Elementary Education Online, 7(3), 640-655, 2008.
İlköğretim Online, 7(3), 640-655, 2008. [Online]: http://ilkogretim-online.org.tr

İki Örnek Olay Çalışması: ABD'deki İlköğretim Öğretmen Adaylarının Kavramsal Değişim Konusunda Öğrencilerle Gerçekleştirdikleri Alan Uygulamalarına Yaklaşımları*

Nermin BULUNUZ[**] **, Olga S. JARRETT**[***] **, Barbara MEYERS**[***]

ÖZ. Bu çalışmanın amacı, ABD'deki ilköğretim öğretmen adaylarının okul deneyimi için gittikleri okullarda, fen bilgisi öğretimi dersi kapsamında verilen kavramsal değişim konusundaki uygulama ödevine yaklaşımlarını değerlendirmektir. Örnek olay çalışmalarının gerektirdiği gibi bu araştırmaya, fen bilgisi öğretimi dersini alan 28 öğretmen adayından performans raporlarından en yüksek (Amy) ve en düşük (George) notu almış iki öğretmen adayı dahil edilmiştir. Adayların performansları hakkındaki yorumları, yedi açık uçlu soru bazında nitel araştırma tekniklerinden "sabit karşılaştırma yöntemi" kullanılarak analiz edilmiştir. Adaylar sınıflarında, fen kavramları hakkında an az dört tane "aktif öğrenme istasyonu" hazırlamış ve bu istasyonlardan en az bir tanesinde öğrencilerin kavram yanılgılarını değiştirmeyi amaçlayan kavramsal değişim stratejilerini kullanmışlardır. Çalışmada, Amy ve George'un raporlarının zayıf ve güçlü yanları ile araştırma sonuçlarının ilköğretimde fen öğretimine ve öğretmen yetişmeye katkıları tartışılmıştır.

Anahtar Sözcükler: fen eğitimi, ilköğretimde öğretmen yetiştirme, kavramsal değişim, aktif öğrenme istasyonları.

ÖZET

Problem Durumu: Eğitim fakültelerinin ilköğretim bölümlerinde okuyan öğretmen adaylarının okul deneyimi dersi için yerleştirildikleri okullarda kazandıkları deneyimler, onların mesleki gelişimi açısından oldukça önemlidir. Öğretmen adaylarının ilk yıllarda kazandıkları okul deneyimleri, edindikleri teorik bilgileri gerçek hayatta etkin olarak uygulamalarına yardımcı olmaktadır. Araştırmalar, öğretmen adaylarının teorik konuları, sınıf ortamında öğrencilerle uygulamalarının göründüğü kadar kolay olmadığını göstermektedir. Adaylar; eğitim programlarında öğretilen bilgilerin sınırlılığı, bilgi seviyelerinin yetersizliği, sınıf öğretmeninin sınırlı desteği, gittikleri okulların fiziksel koşullarının ya da öğrenci kitlesinin durumu gibi sebeplerden dolayı gerekli performansı gösterememektedirler. ABD'deki öğretmen adayları da, Türkiye'de olduğu gibi, aynı sorunlarla karşı karşıyadır. Buradan hareketle bu çalışmanın amacı, ABD'deki ilköğretim öğretmen adaylarının okul deneyimi için gittikleri okullarda, fen bilgisi öğretimi dersi kapsamında verilen kavramsal değişim konusundaki uygulama ödevine yaklaşımlarını değerlendirmektir.

Yöntem: Bu örnek olay çalışması, 2006 yılının bahar döneminde, ABD'deki bir üniversitenin ilköğretim bölümünde fen öğretimi dersini alan öğretmen adayları ile gerçekleştirilmiştir. Çalışmanın birinci yazarı, bu dersin öğretim elemanıdır. Dersi alan 28 öğretmen adayına, okul deneyimi dersinde gittikleri okullarda, ikinci ve üçüncü sınıf öğrencileriyle uygulanmak üzere uygulama ödevi verilmiştir. Adaylar, kararlaştırdıkları fen konusu hakkında aktif öğrenme istasyonları oluşturmuşlardır. "Aktif öğrenme istasyonları" terimi çalışmada, öğrencilerin 4-5 kişilik gruplar halinde, dönüşümlü olarak ziyaret ettikleri, masalarda hazırlanmış bulunan fen materyallerini

[*] Bu makale birinci yazar tarafından Georgia State Üniversitesi, İlköğretim Bölümü'nde tamamlanmış olan "Understanding of earth and space science concepts: Strategies for concept building in elementary teacher preparation" adlı doktora tezinden hazırlanmıştır.

[**] Dr. Nermin BULUNUZ, Uludağ Üniversitesi, Eğitim Fakültesi, nermin.bulunuz@gmail.com
[***] Olga S. JARRETT, Barbara MEYERS, Georgia State Üniversitesi, Eğitim Fakültesi,

kullanarak ve aktivitelere yönelik yönergeleri takip ederek fen konularını öğrendikleri alanlar anlamında kullanılmıştır. İstasyonlardan biri, öğrencilerin sahip olduğu kavram yanılgılarını ortadan kaldırmak ve bilgilerini arttırmak amacı ile hazırlanmıştır. Adaylar, kavramsal değişim stratejileri uygulanmadan önce ve sonra öğrencilerin kavramsal düzeylerini belirlemişler ve genel bir performans değerlendirmesi yapmışlardır. Araştırmacı, çalışmada bu uygulama ödevinden en yüksek (Amy) ve en düşük (George) notu alan iki öğretmen adayını seçmiş ve bu adayların performans değerlendirmelerini nitel araştırma tekniklerinden "sabit karşılaştırma metodu" ile analiz etmiştir.

