand it, the concept...(Kathryn, post-interview)

The preservice teachers began to develop understandings for Standards-based assessment and instruction. When preservice teachers were asked at the beginning of the semester about assessment and instruction, they viewed assessment as tests occurring at the end of a unit and focusing on measuring skill mastery. By the end of the semester, data indicated that preservice teachers changed their views of assessment to seeing it as part of learning and important to inform instructional decisions. Through their experience implementing the tasks, many participants reflected on the value of listening to and observing children in teaching and learning. The following quote is representative of the preservice teachers after the implementation of the tasks.

> [Performance assessment] engages the students in real-world problems, requires them to think critically, and allows the teacher to assess by observation....As I circulated throughout the room listening to students, making mental notes about what was going well and what changes need to be made, it was obvious that the students were using their prior knowledge...(Dora, reflections in final report)

We also found that the project activities facilitated preservice teachers' development in gaining skills for analyzing and interpreting children's thinking and work, as evidenced in their written projects.

> Although the [second group's] worksheets were not...complete..., [they] added new insights to the final group discussion by introducing conjectures to the problem...They exhibited a higher level of reasoning.... They argued various points and brought up ideas that even [we] had not considered. Their inferences and thought processes led others to question their own conclusions (Karen, analysis of student work in final report)

The preservice teachers moved from seeing science as simply doing hands-on activities to being immersed in real-world problems and collecting valuable data. Their successes and challenges led them to understand and form ideas about the complexities of setting up a task, facilitating a task (timing, questioning, intervening), and closing a task.

Importance of the Field Experience

From the preservice teachers' response on the post-project surveys and their final report, it was clear that the majority regarded the chance to actually be in the classroom working with real students as a major benefit of the project. They said that they learned much more about instruction, especially assessment, by implementation of the task in a real classroom with real students than if they had just written the tasks to turn in to their instructor. The experience of collaborating with mentor teachers was also mentioned by many of the preservice teachers as a benefit of the project. From working with their mentors, they were able to gain insights into the students and classrooms where they would be presenting the performance assessment prior to the actual implementation.

Field experience. The feedback from the preservice teachers was positive regarding their time in the classroom. They recognized that through implementing the performance assessment task in the classroom, they were able to find out where their task needed improvement and also what aspects were successful as designed. The following quotes from the preservice teachers' written reflection on the project are representative of the comments provided about the field experience.

> The project was a great learning experience for me. I found out that a topic can and will expand unless the teacher keeps a close focus...Another learning experience for me was the value of a clear Rubric which the student could look at in advance so they could keep themselves on track during the project and also know what would be required on their summative assessment. (Will, final reflections)

> Overall, I think that this task went wonderful, and is a really good activity for both math and science. The students were very excited and really had a good time. I do believe however, the next time I use this I will let the students go all the problem solving instead of teaching them how to do everything. I will be in the room for support and to answer questions. I believe that is how students have fun and learn the most. Give them a task to do what they can do and ask questions from both me and the teacher. (Maria, final reflections)

Working with mentor teachers. The preservice teachers were encouraged to develop a relationship with their assigned mentors and asked to communicate with them as often as possible. The feedback from the preservice teachers was mixed as to the communication they had with their mentor teachers. Some of the preservice teachers felt that the communication was fine and others felt the mentor teachers could have done more.

Most of the challenges facing the project stemmed from situating the preservice teachers in the classrooms. Placements with mentors who had backgrounds in performance assessment and were implementing standards-based approaches were difficult to find, and in the cases where the mentors were not skilled in these areas, the preservice teachers' experiences were often frustrating and less rewarding. The general comment from the preservice teachers on the post project survey was that the mentors did not give in depth constructive feedback on the performance assessment task when asked. The mentors seemed to feel more comfortable simply stating that the implementation had "gone well" or commenting on the preservice teachers' classroom management skills.

While the situated nature of the assignment was an important feature, it needed to be carefully orchestrated through collaboration among all participants, and such orchestration was difficult.

