# Pre Service Elementary Teachers' Concerns about Teaching Science

Mary Hatton, Ed.D.
Associate Adjunct Professor at Endicott College
Science Education Consultant
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***Abstract***
The purpose of this study was to examine the types of concerns pre-service teachers raise about science teaching and how pre-service teachers concerns change through participating in a science methods course. Eight classes of junior level pre-service teachers (n=104 students) were involved in stating their concerns prior to participating in a science methods course. Their comments were coded by constant comparisons to determine if there were consistencies between categories of comments. Results indicate that the majority of pre-service teachers were concerned about pedagogy associated with teaching science. Concerns were also raised about science curriculum, science content, and attitudes about science. Following the course, pre-service teachers indicated that they felt more confident about pedagogy and cited examples of course components that impacted their levels of confidence. Results show that pre-service teachers raised different types of concerns about teaching science, which are related more about themselves than student learning. Pre-service teachers cite different examples that support their professional development. Educators need to offer pre-service teachers multiple opportunities like field experiences and reflection to support them in developing a deeper understanding about themselves as teachers. However, educators also need to consider how to help pre-service teachers bridge the gap between inconsistencies they experience in traditional classrooms

## *Introduction*

As science educators working with pre-service teachers, we have a critical responsibility to promote effective science teaching and learning. It is important for us to understand pre-service teacher knowledge and beliefs about science teaching in order to facilitate their growth in understanding about teaching and learning (Magnusson, Krajcik & Borko, 1999; Leinhardt, Putnam, Stein & Baxter, 1991; Berliner, 1986; Shulman, 1986). It becomes even more concerning when national surveys indicate that fewer than one-third of elementary teachers claim to feel very well qualified to teach any of the science disciplines (Fulp, 2002). Few grade K–5 teachers 63 - 77 percent, rated themselves as well prepared to implement teaching practices aligned with the National Science Education Standards (Fulp, 2002). These included:

- Make connections between science and other disciplines;
- Develop students' conceptual understanding of science;
- Take students' prior understanding into account when planning curriculum and instruction;

- Lead a class of students using investigative strategies; and
- Provide deeper coverage of fewer science concepts.

When I first read these findings, I wondered how effective I was being because I teach early childhood and elementary education majors how to implement methodologies associated with the National Science Education Standards. Why do elementary teachers feel this way about science? And how much do we help to alleviate this feeling through a pre-service program?

These are not simple questions to answer. Yet, many of us, through our science methods courses, try to initiate the development of an awareness of pedagogical content knowledge (PCK) with our students, components of which are illustrated in the standards listed above. PCK, in general, is the teacher's ability to combine knowledge of a particular discipline with the teaching of that discipline. PCK associated with science teaching, for example, "distinguishes the science knowledge of teachers from that of scientists." (NRC, 1996). 'Skilled' teachers of science have developed PCK, which are special abilities that become inherent to their teaching allowing them to integrate their knowledge of science content, curriculum, learning, teaching, and students, as they confront new teaching situations (NRC. 1996; Sanders, Borko, and Lockard, 1993*).* In some situations, however, this inherent knowledge for science teaching never develops and teachers are ineffective and less confident teaching science, tending either not to teach science or to postpone teaching it (Appleton & Kindt, 1999).

This type of understanding is complex. There is not a single factor that will ensure for effective development of PCK in science teaching. Shulman (1986) first described PCK as a knowledge that includes subject matter, student conceptions, and understandings of student difficulties. PCK is also related to one's knowledge and beliefs about orientation towards science teaching at a particular grade level, science curricular knowledge, instructional strategies for

teaching science, science content knowledge, assessment in science, and science teaching experiences from environmental contexts (Magnusson *et al.*, 1999; Cochran, DeRuiter & King, 1993). Research on each of these components associated with PCK has led to different conclusions. Current research indicates that it is most likely multiple factors that affect PCK for teaching science, and can influence changes in pre-service teacher concerns about teaching science.

It has been suggested that more research on the perceived problems of preservice teachers would be useful toward understanding the concerns they face and then making adjustments to enhance their initial successes in teaching (Briggs & Richardson, 1992; Doebler & Roberson, 1987; Moore, 2003; Strawitz &Malone, 1986; Tabachnick & Zeichner, 1984). It's important to become aware of pre-service teacher concerns and beliefs as they are related to the lens through which they view components associated with science teaching. In addition, pre-service teacher concerns and beliefs are tied to their personal motivation towards learning about science teaching, previous experiences about science teaching, metacognition of their science teaching. Ultimately these factors will influence their growth in understanding associated with science teaching (NRC, 2000).

