

# Preservice Science Teachers' Concerns Through Classroom Observations and Student Teaching: Special Focus on Inquiry Teaching

This study develops a picture of how preservice science teachers' instructional concerns changed during a yearlong science methods program spanning classroom observations through student teaching

## Introduction

The ability of teachers to assess and change their pedagogy through reflection is viewed as an important part of teacher professional development (National Research Council (NRC), 1996). Preservice teachers' reflections on their practicum experience through journals, case studies, or seminar discussions have become a vital part of teacher training (Schön, 1987; Zeichner & Liston, 1987). Van Manen (1977) described three stages of reflection: technical rationality, practical action, and critical reflection (Ferguson, 1989). Many preservice and novice teachers' initial reflections fail to advance beyond Van Manen's first stage if the teacher is not given additional support from experienced educators (Ferguson, 1989; Yost, Sentner, & Forlenza-Bailey, 2000). At this first stage, teachers are primarily concerned with the procedures and technical knowledge needed to run a classroom. At the second stage, teachers' reflections are concerned with not only technical procedures, but also the consequences and quality

of those actions. At Van Manen's highest level, teachers reflect on the ethical and political meaning of their knowledge and actions (p. 227). High quality reflection is essential for the professional growth and development of educators (NRC, 1996). In addition to improving preservice teacher performance through self-assessment, reflections can be a medium through which student teachers' beliefs and concerns are made visible.

Much research has focused on analyzing and understanding the attitudes and beliefs of beginning teachers (Kagan, 1992). Preservice teachers' preexisting beliefs act as "filters" to help them understand their education course content and their experience as student teachers (Hollingsworth, 1989).

Apprentice teachers often enter education programs with overly idealistic, optimistic, and affective attitudes of teaching and pupil behavior based on their own experiences as students (Weinstein, 1989). Some researchers believe that these images of teaching and teachers,

developed from years of schooling, are difficult to change even with extensive educational courses and teaching experience (Pajares, 1992). Beliefs also influence student teacher progression from novice to expert teacher (Berliner, 1986).

Fuller (1969) identified three progressive stages in beginning teacher development. Preservice teachers begin in the stage of "no concern", in which they have only vague ideas about teaching, and their ideas stem from their own experiences as students themselves (p.218). Student teachers then reach the stage of "concern with self", in which they are concerned with issues of their own adequacy as a teacher in dealing with class control and the ability to teach the subject matter (p.211). Finally, towards the end of student teaching, the preservice teachers reach the "concern with pupils" stage in which they are concerned with pupil learning and progress (p.211). Fuller (1969) and Kagan (1992) believed that beginning teachers must develop routine and systematic

management and instructional skills before they can focus on pupil learning. In contrast, Veenman (1984) in a review of 83 beginning teacher studies found that students may deal with all three levels at the same time and, therefore; do not require the successful attainment of each level in sequence. Additionally, preservice teachers have been portrayed as being capable of dealing with subject matter content and pupil learning early in their development (De Jong, 2000; Feiman-Nemser & Parker, 1990).

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Preservice teachers' views of important teaching skills are also outlined in the literature. Veenman (1984) found that classroom discipline was perceived as the primary problem among beginning teachers, followed by the ability to motivate students, and assess individual differences (p.154). Others have found that novice teachers focus more on general teaching skills than student learning (Kagan & Tippins, 1992; McDermott, Gormley, Rothenberg, & Hammer, 1995). Wilson and Cameron (1996) analyzed the journals of 28 preservice teachers during their first, second,

and third year of student teaching. The dominant emphasis of student teacher journals, regardless of year, was on "instructional skills", with first year student teachers focusing on teacher actions and third year teachers discussing instruction in more complex and holistic ways (p.183). Wilson and Cameron's research findings follow Fuller's (1969) teacher stages with first year teachers being concerned with self and third year teachers progressing to concern of pupils.

