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Designing a Science Methods Course for Early Childhood Preservice Teachers

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Preparing early childhood (K-3) teachers to teach science presents special challenges for the science methods instructor. Early childhood preservice teachers typically come to the methods classroom with little science content knowledge; they also lack confidence in their own abilities to teach science. This paper presents a theoretical background, reflections of a methods instructor, and recommendations for teaching an early childhood science methods course.

It has been found that primary and elementary teachers are rarely specialists in science and, indeed, often avoid teaching it because they are not confident they can teach it well (2000 *National Survey of Science and Mathematics Education*, 2002 Atwater, Gardener, & Kight, 1991; Cox & Carpenter, 1989; Perkes, 1975; Schoeneberger & Russell, 1986; Tilgner, 1990). It has been shown that elementary teachers generally do not have a solid understanding of science content, exhibiting misconceptions in physical science in particular (Lawrenz, 1986). Research shows that primary teachers hold misconceptions about motion, changes in materials (Kruger & Summers, 1989), forces, energy (Kruger, Palacio, & Summers, 1992), and light and shadow (Smith & Neale, 1989); however, all primary and elementary teachers are required to teach science regardless of their qualifications; they are also expected to help their students meet national Benchmarks (AAAS, 1993) and National Standards (NRC, 1996).

Besides concerns with content knowledge and confidence in teaching science, early childhood teachers have other issues to consider. For instance, are the developmental levels of their students sufficient to allow them to conceptualize specific science content? There is disagreement of what actually constitutes developmental appropriateness of scientific ideas, instruction, and curricula for young children (Kuhn, 1997; Metz, 1995, 1997). How do primary teachers identify science misconceptions of children who often have not yet developed strong writing skills? And how do we help these teachers become more comfortable in their abilities to teach science to young children?

The purpose of this paper is to describe goals for an early childhood science methods course, with the design of the course set up to help preservice teachers meet those goals. The experiences provided in the course were designed to help preservice teachers build both their science and pedagogical understandings, as well as for the preservice teachers to practice them with young children in order to build pedagogical content knowledge (Shulman, 1987). It is hoped that the paper will inform others who prepare early childhood teachers to effectively teach science.

Context of the Course

The Early Childhood Science Methods course is part of a series of courses taken by students in the Early Childhood B.A. and Certification Program at a large Midwestern university. Most early childhood majors intend to teach kindergarten as practicing teachers; being certified in early childhood education is currently the only way to become certified to teach kindergarten in this state. With their Early Childhood certification they can teach preschool through third grade. As part of their 125-credit degree program they take only nine semester hours of science, including a general content course for elementary teachers and a technology course. They then select a three-credit elective science course from a choice of content areas. This nine credit-hour requirement is three credits fewer than what elementary majors take at the same university. The students in the early childhood program do enroll in two science methods courses taken as a cohort—the first to prepare them to teach both math and science to young children 3 to 5 years old and the second to prepare them to teach math and science to kindergarten to primary age students, ages 5-8. The goals of the Early Childhood Program are to actively engage students in a variety of experiences and activities to enable the students to (1) acquire the knowledge, skills, and dispositions of an effective teacher; (2) develop sensitivity to issues of diversity of all forms (i.e., race, class, culture, gender, disability); and (3) embrace ethical, social, and intellectual commitments to young children (university document). Virtually all preservice teachers who are part of the Early Childhood Program are female, and the mean age is 22. There are approximately 17 to 27 students enrolled in each section.

As part of the semester in which they take the K-3 science methods course the preservice teachers are concurrently enrolled in a field placement. They spend one full day each week in a K-3 classroom. Within that day, they are required to teach lessons from all content courses in which they are currently enrolled, including science (the other courses include language arts, math, social studies, and special education).