I wanted to learn about my pre-service teacher concerns prior to the beginning of the science methods course and whether they thought this course was meeting their needs. I also felt that if they consciously identified their personal concerns and needs, they might be motivated to become more metacognitive about their own learning. Through this exercise, I learned about my pre-service teacher concerns, if they thought this course met their concerns, and what aspects of the course impacted them most.

***Participants***

This is one semester (13 week) course for junior level pre-service teachers pursuing licensure in elementary and early childhood education. Participants included 104 students from 8 elementary science methods courses. The majority of students were female (93%). All students were third year students, enrolled in a four year, liberal studies undergraduate program. They were either focusing on elementary education or early childhood education. Students had previously participated in two internship experiences in which they observed teachers in the field during the winter break of their first two years of college. In addition, they participated in a hour pre-racticum experience, consisting primarily of observations and curriculum development.

***Methods***

Overview of the Science Methods Course:

This was a one semester methods course. The overall goals for the course included:

- Begin to guide pre-service teachers to identify and integrate knowledge of science, learning, pedagogy, and students while applying that knowledge to science teaching.
- Use inquiry, reflection, interpretation of research, modeling, and guided practice to build on pre-service teachers' understanding and skill in science teaching.
- Build an understanding about and the ability for lifelong learning in science education.
- Integrate and coordinate a course so that understanding and ability will be build over time, be reinforced continuously, and practiced.

Through this course teaching and learning occurred through a variety of contexts including group work, discussions, readings from professional teacher organizations, case studies, on-line projects, presentations, using technologies, teacher modeling, and mentoring

students as they observe, practice teaching, and reflect on a field experience. Topic areas associated with this course included history of reform and its impact on current theory and practices, identifying professional teaching resources, identify and use state and national science learning standards, scientific inquiry, conceptual change, alternative conceptions in science, brain/psychology and research on learning and assessments. In addition instructional strategies and teaching models related to these topic areas were modeled for students, analyzed by students and practiced by students.

Students participated in learning experiences that require them to demonstrate how to engage children and teach a science process skills activity. Students view case studies as well as participate in a long-term investigation, and short lessons and activities that model strategies to promote teaching through inquiry, the nature of science, and conceptual change. In addition, the students were assessed in various ways, including analyses of instructor modeling of teaching, reflections on pre-service learning, observations and analyses from case studies.

Students also participated in a service learning project. They developed, organized and taught science in an after school program. As part of the science methods course, they were required to use their understanding of science teaching and learning from the semester to teach an inquiry-based science unit. The students were organized into two groups of 5-8 students. Students were required to develop lesson plans as a group – standards, objectives, safety, materials, methods, guiding questions, strategies, and assessments. Students taught once per week in an hour long after school program. Each student was assigned roles in the development of their weekly lessons; they were required to post ideas and reflections online in a forum. Once a week, the students also met face-to-face for planning and reflection with the instructor during

the methods course. Students were also required to develop a final reflection and paper following the experience.

At the beginning and end of the semester, students were asked to complete a metacognitive task by reflecting on their concerns about teaching science and to comment on aspects of the course that were most useful for their preparation as teachers.

Pre-Course Reflection Questions:

On the first day of class, at the beginning of the semester, The pre-service teachers are asked the following open-ended questions'; "What are your concerns about teaching science? And what do you want to get out of this course before you teach science?" After students wrote their ideas on an index card, a summary was develop and shared with them documenting the types and frequency of concerns and needs for the course. The group was encouraged that through involvement in this course, we will try to address their needs together.

Post-Course Reflection Questions

At the final exam, the students' receive their index cards from the first day of classes. They are asked to reflect on their concerns at the end of the course. For the last three years, students were also asked to comment on aspects of the course that were most useful for their preparation as teachers (N=71).

Data Analysis

Preservice teacher comments were recorded and coded using the constant comparative method (Strauss and Corbin, 1990). Categories of preservice teacher concerns emerged around four themes related to elements associated with PCK: content, pedagogy, curriculum, and attitudes toward science teaching.

***Results***

## Pre-Course Reflections

When these pre-service teachers thought about their own concerns and needs, they expressed concerns about attributes associated with pedagogical content knowledge.