In addition to general pedagogical concerns, preservice teachers should be concerned with specific pedagogical content knowledge that will lead to student comprehension (Shulman, 1987). Inquiry teaching has been stressed in the *National Science Education Standards*, (NSES), as well as many state science standards as a way to improve science process skills and pupil understanding (NRC, 1996). The NSES define inquiry as an activity that involves questioning, examining resources, gathering and analyzing data, developing explanations, and communicating results (p.23). Preservice teacher concepts of inquiry teaching are important if, as suggested in the literature, preexisting beliefs shape the way that these teachers will conduct their classrooms in the future (Hollingworth, 1989). Researchers also question the ability of novice teachers to perform inquiry methods with little classroom experience and numerous misconceptions (Crawford, 1999; Hayes, 2002). Preservice teachers often fear the loss of teacher control associated with inquiry and have difficulties translating content into authentic student tasks (Crawford, 1999; Hayes, 2002). Beginning teachers often incorrectly perceive inquiry teaching as chaotic, difficult, and equivalent to hands-on activities

(Eick & Reed, 2002; Rankin, 2000). If inquiry-based instruction is to be incorporated into science classrooms, preservice teachers must not only view it as a vital part of science teaching, but also have practical experience with the method in the classroom.

The purpose of this study was to develop a picture of how preservice science teachers' instructional concerns changed during a yearlong science methods program spanning initial classroom observations through student teaching. As described above, inquiry teaching methods are stressed in the NSES and other reform documents, but are not yet implemented in many secondary teachers' classrooms. For this reason and because inquiry teaching methods were stressed during the preservice teachers' science method courses, another goal of this study was to determine the teachers' ideas about inquiry teaching and the influence of their methods course and classroom experience on their use of inquiry teaching methods during their student teaching.

## **Methods**

### **Participants**

Thirteen secondary preservice teachers (PT), (six male, seven female), who were enrolled in a yearlong science methods program at a large midwestern university, participated in this study. Nine PTs were graduate students with undergraduate degrees in science or engineering. The remaining four PTs were undergraduates majoring in education with a concentration in science. Twelve (92%) of the students had limited previous teaching experience. Five of the graduate students and one undergraduate had experience teaching classes at the

university level, six students taught short summer science programs or summer camps, and one student had no previous teaching experience.

### **University Courses**

The students' university science education program consisted of a 6-week methods course (2.5 hours per week) and 30 hours of classroom observation during the fall semester. General topics covered in the discussion based fall semester course were inquiry science, questioning techniques, evolution, writing performance objectives, and the national and state science standards. In the spring semester, the PTs participated in a second more intensive 6-week methods course (17.5 hours each week), 50 hours of classroom observation, and 10 weeks of student teaching. PTs also met with their professor at six 2-hour seminars during their 10 weeks of student teaching. The spring semester course focused on teaching methods (inquiry, demonstrations, case history, concept mapping, questioning), lesson planning, state standards, and preparation of a teaching portfolio. The PTs had the same experienced professor during both courses.

### **Data Collection**

The researcher was a non-participant observer in both semester methods courses and the six student teaching seminars. The researcher wrote field notes during these course observations, focusing on the PTs' concerns and the content of the courses. In addition to these class observations, the PTs were given an open-ended pre-observation questionnaire during the second week of the fall semester methods course and an open-ended post-observation questionnaire after completion of

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their 30 classroom observation hours, at the end of the fall semester. The pre-observation questionnaire, in addition to demographic questions, asked the PTs whether they thought inquiry was a good method for teaching science content. The post-observation questionnaire asked the PTs whether they observed inquiry science teaching during their classroom observations, and asked them to describe their cooperating teacher's most typical instructional methods.

During each of the PTs' two classroom observation periods (fall and spring), they were required to write six modified KWL (What I know, What I want to know, What I Learned, and What I would do differently) reflections, each 250-400 words in length (Ogle, 1986). The reflections were to cover planning, instructional delivery, or assessment and were part of their science methods course requirements. The PTs chose how many reflections they wrote on each topic. The reflections were generally one-half to one page in length, with one paragraph written on each part of the KWL format. The student teachers were also required to write 10-15 modified KWL reflections during their student teaching.

