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Designing the Best Urban, Preservice Elementary Science Methods Course: Dilemmas and Considerations

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Abstract

This paper addresses the dilemmas encountered by two secondary science education instructors designing a course for preservice elementary teachers. Taking into consideration past experiences of teaching education and science courses in general and with preservice elementary teachers in particular and recommendations from state and national documents and state requirements regarding teacher accreditation, the two instructors engage in an introspective reflection that uncovers the complexity involved in making decisions regarding course goals, course assignments, assessment strategies, and course materials. This was all done in an effort to better prepare preservice elementary teachers to meet the new demands of contextualized urban science classrooms, focusing on inquiry science and students' use of higher-order cognitive skills.

Subject/Problem

Building upon previous work (Moscovici, 1998, 2000a, 2000b), this study uncovers the internal turmoil that we, the authors of this paper—both of us secondary science education instructors—went through when preparing to design a science methods course for preservice elementary teachers. We have over 15 years of science teaching experience at the secondary level (7th to 12th grades) between us and over 12 years of teaching secondary science methods courses at the college level. Uncovering the challenges and dilemmas rising from previous experiences and from credential and science teaching requirements at the district, state, and national levels, this introspective reflection reveals internal struggles that, as instructors, we encounter every time we step out of our comfort zone. What can we do when disequilibrium hits? How do secondary science instructors with deep roots in scientific research and a comprehensive understanding of science prepare a course curriculum that provides the best learning experiences for urban, preservice elementary teachers who have never taught and might not even like science?

In order to answer these questions, we identified the following dilemmas to which we felt we had to respond (see Figure 1 for a schematic visual):

- Can we help preservice elementary teachers who suffer from "sciencephobia" overcome it?

- Can we learn from our personal experiences with preservice elementary teachers and better assist them in helping their students learn science with greater depths of understanding?

- Can we use the literature on curriculum development to build a course that will facilitate a series of positive science learning experiences?

- Can we learn from other science methods courses for urban, preservice elementary teachers and be able to apply our learning to our own context? Can we learn from similar courses taught by experienced elementary teachers at our own institution?

- Are we familiar enough with the latest research findings regarding the preparation of preservice elementary teachers to teach science in urban locations?

- How do we respond to local, state, and national standards and recommendations in the area of elementary science for preservice preparation through an elementary science methods course?

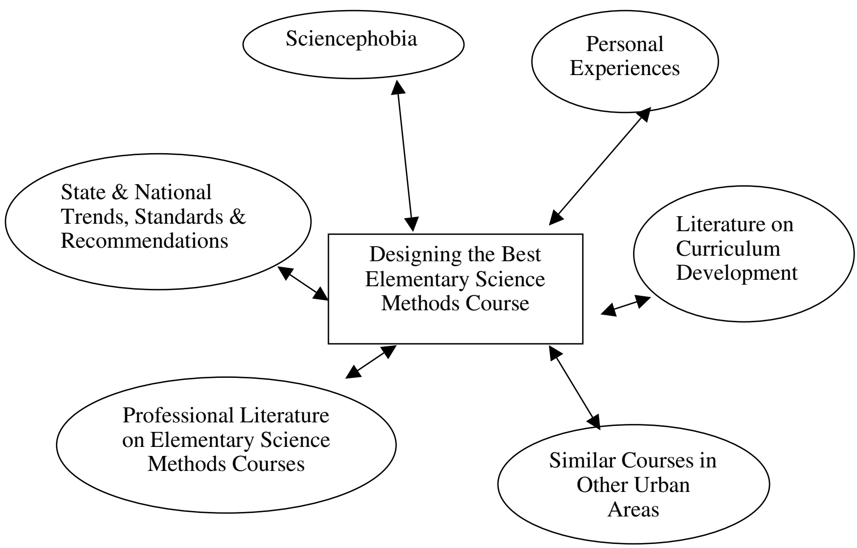
We decided to use these dilemmas as the guiding scaffolds in our search for providing the best curriculum for our preservice elementary teachers that will enable them to engage their K-8 students in meaningful and relevant inquiry science experiences as recommended by the National Research Council (NRC) (1996, 2000). It also made us realize how much we did not know and how much we had to learn about preservice elementary education in order to become effective instructors. Preservice elementary teachers' needs; their students' abilities and willingness to study science; research in the area of elementary science education and, specifically, the preservice subsection; and local, state, national, and international perspectives on preservice elementary science education are all areas we might have touched upon in the past but need a more in-depth exploration of now in light of our preparation of this course.