Comments Regarding Teaching

The majority of pre-service teachers (69%) mentioned concerns about pedagogy by specifically mentioning methods of teaching science most frequently as a "concern." Some 'pedagogy' comments (18%) included anxiety about problematic situations and science content, such as "concerned about knowing answers to children's questions about science" or "having labs that don't go as planned," "Not teaching from the text," and "What happens if we obtain incorrect results?". Others were concerned about conveying science information clearly, learning teaching strategies, or integrating content with pedagogy. Pre-service teachers also mentioned students most frequently in comments about pedagogy; they usually mentioned concerns regarding how to keep science interesting, fun, or how to get kids excited. This occurred in 39% of pedagogy comments. In addition, comments included concerns about learning different strategies, teaching science well, and making science relevant.

Concerns regarding their personal attitudes towards science also emerged. 8/23 pre-service teachers specifically stated that they were concerned about "how to portray a positive attitude towards children." Three preservice teachers mentioned, "not being a fan of science but not wanting to portray this attitude towards children." Making science interesting was the mode in this category.

Table 1 Overall Concerns About Teaching Science

| Themes | Frequency of Occurrence (%) |
|---|---|
| Pedagogy | 69 |
| Curriculum | 28 |
| Content | 24 |
| Attitude towards teaching science | 23 |
| Assessing Students | 3 |

Number of students surveyed

n=101

Comments Regarding Curriculum

Content and curricular concerns were mentioned less frequently by preservice teachers. Content concerns focused on different disciplines or concepts, such as chemistry, physics, or molecules. Thirty three percent stated that they were concerned with their, “lack of science knowledge.” Concerns regarding curriculum knowledge varied, pre-service students mentioned curriculum knowledge in relation to students, organization of curriculum, developmentally appropriate lessons, materials, and student conceptions as shown in Table 2.

Table 2 Curriculum Concerns

| Curriculum Categories | Frequency of Occurrence (%) |
|---|---|
| Curriculum Organization | 44 |
| Students and Curriculum Issues | 20 |
| Curriculum Resources | 16 |
| Developmentally Appropriate | 16 |
| Standards | 4 |

## Post-Course Reflections

What do students say about their initial concerns when they have completed the methods course? Their reflective comments all mention some pedagogical content improvement.

Personal Feelings Towards Teaching Science

Half the students began their comments by first mentioning that they feel more confident, better, improved, more comfortable, or qualified to teach science. Three students stated that they now felt "excited" about teaching science. And some students mentioned specific aspects of the course that they felt comfortable teaching.

> "I feel more confident from the semester. My knowledge of how to integrate process skills and teaching inquiry has increased. I believe I am more creative and confident in using my knowledge to teach."

Reflections About Service Learning Experience

Many students mention that they were concerned about how to initiate and maintain excitement in children. Through the after school teaching experience, they realize that they can foster student interest.

"I realize that teaching students through inquiry will get them excited".

The methods course focused on how to teach science through inquiry by emphasizing how to integrate content and science process skills. Students participated in activities that model various strategies to experience inquiry-based teaching. They also participated in a service learning component of the course. For four weeks, they work in small to teams to plan and teach an inquiry-based unit as part of a local after school program. And 95% of the students indicated that this teaching experience was significant to their confidence about teaching science.

> "I gained the most through the service learning project. I got the opportunity to take everything I learned in the classroom and apply it through the project. I have begun to realize that science is fun."

Five students indicated that the field experience helped them develop a deeper understanding about theory presented through the methods course;

> Through fieldwork, I now have a better understanding of process skills as well as the stages of investigation**.**

<u>Reflections About Science Teaching Resources</u>

Ten students mentioned that learning about resources was useful for them. Resources mentioned include the National Science Teacher's Association (NSTA), the National Science Education Standards, Project 2061, and web links the instructor has reviewed and organized. The instructor-reviewed links contain science content, teaching tools, lesson plans, science organizations, and science activities.

Students also commented on the in class investigation that was modeled, which they indicated was important for their understanding and development of designing an inquiry-based lesson.

Another activity that students reported as important for their growth in teaching science were trade book discussions and in-class exercises. During this activity, students are provided a trade book and information about misconceptions and scientifically accurate information. Then they develop their own critique of a trade book and discuss strategies for integrating the trade book with science activities.

Reflections About Components of the Course

Other general comments included;

" I think I learned about many ways to make science fun and interesting."

"Also throughout the course, while talking about different areas of science, I realized that I remember a lot more materials than I thought I did. This was a pleasant surprise."

"I learned that there are different ways of teaching science, tiering, and taking learning styles, and interests of children into consideration is also important."

I gained the most in terms of experience and knowledge from this course. I felt actively engaged in my learning throughout the semester. Each assignment and task has led me to reflect on how I want to teach by incorporating the theory I have learned over all the years. The most valuable experience for me – working with students.