After student teaching in the spring semester, an open ended questionnaire was administered to the PTs during their final student teaching seminar. This questionnaire asked the PTs to describe their cooperating teacher's three main instructional methodologies, to describe their relationship with their cooperating teacher, and to describe any inquiry lessons they taught during their student teaching. The questionnaire also asked the PTs to describe any constraints they had to using inquiry teaching methods during their student teaching.

### **Data Analysis**

All student questionnaires and reflections were analyzed using content analysis (Merriam, 1998). Using this method, the researcher searched through the data for recurring themes or events that could be used as categories to further reduce the findings and represent the documents' contents. The researcher then attempted to account for the diversity in the data with the developed categories. New categories were developed or old categories reformulated until all the data were described with the developed categories. The number of PT's statements that fit into each category were counted and recorded to provide an overall picture of these teachers' concerns throughout the study period.

Categories were validated through triangulation with survey responses, reflections, and observations of PTs during their student teaching seminars (Merriam, 1998). A second researcher also studying this group of PTs read and separately coded a portion of their reflections. The trustworthiness of the data was further strengthened with the discussion and eventual agreement

of the two researchers' findings with respect to the PTs' concerns (Denzin & Lincoln, 1998).

## Results

### Pre/Post Observation Inquiry Questionnaire

In the pre-observation questionnaire, all of the PTs recorded that the inquiry methodology was a good way to teach science content. The PTs explained that this method helped to increase student critical thinking, motivation, ownership of concepts, and science comprehension. However, eight PTs (62%) reported that inquiry was not always the best way to teach science content. These PTs argued for a mixed teaching methodology that would reach all students' learning styles. Others stated that the inquiry method was too lengthy to use all the time and still cover the necessary science content. One PT stated that content needed to be introduced before inquiry lessons in order to allow students to grasp the "big picture". Another PT thought that inquiry science was only for students that were "good at linking scientific concepts".

Only three out of the 13 PTs (23%) observed an inquiry-type lesson during their classroom observation hours. These consisted of a lesson on growing mustard seeds in different soils, testing enzyme action, and testing solubility of substances. All three lessons were guided inquiry that required the students to make predictions and design their own scientific procedures after being given the initial question to answer (NRC, 2000).

The PTs' descriptions of a typical lesson taught by their cooperating teacher were combined with the

methods discussed in the KWL reflections to give a better picture of the methodologies observed during classroom observations and student teaching. The cooperating teachers taught using a variety of methodologies with an emphasis on small group activities (n=10), laboratories (n=10), and lectures (n=8). Several PT's also described their cooperating teacher's typical lessons as including questioning techniques (n=6), student worksheets (n=6), and science demonstrations (n=4). The pre-service teachers observed little if any inquiry lessons.

### Student Teaching-Inquiry

Similar to classroom observations, only four out of the 13 PTs (31%) observed their cooperating teacher using an inquiry-type lesson during their pre-student teaching observations during the spring semester. However, all of these "inquiry" lessons were described as either inquiry demonstrations with questions or teacher lectures with student questions and not student hands-on inquiry investigations. During the spring methods course, PTs were taught inquiry demonstrations, in which students make predictions and answer questions to determine the outcome of a demonstration. PTs observed no open or guided inquiry laboratories during their student teaching. One preservice teacher commented that their cooperating teacher did not think that inquiry worked. The most commonly observed lessons consisted of lectures, laboratories, and worksheets.

Despite the PTs' limited experience with inquiry in the classroom, 85% (n=11) of the PTs reported teaching at least one inquiry lesson during their

student teaching. Four PTs reported teaching at least two inquiry-type lessons. Through an interpretive process, preservice teacher comments were categorized into seven major categories: instructional delivery, assessment, planning, classroom management, student issues, cooperative/supervising teacher issues, and personal issues. Of the two PTs who did not teach inquiry lessons, one stated that "my students could not handle it" and the other gave time limitations as the reason for not including this methodology. One PT who tried inquiry said, "I tried to use inquiry in an adaptation activity, but the students were very unwilling to think and come up with new thoughts." Table 1 summarizes the most common concerns of teachers in five of the seven categories.