Design of the Study

Planning curriculum is an art as well as a science (Connelly & Clandinin, 1988; Price & Nelson, 2007). In order to plan curriculum for a new course, it is important to consider pertinent available sources of information to create an experience that represents the best fit between what is known, the knowledge and abilities of the instructor, the needs of participants and needs of their students, and the state and national recommendations and requirements. This study integrates multiple sources of information corresponding to the dilemmas considered while developing the elementary science methods curriculum (see Figure 1). Methods of data collection included reading pertinent literature, communicating with professional colleagues via e-mail and at professional meetings, and accessing Web resources. Additional data sources include reflecting on personal experiences and biases related to preservice elementary teachers, writing and analyzing field notes on our discussions during syllabus development, addressing the most updated information on state requirements, and finding out as much as we can about the preservice elementary population at our institution and the K-8 elementary students. We resorted to these diverse data sources in an effort to develop the best science methods curriculum for urban, preservice elementary teachers that will help develop their science pedagogical content knowledge (Cochran & Jones, 2003; Gess-Newsome & Lederman, 1999).

In order to define our goals in terms of the intentions behind the development and implementation of this curriculum, we used Shirley Grundy's (1987) work. We both agreed to use a science methods course covering a series of best practices in the area of science education as an empowering tool that would ultimately result in the empowerment of students in elementary classrooms while thinking, talking, and researching science. In accordance with Grundy, we define achieving curriculum goals and intentions as *praxis*, meaning the intersection between theory and practice (an approach also reinforced by Britner & Finson, 2005, specifically for inquiry science).

Figure 1. Elements for Consideration When Developing New Science Methods Courses for Preservice Elementary Teachers



What Do We Know?

Sciencephobia, or Fear of Science

From our personal experience (we each have taught one elementary science methods course in the past), as well as from reliable research-based sources, we know that some preservice elementary science teachers might exhibit sciencephobia at different levels (Appleton, 1995; Barr, 1994). Sciencephobia goes beyond not liking science or not understanding science concepts—especially when mixed with mathematics—into feelings of fear and panic. The feeling is usually associated with unsuccessful instances where participants felt they could not master science concepts despite the science instructor's multiple and highly visible attempts to teach, question, and clarify them. The fact that their peers in the science course seemed to have mastered the science concepts contributed to the lack of confidence in their ability to do so (Marlow, 1986).

Responses of a sample of 66 preservice elementary teachers enrolled in three sections of elementary science methods at a university in the northwestern part of the U.S. revealed that more than 50% evaluated their comfort level at "fair" or "poor" (rather than "excellent" or "good") for teaching science topics that were covered in the science courses they attended in college. The degree of discomfort was even higher for science concepts that the preservice elementary teachers were supposed to teach according to the state science standards but for which they had no college preparation (Moscovici, 1998).

When considering the lack of elementary teachers' confidence in science, Appleton (2006) identifies it as a barrier to their development of Pedagogical Content Knowledge (PCK):

> They [elementary school teachers] also tend to lack confidence in the adequacy of their own science knowledge and in their ability to do and to learn science for themselves. This general lack of confidence is directly attributable to limited science content knowledge but is also related to a commonly held positivistic view of science. Because some teachers feel more confident about science and some less so, confidence level is a major influence on their development of science PCK. For instance, teachers who have extremely low levels of confidence may avoid teaching science altogether and, consequently, develop little or no science PCK. (pp. 42-43)

As a solution, Appleton (2006) proposes a model (p. 31) that uses "activities that work" (pp. 38-41) as a central point that affects and is affected by science content knowledge, PCK from other subjects, context, existing science PCK, orientation to teaching and learning, and confidence. Knowledge of students and general pedagogy influences the way the teacher perceives activities that work as well as the teacher's use of science PCK in the curriculum. Following Appleton's recommendation, we decided to use a recently developed science immersion unit that addresses most of the 4th-grade life science standards in California. The immersion unit—*Rot It Right*—has the potential to involve students in a well-designed, cohesive, 4- to 6-week-long science experience on food chains and food webs via decomposition, one of the most difficult concepts in life sciences. Although relatively new, the immersion unit is highly effective when implemented properly (with a certain degree of fidelity) according to an unpublished pilot study (Dr. Kimberle Kelly, personal communication, April 2007). As the unit is part of the mandated curriculum in one of the largest districts nearby where most of our preservice teachers find employment, we are able combine Appleton's findings with district requirements.