**Conclusions**

Preservice teachers are concerned about different aspects associated with PCK including pedagogy, science content, student attitudes towards science, strategies, assessment, and curriculum. Some students expressed concerns about specific aspects of teaching science, while others were more focused on general pedagogical issues, which is consistent with other pre-service teacher research (Howlitt, 2005 and Van Driel and De Jong, 2001). How pre-service teacher beliefs and attitudes are related to these categories is complex. The results from this study indicate that pre-service teacher concerns were focused primarily about pedagogical aspects of teaching science. In addition, these concerns focused on preservice teacher concerns about themselves rather than concerns about student learning. Many of the preservice teacher initial concerns pertained to student perceptions or their ability to teach content effectively.

Providing a type of field experience seems to be the only opportunity that would allow students to explore these areas of concern and offer preservice teachers and opportunity to conceptualize how science teaching affects student learning. The results from requiring pre-service teachers to participate in organizing and teaching a science after school program, indicate

that offering this type of field experience integrated with a methods course was significant to their beliefs about teaching science.

Many of the students who participated in the after school program indicated the opportunity was significant to their ability to teach science or significant for their understanding about teaching concepts from the science methods course. For many they commented that they could excite children about science. Methods courses should consider these opportunities for pre-service teachers; as with teachers, student outcomes are significant to teacher efficacy. Teacher research has shown that preservice teacher concerns tend to focus on themselves regarding personal mastery of content and management (Beeth and Adadan, 2006; Fuller, 1969). Preservice teachers from this program focused not only on self concerns but also on teaching strategies, curriculum, and student attitudes. Although students in this after school field experience were being mentored through the science methods course, they took an active role in developing their own understanding about strategies and management with a group of children. Many of the preservice teachers commented that the after school experience was significant in helping them develop confidence about their concerns. In addition, the preservice teachers were asked to reflect on their experience of teaching science through inquiry. These reflections helped students focus on other aspects of PCK, the outcomes from teaching and student learning, which are consistent with more mature levels of professional development (Fuller, 1969). Perhaps being in control of a group of children and reflecting on the outcomes will impact how they view teaching science.

Will this experience make a difference? Will these teachers meet the National Science Education Teaching Standards? I was recently observing a student in the practicum who taught an excellent lesson but it was ‘scripted’ from a science kit. Perhaps the opportunities we give our

students that are considered effective for the development of PCK, will make a difference (Grossman, 1990). However, others have indicated that positive pre-service teacher responses to constructivist science teaching often do not correspond to teaching actions taken during the practicum experience (Van driel, & De Jong, 2002). Additionally, pre-service teachers often view themselves as students rather than teachers during practicum field experiences. How does this course impact them in practice?

Some pre-service teachers I work with will return from the pre-practicum experience and internships appalled that teachers are not teaching science or they are using worksheets with students. Teacher comments from a national survey indicate that; "Most elementary school science lessons include whole class discussion (89 percent) and lecture (60 percent) (Fulp, 2002). Solving worksheet or textbook problems occurs in 44 percent of elementary school science lessons and reading about science in 42 percent. Strategies such as hands-on science activities or investigations occur in 60 percent of lessons and working in groups in 56 percent of lessons".( Fulp, 2002). How much of an impact does seeing this inconsistency between reality and completing an inquiry-based methods course affect pre-service teachers' PCK? Is the confidence that they express in the course carried over into their own classroom?

In general, there has been a gap between classrooms and university work (Moore, 2003, Roth & Tobin, 2001, Mason, C.L., 1999). Pre-service teachers often indicate the lack of practicality of university courses (Watson, 2006, Beach & Pearson, 1998, Roth & Tobin, 2001) and confusion about science teaching because content courses present science as a 'body of knowledge,' while methods courses present nature of science and process of science (Duschl, 1980). Why? These are questions we need to take responsibility to consider as educators of pre-service and in-service teachers in science as well as other disciplines.

Most research on the impact of field and practicum experiences for science teaching have taken place at the secondary level. There is more opportunity to become selective in field placements that promote effective practices in science teaching. In the elementary classroom selection of a field placement is more holistic with more emphasis on programs that promote effective literacy. As a result, science teaching may not reflect current research on science teaching and learning. How does this gap influence transfer of knowledge of science teaching from pre-service teacher coursework to practice? This requires further study.

Working with pre-service teachers alone will not make the changes necessary to change science education. We need to step outside and as higher education professionals, we need to develop opportunities to work with school districts and policy makers. We need to be more creative and develop ways to mentor and support novice teachers to continue to grow professionally and meet reform initiatives. Researchers and practitioners need to come together in order to improve science education both at the pre-service level and the in-service level.

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