

The Effect of an Inquiry-Based Early Field Experience on Pre-Service Teachers' Content Knowledge and Attitudes Toward Teaching

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Abstract. As part of a pre-service science course for teachers at California State Polytechnic University, Pomona, we provided an early field inquiry-based teaching experience. A K-12 science specialist and Cal Poly Pomona faculty member worked together to help students develop a formal standards-based lesson plan and present it to a class of 5th grade students in a local elementary school. We will discuss the effect of the field experience on student content knowledge, confidence in teaching inquiry-based science lessons, as well as their attitudes towards teaching.

Keywords: Physics Education Research, Inquiry, Field Experience, Attitude, Elementary Teacher Prep

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INTRODUCTION

Teaching is more than just knowing the content knowledge; it is a skill that is developed with the appropriate support and personal desire to perfect it. Some individuals believe that they want to become teachers, but have never had the opportunity to engage in the practice of teaching students in a real classroom setting. What is the effect of engaging pre-service teachers in early field experience prior to their acceptance into a credentialing program? Does an early field experience have an impact on their learning of the physics content? How does their desire to pursue a career in the teaching profession change as a result of their experience?

Some research in the field of science education has focused on future teacher learning of the content, while others have studied their attitudes toward learning science [1]. Studies conducted by the physics education research group at the University of Washington primarily have focused on the effect of research-based instruction on K-12 pre-service teachers' functional understanding of science [2] and their abilities to transfer that learning into instruction with students [3]. Other researchers have developed and used attitudinal surveys to learn about students' views about science and learning science, and to study the correlation this may have with student academic achievement in science [4]. For example, the Colorado Learning Attitudes about Science Survey (CLASS) is used to identify any correlations between student beliefs and their learning gains [5], [6].

Considering the challenges in K-12 science teacher education (e.g., lack of adequate training in the subject area knowledge, shortage of well qualified

teachers, negative attitudes toward science, recruitment, and retention issues) more research is necessary to understand all aspects of learning and instruction. These aspects of learning, teaching, and change in attitude are key for successful preparation of future science instructors.

STUDY DESIGN

This study took a tri-fold approach in which the impact of inquiry learning was assessed, the effect of field experience on further conceptual understanding was investigated, and the attitude toward the content and instruction in its connection to the other two components was analyzed.

In a physical science course for pre-service teachers (K-8), we helped students to develop and teach formal standards-based lesson plans with integrated science inquiry to 5th grade students in a local elementary school. The field experience was designed in such a way to create a medium for prospective teachers to:

- gain experience in teaching science as a method of inquiry,
- recognize the importance of in-depth understanding of topics they will teach,
- recognize the challenges in preparation and delivery of a science lesson plan,
- familiarize themselves with California State Science Standards,
- interact with young children as their future students,
- reflect on their future career choices.

We administered pre/post-tests to determine the impact of the inquiry-based teaching model that was used during the quarter. To measure the effect of the

field experience on the pre-service teachers' understanding of the physics concepts, we placed specific questions related to the topics of the lesson plans on the course final exam. To obtain feedback on student experience, attitude, and confidence level in understanding and teaching physics concepts, we administered a pre/post-field survey.

Course & Population

The research was conducted in a physical science course for pre-service teachers, consisting of 17 female and 3 male students. The class met twice a week for three hours each meeting, using an inquiry-based format. The text used throughout the course was *Inquiry Into Physical Science, A Contextual Approach* [7]. The course covered properties of matter, energy, heat & temperature, and thermal equilibrium, under the overarching theme of Global Warming.

In addition to the content, students were introduced to the writing of a formal lesson plan. The students worked with the K-12 science specialist on three separate occasions near the end of the quarter (week 7-10) and developed five-step lesson plans.

Lesson Plan

Experts in the field of education have presented variations in the lesson plan format. The original format used in this study was a traditional five-step lesson plan as described by Madeline Hunter [8], which was tailored to meet inquiry approach. The first step is the anticipatory set; this is the "hook" or attention technique that is used to engage students into the learning process. Step two explains the model and introduces key vocabulary, skills, and concepts developed from students' explorations. Guided practice is step three, in which the teacher provides immediate feedback and guidance. In step four, the closure, the teacher reviews and clarifies any unclear points and decides whether or not any additional activities are required. Step five, the independent practice, gives students an opportunity to practice what they have learned and apply them in a new setting. The teacher incorporates *Checking for Understanding* techniques such as Socratic questioning to assess student understanding and progress throughout all the steps of the lesson plan.

