SCIENCE LESSON PLAN FOR PRE-SERVICE SECONDARY TEACHERS

For the lesson on: October 29, 2008
At: DePaul University
Instructor: Evelyn Mazzucco
Lesson plan developed by: Evelyn Mazzucco, Emily Hergenrother, & Steven Rogg

1 TITLE OF THE LESSON

TEACHING & LEARNING NEWTON'S SECOND LAW: MASS HYSTERIA

2 PARTICIPANTS

This lesson is designed for adult preservice secondary teachers enrolled in T&L 439 "Teaching and Learning Secondary Science". The T&L ("Teaching and Learning") program at DePaul University leads to a Masters of Education degree with secondary teaching certification in biology, chemistry, environmental science, or physics.

3 GOALS OF THE LESSON:

1. 2008-09 general goal for the Chicago Lesson Study Group:
   Increase student self-efficacy.
2. 2008-09 specific goal for the science team:
   Increase student self-efficacy in science through success in a challenging experience requiring analytical thinking about natural phenomena.
3. This lesson: **Teaching**- Experience teaching a common concept (F=MA) in an uncommon way: The Learning Cycle as framed by the BSCS 5-E model (Bybee et al., 2006).
4. This lesson: **Learning** – See the learning experience from the perspective of high school students. Anticipate student responses to each step of the 5-E BSCS Learning Cycle. This will be embedded in the activity sequence and made explicit during the research lesson panel discussion.
5. This lesson: **Curriculum** – Recognize probable strengths and weaknesses in published curriculum materials. This lesson was based on the Active Physics™ *Predictions* module Activity 6: "*The modern cart and book experiment*". During lesson design, the team discovered a discrepancy (p. 166, paragraph 4) that could lead to confusion. During the Panel Discussion, the lesson design team will discuss how they revised the lesson accordingly.
6. This lesson: **Technology** – Experience using computer-based motion detector to capture and analyze (make sense of) data. Use of the Vernier™ system is a means to readily collect sufficient numbers of data points for multiple trials.
7. This lesson: **Professionalism**-introduce preservice teachers to Lesson Study as a viable form of professional development. The lesson was prepared during lesson study, will be experienced as a research lesson, and will be discussed with participants during the post-lesson panel. Since participants are preservice educators, they will be invited to participate in the post lesson panel as participant-observers.

4 RELATIONSHIP OF THE LESSON TO THE STANDARDS

4.1 RELATED PRIOR LEARNING STANDARDS (TOPICS/OBJECTIVES)

This lesson is intended to complement (and potentially assess) to some degree each of the three School of Education program standards assigned to T&L 439: **5. Content Knowledge**; **8. Planning for Instruction**; and, **10. Instructional Delivery**.

5. Content Knowledge. Understands the central concepts, tools of inquiry, and structures of the discipline(s) he or she teaches and can create learning experiences that make these aspects of subject matter meaningful for students.

In the T&L program, content knowledge goals are to be achieved in the content courses taught in the College of Liberal Arts and Sciences. However, this goal also contains the reference to the need to "make … subject matter meaningful to students." Therefore, T&L 439 should provide opportunities for teacher-candidates to develop understandings about how to make content meaningful with a special focus on pedagogical content knowledge (PCK) (Shulman, 1986). This lesson is intended to experience and demonstrate ways to make content knowledge meaningful for students using the 5-E learning cycle instructional model. Specifically, students are provided time to engage natural phenomena as they generate, communicate and extend explanations. The specific content is related to Illinois Learning Standards Goal 12.D. replicated here.

D. Know and apply concepts that describe force and motion and the principles that explain them.

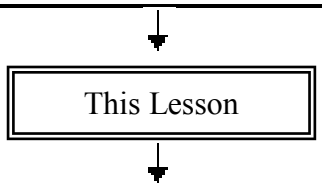
MIDDLE/JUNIOR HIGH SCHOOL	EARLY HIGH SCHOOL	LATE HIGH SCHOOL
12.D.3a Explain and demonstrate how forces affect motion (e.g., action/reaction, equilibrium conditions, free-falling objects).	**12.D.4a** Explain and predict motions in inertial and accelerated frames of reference.	**12.D.5a** Analyze factors that influence the relative motion of an object (e.g., friction, wind shear, cross currents, potential differences).
12.D.3b Explain the factors that affect the gravitational forces on objects (e.g., changes in mass, distance).	**12.D.4b** Describe the effects of electromagnetic and nuclear forces including atomic and molecular bonding, capacitance and nuclear reactions.	**12.D.5b** Analyze the effects of gravitational, electromagnetic and nuclear forces on a physical system.

Source: http://isbe.net/ils/science/standards.htm

8. Planning for Instruction. Plans instruction based upon knowledge of subject matter, students, the community, and curriculum goals.

The BSCS e-5 model is offered as a template for planning for instruction. Likewise, the Lesson Study process if suggested as a means to develop professional habits for planning.

10. Instructional Delivery. Understands and uses a variety of instructional strategies to encourage students' development of critical thinking, problem solving, and performance skills.