Conclusions

Understanding of Performance Assessment

With deliberate instruction on development of performance assessment tasks and detailed attention to the implementation of this task in a classroom, we were able to see the beginnings of an understanding of standards-based instruction and assessment in this group of preservice teachers. Following the design and implementation of their task, the preservice teachers' understanding of performance assessment improved greatly. Analysis of the data show that the preservice teachers did come to understand assessment as a formative process; they also constructed ideas of what performance assessment is, when it is useful, and when it is not appropriate. As recommended by the NRC (1996), the preservice teachers designed assessments that had explicitly stated purposes in which students were given adequate opportunities to demonstrate their achievements. The preservice teachers in this study came to see that authentic assessment is truly what captivates students' interest. As recommended by the NRC (1996), the preservice teachers designed tasks requiring "students to apply scientific knowledge and reasoning to situations similar to those they will encounter in the world outside the classroom as well as to situations that approximate how scientists do their work" (p. 78).

When asked, either on the questionnaires or in the interviews, about the features of a performance assessment task after direct instruction on performance assessment and the development and implementation of a task, the preservice teachers showed improvement in all features. Some of the features showed more improvement than others, the four features showing the strongest improvement being (a) containing two or more questions, (b) providing opportunity to apply three or more skills, (c) requiring students to discriminate between relevant and irrelevant information, and (d) requiring students to generate information. Inclusion of these features demonstrates that the preservice teachers were able to describe tasks and recognize the importance of requiring students to attend to more than one area of information, use multiple skills, and produce some type of informational product. Improvement in these areas was possibly due to the preservice teachers' comfort and skill with these features from previous experience. Less improvement was seen in the other four features (a) designing a detailed, well developed task, (b) requiring students to explaining their work, (c) requiring students to generate a written product, and (c) requiring students to produce tables and graphs. This may be due to these features being more foreign to the preservice teachers than other features. The single element that was not consistently incorporated by the preservice teachers was the requirement for students doing the task to display data using graphs or tables. This may be due to an inability of the preservice teachers to use tables and graphs to display data themselves; this feature of a performance task may have remained foreign to the preservice teachers. This is consistent with Firestone, Mayrowetz, and Fairman's (1998) discussion of the need for teachers to have a sophisticated content knowledge in order to implement performance assessment. Possibly a lack of science content knowledge left the preservice teachers with little experience using tables or graphs to display data.

As stated by Borko, et al. (1997), teachers need substantive and sustained professional development on performance assessment. The preservice teachers possibly did not have long enough or in depth enough exposure to the four features on which they demonstrated less improvement. Also, as Firestone, Mayrowetz, and Fairman (1998) concluded, rich tasks are needed as models for teachers learning about performance assessment, the preservice teachers may have benefited from more exposure to exemplary tasks during their instruction on performance assessment.

Our analysis also reflected some areas that need additional attention. While they became aware of issues and complexities of standards-based instruction, the preservice teachers did not leave the course having developed strong skills in either analyzing children's thinking or in designing inquiry-based science instruction. Additionally, challenges scoring children's work indicated that preservice teachers needed more experience with rubrics than the project provided.

Importance of the Field Experience

It was clear from the data that the situated nature of the project was the most important factor in the preservice teachers' learning about assessment. Much of the learning stemmed from the preservice teachers knowing they were going to be implementing their tasks (motivating quality work more than a semester grade in a course), observing and interacting with children doing science, and then analyzing and reflecting on problems experienced in instruction. While the preservice teachers had earlier analyzed children's work as part of the methods course, it was not as meaningful as being immersed in the classroom environment.

It is possible that the preservice teachers were able to improve in their understanding of performance assessment due to their field experiences. As Schoon and Sandoval (1997) indicate, being involved in field experiences where they can practice new skills allows preservice teachers to gain necessary skills sooner than simply discussing or reading about these skills in their methods classrooms. Putnam and Borko (2000) maintain that learning needs to be situated in an authentic context in order for new knowledge to be constructed, for a transfer from classroom to practice to occur. Our findings align with those of Borko et al. (1997) that the preservice teachers needed to experiment with the performance assessment tasks in an authentic context in order to understanding the full potential and value of the task. We feel that this could not have occurred without the valuable mentorship provided by the inservice teachers. As recommended by Spector (1999), the preservice teachers were able to implement their performance assessment tasks successfully with the help of mentor teachers. We felt that implementing the designed task in an authentic context and reflecting on that experience allowed the preservice teachers to gain essential insights into teaching and learning.

