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A Workshop Approach: Instructional Strategies for Working Within the Constraints of Field Experiences in Elementary Science

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Successful experiences teaching science early on can impact teachers' continued teaching of science; therefore, field-based teaching experiences are critical to preservice teacher education in science. Such field experiences may be subject to constraints, however, such as limited time, which prevent preservice teachers from experiencing this early success. In this paper, the author describes an existing field-based teaching experience and her personal experiences implementing an innovative approach while working within limited time constraints. The workshop approach used in the field experience provided preservice teachers with the opportunity to readjust ineffective strategies and refine their teaching while developing techniques for working with students of different grade levels.

Introduction

Prior experiences have a profound effect on how teachers teach science (Ginn & Watters, 1999). Successful experiences teaching science early on can impact a teachers' continued teaching of science, especially hands-on science (Crocker, Shaw, & Reed, 1990). Field-based experiences, during which preservice teachers have their first opportunity to put into practice what they learn in their science methods courses, can thus be viewed as critical to their development as teachers of science. As Lowery (2002) emphasizes, access to teaching elementary children in real-world situations is critical for preservice teachers to focus on content and instructional strategies at deep levels, and to address anxieties associated with teaching elementary science in order to become more confident and competent teachers. Because many preservice teachers enter their methods courses with negative perceptions of science and low enthusiasm for teaching science (e.g., Ellsworth & Buss, 2000), providing them with a positive experience in their field placement is critical for increasing their science teaching self-efficacy (Bandura, 1997). Further, such teaching experience is critical to the development of context-specific pedagogical knowledge, which assists in teacher decisionmaking and contributes to the development of pedagogical content knowledge (PCK) (Gess-Newsome, 1999).

If we think of knowledge as analogous to a set of tools (Perkins, 1986), it is quite possible for preservice teachers to acquire tools, such as knowledge of methods and strategies for teaching science, yet to be unable to use them. Those who actively use tools, rather than just acquiring them, are able to build more robust understandings of the contexts in which the tools are used and about the tools themselves. Learning how to use a tool—for example, a teaching strategy—

involves far more than can be captured by any explicit set of guidelines or steps. Implementation consists of reacting to conditions and situations that arise within the context of teaching, including the environmental conditions and the students themselves. As such, methods classes alone cannot sufficiently prepare preservice teachers for the challenges of teaching science at the elementary level. Field-based teaching experiences are critical as a context for authentic practice.

Not all field-based teaching experiences are equally successful in helping preservice teachers experience early success. Potthoff and Kline (1995) found that preservice teachers were significantly less positive about teaching by the end of their field experience. Several studies (e.g., Lowery, 2002; Wilson, 1996) have examined successful and innovative designs for elementary science methods courses and field experiences. The current body of research in this area suggests that the design of the field experience is important, but what can those science educators do who must work within the constraints of existing programs?

The purpose of this paper is to discuss an existing field-based teaching experience and the efforts of the instructor, working within the constraints of the program design, to optimize the opportunities for preservice teachers to experience early success in science teaching. The workshop approach described in this paper provides a structure for implementation of teaching strategies learned by preservice teachers during their methods course and serves as a springboard for a discourse on pedagogical issues related to science teaching. The author's personal account of her experience in developing and implementing this approach can provide other science teacher educators with ways to work within the constraints of the field experience component of their college or university's teacher preparation programs. Student feedback from course evaluations prior to and following implementation of this approach is included to illustrate the impact on students.

Early Field Experience

The Early Field Experience (EFE) is part of a 9-credit hour cluster of courses taken by elementary education majors, usually their junior year, as the first of their professional preparation courses. Thirty students are enrolled in the course, the majority of whom are white females 20 years of age. For many of the preservice teachers, this is their first time entering the schools in an instructional capacity. In addition to the EFE, students are enrolled in math and science methods courses as part of the cluster arrangement. Preservice teachers are assigned in groups to a classroom in a local elementary school for a period of 45 minutes once a week for nine weeks. Each works with a small group of four to five students. Five of the sessions are reserved for math instruction, while the remaining four are intended for science teaching.