Bulgular: Uygulama ödevinden en yüksek notu alan Amy ve en düşük notu alan George'un performans değerlendirmeleri yedi farklı açıdan karşılaştırılarak, dört temel fark tespit edilmiştir. Bunlar; ilk olarak öğretmen adayının dersin öğretim elemanından ilgili kavramlar ve kavramsal değişim konusunda edindiği bilgilerin seviyesi ve doğruluğu, sınıf öğretmeninin öğretmen adayına ödevinin her aşamasında verdiği destek, öğretmen adayının planlama, hazırlık ve uygulama için ayırdığı toplam zaman ve adayın öğrencilerden topladığı verileri sistematik bir şekilde analiz etme biçimidir. Her iki öğretmen adayı da, aktif öğrenme istasyonlarını ilkokul öğrencileriyle birlikte uygulamış olmalarına rağmen, Amy bu ödevde George'a göre pek çok açıdan daha başarılı olmuştur.

Tartışma: Bu araştırma ABD'de gerçekleştirilmiş olmasına rağmen, sonuçları ülkemizde fen öğretimi dersini veren öğretim elemanları, öğretmen adayları ve araştırmacılar için de önemlidir. Çalışmanın sonuçları üç açıdan önemlidir. İlk olarak bu araştırmanın sonuçları, uygulamalardaki başarı durumları açısından iki farklı düzeydeki öğretmen adayının, fen öğretimi derslerinde öğretilen kavramsal bilgi ve kavramsal değişim stratejilerini, gerçek sınıf ortamında kullanma ve uygulama becerilerine ilişkin bilgi vermektedir. Araştırma ikinci olarak, öğretmen adaylarının fen öğretimi konusunda üniversitelerde edindikleri bilgilerin ne denli etkili ve işlevsel olduğunu görme şansını vermektedir. Son olarak, bulgular özellikle ABD'de tüm öğretim derslerinde öğretmen adaylarına yaygın olarak verilen uygulama ödevlerinin etkililiği, adayların ödevlere yaklaşımları ve adaylardan beklentiler hakkında önemli mesajlar vermektedir. Araştırmanın, okul uygulamaları için öğretmen adaylarına verilen yönergelerin tekrar düzenlenmesi ve geliştirilmesi, ayrıca öğretim elemanının adaylardan beklentilerinin netleştirilmesi konusunda araştırmacılara faydalı olacağı düşünülmektedir.

How preservice teachers approached their field assignment: Two illustrative case studies*

Nermin BULUNUZ, Olga S. JARRETT***, Barbara MEYERS*****

ABSTRACT. This study involved qualitative analyses of two preservice teachers' field assignments that received the highest and the lowest scores in a teacher training course in science methods. A constant comparison method was used to analyze two participants' answers to seven guided reflection questions in a field assignment. Analyses of the field assignments gave a detailed portrait of how they applied hands-on activities at learning stations to change their students' alternative conceptions and improve their initial understanding. Four critical factors emerged that might have affected their overall performance such as the degree of support provided by classroom teachers; the amount of time needed to plan, prepare, and implement the stations; the way of analyzing the data collected from their students in a systematic way, and the level of understanding of conceptual change terminology. The research findings indicate that practice of strategies learned in a science methods class helps preservice teachers connect theory with practice. The major implications and recommendations for teacher preparation programs and conceptual change practices in preservice and in service field placements were presented.

Key Words: conceptual change, misconceptions, field assignments, preservice teachers, science education

INRODUCTION

Field experience in science is an important element 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. Field experiences have great importance for providing preservice teachers the opportunity to make connections between learning theory and practice (Moore, 2003). Hanuscin (2003) notes that although preservice teachers learn many strategies for teaching, applying these strategies in the classroom is not easy. Researchers have examined the effects of field experience during elementary science methods courses in terms of the changes in preservice teachers' behavior (Sunal, 1980), concern and attitudes toward science and science teaching (Strawitz & Malone, 1986), and conceptions of teaching and learning science (Mellado, 1998). The findings of these studies confirm that field experiences are effective in general education classes, methods courses, and science methods courses.

In teacher preparation programs various field assignments are given to preservice teachers by different course instructors to practice the knowledge that they gain in their methods courses in real classroom situations. Science methods course instructors also assign field assignments to preservice teachers on various science subjects. In this paper, specifically, hands-on learning stations as a field assignment given by the science method course instructor will be the main focus. Before discussing what we mean by *hands-on learning stations*, we will clarify related terminology in science education and discuss the research on preservice teachers.

[*] This paper is extracted from the first author's doctoral dissertation "Understanding of earth and space science concepts: Strategies for concept building in elementary teacher preparation" submitted to the Georgia State University.

[**] Dr. Nermin BULUNUZ, Uludag University, Education Faculty, nermin.bulunuz@gmail.com
[***] Olga S. JARRETT, Barbara MEYERS, Georgia State University, Early Childhood Education Department

Hands-on Science Activities

Popular terms in the world of practicing teachers, such as ‘doing science’ ‘hands-on science’ and ‘real-world science’ are frequent descriptors of inquiry-based learning approaches (Crawford, 2000). Crawford states that these types of projects with hands-on science instruction enhance opportunities for construction of knowledge. Costa (2003) reported that based on the study of “hands-on science network,” hands-on activities were indicated as the most effective way of acquiring scientific knowledge for most of the children and adolescents. The researcher noted that the pedagogical usefulness and effectiveness of hands-on experimental activities were clearly seen in different grade levels and disciplines in Europe. 'Hands on' means doing practical investigations usually with scientific equipment. Using hands-on activities for conceptual change in science has become very popular in the last four decades. To overcome alternative conceptions, a number of researchers have explored the effects of hands-on activities and science experiments for different age groups including preservice teachers (Gibson, Bernhard, Kropf, Ramirez, & Van Strat, 2001; McConnell, Steer, & Owens, 2003).

Research with Preservice Teachers

Gibson et al. (2001) conducted their study with preservice teachers enrolled in an introductory physical science course taught using hands-on activities, co-operative group work, manipulatives with variable controlled experiments, and real life applications. Researchers analyzed participants’ weekly reflective journals at the end of the course. They found that an introductory science course taught using constructivist methods had a positive impact on preservice teachers’ scientific understandings.