State and National Trends and Recommendations

Inquiry science has gained momentum worldwide since the 1980s. In the U.S., it is supported at the local district level (e.g., "Instructional Guides" developed by a large neighboring local district), the state level, and the national level (California Department of Education, 2003; National Research Council [NRC], 1996, 2000). With the groundbreaking national standards for teaching and learning science in 1996, *inquiry science* became an accepted term in the science education arena: "Inquiry into authentic questions generated from student experiences is the central strategy for teaching science" (NRC, 1996, p. 31). The *National Science Education*

Standards (*NSES*) went beyond defining the place of science inquiry in teaching science to clarifying expectations from students:

> Students formulate questions and devise ways to answer them, they collect data and decide how to represent it, they organize data to generate knowledge, and they test the reliability of the knowledge they have generated. As they proceed, students explain and justify their work to themselves and to one another, learn to cope with problems such as the limitations of equipment, and react to challenges posed by the teacher and by classmates. Students assess the efficacy of their efforts—they evaluate the data they have collected, re-examining or collecting more if necessary, and making statements about generalizability of their findings. They plan and make presentations to the rest of the class about their work and accept and react to the constructive criticism of others. (p. 33)

In an effort to clarify the idea of inquiry science for classroom applications, *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning* (NRC, 2000) provides science educators with the five features of inquiry as well as a continuum as to how inquiry might look in classrooms depending on the teacher's ability and willingness to move toward a more student-centered classroom environment.

At the local level, the "Investigation and Experimentation" standards need to be infused with the other science content standards on a regular basis (California Department of Education, 2003). Examples of classroom activities illustrate the infusion and present the learner as an active participant in the learning process (California Department of Education, 2003; NRC, 2000). The immersion unit mentioned previously (*Rot It Right*) integrates content standards from the California 4th-grade life sciences with "Investigation and Experimentation" standards, following an approach to guided inquiry as described by the NRC (1996, p. 31).

In our search, we found that inquiry science was the central ingredient in all syllabi for preservice elementary science methods in over 25 urban centers in the U.S. and other countries. Topics for the different lessons would vary according to the emphasis of the course, instructor, and college. Emphases changed from science in the community, to roles of students and the teacher in science classroom environment, to the nature of science, to diversity in science teaching and learning.

Credential Requirements and Standards

During the last few years, California has restructured its credential requirements into a "Teaching Performance Assessment" system that identifies and assesses various skills of teacher candidates. Signature assignments for every course are aligned with this system and become part of the preservice teacher's electronic portfolio. In addition, a final summative assessment that follows the credential candidate during planning, instruction, assessment, and reflection dimensions certifies that the preservice teacher meets or does not meet the necessary requirements to become a professional teacher. Mirroring the National Board for Professional Teaching Standards (NBPTS) certification, the final summative assessment requires an unedited video clip that serves as part of the evidence regarding classroom teaching practices. Credential candidates also are strongly encouraged to infuse other subjects while teaching their prepared curricula.

Similar Courses in Other Urban Areas and Professional Literature

In an attempt to answer this question, we reviewed the literature (e.g., Britner & Finson, 2005; McGinnis & Pearsall, 1998; Moseley, Ramsey, & Ruff, 2004; Moseley & Utley, 2006), communicated with respected colleagues from other institutions via e-mail or in-person at professional meetings, and visited the Web pages of many experts in the field. The main ingredients that appear in most curricula and syllabi for preservice elementary teachers include inquiry science; learning cycles; active learning; cooperative groups and learning science; science as product and process (nature of science); curriculum integration; assessment strategies in the science classroom; equity and science teaching and learning; science, technology, and society; constructivism; concept mapping; curriculum evaluation; safety in the science classroom; reflective practice and professional growth; and alternative conceptions/misconceptions.