Working Within Constraints

In the semester in which the workshop approach was implemented, the author, a former elementary teacher and then graduate student, was an instructor of the semester-long elementary science methods course and the accompanying EFE. This was her third year teaching the methods course, and her second semester teaching it in conjunction with the EFE. In her experience with teaching the course, she encountered several constraints of the course structure that functioned as barriers to providing an optimal learning experience for preservice teachers. These were related either directly or indirectly to the length and frequency of time preservice teachers spent in the schools.

Time is just one constraint under which methods instructors and field experience supervisors must design their courses. While Cannon (1999) found that extended practicum experiences in elementary science teaching positively increases preservice science teachers' personal-science-teaching-efficacy beliefs, extended practicum experiences such as these are not the reality in all universities, as illustrated by the situation herein. One preservice teacher's comments at the end of the semester indicated that in light of the time constraints, expectations for teaching science were unreasonable:

> *I honestly feel that it is virtually impossible for the students to do a minds-on, hands-on activity in the 45 minutes that we are in the classroom.*

The four science teaching sessions of the EFE provided preservice teachers little opportunity to modify approaches or adjust ineffective teaching strategies to achieve success.

The limited time, combined with the practice of assigning students in groups to different grade levels, posed several challenges for the instructor. First, this practice provided preservice teachers with a limited experience working with students at different grade levels and unclear as to differences in science teaching methods for children of different developmental levels and abilities. Second, having thirty preservice teachers spread out into six different classrooms in which five lessons were occurring simultaneously made it difficult to observe individuals on a regular basis for extended periods of time. Such observations are necessary for providing meaningful feedback that can assist the preservice teachers in improving their practice; they can also be an important source of information for building self-efficacy (Bandura, 1997).

Feedback from the cooperating teacher would also be an important source of information toward improving preservice teachers' self-efficacy; however, with such little time spent in the schools, preservice teachers have limited opportunities to interact with the classroom teachers. In previous semesters, this lack of interaction was perceived as a lack of interest on the teachers' part by some of the preservice teachers. One student voiced her concern on her course evaluation:

> *It was as if [the teacher] didn't even know we were coming. It was either this or just the fact that she didn't care. I don't understand; were we not expected, or worse, wanted?*

This is especially alarming in light of research by Whitney, Golez, Nagel, and Nieto (2002) which indicated that master teachers exerted a greater influence on student teachers than did their university supervisors.

The structure of the EFE was less than ideal in terms of providing preservice teachers an opportunity to have a successful science teaching experience. The sharing of "science autobiographies" (Koch, 1990) written during the first week of the methods course made the importance of this goal all the more apparent. Preservice teachers recalled few, if any, experiences with science as elementary students. This lack of experience served to fuel their anxiety about teaching science to students in the EFE. Because the structure of the EFE was already in place, the amount of time the preservice teachers spent in the schools could not be increased. In order to work within these constraints, a new approach was needed. That approach would come from within the science methods course, from one of the assigned readings.

The Workshop Approach

Jones (1999) describes a "workshop approach" in which teachers create learning centers focused on a single science concept. In past semesters, this article from *Science and Children* had been a favorite course reading among the preservice teachers, and one they consistently recommended be retained on the reading list. The appeal of the piece is that it gives practical solutions for dealing with constraints to teaching science such as limited time, money for supplies, classroom management, organization, and space while at the same time focusing on pedagogical issues such as constructivist perspectives on learning, questioning strategies, and the teacher's role during inquiry. As such, it provides an appropriate bridge between theory and practice.

Additionally, the workshop approach described in the article is consistent with the National Science Education Teaching Standards: Teaching Standard B: Teachers of science guide and facilitate learning, and Teaching Standard D: Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science (National Research Council, 1996, Chapter 3). As Van Zee and Roberts (2001) attest, preservice teachers often enter methods courses with prior knowledge about science learning and teaching that can serve as a basis for learning approaches to science instruction advocated in the National Science Education Standards. Being familiar with learning centers from their own elementary schooling, the method was one preservice teachers could envision themselves implementing in their teaching.