Goals for preservice teachers that are specific to the early childhood science methods course include the following: (1) to increase their confidence and comfort level for teaching science; (2) to acquire strategies for teaching science to 5- to 8-year-old students; (3) to demonstrate an awareness of the developmental appropriateness of various science concepts for young children; (4) to demonstrate an understanding of state and national benchmarks as they relate to science teaching; and (5) to demonstrate skills in instruction of, curriculum development in, and assessment of, science standards for young children. To help preservice teachers meet these goals, the science methods course instructor turned to a research base in elementary science education to design the course. The design of the course and its components are presented in the following sections.

Design of the Course

The components of the course (Table 1) were designed to meet the course goals while addressing issues of teacher comfort level for teaching science, developmental appropriateness of concepts for young children, and pragmatic issues in learning to be an early childhood science teacher. Within the following sections below are descriptions of the foci for each component.

Table 1. Main Components of the Course

Components	Strategies
Component One Increasing preservice teachers' comfort with science and teaching science	Instructor credibility Openness to student questions Development of content knowledge Emphasis on nature of science and inquiry Literacy connections Allowing revision of assignments
Component Two Explicit reflection for teaching young children science	Assessing primary student ideas Lesson planning Reflections on teaching Weekly reflections on issues in primary science teaching
Component Three Pragmatic issues for teaching young children science	Classroom management Selecting activities Assessment issues Working in another teacher's classroom

Component One: Increasing Preservice Teachers' Comfort with Science and Teaching Science

Instructor Credibility

The first item on the course agenda is to introduce myself, the course instructor, as a former primary teacher of the first, second, and third grades. I have found that sharing that I have actually been a primary teacher responsible for teaching all subjects, including science, adds credibility to my methods instruction and the preservice teachers' willingness to attend to course discussions and theoretical issues. I am able to share teaching vignettes and examples of primary student work to illustrate important points. Preservice teachers have commented in course evaluations about how much they appreciated the teaching stories and examples of student work. Prior work with inservice teachers also supports the value primary teachers place on professional development by someone who has experience teaching at their grade level (Dickinson, Burns, Hagen, & Locker, 1997).

Being Open to Student Questions

I also remained open to preservice teacher questions. For example, on the day of the equinox, one preservice teacher stated that on this day we should be able to balance an uncooked egg on one end. I stated my disbelief, but turned the comment back to the preservice teachers by asking "How can we find out?" One preservice teacher who lived on campus near our classroom went home to get some eggs. When she returned, several preservice teachers, indeed, were able to balance the egg on its end. The preservice teachers were amazed and believed it was something to do with the equinox; however, I told them I was still unconvinced. Yes, our observation is that certain people can make an egg stand on one end, yet what would our inference be? What could possibly explain that some of us could balance an egg on its end on this particular day? Could we do it on other days as well, or is there something special about this day? And why can't all of us do it? Students proposed elaborate explanations for the event. Finally, someone connected to the Internet and found an explanation that satisfied us all: Yes, we can balance an egg on its end, but it has to do with the talent of the person doing the balancing, and it can be done on any day. The preservice teachers tested this idea by balancing eggs on their ends on several days following the equinox, supporting the claim. Thus, by allowing them to ask questions, and being responsive to their questions, I encouraged them to explore ideas they may not have otherwise explored in a manner that I hope they encourage their own students to utilize. They were free to ask questions and confront their ideas, which may not have been the case in earlier science content courses.

Development of Content Knowledge

Another part of this component to help preservice teachers improve their comfort level was to help them find strategies to improve their science content knowledge. Sixty minutes of each three-hour class session were devoted to exploration of science content in the context of a hands-on exploration that shared a model for teaching science to young children. These weekly investigations were all in the physical sciences (e.g., chemistry, physics) because primary teachers tend to focus on biological science if they teach science at all, and we wanted to improve their knowledge of physical science. The preservice teachers were asked to respond to an open-ended question to elicit their ideas about the science content such as "Why do you think some things float and others sink?" They then participated in a hands-on investigation to test things that float and sink, followed by a discussion on how such an investigation could be orchestrated with young children. Finally, they were asked to revisit their earlier elicited ideas and respond again to the open-ended question. This technique has proven to be an effective way for experienced primary teachers to elicit student ideas, and to design instruction to address those ideas (Akerson & Flanigan, 2000; Akerson, Flick, & Lederman, 2000).