### Reflections

A total of 286 preservice teacher KWL reflections were analyzed and divided into three time periods: observation-1 reflections (n=69) during the fall semester, observation-2 reflections (n=61) at the beginning of spring semester, and student teaching reflections (n=156) during the spring semester. Through an interpretive process, preservice teacher comments were categorized into six major categories: instructional delivery, assessment, planning, student issues, cooperative/supervising teacher issues, and personal issues. Although all coding categories were developed from interpreting the reflections, the methods' course instructor gave three of these categories (instructional delivery, assessment and planning) to the PTs as general topics of focus for the reflections. Table 1 summarizes the most common concerns of the teachers in five of the six categories.

Table 1. Preservice Teacher Concerns in Five Major Areas

<b>Number of Preservice Teachers</b>			
<b>Instructional Concerns</b>	<b>Observation 1</b>	<b>Observation 2</b>	<b>Student Teaching</b>
Instructional Methods	13	13	13
Teacher behavior to ensure student understanding	9	10	11
Improve/change instruction	8	11	10
Relate content to student interests	4	5	7
Prior Knowledge	4	4	7
Comparison to own school experience	3	3	7
Interactive Learning	2	6	9
Instructional Pace	2	5	4
<b>Assessment Concerns</b>			
Grading/test construction	9	7	12
Difficulty level and amount	8	6	6
Motivational tool	6	1	3
Use variety	6	3	4
Student cheating	4	3	8
Low/high test grades	1	1	10
Fair to students	1	2	2
<b>Planning Concerns</b>			
Equipment/Materials	6	6	7
Preparation Time	5	9	12
Time management	4	6	12
State Science Standards	3	1	1
Special planning	2	3	5
Flexibility	1	0	9
<b>Classroom Management Concerns</b>			
On/off task student behavior	11	6	12
Methods to reduce student problems	5	3	5
Control	3	1	5
Discipline to students	3	–	4
Organization	3	5	7
Management style	3	2	4
<b>Student Concerns</b>			
Engagement	11	11	11
Differences	7	5	9
Affective	6	7	12
Understanding	6	5	13
Effort	2	1	11
Weak skills (math, reading)	2	3	5

## **Instructional Delivery**

PTs' instructional delivery concerns were divided into 16 categories during observation-1, 18 during observation-2, and 21 during student teaching. PT comments on instructional delivery focused most prominently on types of instructional methods, changes the preservice teachers would make to instructional delivery after viewing a lesson, and techniques to increase student understanding of content (Table 1). Many PTs, in their observation reflections, expressed a desire to change or improve their cooperating teacher's instruction by adding more interactive lessons, student questions, and demonstrations. During student teaching, the PTs reacted to their own failed instruction with similar suggested improvements. They suggested changing teacher communication techniques, adding concrete examples, increasing content depth, and adding interactive student-centered activities.

During all reflection periods, teacher behavior to ensure student understanding included such items as adding formative assessments, improving explanations, and breaking down concepts into smaller more understandable chunks. The PTs were also concerned with relating content to student interests and making sure that the students' prior knowledge about a concept was understood and incorporated into instructional delivery.

## **Assessment**

Preservice teachers' assessment concerns were divided into 11 categories during all three reflection periods. PTs reflected on methods of assessment, grading, and test construction issues most during all three reflection periods. However,

during student teaching, more PTs focused on student test grades than the level of assessment or amount of assessment, which was the third most reflected category during both observations. At least three PTs discussed the importance of using multiple assessment methods during each reflection period, with a focus on using writing assignments or student presentations.

## **Planning**

PTs' planning concerns were divided into 10 categories during observation-1, 6 during observation-2, and 7 during student teaching. Preservice teachers concerns with planning varied little over the observation and student teaching periods. During all reflection periods, preservice teachers were concerned with lesson planning, time management, preparation time, and material/equipment ordering. Planning flexibility and planning for special classroom circumstances (e.g., substitutes, half-days, snow days) became a heightened concern of teachers during their student teaching. Snow days were occasions in which the school day was delayed for several hours in the morning due to severe weather conditions. Planning lessons and curriculum to include the state science standards was a concern of at least one teacher during each reflection period.