The following chart (Figure 2) summarizes the findings from other science methods courses for urban, preservice elementary teachers:

Figure 2. A Summary of the Elements Found in Science Methods Courses for Preservice Urban Elementary Teachers

Text Used	Topics	Focus	Main Product	Peer-Teaching	Teaching Inquiry Lesson in Elementary Classrooms
• One general science methods text and/or one text with case studies • Collection of articles • Websites	• Inquiry science • Learning cycles • Active learning • Cooperative groups • Nature of science • Assessment • Integration with other subjects • Equity and diversity • Technology • Constructivism • Concept mapping • Curriculum evaluation • Safety • Misconceptions • Reflective practice	Inquiry science + • Community and diversity • Technology • Nature of science • Interdisciplinary • Standards • Assessment	Science Inquiry Project (from one day to multiple weeks)	• In small groups • Individually with peer-coaching and peer-planning • Individually	• Mostly yes • Sometimes for a small group of children (part of class) • Sometimes as part of an after-school program for science enrichment

The elementary science methods courses usually include peer coaching during the lesson planning stages and peer teaching and/or teaching in a regular elementary classroom for up to four weeks in a science practicum. One program uses a science-oriented, after-school program as the "fieldwork" site, with more than 150 students attending sessions. Another program recruits and uses students in a summer camp (Hanuscin & Musikul, 2007) for fieldwork, while another uses science museums and nature centers, "places where visitors expect lively, vibrant, and engaging lessons" (Jung & Tonso, 2006, p. 19) for the same purpose. In the case of preservice teachers who are interns, fieldwork takes place continuously as they are transferring learned materials into their own classrooms. The elementary science methods course is held on university campuses or in professional development centers located on or near elementary school campuses. While some courses take place during elementary school hours and involve preservice teachers directly with elementary students, others use the facility after hours.

In terms of the text materials used to teach the science methods course, we found a wide range from two to three science methods texts (focusing on case studies, literacy, epistemology, and theories), to websites only (focusing on technology), to using a collection of articles gathered by instructors.

One of the most valuable resources for research findings in the area of preservice elementary science was the *Journal of Elementary Science Education*. While we knew about its existence, we had never searched it for articles as we had concentrated on secondary science in our previous work. While Plevyak (2007) researched the evolvement of inquiry practices during the science methods course, Jeanpierre (2006) researched the inquiry beliefs and practices of practicing elementary teachers as these align to the recommendations for "full inquiry" provided by the *NSES* (NRC, 1996). Plevyak (2007) reported that despite the preservice teachers' increased knowledge on how to implement inquiry science, they were still hesitant to do so, possibly because of a "[f]ear of science content, little experience with the areas of science, and still not understanding concepts. . . . [These] are barriers to full acceptance of inquiry as well as even implementing science at all" (p. 10). Her concern is echoed by Jeanpierre's (2006) findings which show that elementary teachers score low on students designing their own experiments (41% choosing "often" or "almost always"), analyzing data for their own research (30% choosing "often" or "almost always"), or having students work on different research questions during a class period (40% choosing "often" or "almost always"). Jeanpierre concludes that during the initial stages of inquiry science implementation, teachers might begin with "*partial inquiry*" or "*simple inquiry* tasks" [italics in text] (p. 64), findings that are aligned with Appleton's (2006) use of "activities that work" (pp. 38-41) to train preservice elementary teachers to use inquiry.

Looking at using culturally relevant pedagogy, we were impressed by two programs—one in Hawaii and one in the Philippines. Both programs moved the "science in the community" and "cultural and relevant science learning" aspects to a very high level. The program from Hawaii (Chinn, 2007) looked at science using the perspective of the native people and preservation of "indigenous knowledge and practices" that included land preservation. Using an ecocentric worldview (oriented toward sustainability of land) and focused on science-related narratives from the elderly conversant with local customs, the "place-based" curriculum addressed relevant science that was embedded in Hawaiian culture and nature while supporting teachers' agency. In the program from the Philippines (Handa, Tippins, & Thomson, 2007), preservice teachers were placed for one week in a community with which they were not familiar. Preservice teachers from the mountainous areas were asked to reside in a fishing village and vice versa. During the one-week experience, the preservice participants had a number of planned events that encouraged familiarity with science-related practices in the community. Needless to say, such culturally relevant science education practices had a significant effect on the preservice teachers' understanding of the concept of science in the community and on the ways in which they could blend science teaching and learning with this native experience.