In planning to implement the workshop approach in the EFE, the instructor met with the principal and cooperating teachers. The school had a separate science lab facility, which was a converted classroom containing laboratory tables rather than desks. The principal agreed to reserve the lab for the EFE during the designated teaching sessions. Four classroom teachers, two each at the primary and intermediate levels, were recruited to bring their classes to the lab for one of the designated science teaching sessions. The instructor met with teachers to review their long-range plans and curricula for the purpose of choosing topics consistent with the state academic standards for science, as well as ones that would complement their own classroom instruction. It was decided that the four workshops would focus on electrical circuits (4th grade), magnetism (kindergarten), properties of light (6th grade), and sound (2nd grade).

During the first part of the semester, preservice teachers were exposed to the workshop approach through reading and discussion of the article and by participating in a science workshop in the science methods course. Preservice teachers were then divided into cooperative groups for the EFE, each of which was responsible for planning a science learning center that related to the central concept or question such as "What do magnets attract?" and "What is a circuit?" The "workshop" itself would be an hour-long event during which a single class of elementary students would rotate in groups through the series of learning centers, which were facilitated by groups of preservice teachers.

Groups prepared a list of necessary materials, organized their arrangement for the station, and prepared lists of productive questions (Elstgeest, 2001) to facilitate the activity at the learning center. Plans were submitted in draft form for feedback and approval (nongraded) to the instructor prior to the event; upon completion of the event, a revised plan was submitted along with preservice teachers' reflections on the experiences for formal evaluation.

On the day of each workshop, preservice teachers arrived early at the school site to set up their stations in the science laboratory. At the designated times, the classroom

teachers brought their classes to the lab, divided them into groups, and sent each group to a station to begin. During these workshops, the classroom teachers remained in the lab, taking an interest in what their students and the preservice teachers were doing at each station. The principal also visited the lab each of the four days to observe the goings-on. As the workshop took place, the instructor circulated through each station, observing the preservice teachers as they facilitated the activities.

Benefits of the Approach

Without actually increasing the amount of time spent in the schools, the workshop approach allowed the instructor to increase the opportunities for preservice teachers to experience success in science teaching. Being able to facilitate the lesson multiple times within a single workshop as small groups of children rotated to their station allowed the preservice teachers to improvise and adjust ineffective strategies in order to improve their instruction. In a debriefing session held at the conclusion of the workshops, the general consensus of the preservice teachers was that their instruction had improved with each rotation of the students through their station. One particular student commented in her evaluation,

> *Each time I led the activity, I changed a question I asked or added something. By the end, I felt like an expert.*

Normally, these preservice teachers would implement a lesson a single time, and if that lesson proved unsuccessful or ineffective, they would have no such chance to adjust their strategies and try again. According to Bandura (1986, 1997), such mastery experiences are one of the most powerful sources of self-efficacy and directly influence self-perception of teaching competence.

An additional benefit of working with a variety of grade levels was firsthand knowledge of the range of knowledge and abilities elementary students span. For some preservice teachers, this experience served as a "wake up call" for the need to strengthen their own content knowledge in science:

> *I couldn't get over how much the kids knew. As a teacher, I'm really going to need to know my stuff!*

Being aware of such issues early-on enables preservice teachers to take action to address them prior to entering the classroom.

The structure of the workshop approach provided preservice teachers the opportunity for immediate and direct feedback regarding their instruction. At the end of each workshop, students protested having to leave the lab, which made quite an impression on the preservice teachers, many of whom themselves had lacked enthusiasm for science. Two of the classroom teachers requested copies of the plans from the preservice teachers, and all complimented the group on their teaching. The principal addressed the group on the day of the final workshop, giving her own praise for what she referred to as a job well done.