Preservice teachers were also asked to find a content area in consultation with their field placement mentors and the national benchmarks (AAAS, 1993) about which they could study and eventually design and teach lessons to young children. After they identified an area, they researched and prepared a document delineating important concepts related to that content. For instance, in a paper to prepare herself for teaching a unit on static electricity to second graders, the preservice teacher used resources to improve her understanding. Her conceptions of "how charges worked" and how charged objects would "stick" to uncharged objects improved as a result of her study. I hoped that all preservice teachers would realize that while they may not initially understand all the science content they were to teach, they could be resourceful enough to improve their own conceptions.

Emphasis on Nature of Science and Inquiry

Because there is evidence that elementary teachers do not have a strong understanding of the nature of science and inquiry, there is a nature of science and inquiry component that is a theme in the course, taught in a reflective explicit style previously shown to be effective with elementary and preservice elementary teachers (Akerson & Abd-El-Khalick, 2003; Akerson, Abd-El-Khalick, & Lederman, 2000). To emphasize nature of science and inquiry, preservice teachers were treated to weekly investigations of content (as described above), during which they were often asked to design investigations to answer a particular question. As part of this emphasis on inquiry, discussions were held regarding how to teach inquiry science to young children, beginning with helping young children frame questions that can be answered through scientific investigations.

At the beginning of each class session, approximately 30 minutes were devoted to discussion or exploration of ideas related to nature of science (NOS). The aspects of NOS that were emphasized are the seven that are thought to be attainable by K-12 students. These aspects are that science is tentative, subjective, creative and imaginative, and based on empirical data. Two other aspects that were emphasized were the distinction between observation and inference, and theories and laws. The activities that were used to sensitize preservice teachers to the ideas were those found in Lederman and Abd-El-Khalick (1998), which previously had been used successfully with preservice elementary teachers (Akerson, Abd-El-Khalick, & Lederman, 2000). Throughout the semester, the preservice teachers engaged in the NOS activities and described which aspects of NOS were illustrated by the activity and how. In addition, the preservice teachers were asked to describe which aspects of NOS were illustrated by the content activities each week. Preservice teachers read several papers describing appropriate NOS conceptions (e.g., McComas, 1996; Penrose, 1994) and responded with their views through reflective papers. Preservice teachers were also asked to orally describe which emphasized NOS elements were illustrated in the scientific inquiries in which they engaged in class. Thus, NOS and inquiry were emphasized each class session, through written and oral means.

Literacy Connections

There is evidence that elementary teachers have strengths, interest, and comfort levels in literacy instruction (Akerson et al., 2000; Dickinson et al., 1997), so one part of this component has been established to help preservice teachers see interdisciplinary connections between literacy and science instruction, and when it is appropriate to use these as opposed to straight disciplinary instruction.

Several tactics helped preservice teachers see connections between literacy and science instruction, and when they should remain separate. First, samples of both fiction and nonfiction science-related children's literature were read at the beginning of each class session to allow discussion of appropriate use in primary classrooms. For instance, I read Wiesner's (1992) *June 29, 1999* one class period, and a discussion ensued following the open-ended prompt, "How might this book be used in your future classrooms?" The preservice teachers responded with statements such as "to show how science takes place in schools" and "to illustrate the aspects of nature of science that we have been studying." Thus, they have taken a step beyond simply reading a science book to their class and have begun thinking about effectively using children's literature to reinforce important ideas.

Second, I wanted students to recognize the importance of writing in helping them develop their scientific ideas (Fulwiler, 1987; Langer & Applebee, 1987; Mayher, Lester, & Pradl, 1983). To model the importance of writing in improving scientific ideas, I asked preservice teachers to write down their own ideas and explanations for scientific phenomena such as how they thought a Cartesian Diver worked. A class discussion was subsequently held during which several student explanations were shared, and students were free to revise their explanations.