McConnell et al. (2003) compared the conceptual understanding of college students in traditional versus inquiry-based earth science classes where students were active and collaborative, while engaged in hands-on activities. Their interviews of the students show that most of the participants enjoyed the inquiry-based class, preferred the hands-on activities to a traditional lecture class, and would recommend this course to their peers. In addition, Ebert and Elliot (2002) conducted a study with preservice teachers in a laboratory techniques course about rock and mineral identification and obtained significantly positive results. The researchers reported that the activities helped the students to review minerals and rocks and to learn more about them.

Organizing Hands-on Activities through Learning Stations

One way to structure hands-on activities is through centers or learning stations. Although the terms *learning centers*, *science centers* (Irwin, Nucci, & Beckett, 2003), and *science discovery centers* (Radeloff, 2001) are used interchangeably in the literature, the term *hands-on learning station* (Bulunuz & Jarrett, 2006) is used throughout this study. In this approach, the idea of students working together as active learners is consistent with the *National Science Education Standards* (National Research Council, 1996).

The term, *hands-on learning stations,* refers to centers set up around the room with instructions and materials for doing specific activities. At learning stations, participants did hands-on activities, discussed procedures and results of the activities with their partners, and answered questions in their journals. After a certain period of time each group rotated to another station and experienced another set of activities.

Plourde and Klemm (2004) investigated effects of learning stations on preservice elementary teachers' concepts about sound through five learning stations, including one in which students used a slinky, a rope, cardboard, paper, and construction paper to demonstrate sound. The findings were that the preservice teachers were engaged in the learning experiences associated with the specific hands-on inquiry activities and also developed their own conceptual understandings about sound. Research by Bulunuz and Jarrett (2006) on earth and space science concepts showed that learning stations could be used to clarify student concepts. Bandura’s (1974) seminal research suggests that the behavior of positive models tend to be copied, and more recent research by Palmer (2001) suggests that preservice teachers tend to implement strategies modeled in their methods course. Therefore, learning stations in a science methods class should promote the use of learning stations in the elementary school classroom.

Hands-on Learning Stations as a Field Assignment

Some teacher education programs require implementation of learning stations during field experiences (Hanuscin, 2003 and Radeloff, 2001). Radeloff (2001) described the experiences of preservice teachers in a methods class as they created science learning stations for preschool children aged 5 and 7. They found that preservice teachers had a great experience doing these stations, and the children were eager to participate. Hanuscin (2003) assigned her preservice teachers to implement learning stations in their field placements and found that the preservice teachers reported noticeable differences in students' understandings and their confidence after several rotations. According to her, the preservice teachers were able to relate students' cognitive functioning to course topics on misconceptions and conceptual change.

Watters and Ginns (2000) investigated the effect of collaborative learning workshops and hands-on practices on understanding of a range of concepts (e.g., earth, weather, life science, and space) in a science methods course. As part of the course assignment, preservice teachers were observed in the classrooms to ensure they could apply hands-on approaches with children. According to Watters and Ginns, this methods course, that helped the participants get direct experience with teaching science to children in field experience sessions, enhanced preservice teachers' outcome expectancy for the teaching of science.

Teaching for Conceptual Change in Science Methods Courses

In the literature, it is argued that preservice teachers need to experience conceptual change pedagogy first as *learners* in the methods course and then to apply this experience in classrooms (Marion, Hewson, Tabachnick, & Blomker, 1999; Stofflett & Stoddart, 1994). Therefore, these researchers developed elementary science methods courses, specifically called *elementary science conceptual change methods courses,* in which conceptual change theories, strategies and methodologies were taught. In these courses, the instructors modeled good practices as complete conceptual change science lessons so that preservice teachers learned science in a very different way from their previous experiences (Marion et al., 1999). The researchers investigated the applicability of the conditions of accommodation in the conceptual change science methods courses (Stofflett, 1994; Stofflett & Stefanon, 1996).

Stofflett (1994) reported that the instructors could easily implement conditions of accommodation in the methods courses with preservice teachers. They were not able to determine if preservice teachers were dissatisfied with their existing conceptions or not. In the study of Stofflett and Stefanon (1996), although the course was completely designed for teaching conceptual change, only 25 % of the teacher candidates thought they were able to change their students' misconceptions, and only 3 out of 76 reported that these conditions had been effectively met in their field placements.

Unfortunately, most preservice teachers have never personally experienced learning science content through conceptual change methods (Stofflett & Stoddart, 1994; Tabachnick & Zeichner, 1999; Thorley & Stofflett, 1996). According to Stofflett and Stoddart (1994), because many teacher candidates came from traditional didactic instruction and previously completed limited science related courses, their content knowledge could not be expected to be strong enough for them to teach science. The same researchers compared preservice teachers' science content knowledge and ability to apply this knowledge in two science methods courses that received content instruction through either traditional or conceptual change methods. They found that the conceptual change group planned to use conceptual change strategies and performed discovery activities with children by translating this conceptual change pedagogy into practice. However, the traditional group did not plan to use the conceptual change pedagogy in their teaching.

Many preservice teachers have difficulty in using their new conceptual change experiences in creating new conceptual change lessons for their students (Meyer, Tabachnick, Hewson, Lemberger, & Park, 1999; Stofflett & Stefanon, 1996; Tabachnick & Zeichner, 1999). Tabachnick and Zeichner (1999) analyzed the action research that was conducted by teacher candidates in their field experiences after they completed the conceptual change methods course and they found that most of the preservice teachers began to think about their students' prior knowledge and what the students learned at the end. However, it was reported that the preservice teachers' prior knowledge, conditions of school placements, and cooperating teachers' resistance also affects the outcome of conceptual change pedagogy and its success in the classroom (Stofflett, 1994; Tabachnick & Zeichner, 1999). According to the same authors, preservice teachers' nonconstructivist views of science teaching, the lack of modeling conceptual change teaching in school placements, preservice teachers' lack of deep science content knowledge, and the lack of conceptual change teaching in preservice training might be the reasons why the preservice teachers could not effectively implement conceptual change strategies in their classrooms.