The science specialist worked with students through three phases to help them prepare the five-step lesson plan appropriate for 5th graders. First, students were introduced to the different steps involved in the lesson plan. Students then selected a concept of interest related to a topic covered in the course and in

alignment with the California State Science Standards for 5th Grade, and wrote a learning objective for the lesson to guide their instructional planning and outcome. Lastly, students were provided with examples and were given resources they could use. Throughout all these phases, students received frequent feedback, especially on their writing of the formal lesson plan and related lesson documents. Meanwhile, the course instructor continuously advised students on science content, choices of activities, and use of inquiry-based approach.

Students were broken up into five groups of four, two of which prepared lessons on energy transfer and three of which chose topics related to the properties of matter. Students then taught their lessons to two 5th-grade classes at a local elementary school. The science specialist accompanied the students to the school site where she served as a support and facilitator.

CONCEPTUAL LEARNING

The content knowledge data was collected in three different stages. We administered written conceptual pretest questions on different topics of the course, before regular class instruction. Posttest questions were placed on the first and second midterm exams. In addition, after the field experience (After FE), on the final examination of the course, we asked specific questions that addressed the topics taught by all groups. An example of a written question used to assess student understanding of mass, volume and density is illustrated in **Figure 1**. The questions for pre/ post and after FE were the same questions with some differences on surface features.

Three identical beakers A, B and C filled with water to the same initial level. Suppose you add a 7.8 g piece of iron to beaker A, a 8.0 g piece of iron to beaker B, and a 7.8 g piece of gold to beaker C. All the pieces sink. What is the rank of the water levels from largest to smallest? *Explain your reasoning.* (Note: The density of gold is 19.3 g/ml and the density of iron is 7.8 g/ml.)

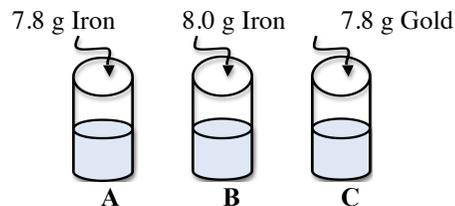


FIGURE 1. Example of written assessment question on density.

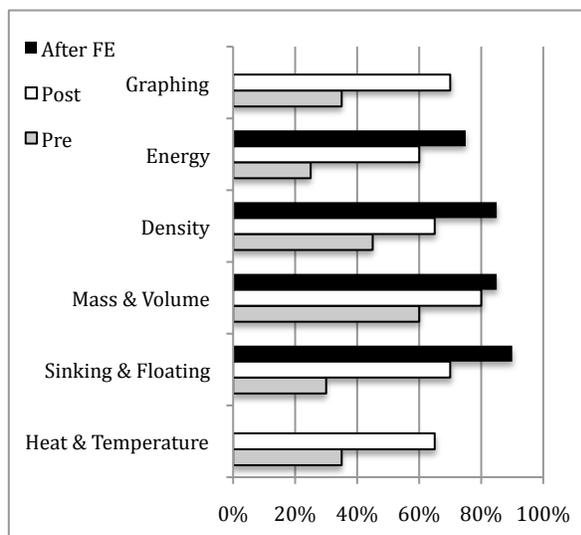


FIGURE 2. Percentage of correct responses on pre/post and after field experience on written conceptual questions.

We analyzed student responses separately for the students whose lesson plans were focused on the properties of matter (POM, N=12) and the groups who chose energy transfer as their lesson plan theme (ET, N=8). Since the difference in the average scores of the POM and ET groups on pre and posttest questions was less than 5%, we combined the results on **Figure 2**. The pre/posttest results show between 20%-40% gain, with no deviations for POM and ET groups. While the student responses to the post FE questions show higher conceptual gain for the students on the topics of their lesson plans. **Table 1** shows the details of student conceptual assessment data in the three stages of pre/post and after FE. The higher percentage of the students' correct responses on the topics of their lesson plans suggests improved understanding of these concepts after the field experience. For example, students who prepared and taught lessons on energy received higher scores (75%) on related questions after FE compared to the POM group, which maintained their posttest scores (60%). On the questions regarding density and sinking & floating we observed additional 20% gain for the POM group, while the ET group maintained their posttest scores ($\pm 5\%$). This is consistent with

student self-assessment survey data, discussed in the next section and reported in **Table 2**.