Implications

Teachers are at the center of reform for teaching and learning in science. As such, we need to find effective ways to facilitate preservice teachers' development toward standards-based approaches. This study described and analyzed one approach to help preservice teachers build these understandings. To effectively situate learning in classrooms, all participants (preservice teachers, mentors, and teacher educators) needed to collaborate in thoughtfully planning for, orchestrating, and then analyzing their shared teaching and learning experiences. Significant and deliberate efforts were needed, but even with these efforts, we only saw the beginnings of a foundation being constructed. These findings for preservice teachers are consistent with what others (e.g., Borko et al., 1997) have found for inservice teacher development: while professional development focusing on performance assessment is worthwhile in moving toward Standards-based practices, such efforts are challenging to implement and are just a beginning to changing teachers' beliefs and practices.

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Appendix A
Performance Assessment Project

The project will be completed in three parts, with separate due dates for each part (indicated on your syllabus). The project may be done in pairs or individually. The relative point value of each part is given below.

Part I: Planning the Task

A. Background research: Gain an understanding of the teaching and learning issues associated with your topic. Each person must review a minimum of two journal articles (quality, peer-reviewed journals) addressing your topic. While you may gain access to journal articles through the library's web site, these should not be articles from Internet sites. Each article review should be about 1 page. (6 points)
B. Planning guide: Complete the Performance assessment planning guide as a first step in writing your task. Submit one guide for your group. (4 points)

Part II: The Task

Include a brief overview of the task, and a copy of the original task/resource from which your task is based. Include a table showing alignment between task items and the state standards (EALRs)or NSES/NCTM *Standards*. Include any special instructions for administering the task and a list of materials needed. Include a copy of the task as it will be administered to students. Include rubrics for scoring the task. Submit one per group. (10 points)

Part III: The Final Report of Findings

A. Analysis of Students' Work and Understandings: Include your original task and rubrics with instructor (and mentor teacher) comments from Part II. Include samples of the scored student work, and your analysis of the students' understandings based on their performance on the task. Each person must submit an analysis of at least 3 students' work (preferably a high, medium, and low scoring project). If you are working with a partner, each person should select different students. (5 points)

B. Reflections, Implications, and Suggestions for Improving the Task: Include your reflections on the assessment process, such as whether you believe the task was an effective assessment strategy and why or why not, whether it assessed important math or science concepts and/or processes, and whether and how you had to intervene to clarify any problems students may have had when engaged in the task. Make recommendations for revising the task. Each person must submit this section. (5 points)

Appendix B

Planning Guide for Developing a Performance Assessment Task

(Adapted from McTighe, 1999)

Title of Task:

Grade Level:

Concepts and Processes Assessed:

Task Context/Situation:

Students' Role in Performing the Task:

Audience/Client/Customers for whom the task product and/or performance is being created:

Appendix C

Pedagogical Beliefs Questionnaire / Interview Questions
(Adapted from Peterson, et. al., 1989)