In this paper, we present two illustrative cases from a science methods course in which students were to implement a conceptual change learning station as part of a field assignment. The two cases were Amy, who received the highest score on the field assignment and George, who received the lowest score. The emphasis will be on comparing the reflections of Amy and George based on seven guided reflection questions assigned in the course syllabus. This study addressed the following research question: How do two different preservice teachers apply conceptual change teaching strategies in their field assignment on conceptual change?

METHODS

Participants and Context

The first author was the instructor of a science methods course. This science methods course was offered in an early childhood education program at a large southeastern urban university in the U.S. during Spring Semester 2006. The subjects of this study (between 20 and 25 year olds) who were registered for this science methods course were the members of one of the two cohorts of the undergraduate Bachelors of Science in Education program in this department.

Undergraduate Program

Undergraduates wanting a degree in early childhood education go through an application process and are admitted into cohorts at the beginning of their junior year. The program is heavily field-based with school placements each semester in schools having various levels of partnership with the university. Following a developmental sequence, cohort members are first placed in pre-K and kindergarten classrooms and eventually are placed in grades four or five classrooms. The undergraduate cohorts included in this study were second semester juniors and were placed in first grade classrooms the first half of the semester and second or third grade classrooms the second half of the semester. They were in schools two days a week, placed with an experienced cooperating teacher and observed at regular intervals by a university supervisor. Cohort members took classes on campus two days a week. One of their courses was a three-credit science methods course, *Science and Inquiry in Early Childhood Education* in which the instructional intervention research was implemented. During Spring Semester 2006, one cohort with 25 members (Cohort 1) was taught by another instructor, and the second cohort with 28 members (Cohort 2) was taught by the researcher. Therefore, the term *researcher* is reserved for both the first author and the instructor in this paper.

Field Assignments

Designing and implementing learning stations in their school placement was a course requirement for the preservice teachers in the researcher's science methods course. In this assignment, they developed at least four hands-on learning stations that gave children experience with one or more topics and created connections with other subjects. Participants developed a management plan for moving the children among stations. In at least one of the stations, they were expected to apply conceptual change strategies that they were taught in class. Participants looked through the state standards to determine which science concepts were to be taught at their grade level. The preservice teachers talked with their cooperating teachers about which concepts had already been taught and how. They found out what the children knew about the concept using the "know" part of a KWL (Know, Wonder, and Learn) chart. On this chart, the preservice teachers noted what their students said they knew about the topic, the areas that their students wondered about, and after the learning stations, what their students learned based on the strategies that they applied.

The preservice teachers implemented their stations in the last month of their second placements after three weeks of training in their science methods course. During the first week of the study, the researcher made a short introduction to the field assignment and gave general instructions. During the third week of the study, the researcher discussed the conceptual change learning station assignment as described in the syllabus and the guided reflections questions the preservice teachers needed to answer in their personal reflections. The field assignment required five sections including lesson plans, management plan, guided reflection with seven open-ended questions, observer's reflection about the preservice teachers' performance, and the photos of each station. The following week, the researcher focused on details of the assignment and answered questions in class, if needed. She gave instructions about the terms "concepts," "conceptual understanding," "conceptual change as a process," and "common conceptual change strategies in science."

In this assignment all the preservice teachers were required to develop hands-on learning stations in their field placements. Throughout the semester, the researcher modeled *hands-on learning stations* on various science topics with the preservice teachers. Therefore, the participants learned how hands-on learning stations could be used in science. Conceptual change texts, concept mapping activity, and analogies were also discussed as other conceptual change strategies in one class period. A conceptual change text on "food chain," described in a research article (Palmer, 2003) was shared with the class and the details were discussed. The effects of using analogies in changing students' misconceptions in science were discussed by giving examples from life science (blood cells) and physical science (electricity). Participants had experienced a concept mapping activity on earth science concepts during a whole class period as part of this research.

The researcher reminded the class that after their students rotated through the hands-on learning stations, they could also process their students' final understandings by using additional strategies. For example, the preservice teachers could: a) give different examples from analogies; b) let the students make comparisons between what they already knew and what they learned about the concept; or c) ask additional questions to highlight the scientific explanation of that concept.

As part of the assignment, preservice teachers in this class implemented a conceptual change activity in a hands-on station in their field placements. The purpose of this learning station was for preservice teachers to attempt to change their students' initial understanding about a particular science concept. To do that, they got further instructions on conceptual change and conceptual change strategies from their course instructor. The preservice teachers wrote guided reflections at the end of their field experiences and turned them in to the researcher. In their guided reflections, preservice teachers were expected to answer seven open-ended questions about the process that they went through.

In reflecting on their conceptual change stations, the preservice teachers answered the following questions:

1. What science concept did you choose and why?
2. How did you determine your students' initial understandings of that concept?
3. How did you make sure you completely understood the concept yourself, and what did you do to develop your own understanding?
4. What conceptual change strategies did you use in your center(s)?
5. What influenced you in your choice of strategies?
6. Do you think you were successful in building your students' conceptual understandings?
7. How do you know whether you were successful?

There were 28 preservice teachers registered in the science methods class. However, two of the preservice teachers, Amy who turned in an elaborate and well-written field assignment which received one of the highest scores in the class (30 out of 30) and George, who received the lowest score (20 out of 30) were selected as illustrative cases. The analysis of their field assignments provided a detailed portrait of how two very different preservice teachers approached the conceptual change field assignment in their second or third grade field placements. The second grade students were 7 and the third grade students were 8 years old in the school they were placed. Both *Amy* and *George* are pseudonyms.

Data Analysis

The researcher used a constant comparison method (Lincoln & Guba, 1985; Strauss & Corbin, 1990) to analyze the data in this study. The researcher read all sections of their field assignments (lesson plan, management plan, a photo of each station, observers' feedback, and guided reflection) as a whole and made sure whether or not all the assigned sections were complete. Amy's personal reflection was more elaborate and informative than George's reflection, enabling the researcher to pull out the related answers of the guided reflection questions from Amy's answers. On the other hand, George's short reflection did not give enough information about each guided reflection question.

