SCIENCE RESEARCH LESSON PLAN

Date:	March 15, 2010	March 18, 2010
Location:	Greenman Elementary School, Aurora, Illinois	Prairie Point Elementary School, Oswego, Illinois
Instructor:	Steven Rogg, Ph.D.	
Planning Team:	Steven Rogg, Emily Hergenrother, & Evelyn Mazzucco	

I. TITLE OF THE LESSON

Experience the 5E Instructional Model with Electrical Circuits

II. PARTICIPANTS

This lesson is designed for adult preservice elementary teachers enrolled in EDU3330 "Methods of Teaching Science" at Aurora University.

III. GOALS OF THE LESSON:

1. Experience a Science Research Lesson
2. Experience and recognize the phases of the 5-E instructional model (Bybee, et al., 2006).
3. Relate the 5E model to characteristics of exemplary science teaching.

IV. RELATIONSHIP OF THE LESSON TO THE STANDARDS

A. Related prior learning standards (topics/objectives)

- ♦ Candidates examined a classic case study (video) of cognitive change in which a skilled interviewer exposes a child's conceptions before, during, and after a common Grade 6 lesson on "photosynthesis" taught in apparently exemplary fashion (H. Schneps & Sadler, 1987; M. H. Schneps & Crouse, 2002).
- ♦ Candidates have read about and discussed characteristics of effective science teaching as represented in representative sources (Center for Science Mathematics and Engineering Education. Committee on Development of an Addendum to the National Science Education Standards on Scientific Inquiry., 2000; Harwood, 2004; NRC, 1996; Rutherford, Ahlgren, & Project 2061 (American Association for the Advancement of Science), 1994, Chapter 13; Sawada, et al., 2000)

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This Lesson

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B. Related post learning standards (topics/objectives)

- ♦ Candidates will work in teams at the host school to develop a Science Research Lesson which uses the BSCS 5E instructional model and this lesson as an example.

V. UNIT PLAN

This Science Research Lesson represents one experience within a one-semester university course: EDU3330. The course is not organized as instructional units (as K-12 school curriculum may be). However, this lesson certainly fits in the instructional sequence of the course. Refer to the EDU3330 schedule and syllabus for details.

VI. OVERVIEW OF THE LESSON

This lesson is designed to provide adult preservice teachers a strong opportunity to examine the inquiry-based BSCS 5E Instructional Model from both the “inside” (direct experience) and “outside” (metacognition).

Direct experience of the model is considered important given that (1) it is not likely that candidates have experienced the model while learning science themselves, and (2) if they had experienced this model, candidates would not have explicitly considered its characteristics and instructional significance. An overview of the 5E model is attached.

In this lesson, participants will experience the 5E model through a simple, common, yet challenging (for most adults) embedded lesson on “electrical circuits”.

Participants will be engaged in learning about electrical circuits as a means of experiencing the 5E Instructional Model, cognitive dissonance, exposing thinking, and (hopefully) cognitive change.

The lesson concludes with a metacognitive examination of the 5E Instructional model.

VII. Plan of the Lesson

A. ENGAGE–"Make Light"

Steps, Learning Activities Teacher's Questions/Expected Student Responses	**Teacher's Support**	**Points of Evaluation**
We have been studying the "Nature of Science" and we have argued that understanding the workings of our natural world is a powerful and essential aspect of literacy in this 21st century. Today, you are going to harness one of the powerful forces of nature! ♦ Tell Ss that they are to **work independently until instructed otherwise**. ♦ Remind Ss to use their lab notebooks to **record all trials**. ♦ Invite Ss to collect materials. When everyone has collected materials, provide the initial challenge: "***Make Light***"	For each student: ♦ 3"×9" (approx.) strips of aluminum foil ♦ 2 D-Cell batteries ♦ 1 2D flashlight bulb Materials are available in supply bins on the equipment table to be picked up "smorgasbord style". An example set-up is provided on a tray so that Ss know what they need. <u>Alternative</u>: Package and distribute each materials set in a brown paper lunch bag.	Does everyone engage independently with the materials? Do students have journals ready to record their trials?
Anticipating Student Responses…		
Ss may ask for clarification or more instructions. Simply repeat the invitation to "make light" using the materials supplied. Some may hesitate to "experiment". Encourage them to try out their ideas. Ss attempts may appear random or without purpose. Ask them to say what they are thinking ("talk aloud"). Remind them to record their thinking and trials in the journal. Encourage Ss to use their "powers of observation". Observing the materials carefully may help them find solutions.	A clipboard and seating chart may be helpful for assessing Ss engagement. Consider a timer to see how long it takes for solutions to be discovered. This could be of interest in the discussion later.	Do **NOT** show Ss how to make connections. Someone will eventually discover a way and solutions will disseminate from that. **Scan the room** to see that everyone has the materials and is engaged independently.

B. EXPLORE–Ways to make light.

<table>
<tr><th>Steps, Learning Activities
Teacher's Questions/Expected Student Responses</th><th>Teacher's Support</th><th>Points of Evaluation</th></tr>
<tr><td>♦ Ss are expected to struggle with configuring the materials in ways to make the bulb light up (see "Anticipating Student Responses", below). They will also "discover" different initial solutions, and at different times.
♦ Remind Ss to document all trials – those that "work" and those that "do not." All results are important.
♦ As individual Ss identify solutions, invite them to document this on the Whiteboard.
♦ Now invite Ss to find at least 3 solutions.
♦ Now invite table groups (neighbors) to work collaboratively.
♦ As viable solutions are recorded, invite Ss to invent a "general rule" for making light with these materials.</td><td>♦ Use the whiteboard to document solutions as they are discovered.
♦ Challenge Ss to identify additional solutions.
♦ As solutions begin to emerge, allow Ss to begin working collaboratively.</td><td>Check that solutions documented on the whiteboard are viable.