1. A. Describe, as specifically as you can, a lesson in which you introduce a *new* mathematics topic to your class. We are interested in the way you organize and present the mathematics content, as well as the specific teaching methods and strategies that you use. Preservice teachers: *imagine* a lesson and describe it (if you have not had experience teaching a new mathematics topic). Inservice teachers: *recall* a particular lesson and describe it. B. How does your introductory lesson differ from a typical lesson on a mathematics topic?
2. Describe, as specifically as you can, a lesson in which you introduce a new science topic to your class. We are interested in the way you organize and present the science content, as well as the specific teaching methods and strategies that you use. Preservice teachers: *imagine* a lesson and describe it (if you have not had experience teaching a new science topic). Inservice teachers: *recall* a particular lesson and describe it. B. How does your introductory lesson differ from a typical lesson on a science topic?
3. Describe, as specifically as you can, a lesson in which you include elements of the Nature of Science. We are interested in the way you organize and present the philosophy, as well as the specific teaching methods and strategies that you use. State specifically the elements you included. Preservice teachers: *imagine* a lesson and describe it (if you have not had experience teaching science). Inservice teachers: *recall* a particular lesson and describe it.
4. Describe, as specifically as you can, a lesson in which you include writing in mathematics and/or science activities. We are interested in the role of writing in the lesson and the type of writing expected, as well as teaching methods and strategies that you use with writing. Preservice teachers: *imagine* a lesson and describe it (if you have not had experience teaching a new mathematics and/or science topic). Inservice teachers: *recall* a particular lesson and describe it.
5. What do you think the role of the teacher should be in teaching problem solving and reasoning to students?
6. What do you think the role of the learner should be in a lesson involving problem solving and reasoning?
7. Are there certain kinds of knowledge and/or skills in mathematics that you believe all students should have? If so, what are they?
8. Are there certain kinds of knowledge and/or skills in science that you believe all students should have? If so, what are they?
9. For the grade that you teach (or intend to teach), what do you believe should be the relative emphasis in mathematics on fact knowledge versus understanding topics and processes versus solving of real-world/ authentic problems? Why?
10. What do you see as the relationship between learning of mathematics facts, understanding mathematics concepts and processes, and solving real-world/ authentic problems involving mathematics?

11. For the grade that you teach (or intend to teach), what do you believe should be the relative emphasis in science on fact knowledge versus understanding scientific concepts and processes versus solving of real-world/ authentic problems? Why?
12. What do you see as the relationship between learning of scientific facts, understanding scientific concepts and processes, and solving real-world/ authentic problems involving science?
13. What do you think the role of technology (e.g., calculators, computers, internet-use, etc.) should be in teaching and learning mathematics?
14. What do you think the role of technology (e.g., calculators, computers, internet-use, etc.) should be in teaching and learning science?
15. Students have different abilities and knowledge about mathematics. How do you find out about these differences?
16. Students have different abilities and knowledge about science. How do you find out about these differences?
17. Describe, as specifically as possible, what you understand performance assessment to be, when you believe it is useful, and when you believe it is not appropriate to use. If you have used performance assessment in your teaching, describe how you have used it.
18. Write and/or describe a mathematics problem that might be categorized as an example of performance assessment.
19. Write and/or describe a science problem that might be categorized as an example of performance assessment.

Appendix D
Task Analysis Scoring Guide
(Adapted from Fuchs, et al., 1999)

Feature	Our Operational Definition
1. Well-developed, detailed scenario. Contains 2 or more paragraphs	2) Problem(s) presented with detail; well developed scenario; 2 paragraphs or the equivalent as a guideline. 1) Problem(s) presented with some description but needs further development; 1 paragraph or the equivalent as a guideline. 0) Problem not presented (may be an exercise); 2 or fewer sentences written.
2. Contains 2 or more questions	2) Tasks includes two or more questions/ aspects of a problem for students to address. These questions are problematic in nature (i.e., not limited to exercises/ recall of facts or procedures). 1) Task includes one question/ aspect of a problem for students to address that is problematic in nature. 0) No questions/ aspects of a problem are presented.
3. Provides opportunity to apply 3 or more skills	2) Task clearly provides students an opportunity to apply 3 or more skills in solving the problem(s). 1) Task provides students an opportunity to apply 2 skills; OR task requires thoughtful application of one skill. 0) No evidence that students are required to thoughtfully apply skills
4. Requires students to discriminate between relevant and irrelevant information;	2) Task presents both relevant and irrelevant information, requiring the student to discriminate, and/or make judgments from the information given. 1) Task description implies that students would have to discriminate/ make judgments in approaching the problem, but not clearly stated as such. 0) No evidence that students are required to discriminate/ make judgments (i.e., all information given is needed and no additional information is required).
5. Requires students to generate information	2) Task requires students to generate conclusions and/or extrapolate meanings of work; more than one solution is possible; more than one approach (solution method) is possible. 1) Task is presented such that more that one solution and path are possible. 0) Task includes only closed problems without multiple solutions and methods possible.
6. Requires students to explain work.	2) Task requires students to explain their work (including solution methods, reasoning, calculations, etc.). 1) Task includes some aspects of explanation, but not fully developed. 0) Task does not require students to explain their work in any way.
7. Requires students to generate written communication	2) Task requires students to generate a written product with writing elements defined (such as writing style [e.g., persuasive, descriptive, expository], students' role, audience). 1) Task includes some written communication, but not fully developed. 0) Task does not require a written product ("explaining work" is not included here).
8. Requires students to produce tables and/or graphs	2) Task requires students to produce table(s) and graph(s). 1) Task requires student to produce a table or a graph. 0) Task does not require tables or graphs.