Using What We Know to Create the Preservice Science Elementary Course: Analyses

In an attempt to integrate personal experiences with state and national requirements for science teacher preparation and expected performance and with other science methods courses, we decided to identify the goal of the course as introducing preservice teachers to inquiry science and providing experiences to infuse this idea into the elementary classroom curricula. We decided to focus the course around the following four ideas:

1. Use inquiry science as the overall umbrella—from long-term projects to daily activities utilizing essential features of inquiry as identified in *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning* (NRC, 2000). Use examples to illustrate use of inquiry science in short activities (using various collections such as Great Explorations in Math and Science [GEMS] and Full Option Science System [FOSS]) and in long-term units such as *Rot It Right*.

2. Use Appleton's model (2006) and provide participants with science experiences that will raise their confidence on three levels: (1) their ability to learn science (while getting involved in the immersion model); (2) their ability to involve others in this process and, at the same time, develop pedagogical knowledge; and (3) their ability to use the immersion model to develop a multi-day lesson plan to be tried in an elementary classroom. Use reflection in action and on action (to use Donald Schön's [1987] terms) on the development and implementation of the multi-day inquiry and begin developing PCK.

3. Help participants correlate and integrate state content standards for science and other subjects with credential requirements in preparation for the course signature assignment and end-of-the-program summative assessment that includes lesson planning, implementation, and reflection using multiple data sources, including a short video (McGinnis, McDuffie, & Graeber, 2006; Moseley & Utley, 2006; Wieseman & Moscovici, 2006).

4. Facilitate preservice teachers' development of student assessments (including something similar to "science buddies" as used in Moseley et al. (2004) and their use of student assessment data (diagnostic, formative, and summative) to improve the science experience for future implementations.

(See Appendix 1 for schematic view of course sessions—ten sessions of three hours each—and course assignments.)

In order to provide the preservice elementary teachers with a cohesive and extended science learning experience, we will be using the *Rot It Right* curriculum. Realizing that we need to include other science experiences from the areas of physical science, chemistry, and earth sciences, as well as address standards from different grade levels, we included some activities from these areas of science in our preservice elementary science curriculum. While the *Rot It Right* curriculum provides participants with an extended science experience in a more familiar area of science (biology/life sciences), we know we need to model and support their curriculum development and implementation in areas where they seem less confident (Moscovici, 1998).

Plans for the Future: The Continuing Dilemmas as Areas of Growth

We would like to be able to enhance the quality of our program by strengthening the place-based dimension of our course. Although it is difficult in a highly urban area to identify the elements of the land and decide on the need to preserve environments, it is worth trying. It is essential to develop the role of agency in these places as it relates to documented inquiry.

In addition, we would like to use the idea of K-8 students as active participants in the elementary teacher's growth as explored by Moseley et al. (2004) and expand it to include the notion of students as co-researchers as reported in Tobin, Elmesky, and Seiler (2005) for the secondary to high school levels.

Contribution and General Interest

Not once in our professional lives have we been placed in a state of disequilibrium that required us to step completely out of our comfort zone. We usually resorted to using what we know and asking for professional advice from other members of the science education community. This study provides a roadmap that addresses dilemmas of secondary science educators who are faced with entering an unknown area—the area of teaching the elementary science education methods courses and preparing preservice elementary teachers to engage their urban students in meaningful science inquiries. As we get involved in providing meaningful science education experiences, we join a new discussion group and we get involved in documented inquiry, researching the effect of the newly developed course on our preservice elementary teacher population and on their students. As secondary science faculty, we have a lot of science knowledge and a lot of experience teaching and researching various aspects of the sciences; however, we must use our background wisely and in a nonthreatening manner to be effective in teaching the elementary science methods.

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Appendix 1

Course Tasks (all written assignments need to be typed and all bibliographical references need to be listed using APA style):

1. **Unit/Lesson Plan (Signature Assignment = 40%)** – Using the *Rot It Right* curriculum as an example, each credential candidate will be required to design a mini science inquiry unit of instruction that integrates the five features of inquiry (NRC, 2000, p. 29). The mini unit should include three to five sequential lessons that integrate science, language arts, and mathematics standards and resources used (three texts, three websites, one expert, and one peer). Teach one of the lessons to your students and to the credential candidates (CCs) in class and write a reflection of student learning from the lesson and the unit. In the reflection, you should address the five features of inquiry and explain the variation used. Share copies of student work, and provide copies of the lesson presented for each class member. *Meets objectives a, b, c, d, e, f, g, h, i, j, k, l, m & n (TPE: 1A, 2, 3, 4, 5, 6, 7, 8, 9, 11, 14 d & f; NCATE: Standards 1, 2 & 4).*