Participating in using writing to explore their own ideas illustrated to them firsthand the importance of writing in developing conceptions. Additionally, I shared samples of primary student science writing from first, second, and to third grade classrooms. These writings took place in the form of student science journals, one-page responses to teacher prompts, and formal reports after independent research. The preservice teachers had the opportunity to see science writing samples from students of various grades and developmental levels, and to note the progression of scientific ideas and conceptions over time. For instance, in a first-grade student's electricity science journal, the student's initial entry was that "electricity works by shocking you." Several entries later the preservice teachers were able to note that the student's response improved to "electricity works when there is a complete circuit." Thus, the preservice teachers could note improvement in scientific conception as a result of student writing, and they could also recognize the value of student writing in assessing student science understanding.

Third, I stressed that interdisciplinary instruction should not take the place of disciplinary instruction in either science or literacy. I led an initial discussion in which preservice teachers and the instructor shared ideas for interdisciplinary literacy and science instruction. Ideas were given that related to reading about, writing about, talking about, and listening to stories about science concepts. I then raised the question, "If we are spending time reading, writing, talking, and listening about science, does that count as our science for the day?" Some preservice teachers indicated that yes, a teacher could thus consider science taught for the day. Others were not so sure—there was no hands-on component. Finally, we ended up relating science instruction to literacy instruction. It has been said that the best way to teach children to write is to let them write (Graves, 1991), so we decided that a similar statement, "Let them do science," would work for us. Although we would definitely have students read, write, talk, and listen to stories about science, the most important thing we could do as teachers would be to let them do science at their levels.

Allowing Revisions

The preservice teachers tended to be concerned with course grades, while I wanted to emphasize their gain in conceptions of science and pedagogy related to teaching young children. Thus, I allowed preservice teachers to revise assignments, along with their thinking, to improve course grades, and hopefully, their own teaching. For instance, if preservice teachers submitted a paper describing their knowledge of content that was incomplete or in error, instead of grading them harshly, I asked them to revise the paper by rethinking the content or elaborating on the ideas contained within. This revision encouraged them to recognize that they needed to understand the content at a level high enough to interpret their own students' thinking, and this made it less threatening to submit a paper because they knew they would get feedback that would enable them to continue to learn and make adjustments in their understandings.

Component Two: Explicit Reflection for Teaching Young Children Science

Preservice teachers need experience working with children of the age they intend to teach to develop an understanding for the capabilities of those children and the kinds of strategies that help those children learn. The field placement was instrumental in providing a venue for this experience, allowing preservice teachers the opportunity to work with primary children to see what they "can do" in science.

Because of evidence that teachers need to uncover student understandings, or misconceptions, of science content to help students develop more scientific conceptions (Driver, Guesne, & Tiberghien, 1985), one assignment was for preservice teachers to interview at least one primary student for understandings of a chosen science concept. This science content was the same as what they had earlier studied to improve their own content knowledge. From their study of the content, and through review of the K-2 Benchmarks for Science Literacy (AAAS, 1993), the preservice teachers individually designed interview protocols of approximately ten questions, and then interviewed at least one student from their field placement classrooms. They viewed example interviews of primary students on videotapes, and were given examples of interview protocols. They received instruction on how to write open-ended questions that would elicit student ideas about the science content of their choice. They then conducted an interview of the primary student to elicit that student's ideas about the science content and compared the student responses to the scientific idea. When students could not respond in a way that was in line with the scientific explanation, they determined that the student held a misconception about that scientific idea. They then wrote a reflection paper that described their interview—the student(s), what the student(s) understood about the content, and any ideas they had for improving the student(s)' understanding of the content. They concluded the paper with a reflection on implications of student science misconceptions on their own teaching.