## **Classroom management**

Although not initially asked to write reflections on classroom management, all of the PTs discussed concerns over this topic during their student teaching. PTs' classroom management concerns were divided into 9 categories during observation-1, 5 during observation-2, and 10 during student teaching. One preservice teacher did not

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discuss classroom management during observation-1 and four did not during observation-2. All other preservice teachers' concerns dealing with classroom management are summarized in Table 1. Most classroom management concerns dealt with on/off task student behavior (mostly off task), student discipline, teacher control issues (rules), classroom organization (absences, late work), and methods to reduce student problems. During observation-1, five preservice teachers commented on their cooperating teacher's lack of classroom management skills or control. During student teaching, preservice teachers' instruction often suffered from their inadequate classroom management. One preservice teacher stated, "I was definitely concentrating on discipline issues instead of content issues", and another said that "the activity didn't go as smoothly because of my lack of complete control".

## **Student Issues**

PTs' student concerns were divided into seven categories during observation-1, six during observation-2, and seven during student teaching. Preservice teachers' concerns with students focused on student engagement in lessons, student effort

(or lack of), student differences (learning styles, learning abilities), student understanding of content, and affective comments. Affective student comments dealt with students' attitudes toward a lesson, and teacher-student relationships. Examples of PTs' affective comments include statements such as "students and I need to be more comfortable with each other" or "students really enjoyed this lesson". The number of teachers concerned with student issues increased for all categories during their student teaching, except student engagement, which remained unchanged. Concerns with student understanding progressed from superficial comments such as, "students were confused" or "students seemed to grasp the concepts" during observation-1 to more evaluative comments during their student teaching. For example, one PT stated, "I had them talk me through a couple of examples so I could see if they really had an understanding".

### **Cooperative/Supervising Teachers**

PTs' cooperating teacher concerns were divided into five categories during observation-1 and observation-2, and eight during student teaching. PTs' comments about their cooperating classroom teachers focused on their agreement or disagreement with teaching methods, the guidance and support given to them, and their control over lessons during their teaching. PTs more often disagreed with their cooperating teacher's instructional methods. PTs wanted to see more inquiry-based instruction, labs, and hands-on student activities. For example, one preservice teacher said that his cooperating teacher believes that "science laboratories are activities, and not much time should be spent on them". Three students commented on

either a lack of freedom or lack of help from their cooperating teachers during their student teaching. However, not all comments were negative; one preservice teacher stated that her "cooperating teacher continues to be a joy to watch". Two PTs failed to comment on their cooperating teachers during observation-1 and observation-2 and one during student teaching.

### **Personal Issues**

PTs' comments about their teaching confidence, frustrations, and enjoyment with teaching were categorized as personal issues. Only three PTs' reflections dealt with personal issues during observation-1. All three of these teachers commented on their lack of confidence in teaching. Ten PTs commented on self-confidence issues during observation-2, with eight negative comments and two positive comments. The remaining three PTs did not reflect on personal issues during observation-2. All thirteen PTs reflected on personal issues during their student teaching. Twelve of the PTs' concerns dealt with self-confidence (4 positive, 4 negative, 4 both), six with being overworked/tired, four with frustration over lack of student effort or classroom management, and six with positive comments about teaching. One PT stated, "It is amazing to watch great teachers do what they love-it is an art". Other teachers commented on their enjoyment when interacting with students, planning particular lessons, and seeing students achieve at high levels.