Invite Ss (especially those still struggling) to test posted solutions by replication.</td></tr>
<tr><td>Anticipating Student Responses…</td><td></td><td></td></tr>
<tr><td>Although this is a common activity ("Batteries and Bulbs") for Grades 4 and up, adult students often struggle with this task.

Attempts may include wrapping the batteries in foil (which is not necessary) and short-circuiting the battery-which generates readily observable heat rather than light.

With success, Ss may recognize that only one battery is actually needed.

Ss may also observe that more batteries in series increase the brightness (intensity) of the light.</td><td>When Ss short circuit the battery they might notice that the foil can become hot to the touch. The heat can be intense enough to become uncomfortable.

Do not explain this, yet.

Instead, suggest that this effect is "real" and should be noted in their lab journal.</td><td>Observe Ss interacting with the materials.

Encourage Ss to define a "general rule" for making light with these materials. The rule should apply for all documented solutions.</td></tr>
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C. EXPLAIN-Circuit as "Path"

Steps, Learning Activities **Teacher's Questions/Expected Student Responses**	**Teacher's Support**	**Points of Evaluation**
♦ Invite Ss to share their ideas for a "**general rule**" that explains the requirements for making light with these materials. ♦ Working with the solutions posted on the whiteboard, develop the idea that the circuit as a complete path. • First identify the simplest model. • Test "predictions" on the more complex models.	♦ Compare "general rules" constructed by Ss. ♦ Invite examples of the common use of the idea "circuit"	Remind Ss to record their thinking in their journals.
Anticipating Student Responses…		
♦ Ss may not see that the "short circuit" (when they made heat but not light) is also a complete path, only without the "load" – a light bulb in this case. In this special case the path is from the power source through the conductor to the power source. ♦ Ss may be surprised by two-battery circuits where one battery is in a closed circuit with the bulb (which lights) but the other battery is short-circuited. The key here is to observe that the bulb is lit with "one battery intensity" only.	♦ Examples might include a newspaper route, a concert tour, recycling, etc.	It is important to make certain that two ideas are clear: the circuit is a "closed path" which continued through the bulb.

D. ELABORATE-The Circuit Inside

Steps, Learning Activities **Teacher's Questions/Expected Student Responses**	**Teacher's Support**	**Points of Evaluation**
♦ Demonstrate the "dissection" of a standard bulb. ♦ Distribute bulbs with clear glass so that Ss might observe the construction directly. ♦ Point out (and insist upon) the late Arnold Arons' dictum "***Understanding first, terminology later***." ♦ **METACOGNITION**-Distribute and discuss the 5E Instructional Model.	♦ Large bulbs with clear globes (for observing) ♦ Standard 60W light bulb (for dissection) ♦ Light bulb base with extension cord. ♦ Goggles ♦ Gloves ♦ Triangular file ♦ 5E Instructional Model Handout (1 copy each)	Collect a carbonless copy of lab notes. Do our general rules predict the more complex circuits?

Steps, Learning Activities **Teacher's Questions/Expected Student Responses**	**Teacher's Support**	**Points of Evaluation**
Anticipating Student Responses…		
♦ Ss may try to light the 60W bulbs by stacking batteries. Allow this for a while. They will discover that this does not produce visible light.	♦ Use this as an opportunity to make it ABSOLUTELY clear that the wall socket is 120V AC while the batteries are a mere 1.5V DC. While the batteries are not capable of delivering a dangerous electrical shock, the wall outlets are **very dangerous**. In fact, the 60 Hz. AC current is a resonant frequency of the human heart – making it highly hazardous.	♦ Why does a stack of batteries fail to light the 60W bulb? ♦ Why are the batteries not dangerous? ♦ Why is the wall outlet so very dangerous?

E. EVALUATE-The 5E model and the Science Research Lesson

Electrical "circuits" is a common and popular topic in elementary science texts. Yet, teaching the topic "electrical circuits" turns out to be inherently complex and time-consuming. This is a conclusion drawn from a wealth of literature on the subject (c.f., Duit, Neidderer, & Schecker, 2007). Remarkably, Project 2061 even suggests that teacher consider avoiding this topic since the instructional costs might not be worth the intended benefits (Project 2061 (American Association for the Advancement of Science), 2001).

Given these concerns, we want to know how well the format serves as a context for adults learning about the 5E Instructional Model. Is it too complex? Does the struggle with the circuit idea overwhelm our primary goals?

Likewise, this lesson is expected to provide a foundation for an exploration on children's' thinking, and especially cognitive change. We would like to know if the adult learners' experience is one of cognitive change. If so, are they likely to recognize how the implement a 5E model in a way that effectively stimulates cognitive change for children?

Steps, Learning Activities Teacher's Questions/Expected Student Responses	Teacher's Support	Points of Evaluation
♦ Assemble the Research Lesson Panel. ♦ Using the 5-E overview, invite Ss to identify each of the stages, in temporal order, of the lesson that they just experienced. ♦ Continue with a whole-class discussion of the relevance of the 5E Instructional Model and this experience of a Science Research Lesson.	♦ Copies of the 5-E model overview handout. ♦ Copies of this plan.	Do Ss recognize how the 5E model was applied in this investigation?
Anticipating Student Responses…		
Ss should be able to identify the stages with the handout provided. Ss might not recognize that THIS STEP represents the Evaluation Stage.		Do Ss see the value of this model?

VIII. References

Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Carlson Powell, J., Westbrook, A., et al. (2006). The BSCS 5E Instructional Model: Origins and Effectiveness (pp. 43). Colorado Springs, CO: BSCS.

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