The preservice teachers then wrote a series of lesson plans designed to confront student misconceptions uncovered in the interview. If many misconceptions were identified, the preservice teachers were cautioned to focus on only one or two in individual lessons. The preservice teachers then taught at least one of the lessons to the students in their field placements, allowing them to see how primary students reacted to the lesson, and what they seemed to gain from the lesson. They assessed any change in student misconceptions (though they taught the lesson to the full class and interviewed only a few [or one] students, they assumed most primary students held similar misconceptions). Finally, they wrote a reflection paper on their instruction of the lesson—their perceptions of how the lesson went, what the students gained from the lesson (as evidenced by student performance on their assessment that was included in the lesson plan), whether the student(s) seemed to make progress toward more scientific ideas related to the chosen content, and ideas for lesson improvement. From preservice teacher comments in class and lesson, reflections, it was apparent that actually interviewing, designing a lesson, and teaching the lesson to primary students (rather than microteaching to peers) was a critical experience in helping the preservice teachers develop a better understanding for working with primary students in science. For example, one student noted in her lesson reflection paper:

> I had no idea that students would have misconceptions about how plants grow, but after working with them on this lesson, I know these first graders no longer think a leaf is the first thing that grows from a bean seed. Actually doing this lesson with the students is better than reading about it.

Completing the whole cycle of researching a content area; interviewing a student; and then designing, teaching, and reflecting on teaching to primary students appeared to help the preservice teachers better understand how to improve their own content knowledge, as well as the knowledge of primary students.

Another assignment that focused the preservice teachers on reflecting about teaching science to young children was weekly reflection papers. Topics of weekly reflection papers were assigned at each class session and were pertinent to whatever theoretical teaching concepts were being focused on at the time. For instance, one week the topic assigned was "Consider assessment of young children's science knowledge. Describe some ways you could assess what science knowledge they had obtained from an investigation. Relate your description to our text chapter (Harlen, 2000)." The preservice teachers then had a week to reflect on the topic and write a one- to two-page response to the question. We used the reflection papers as a springboard for oral discussion surrounding the topic the following week. Thus, the preservice teachers gained experience in reflecting on issues related to teaching science to young children both in written and oral form.

Component Three: Pragmatic Issues for Teaching Young Children Science

While theoretical issues and a focus on developing confidence for teaching science is important for primary teachers, it is also valuable to explore the "nuts and bolts" of teaching science to primary students. Preservice teachers were particularly concerned with classroom management, selecting appropriate activities, assessment of students, and working with their mentor teachers. Each of these issues is discussed below.

Classroom Management

Because there is evidence that teachers say they do not teach science because of the messiness, disorder, and lack of materials (Fitch & Fisher, 1979; Tilgner, 1990), one focus was on helping preservice teachers develop classroom management strategies specific to teaching science to primary students. Children who are 5- to 8-years old are learning to work and play together, and thus, while science activities should be open-ended to encourage them to explore ideas, there should be specific rules and procedures in place to ensure safety, fairness in using materials, and learning of science content.

As a class, we brainstormed ways of effectively managing young children in the context of doing science investigations. We generated ideas via consensus and consultation with our text and with child psychology texts. First, our class recommended having young children work together in groups no larger than two so they are more assured of each interacting with materials and sharing ideas via discussion. Second, we found it important to give very clear directions for retrieving materials—there should be a classroom procedure set up for which member of the investigation group collects the materials, who gets to use them first, who records observations, etc. Clear directions for retrieving and using materials maximizes time on task and minimizes any arguments over who should be using the materials at a certain time. Another management technique that we found important for young children is clear directions for clean-up procedures. Simply stating to young children "It is time to clean up" is not sufficient and, paradoxically, is likely to incur chaos in the classroom. Students should be told where to put materials, who should be returning the materials, and who should be collecting and turning in any written work generated from the activity. Again, a clear procedure for clean-up ensures maximum time on task and, consequently, makes it possible for more content learning to take place.

Beyond simply managing materials, students should have clear expectations for participating in scientific investigations. Students should be taught what it means to make observations, to generate ideas to record those observations, and to explore how to make appropriate data-based inferences. Teachers should provide clear directions for what students are to do in the open-ended investigations (e.g., design a way to float the most cargo with these given materials). It is my experience (and that of many preservice and inservice teachers) that if primary students are actively pursuing a problem in which they are interested and which they understand, there are minimal classroom disruptions; however, should student behavior disturb others' learning, the teacher should already have set up classroom rules and consequences devised for disruptions.