After a general reading of both assignments, the researcher highlighted the sentences in Amy and George's personal reflections that had the related answers to each guided reflection question in their field assignments. Then, the instructor classified their related answers, copied these answers into another word document, and organized them according to each guided reflection question. It was easier to organize the participants' answers, determine the similarities and differences, and find the common themes in the new document than their original field assignments where the answers were mixed. All the answers for each question were read again from the new document. By doing this, the researcher determined the illustrative quotes under each question in both of their field assignments. For some of the questions, there was more than one quote that might be appropriate to be included for the discussion. If so, the researcher read these quotes many times and chose the clearest quotes as the illustrative examples from their assignments.

Each participant's field assignments were read many times until no more additional information emerged from their responses. The researcher specifically focused on the sections where Amy's assignment was common or different than George's assignment. In addition, strengths and weaknesses of Amy and George's field assignments were reported.

RESULTS

Amy: Highest Score

Context

Amy is a female Hispanic preservice teacher who had 20 third grade students in her second placement when she implemented her field assignment. According to the records of the State and the U.S. Departments of Education (2004), her school had over 1,046 students with a predominantly

Hispanic (36%) and African American student (26%) population. About 13% of the students attending this school are enrolled in the "English to Speakers of Other Languages" (ESOL) program.

In her personal reflection on the way science was taught at the school, Amy reported that the way science was taught at her school was mostly by direct instruction and teacher centered. Therefore, the hands-on science learning stations that she implemented with students were new to them and addressed many incorrect science concepts. Amy had an advantage of having extra time to implement her learning stations in the classroom. She reported that her cooperating teacher allowed her the whole afternoon plus additional time before and after to teach the children.

Amy's Learning Stations

Amy conducted six hands-on learning stations in her classroom. She identified two stations as the conceptual change stations for this assignment. Amy chose the concept of "floating and sinking" for the conceptual change stations. From the students' answers, Amy discovered that the students held what she called "an incomplete misconception" that was: heavy objects sink while light ones float. She reflected that: "They were not taking into consideration of the surface area of an object or its density." Therefore, Amy decided to focus on surface *area* and *density* to change her students' initial ideas. For children, 'heavy' is likely to mean density. Therefore, she was correct in her use of the term density, but she should have referred to *volume* instead of *surface area*. This illustrates that either Amy herself does not scientifically conceive floating or she has lack of conceptual understanding about the effect of volume of an object on floating.

At the first conceptual change station, Amy provided a plastic bucket for water, a variety of items (e.g. wood stick, peeled and unpeeled orange, potato, apple, marble, coins, floating rock, and CD), aluminum foil precut in equal squares, pennies, and a floater or sinker prediction chart. Amy wanted the students to make a prediction for a variety of objects. Amy's students tried to figure out why a pumice rock could float while the other rocks sank. She let the students create different size boats, make predictions on the amount of pennies (coins) their boats would hold, and explain their results.

At the second conceptual change station, Amy included a plastic bucket for water, raisins, Alka-Seltzer, and a directions chart. The main question was: how can we make a sinker float? By using Alka-Seltzer, the students observed the raisins' dancing movement in the cups. Amy wanted them to observe the 'dancing' raisins, discuss why they were dancing, and draw a picture of what her students did to make a sinker float. Then, Amy asked open-ended questions while the children were exploring the materials and collected their drawings.

Amy's Reflection

*A*my's answers to the seven open-ended questions of guided reflection are summarized below:

1. What science concept did you choose and why?

Amy chose the concept *why do some objects float and others sink?* for the conceptual change stations. She gave three reasons for picking this concept. One reason is because she believed that the concept of floating and sinking was not an easy concept. Secondly, her students were not familiar with the scientific process. Amy thought they could practice a variety of scientific approaches at the stations. The third reason for Amy's selection was because she felt that some of her students had incomplete understandings of floating.

2. How did you determine your students' initial understandings of that concept?

In order to determine her students' initial understandings, Amy talked to her students about what they knew about sinking and floating. She stated that learning about the students' initial understandings was not difficult and she really enjoyed the process: "Surveying [trying to know their conceptual understanding] children is really not that hard. They love to talk and they will answer any questions and give you quick insight into what they know and how they perceive the world around them."

3. How did you make sure you completely understood the concept yourself, and what did you do to develop your own understanding?
Amy reflected that some of the concepts she chose were challenging and therefore she wanted to learn more about them: "It [her assignment] gave me the opportunity to learn new concepts through lots of research. I did a lot of research [from books and internet] and learned about the concept of floating well-enough to address any misconceptions that the children might have had."

4. What conceptual change strategies did you use in your station (s)?
Amy chose hands-on activities as the conceptual change strategy for this assignment. She supplied various kinds of materials for every station so that the students would have enough opportunity to experience with manipulatives (like a plastic bucket, wood stick, peeled and unpeeled orange, potato, apple, marble, coins, floating rock, CD, Alka-Seltzer, raisins, and etc.): "My main goal was to give them enough hands-on opportunity so they could come up with questions that challenge their misconceptions…"

5. What influenced you in your choice of strategies?
It was understood from Amy's explanations that the difficulty level of the concept and the students' low background knowledge about scientific process influenced Amy in selecting hands-on activities as the conceptual change strategy: "I realized that the concept of floating and sinking was not an easy one. I wanted to provide the students with a hands-on experience that sparked a lot of questions."

6. Do you think you were successful in building your students' conceptual understandings?
Amy reported the results of the stations objectively. She thought that she was successful in building her students' conceptual understanding, and that her students learned a lot from the stations. However, Amy did not think that all of her students gained complete scientific understanding: "They still do not have a full understanding about sinking and floating but, they know that there is more to it then just weight."

7. How do you know whether you were successful?
Amy mentioned that she held a final meeting with students where she addressed students' questions. After the stations she analyzed the students' answers to the question "what makes an object sink and another one float?" She reported the percentages of the students who changed their initial understandings as follows: "At least 85% of the kids accepted that there is more to sinking and floating than just weight. At least 40% grasp the concept of surface area [volume] and only 20% were able to explain the concept of density."