The preservice teachers seemed energized by this feedback as they recalled the experience during a debriefing session held in the methods class following each of the workshops. These debriefing sessions allowed preservice teachers to reflect on effective and ineffective strategies, and to brainstorm ways to enhance their teaching. Additionally, the instructor was able to observe and provide feedback to individual students, identifying their strengths and suggesting areas for improvement.

Another benefit of the workshop approach was the opportunity to work with classes of different grade levels. Preservice teachers were able to connect theory and practice, offering firsthand examples of differences in elementary students' cognitive functioning and abilities in science and relate these to course topics such as misconceptions and conceptual change. For example, the persistence of misconceptions was evident in a case shared by two preservice teachers who worked with a kindergartener who insisted that magnets attracted all metals, despite the fact she could not make a magnet attract aluminum foil. Instances such as these served as springboards for dialogue on ways to address misconceptions and elementary students' developmental readiness for conceptual change. The preservice teachers brainstormed ways a teacher might respond in similar cases, and further contrasted the situation with examples from the workshops held with other grade levels. Because all preservice teachers had shared the experience of working with each grade level, they could all participate actively in the discussion during these debriefing sessions.

Wilson (1996) reported preservice teachers preferred small group activities, which increased self-efficacy. A cooperative early field experience investigated by Cannon and Scharmann (1996) in which preservice teachers team-taught lessons was found to have a positive influence on students' science teaching self-efficacy. Similarly, preservice teachers indicated that the cooperative structure of the science workshop was a benefit of the EFE:

> *I like the "team teaching" approach. I feel a lot less pressure because if I mess up, hopefully someone else will catch my mistake, or if I forget to include something we talked about, someone can fill me in. I would rather teach like this than alone. I like to work as team with people, and I think our group of teachers worked well together. We had a good dynamic; where one person had difficulties, the other was stronger in that area . . . .*

Additional feedback given on course evaluations indicated preservice teachers found the experience relevant and meaningful, and they felt enthusiasm for teaching science:

> *[The workshop] helped prepare us for actually teaching an elementary science class.*

> *I really value the fact that after this semester I feel much more comfortable with the idea of teaching science.*

Even those students who entered the course with positive attitudes toward science and who were relatively comfortable with the idea of teaching science benefited:

> *Even though I felt confident about science teaching before this . . . I learned so much that now I am more enthusiastic and confident about guiding children in their exploration of science concepts.*

Judging from such feedback from students, the workshop approach was successful in overcoming the constraints of the existing field experience, while providing preservice teachers with a positive and successful science teaching experience.

Summary

Science teacher education is not limited to methods courses; the accompanying field experience in science (where it exists) and student teaching are both

important elements in preparing preservice elementary teachers for the challenges of teaching science at the elementary level. Early field experiences should provide preservice teachers with meaningful and relevant opportunities to experience success in teaching science to children in order to increase their self-efficacy and the likelihood of teaching science in the future (Tilgner, 1990).

While educators of teachers of science may not always have the freedom to design ideal field experiences for their preservice elementary teachers, there are ways to find freedom within the constraints of existing programs. The workshop approach is just one example of a successful undertaking that allows preservice teachers to develop their instructional skills, and provides the prior experience necessary for internalization of content presented in methods courses. Initial evidence from course evaluations merits further inquiry into the effects of this approach on preservice teachers' self-efficacy, as well as the development of their instructional skills as a result of repeated practice in facilitating the activities of the workshop.

Research on innovative approaches for field experiences, such as the workshop approach, can benefit educators of teachers of science in designing their own courses and field experiences and working to overcome the constraints they encounter in doing so. Self-study by methods instructors, such as the study carried out by Rice and Roychoudbury (2003), can provide insight into the difficulties encountered by science teacher educators and the effectiveness of the approaches and strategies they implement. Additional exploration in this area, and identification of alternative formats for such experiences, can improve our understanding of effective means for helping achieve the vision of science education outlined by reforms.

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