Having preservice teachers reflect on and generate strategies for classroom management for science helped them envision the practical issues for teaching science to young children. It also gave them some strategies that they could use immediately in their field placements when they taught the lessons.

Consideration of Activities

Teaching science to young children is similar to teaching science to anyone—finding ways to help the student conceptualize content at a level higher than what they already understand. Thus, the preservice teachers were advised to identify student content knowledge prior to any formal instruction. It is virtually impossible to hold individual interviews of each child in the class, however. Thus, it was recommended that preservice teachers hold class discussions of an open-ended question such as "How do we think electricity works?" The teacher accepts all ideas and records them on butcher paper for the students, making certain that students realized that they did not have to agree with all of the ideas on the chart, and that these ideas could change over time. Next, it was recommended that preservice teachers ask individual students to write down for themselves (possibly in science journals) their response to the question. They could either copy down the responses with which they agreed from the class-generated chart or they could write their own new ideas. From this method, the preservice teacher would have a conception of what, in general, most students in her class believed, and then a snapshot of what individual students understood. If the preservice teacher revisited these ideas over time, asking students to respond several times, she could note any changes in student conceptions. This strategy helps to overcome the difficulties associated with identifying misconceptions in large groups of students, and with primary students' limited writing abilities.

Following the identification of student ideas, we discussed how to select activities to improve student understandings. Preservice teachers were encouraged to find many sources for activities and to note whether they emphasized scientific inquiry and seemed to be developmentally appropriate. If they seemed to be good investigations but were not inquiry-based, or developmentally appropriate, preservice teachers were asked to revise them for use with primary students. For instance, a straightforward lab that asked primary students to follow a given procedure to test whether certain items would float or sink was changed by one of the preservice teachers to "How can we find out whether these items float or sink? What different ways can we test our predictions?" Asking preservice teachers to adapt published activities to be more in line with inquiry recommendations and for their particular students gives them experience and feedback for what they will be doing as practicing teachers.

Assessment Issues

Even experienced teachers have difficulties assessing young children's science understandings (Dickinson et al., 1997). The preservice teachers in this course were no different, wondering how they could understand their students' science conceptions. Two class sessions (six hours) were spent on assessment issues particular to young children. First of all, young children's writing skills are not fully developed, meaning it is difficult to require them to write full explanations of their ideas. Second, using standardized assessments is particularly difficult for young children because they often do not understand the need for assessment, nor how to go about responding appropriately on standardized assessment tools such as multiple-choice or matching exercises. Thus, if a teacher uses those types of assessments, it is likely she is assessing students' abilities to use assessment tools instead of their science understandings. Consequently, as a class, we brainstormed ideas for assessment of student scientific conceptions. We determined that having students write their ideas was good, but we needed more because of their limited writing abilities. We could have them use illustrations to accompany their writing, but even then we probably would not have enough information to assess their scientific understandings. Using class discussions and recording of ideas on butcher paper, with a check of student understandings over time, was thought to be helpful in assessing student understandings (described in the activities section), particularly in formatively assessing for further teaching of a particular concept.

One strategy that I shared with the class was the use of checklists that were used by experienced primary teachers (Dickinson et al., 1997). Checklists could be duplicated for each student each semester, and the primary teachers could then formally observe individual students during science investigations, making records of student understandings directly on the checklist. The checklists for individual students could be compiled and reviewed to assess individual student science conceptions. The checklists, combined with student drawings and writings, as well as class discussions, were expected to be effective ways to assess science understandings of primary students. Using a variety of assessment strategies that assess both individual and group understandings, and that do not all require strong writing abilities, will ensure that the teacher has a fairly strong picture of her students' science conceptions.