Table 1: Percent Showing Improvement in Interviews (n=8)

Feature	**Percent Showing Improvement (Moving from 0-1, 1-2, or 0-2)**	**Percent showing no change (at each score)**	**Percent Decreasing (Moving from 1-0, 2-0, or 2-1**
Detailed, well-developed task. Contains two or more paragraphs	37.5%	37.5% (0) 25% (1)	
Contains two or more questions	62.5%	12.5% (0) 12.5% (2)	12.5%
Provides opportunity to apply 3 or more skills	75%	12.5% (0)	12.5%
Requires students to discriminate between relevant and irrelevant information	62.5%	25%(0) 12.5% (1)	
Requires students to generate information	50%	37.5% (0) 12.5% (2)	
Requires students to explain work	37.5%	37.5% (0)	25%
Requires students to generate written product	25%	62.5% (0) 12.5% (1)	
Requires students to produce table(s) and/or graph(s)	25%	75%(0)	

Table 2: Percent Showing Improvement on Questionnaires (n=23)

Feature	Percent Showing Improvement (Moving from 0-1, 1-2, or 0-2)	Percent showing no change (at each score)	Percent Decreasing (Moving from 1-0, 2-0, or 2-1
Detailed, well-developed task. Contains two or more paragraphs	19%	36% (0) 39% (1)	6%
Contains two or more questions	56%	16% (0) 13% (1) 9% (2)	8%
Provides opportunity to apply 3 or more skills	56%	17% (0) 13% (1) 7% (2)	7%
Requires students to discriminate between relevant and irrelevant information	56%	34%(0) 3% (1)	7%
Requires students to generate information	62%	21% (0) 5% (1) 10% (2)	2%
Requires students to explain work	25%	49% (0) 5% (1)	21%
Requires students to generate written product	25%	56% (0) 4% (1)	15%
Requires students to produce table(s) and/or graph(s)	6%	88%(0)	6%

Table 3: Percent Showing Improvement on Interviews Compared to Questionnaires

Feature	Interviews (n=8)	Questionnaires (n=23)
Detailed, well-developed task. Contains two or more paragraphs	37.5%	19%
Contains two or more questions	62.5%	56%
Provides opportunity to apply 3 or more skills	75%	56%
Requires students to discriminate between relevant and irrelevant information	62.5%	56%
Requires students to generate information	50%	62%
Requires students to explain work	37.5%	25%
Requires students to generate written product	25%	25%
Requires students to produce table(s) and/or graph(s)	25%	6%

Table 4: Performance Assessment Tasks Scores (n=24)

Feature	Total tasks scoring 0	Total tasks scoring 1	Total tasks scoring 2
Detailed, well-developed task. Contains two or more paragraphs	0	3	21
Contains two or more questions	0	6	18
Provides opportunity to apply 3 or more skills	0	3	21
Requires students to discriminate between relevant and irrelevant information	0	5	19
Requires students to generate information	0	1	23
Requires students to explain work	0	5	19
Requires students to generate written product	1	0	24
Requires students to produce table(s) and/or graph(s)	6	9	9

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