   Within the unit, develop three to five lessons that incorporate the following:
   - Teacher Education Lesson Plan Format correlation using the science content standards along with applicable language arts and mathematics standards
   - Materials needed
   - Procedural descriptions for the lesson
   - Formal and informal assessments, student writings (three samples), and rubric for evaluation
   - Opportunities for student content dialogue and language development
   - Teacher instructional strategies, including questioning techniques
   - Differentiated instruction accommodating all students, including English language learners (ELLs) and students with special needs.
   - Situations in which students in the elementary classroom will develop and expand on their higher-order thinking skills.

   To earn full credit, a copy of the final unit plan must be e-mailed as an attachment to me. This is your signature assignment and will be submitted to your electronic portfolio after the hard copy has been reviewed by the instructor and revised by the candidate. To send this by e-mail, the file name should be your last name, the last four digits of your student ID, TED 416-01, and Sig. Assign. For example: Smith3456TED416-01 Sig. Assign. On the subject line, type TED 416-01.

2. **Reactions to Readings (20%)** – CCs are going to read the assigned pages/chapters/topics and write (1) three things they got from the reading, (2) how they intend to apply what they have learned to their classroom, and (3) one question connected to the readings that they need answered. All reactions must be turned in prior to class. *Meets course objectives a, b, d & k (TPE 1B: Subject-Specific Pedagogical Skills & TPE 9: Instructional Planning; NCATE 1 – Candidate's knowledge, skills, and dispositions & NCATE 4 – Diversity).*

3. **Attendance, Punctuality, and Participation Are Mandatory (10%)** – You will be allowed one excused absence if notified prior to class. You have to catch up, however, using other CCs in class. Two tardies or getting out of class early are equivalent to one absence. Please avoid disrupting our learning environment.

Meets course objectives a, b, d & k (TPE 1B: Subject-Specific Pedagogical Skills & TPE 9: Instructional Planning; NCATE 1 – Candidate's knowledge, skills, and dispositions & NCATE 4 – Diversity).

4. **Five Best Learning Experiences (15%)** – Develop a collection of *your* five best learning experiences in the science methods course (e.g., reaction to reading, lesson/unit plan preparation and presentation, journal writing) or connected to this course (e.g., implementation of the lesson/unit plan in your classroom, use of ideas from this class in other subjects). For each experience, include a description of the learning experience and a reflection as to why you consider this experience valuable. *Meets course goals e, f & h (TPE 6C: Developmentally Appropriate Practices, TPE 8: Learning about Students & TPE 9: Instructional Planning; NCATE 1 – Candidate's knowledge, skills, and dispositions & NCATE 4 – Diversity).*

5. **Journal (15%)** – During the course, you are expected to keep a reflective journal that will include a minimum of ten entries. Journal entries could be reflections on class activities, classroom implementation, "just read an article connected to class" events, etc.

Timeline

Session Date	Subject/Topic	What's Due
8/28	Syllabus, science, teaching, science standards	
9/4	Inquiry in science and in classrooms	1. Reflection for NRC (2000), Chapter 1 2. Download and bring pages from California Science Content Standards and Framework: www.cde.ca.gov/be/st
9/11	Essential features of inquiry Introduction to *Rot It Right*	Reflection for NRC (2000), Chapter 2
9/18	Images of inquiry and interdisciplinary curricula *Rot It Right* continued	Reflection on NRC (2000), Chapter 3
9/25	All students can do it [inquiry]	Reflection on Moscovici (2002) (ELL)
10/2	Classroom assessment and inquiry Assessment strategies in *Rot It Right* and application—use earth sciences	Reflection on NRC (2000), Chapter 4
10/9	Activitymania Internet searches and transformation of an activity into inquiry—use physical sciences	Reflection on Moscovici & Nelson (1998)
10/16	*Rot It Right:* Data analysis and conclusions—explanation stage (use available resources, including the Internet)	1. Unit/lesson plan (Signature Assignment) 2. Unit/lesson presentations
10/23	Questions regarding using inquiry	1. Reflection on NRC (2000), Chapter 7 2. Unit/lesson presentations
10/30	Reflective practice: Growing as a science educator	1. Five best learning experiences 2. Journal entries 3. Electronic version of the Signature Assignment

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