Working in Another Teacher's Classroom

Many preservice teachers indicated that their cooperating teachers taught no science at all. This finding is probably not unexpected given that many primary teachers avoid teaching science, and the preservice teachers were placed in primary classrooms. One group had a particularly sticky situation of being required to fit all lessons, including science, within the Teddy Bear theme that the cooperating teacher had selected for the school year. Thus, the course requirement for the preservice teachers to focus at least some of their energies on science instruction was upsetting to many of the cooperating teachers. Most cooperating teachers were agreeable to allowing the preservice teachers to teach science in their classrooms as long as they did not need to provide much advice or support, and some were actually relieved to have someone else teach science so they did not have to do it.

Of course, this finding begs the question for the kinds of professional development that might help the cooperating teachers improve their science teaching, but that is a subject for another discussion. For the preservice teachers, the problem became how to teach science without much support or advice from the cooperating teachers, how to select science content appropriate for the primary grades, and how to fit their requirements into the cooperating teachers' classrooms.

To help the preservice teachers be more successful in being able to experience teaching science in their field placements, I was flexible in my requirements. If the cooperating teacher would allow the preservice teacher to only teach science to the "high" students while she provided remedial reading instruction to the others, then that is what occurred. If the practicing teacher never taught science, and did not know what kinds of science was appropriate for primary children, the preservice teacher was directed to look at both the state and national benchmarks (AAAS, 1993) for ideas of appropriate content for the developmental levels of the students. If the cooperating teacher did not want any science taught in her classroom (this only happened in one case) because she was very concerned about her students doing well on a statewide literacy exam, I suggested that the preservice teacher request to teach a science content lesson in an interdisciplinary fashion—using children's literature to introduce the content, having students carry out an investigation, and then having students record in writing their understandings of the science content. The preservice teachers in the second-grade classroom who were forced to comply with the Teddy Bear theme were able to use an activity that mimicked a police investigation of a crime scene for a stolen teddy bear. The preservice teachers then emphasized how the police investigation used scientific ideas such as empirical evidence, observation, inference, and creativity to identify the criminal. Not the perfect science lesson, but it did allow for some discussion of nature of science elements with the second-grade students.

Implications and Recommendations

As others have noted (Abell, George, & Martini, 2002), teaching teachers is a reflective process, and my teaching of early childhood science methods will be different each time I teach a course because I will learn more about how to help future primary teachers be the best science teachers they can be. How the course is presented will differ not only by the knowledge and experiences that I will gain, but also by differences in the preservice teachers enrolled. As in all teaching, the teacher needs to adapt and revise instruction to best fit the students in the class. Even so, it is reasonable for me to state that there are several ideas that will remain a focus of my early childhood science methods instruction that I would recommend other early childhood science educators consider.

First, I will continue to seek to improve preservice primary teachers' confidence for science teaching by helping them find ways to improve their content knowledge, being open to their questions to model responding to student questions, emphasizing nature of science and inquiry, and sharing ideas for effective interdisciplinary literacy and science instruction. These components seem crucial in helping primary teachers understand what science is and how scientists go about their work (nature of science and inquiry), and the content they are to teach. It also helps them recognize how to include science in a primary classroom where often the focus is literacy (interdisciplinary instruction). These components will give them the tools they need to build their confidence in their own abilities to both understand and teach science.

Second, I will continue to ask preservice teachers to reflect on issues related specifically to teaching science to young children. I will continue the overarching assignment of having students research a content area, interview a primary student for content understanding, design a lesson, and teach content to primary students. This experience in teaching science to young children is instrumental to preservice teachers' development of pedagogical content knowledge for teaching science.

I will also continue to focus on the pragmatic issues related to teaching primary children science, including teaching science in an uncooperative cooperating teacher classroom. Preservice teachers' reflections on issues of classroom management, assessment, and selection of activities are important to their success in their intern experiences and to their success as future practicing teachers. Having preservice teachers problem-solve ways to teach science in a reluctant cooperating teacher's classroom will given them experiences in including science in a curriculum that may be literacy heavy, and in a district that may focus on only tested subjects, which may be literacy and math.

Again, courses always evolve, and it is certain that this one will as well. Though the specifics may change, my recommendations stand to help preservice primary teachers become more confident in teaching science, reflect on and experience teaching science to young children, and address pragmatic issues for teaching science to young children.

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