In addition to a higher percentage of correct responses, we also noticed a more cohesive and clear reasoning in students' written responses. We interpreted this not only as better understanding of the material, but also as evidence of improved communication skills, something we emphasized periodically throughout the lesson plan preparation process.

SURVEY RESULTS

Before and after the field experience we administered a survey to receive feedback on student experience. Students were asked to agree or disagree on a five-point scale with several statements about the effect of the process of preparing and delivering lesson plans, and also to rate their confidence level in teaching and understanding of the concepts. Additionally, we were interested to know whether or not this experience would impact the students' future career decisions regarding becoming elementary school teachers.

Table 2 summarizes students' responses on some of the survey questions before and after the FE in which they experienced teaching a science lesson. Based on student responses before and after FE, the early field experience helped students to recognize the effect of the lesson plan preparation process and practice of teaching by inquiry in their own conceptual understanding (0.52 and 0.35 positive increase in average rating respectively).

Even though before the FE, most students had expressed high confidence in their conceptual understanding of the topics they were going to present (ave. pre 4.76), their confidence level had decreased by about 0.5 points after the FE in which they tested their own understanding by actual practice. In addition, the small negative change on student confidence in teaching by method of inquiry (-0.36) suggests that perhaps through FE students faced some of the challenges associated with teaching science by inquiry. Finally, data indicates that students found the process of preparation and the delivery of the lesson enjoyable.

Topics	Pre N=20	Post N=20	After FE
Heat & Temperature	35%	65%	
Sinking & Floating	30%	70%	90% POM (N=12)
Mass & Volume	60%	80%	85% POM (N=12)
Density	45%	65%	85% POM (N=12)
Energy	25%	60%	75% ET (N = 8)
Graphing	35%	70%	

TABLE 1. Pre/post instruction and after Field Experience (FE) test scores on written conceptual questions. After FE results are rounded to nearest 5%.

	Pre FE	Post FE	Ave. Gain
The process of preparing the lesson:			
is helpful in preparing me to teach	4.33	4.53	0.20
is helpful in my understanding concepts	3.89	4.41	0.52
requires lots of work and is challenging	4.12	4.22	0.10
is enjoyable to me	4.29	4.59	0.29
The field experience:			
is helpful to me in understanding concepts	4.35	4.71	0.35
requires lots of work and is challenging	3.89	3.94	0.05
is enjoyable to me	3.89	4.35	0.46
I am confident in my:			
conceptual understanding of the topics I present	4.76	4.28	-0.49
ability to explain the concepts to 5th graders	4.33	4.35	0.02
ability to teach by method of inquiry	4.47	4.11	-0.36
overall preparation	4.12	4.41	0.29

TABLE 2. Student response on a five-point scale survey questions before and after field experience. (1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, and 5: Strongly Agree). The results are the class average and rounded to nearest 1%.

In response to the question regarding the impact of the FE on student future career decision as teachers student overall feedback reflected excitement and confirmation of their career choices. Examples of student comments regarding the field experience include the following:

"I always wanted to be a teacher but doing the field experience just gave me more motivation for becoming a teacher."

"It [FE] encouraged me more, showing me that the job would not only be fun but also challenging."

"... confirmed how much I wanted to be a teacher because I got a hands on experience."

"I learned how much work goes in one lesson!"

"It [FE] made me excited and informed me of hard work ahead."

After FE, nineteen students firmly confirmed that teaching is what they would like to pursue as their future careers. One male student, while appreciating the experience, indicated that he is no longer interested in teaching as his future career; he had realized he did not have the patience required for teaching elementary students.

CONCLUSION

A primary purpose of integrating field experience into this course was to provide prospective elementary teachers with an opportunity to teach science in an inquiry-based manner. During the preparation of the formal lesson plans, students began the process of converting their own understanding and learning experience into future classroom practices and as a result gained somewhat better understanding of the concepts. However, this experience rather reduced their confidence on their own understanding and abilities to teach the science by method of inquiry, which might have been falsely high before the FE. It

seems that the FE created a venue in which students gained a more realistic perspective of teaching and recognized the hard work required for a well-prepared science lesson. Student responses to survey questions indicate that most students recognized some of the challenges of teaching science at elementary level while they passionately enjoyed interacting with young children in classroom.

Our findings confirm that it is crucial to model prospective teachers' future practice of teaching by inquiry in their own learning experience [9] and it is invaluable to provide opportunities such as field experiences to give them first-hand experiences of such teaching practices.

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