4.2 RELATED POST LEARNING STANDARDS (TOPICS/OBJECTIVES)

Following this lesson is an application of the 5-E Learning Cycle model in the evaluation of extant curriculum materials.

5 UNIT PLAN

Please refer to the attached schedule.

6 OVERVIEW OF THE LESSON

[THIS IS TO BE REWRITTEN FOR LESSON RE-TEACH]

According to Duit, et.al., (Duit, Neidderer, & Schecker, 2007) and (Newton, 1687) & Rosalind Driver…

"*Lex II: Mutationem motus proportionalem esse vi motrici impressae, et fieri secundum lineam rectam qua vis illa imprimitur."*

Translates to:

"The rate of change of momentum of a body is proportional to the resultant force acting on the body and is in the same direction." (http://www.answers.com/topic/newton-s-laws-of-motion)

7 SEQUENCE OF THE LESSON

Steps, Learning Activities Teacher's Questions/Expected Student Reactions	Teacher's Support	Points of Evaluation
7.1 INTRODUCTION (5:30 PM., 10MIN.)		
Welcome the class and introduce the idea of "Lesson Study". Welcome the guests. Acknowledge the cameras. Offer consent forms. Position anyone who does not consent to be on videotape away from the view of the cameras.	Adult Consent Forms (2 copies each)	Does everyone appear comfortable with this?
7.2 POSING THE PROBLEM		
7.2.1 Phase 1: ENGAGE		
7.2.1.1 Part A: Observe and describe the static system. What is going on? (5:40PM, 10min.)		
Students observe the statics of the system that represents relationships between forces and objects (masses). **DO NOT** introduce the terms "mass", "force", "acceleration", etc. yet. Have students describe in common language. • Do not touch or move the materials-yet. Anticipated student responses: • The hanging weight is pulling on the cart through the string. • Gravity pulls on the hanging weight. • Students will (hopefully) want to know the mass of the cart and the hanging mass.	**Materials**…. For the teacher: • Know the mass of the cart and hanging mass. For each student: • Lab journal (carbonless copy) For each group: • Mass & pulley system with *Vernier* motion detectors and laptops loaded with *LabPro*.	• Does everyone engage independently with the materials?

Steps, Learning Activities **Teacher's Questions/Expected Student Reactions**	**Teacher's Support**	**Points of Evaluation**
7.2.1.2 Part B: Predict what will happen in the dynamic system. (5:50PM, 10min.)		
ASK: ***What will happen when the cart is released?*** Notice the boundary conditions at (1) the transition from rest to motion, and (2) at the end of the run. To coincide with first boundary condition, it should be noted that something prevents the cart from moving. • Sketch ***predicted*** graphs on newsprint. • How do features of the graph relate to the motion of the cart? • What part(s) of the graphs is useful for your analysis? • What causes the motion of the cart? • What moves when the system is in motion?	• Postit newsprint pads	• Listen in on group discussions. • Look at some of the student journal entries. • Ask groups to post expected graphs on newsprint.
7.2.2 Phase 2: EXPLORE		
7.2.2.1 Part A: Qualitative Observations – Run the cart. (6:00PM, 10min.)		
• At least 2 test runs with no data		
7.2.2.2 Part B: Quantitative Data Collection – Produce the graphs. (6:10PM, 10min.)		
• Complete at least 2 runs producing graphs		
7.2.3 Phase 3: EXPLAIN (6:20PM, 15min.)		

• Add the ***achieved*** graphs onto the newsprint that has the ***predicted*** graphs.
• Interpret your graphs. Put **in words** what the graphs tell you.
• What data do you need concerning the static system?
  • Anticipated student response:
  • the mass of the hanging weight
  • the mass of the cart
  • Gravitational constant, 9.8m/s2
	• Newsprint.	

Steps, Learning Activities Teacher's Questions/Expected Student Reactions	Teacher's Support	Points of Evaluation
7.2.4 Phase 4: ELABORATE		
F=MA? (Newton's second law) What do the letters in the equation stand for in words? What do they stand for in the elements of your experiment? Does your data tell you the same thing as Newton's equation? a. If it is not exact, point out the discrepancy. b. Can you explain the discrepancy?	• (continued)	
7.3 ANTICIPATED STUDENT RESPONSES		
7.4 COMPARING AND DISCUSSING		
Let each group explain the relationship of their graphs to F=MA		Remind Ss to record their thinking in their lab journals.
7.5 SUMMING UP		

8 EVALUATION

8.1.1 Phase 5: EVALUATION

[In this case we use the Post-Lesson Panel Discussion as the final stage of the 5-E model: Evaluation.]

9 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. Colorado Springs, CO: BSCS.

Duit, R., Neidderer, H., & Schecker, H. (2007). Teaching Physics. In S. K. Abell & N. G. Lederman (Eds.), Handbook of research on science education (pp. 599-629). Mahwah, N.J.: Lawrence Erlbaum Associates.

Newton, I. (1687). Philosophiæ naturalis principia mathematica. Londini,: Jussu Societatis Regiæ ac Typis Josephi Streater. Prostat apud plures Bibliopolas.