### **Conclusion**

The preservice teachers' reflections emphasized self-concerns over pupil concerns as predicted by Fuller (1969). Self-concerns, which focused on instructional delivery, assessment,

and planning, changed little over the reflection periods. Overall, the student teachers' reflections focused on procedural and classroom management concerns as predicted in the literature (Veenman, 1984). Despite the focus on self-teaching issues, the preservice teachers were able to reflect on issues of pupil learning throughout the reflection periods. Preservice teachers' concerns with student issues such as student content comprehension and student differences in learning did increase from their classroom observations to their student teaching. The complexity of these concerns also increased during their student teaching. These findings argue against a strict stepwise development of teachers (Fuller, 1969; Kagan, 1992), in favor of a more complex model of development that allows for interaction between teacher pedagogy concerns and pupil learning (Grossman, 1992).

As suggested above, the student teachers most often reflected at Van Manen's (1977) technical level, with concerns about how to apply their pedagogical knowledge. However, preservice teachers' comments on how they would adapt instructional and assessment methods to increase student understanding show their concern with the consequences of their actions on student learning. These reflective statements, which fit better into Van Manen's second level, were prevalent during all three reflection periods and varied in depth from student to student. One student reached Van Manen's critical reflection level, questioning the value of extrinsic motivators and the structure of modern school systems. This student also experienced the most "cognitive dissonance" realizing during student teaching that a science teaching career

was not his passion (Hollingsworth, 1989).

Ideally, competent cooperating teachers should provide useful feedback, share resources, and provide freedom for preservice teachers to try new ideas and methods (Connor & Kilmer, 2001). Research also shows that cooperating teachers have a direct impact on their student teacher's behavior and attitude (Yamashita, 1991). In this study, preservice teachers often disagreed with their cooperating teachers' advice or teaching style. Disagreements between cooperating teacher methods and preservice teacher methods may be helpful in providing the "disequilibrium" needed to push forward science teaching reform (Hollingsworth, 1989; Piaget, 1978). The preservice teachers reflected on a need for students to "think" more and become more actively involved in the classroom. However, without adequate support, preservice teachers may revert back to the way that they were taught instead of trying to incorporate new teaching techniques if they are uncomfortable or uncertain about their abilities (Grossman, Wilson, & Shulman, 1989). One student with two cooperating teachers reported that "my teachers said I could do whatever I wanted [during my student teaching], but were not able to guide me in using anything other than lectures, demonstrations, and homework review." These three methods were the ones the cooperating teachers were reported using most often in their classrooms.

Teacher education students who experience lower levels of support from cooperating teachers often

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have elevated stress and reduced teaching performance during student teaching (Murray-Harvey *et al.*, 2000). Preservice and cooperative teachers need to develop collaborative relationships that will benefit both parties and lead to increased student performance.

Although few preservice teachers observed inquiry lessons during their observations and student teaching, 85% of the teachers experimented with teaching inquiry. However, many of the preservice teachers' definition of inquiry differed from the definition found in the *National Science Education Standards* (NRC, 1996). Keys and Bryan (2001) discuss similar confusion among novice teachers when teaching inquiry-like lessons. Whereas questioning should be seen as the beginning phase of an inquiry investigation (NRC, 2000), some preservice teachers in this study

believed that questioning or predicting was the complete inquiry process. The preservice teachers in this study also encountered frustration and difficulties with teaching inquiry in the form of negative student attitudes, time restraints, and lack of student effort. Teacher beliefs that constrain quality inquiry teaching are prevalent among both inservice and preservice teachers (Crawford, 1999; Keys & Kennedy, 1999). Lack of experience with inquiry based instruction in the science classrooms, places greater emphasis on university instruction to teach preservice teachers this science pedagogy. The lack of experience also increases the chances that confusion and frustration will overcome the process.

The teachers' reflections demonstrate their knowledge of the skills needed to be competent teachers (Reynolds, 1992). The preservice teachers were able to reflect on the importance of developing lessons that take into account student interests and prior knowledge. The teachers were also concerned with engaging students in active substantive lessons and developing strategies to increase student understanding. Despite these strengths, the reflections also illustrate the preservice teachers' weaknesses. These areas can be used to focus instruction at the university level in an attempt to develop teachers with a solid teaching base. This study also shows a need for further experience and instruction on inquiry-based learning and a need for a greater change in preservice teacher focus from self-concerns to pupil learning concerns.



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