Because Amy was very successful with the stations, her classroom teacher suggested that she re-implement the same stations in another teacher's classroom. Following is her reflection about her teacher's recommendation: "My cooperating teacher asked me to re-do the stations with another teacher because, they thought it was great for the children to be part of it. It was accepted gladly and I will be repeating these stations with another 3rd grade class."

Summary of Amy's Field Assignment

Overall, Amy's field assignment was very well-organized according to the criteria that were assigned in the syllabus. Generally, Amy grasped the purpose of the assignment correctly, understood the importance of knowing students' conceptual understanding as a teacher, learned her students' initial understanding before implementing the stations, implemented the stations in her classroom successfully, and tested her students' final understandings. In addition, the content of the field assignment that she turned in was more reflectively-written than her classmates' field assignments.

The authors detected a series of strengths in Amy's assignment. First, Amy developed six well-designed learning stations. These learning stations were managed with a variety of materials for this assignment. She put great effort into developing these stations, finding the appropriate materials, and implementing them.

Another strength is that Amy specifically presented the scientific explanation of the misconception with what she called "truth" in her reflection: "Weight is only part of it. The amount of space an object occupies, relative to its weight is also important. Different objects have different densities, and depending on their relative densities to solutions, they will either sink or float." Although most of the preservice teachers recognized students' misconceptions and specifically mentioned them, they did not give the correct or scientific explanation for these misconceptions. Therefore, it was hard for the researcher to determine whether the preservice teachers correctly understood the content knowledge about the concept themselves.

George: Lowest Score

Context

George is a white American male preservice teacher who had 24 students in his third grade classroom when he implemented the field assignment. His school was one of the most highly populated schools (1,143 in 2004) (State and U.S. Departments of Education statistics) within its district and had predominantly Hispanic (46%) and African American student population (21%). In this school, the number of students per teacher is 12 and the average teacher experience is 13 years. About 37% of the students attending this school are enrolled in the "English to Speakers of Other Languages" program.

George pointed out that science was generally taught theoretically in his classroom. His classroom teacher's way of teaching science was teacher-centered without doing any hands-on activities. Therefore, he reported that implementing this conceptual change station was a great opportunity for his students to learn from the activities instead of just enjoying them as fun, time filling activities.

George's Learning Stations

George conducted two hands-on learning stations in his classroom. One station was about designing paper airplanes. He aimed to teach the effect of different materials (e.g. colored papers and decorative materials) on planes that the students would create themselves and to introduce the idea of variables in an experiment. The students would attempt to design a paper plane that would stay in flight for the longest period of time by using a "plane guide." The second learning station was the one that George presented as the conceptual change station. George let the students create their own molds out of Crayola clay and plastic bug creatures. The purpose of this station was to teach students what fossils are, how they form, and the difference between paleontologists and archeologists.

George's Reflection

George's answers to the seven open-ended questions of guided reflection are as follows:

1. What science concept did you choose and why?
George chose the concept of *how fossils are formed* for the conceptual change station. However, he did not mention if he used the state standards to determine what science concepts are taught at his grade level. From his assignment write-up, it appears that he decided the science concept by himself and did not talk with his cooperating teacher about which concept he would choose. From George's observer's feedback, this concept apparently was not previously taught to the students: "…… but I understood this was an introductory activity." George described his topic *fossils* and explained the reason why he chose this concept as the conceptual change station: "To prepare myself for the conceptual change station, I tried to think of a topic that could be modeled as well as learned within the stations. The station I chose because it gave the students an opportunity to see first hand how a certain type of fossil would first begin its formation millions of years ago."

2. How did you determine your students' initial understandings of that concept?
Although George gave some examples from his students' initial understanding, he did not give any information about how he assessed his students' knowledge about the concept. It is unclear whether he asked students open-ended questions, had them write their initial ideas in their science journals, or let students fill out a KWL chart. In terms of the students' initial knowledge about fossils, George reflected the following: "The students either had no clue what they [fossils] were or simply thought they [fossils] were the bones of dinosaurs." Additionally, George highlighted that his students did not know what fossils actually were, nor the difference between paleontologists and archeologists: "The children at first just thought that dinosaurs died, they left their bones behind, and archeologists dug them up later. They had no idea that it was actually paleontologists who excavate pre-historic creatures and that fossils are not actually bone at all but the remnants of bones from millions of years ago."

3. How did you make sure you completely understood the concept yourself, and what did you do to develop your own understanding?
It is difficult to understand whether George completely understood the concept himself. He did not give any information about the way that he learned this concept so that he could teach it to the students. George's science content knowledge about fossils and fossil formation needs more elaboration so that he could present the scientific explanation to his students. The observer appeared to agree with the researcher by writing: "I would like to have seen more in-depth coverage of the content"

4. What conceptual change strategies did you use in your station (s)?
George used hands-on activities as the conceptual change strategy in the learning stations: "The learning stations I chose to use in my classroom placement were both chosen on the basis of creating an activity. In this activity, my students could connect to a new idea through hands-on experience."

5. What influenced you in your choice of strategies?
It was understood from George's reflection that his students did not have much experience in terms of doing hands-on activities in their classroom. The following is his reflection on that: "The students do not get many opportunities to do a lot of hands-on activities, especially ones in which they get to use clay, and fly paper airplanes." He reported that using hands-on activities for the stations was very helpful for his students since they were not familiar with this approach in science.

However, the science support specialist at the school where George was placed reported that: "There is an emphasis on student understanding based on their interests using scientific knowledge and the inquiry process. Students learn best when they construct their learning through discovery. To this end we are heavily hands-on."

6. Do you think you were successful in building your students' conceptual understandings?
George did not record information about how many of his students changed their initial understanding after they visited the conceptual change station or give examples of the students' understanding after participation. However, George stated that: "In general, the stations were a great success in my classroom. The students really seemed to be genuinely interested in the topics and ideas discussed." He also did not specifically record what changed in his classroom.

7. How do you know whether you were successful?
George wrote that he would let the students answer open-ended questions in their science journals, which would give information on what they did. However, he did not really thoroughly state whether or not the students answered the questions or whether he read their journals. It is hard to understand how successful he was in terms of changing the lack of understandings and incomplete or incorrect understandings of his students.

George wrote a descriptive management plan for both learning stations in his field assignment. From beginning of the class to the end, he explained each step in terms of the students and the teacher’s activities. Based on his further explanations and the observer’s feedback, George did not have management problems during his class period.

Summary of George’s Field Assignment

It is the researcher's general impression from reading George's field assignment that he did not prepare himself thoroughly. There might be several reasons for his poor performance in this assignment. Because he was not a talkative student who always sat at the back of the classroom without participating in class discussions or it might be just George's laziness that caused a lower score. Second, the outcomes of the assignment and his personal reflections indicate that he did not follow the instructions for the requirements of the assignment. Therefore, he had a poor grasp of teaching with conceptual change. Thirdly, there is no indication in his assignment on whether his co-operating teacher was helpful both at the period of preparation, organization, and finally at the implementation of his stations in the classroom.

The researcher detected a series of weaknesses: George developed only two hands-on learning stations instead of the four that were assigned in the syllabus. He chose one of these two stations as the conceptual change station for this assignment. George’s field assignment was not complete in terms of all the sections assigned in the syllabus. Because George did not take pictures of the stations, the instructor did not have any visual documentation about how he set up the materials in the classroom. In addition, George did not clarify whether the observer was a student or a cooperating teacher.

CONCLUSIONS

The in-depth analyses of Amy and George’s field assignments gave a portrait of how they applied learning stations to change their students’ alternative conceptions and improve their initial understanding. Four critical factors emerged from their statements that might have affected their overall performance in this field assignment. One of the factors is the degree of support provided by classroom teachers. Amy highlighted that she appreciated her classroom teacher’s support during the implementation of the stations. This finding was consistent with the idea that differences in learning environments in the school placements and the classroom teachers’ attitudes toward science may have influenced preservice teachers’ performances during their field practices (Strawitz & Malone, 1984). Similarly, Stofflett (1994) found that preservice teachers being in a supportive environment was conducive to the use of conceptual change techniques.

The second factor is the amount of time needed to plan, prepare, and implement the stations. In addition to Amy’s strong background knowledge and the time she put into preparation, the finding that she was given extra time to implement her learning stations in the classroom can be considered as another positive contributor to her performance, consistent with previous research (Butzow & Davis, 1975). On the other hand, George encountered classroom impediments such as problematic students and time restrictions that could have negatively affected his general performance.

The third factor is that although both preservice teachers had some kind of data on their students’ pre and final understanding, they did not really understand how to analyze these data in a systematic way. The authors do not think that they compared each student’s pre and post answers in the KWL charts at the end of the implementation. This would have given them a more objective idea about the effectiveness of their stations on students’ conceptual understanding.

The last factor is the level of understanding of conceptual change terminology. It is important to point out that neither participant appeared to have learned the terminology of *conceptual change* prior to the science method course. Although the researcher gave instruction about these concepts in one class period and reminded the class of her expectations several times throughout the semester, several key points did not seem to be clear for the participants.

In their personal reflections, Amy and George showed that they valued the importance of changing incorrect understandings of their students. They stated that they wished they could have had more time for planning, preparing themselves on their stations, implementing other conceptual change strategies and having more chance to talk to their teachers about their students' ideas about the concepts. This study supports the findings of Sunal (1980) that increased field experience does positively affect a preservice teacher's performance in the teaching of elementary science. Like other researchers (Strawitz & Malone, 1984) we believe that the anecdotal findings from field assignments are very promising in terms of both the introspective awakenings of the preservice teachers who implemented the assignments in their field placements and for their future students.

Recommendations

The idea of "teaching for conceptual change" (Marion et al., 1999) in science methods courses should be included in teacher preparation programs. Like the *elementary science conceptual change methods courses*, similar science methods courses may be helpful in teaching conceptual change theories, strategies, and methodologies to teacher candidates. Hands-on stations model learning in a way that is appropriate for children. According to constructivist theory (Piaget, 1970), young children best build their conceptual understandings through interaction with their environment and their peers. Therefore, preservice teachers need to learn how to teach concepts to young children in a hands-on way. Science method course instructors should model (Bandura, 1974) the use of different science manipulatives and materials in hands-on activities.

More research is needed on how children and preservice trainees best learn concepts. Teachers could conduct action research to learn their students' preconceptions on certain science concepts. Researcher, educators, and teachers could implement conceptual change strategies and test students' knowledge at the end to determine whether or not the instructional methods they practiced were effective.

The findings suggest that conceptual change stations can be readily implemented by new classroom teachers. Beginning teachers who have implemented conceptual change stations during their field placements have had experience in selecting an appropriate science concept, assessing student understanding, planning, and managing relevant conceptual change strategies in classrooms. In addition, the field assignment might sensitize teachers to the existence of resistant science misconceptions among students such as "heavy objects sink, light objects float" (Amy).

Classroom teachers who currently teach science through hands-on learning can focus on how these approaches develop students' understanding about particular science concepts. They can implement similar science activities according to the grade level they teach. They can challenge alternative conceptions by developing students' skills in various fields, such as using questions during field work and practical demonstrations (Dove, 1999). If inservice teachers implement similar hands-on learning stations in their classrooms to change their students' alternative conceptions, both their students and teachers are likely to benefit from the information teachers can gather on their students' alternative conceptions. Based on students' initial understanding, teachers may re-examine their own understanding and try to improve it. This may give them a chance to present their lesson in a different way next time. With all these activities, teachers may discover that they hold some of the alternative conceptions similar to conceptions of students. As a result, these activities contribute to professional development of teachers.

When preservice teachers are required to implement field assignments in their school placements, collaboration between course instructors, cooperating teachers, and preservice teachers might be very helpful in creating a common vision of what experience preservice teachers should have with students. Science methods course instructors can write letters to classroom teachers with detailed descriptions of the field assignments and specific expectations for preservice teacher accomplishment, constructing a triangle among the university instructor, the teacher, and the preservice teacher. The findings of the two cases provide instructors and researchers with a general idea of how preservice teachers can practice the knowledge that they gain in their science methods courses in real-life classroom situations.

In conclusion, this study is unique for the following reasons: First, it provides a window into how two different preservice teachers implemented the knowledge they learnt in their science methods course in real classroom environments. Second, it gave researchers a chance to see the effectiveness of the knowledge the preservice teachers gained. Thirdly, it gives researchers ideas for revising and improving field assignment instructions and modifying the expectations of preservice teachers in the future

REFERENCES

Bandura, A. (1974). Behavior theory and the models of man. *American Psychologist*, *December,* 859-866.

Bulunuz, N. & Jarrett, O. S. (2006, February). Basic earth and space science concepts: Building elementary teacher understanding. Paper presented at the annual conference of the Georgia Science Teachers Association in Columbus, GA.

Butzow, J.W. & Davis, A. (1975). The development of a semantic differential test of teachers' attitudes toward teaching elementary school science. *Science Education, 59*, 215-216.

Costa, M.F. (2003). "Hands-on Science. European Commission under the Socrates Project." [Online] Retrieved on 20-August-2004, at URL: http://www.isoc.siu.no/isocii.nsf/projectlist/110157.

Crawford, B.A. (2000). Embracing the essence of inquiry: New roles for science teachers. *Journal of Research in Science Teaching, 37*(9), 916-937.

Dove, J. (1999). Physical Geography. In M. Biddulph & G. Butt (Eds.), *Theory into practice: Immaculate misconceptions* (pp.15-20). Hong Kong: The Geographical Association.

Ebert, J.R. & Elliot, N.A. (2002). Mr. Chalkentalk's cupboard- practical lessons for preservice teachers in rock and mineral identification and the management of teaching collections. *Journal of Geoscience Education, 50*(2), 182-185.

Gibson, H.L., Bernhard, J., Kropf, A., Ramirez, M.A. & Van Strat, G. A. (2001, March). "Enhancing the science literacy of Preservice teachers through the use of reflective journals." *Paper presented at the annual meeting of the National Association for Research in Science Teaching, St. Louis: MO.*

Hanuscin, D. (2003, February). "A workshop approach: Instructional strategies for working within the constraints of field experiences in elementary science." *Paper presented at the annual meeting of the Association for the Education of Teachers of Science, St. Louis, MO.*

Irwin, L., Nucci, C. & Beckett, E.C. (2003). Science centers for all: Suggestions on using classroom science centers to engage every learner. *Science and Children, 40*(5), 35-37.

Lincoln, Y. & Guba, E. (1985). *Naturalist inquiry*. Newbury Park, CA: Sage.

Marion, R., Hewson, P.W., Tabachnick, R., & Blomker, K.B. (1999). Teaching for conceptual change in elementary and secondary science methods courses. *Science Education, 83*, 275-307.

McConnell, D.A., Steer, D.N. & Owens, K.D. (2003). Assessment and active learning strategies for introductory geology courses. *Journal of Geoscience Education, 51*(2), 205-216.

Mellado, V. (1998). The classroom practice of preservice teachers and their conceptions of teaching and learning science. *Science Education, 82*, 197-214.

Meyer, H., Tabachnick, B.R., Hewson, P.W., Lemberger, J. & Park, H. (1999). Relationships between prospective elementary teachers' classroom practice and their conceptions of biology and of teaching science. *Science Education, 83*, 323-346.

Moore, R. (2003). Reexamining the field experiences of preservice teachers. *Journal of Teacher Education, 54*(1), 31-42.

National Research Council (NRC). (1996). *National Science Education Standards.* Washington, DC: National Academy Press.

Palmer, D.H. (2001). Factors contributing to attitude exchange amongst preservice elementary teachers. *Science Education, 86*, 122-138.

Palmer, D.H. (2003). Investigating the relationship between refutational text and conceptual change. *Science Education, 87,* 663-684.

Piaget, J. (1970). *Piaget's theory, Manual of Child Psychology*, In P.H. Mussen (Ed.) Third Edition, Vol. 1, New York: John Wiley & Sons, Inc.

Radeloff, D. J. (2001). Science discovery centers: Stimulating young children's minds. *A Quarterly Newsletter for the Education Community, 13*(3), 1-3.

Stofflett, R.T. (1994). The accommodation of science pedagogical knowledge: The application of conceptual change constructs to teacher education. *Journal of Research in Science Teaching, 31*(8), 787-810.

Stofflett, R.T. & Stoddart, T. (1994). The ability to understand and use conceptual change pedagogy as a function of prior content learning experience. *Journal of Research in Science Teaching, 31*(1), 31-51.

Stofflett, R.T. & Stefanon, L. (1996). Elementary teacher candidates' conceptions of successful conceptual change teaching. *Journal of Elementary Science Education, 8*(2), 1-20.

Strauss, A. L. & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, Ca: Sage.

Strawitz, B.M. & Malone, M.R. (1984). The influence of field experiences on stages of concern and attitudes of preservice teachers toward science and science teaching. *Journal of Research in Science Teaching, 23*(4), 311-320.

Sunal, D.W. (1980). Effect of field experiences during elementary methods courses on preservice teacher behavior. *Journal of Research in Science Teaching, 17*(1), 17-23.

Tabachnick, B.R. & Zeichner, K.M. (1999). Idea and action: action research and the development of conceptual change teaching of science. *Science Education, 83*, 309-322.

Thorley, N., R. & Stofflett, R.T. (1996). Representation of the conceptual change model in science teacher education. *Science Education, 80* (3), 317-339.

Watters, J.J. & Ginns, I.S. (2000). Developing motivation to teach elementary science: Effect of collaborative and authentic learning practices in preservice education. *Journal of Science Teacher Education, 11(*4), 277-313.