May 18, 2009
version 1

Interview Protocol

I. Warm-up

1. Warm-up subject. Get background and experience.
2. Pose two driving questions.
   - Could a magnet affect an electric current? How or why?
   - What are some of the ways that you could make a magnet?

II. Sim

1. Play with sim (either VM or NM)
   - Think out loud.
   - Allow up to 45 minutes of uninterrupted exploration.
2. After exploration, pose this question: In all the cases shown in the sim, there is one principle (called *Faraday's Law*) that describes what makes the light bulb turn on. Try to state this principle as generally (and as simply) as possible. Make sure your statement works for the "Pickup Coil", the "Transformer" and the "Generator".
3. Rank difficulty of learning Faraday's Law from 1-5.

III. Flux Lesson

1. Explain: "Now I'd like to work through a concept that we use in physics called flux. Flux describes the rate (speed) of flow through a given area."
2. Work through the following steps verbally, assisting student along the way to learn flux.
   - Think of a room fan blowing air. Draw the fan and the air flow around it. Where is the air moving fast and slow? What direction is the flow at various points?
   - Think of a windsock (the sock part is not as important as the hoop part). If "flux" is a measure of how much flow there is through the hoop, how does the flux compare when the following variables are changed: flow speed, loop area, loop orientation.
3. Referring to a vector field drawing (the student's own, if it's good enough), pose the questions about the factors that determine flux. Correct answers and explain where necessary.
4. Rank difficulty of learning the meaning of flux from 1-5.

IV. Follow-up Activity

1. Look again at both driving questions.
2. Further questions:
   - Have you ever heard of a "magnetic field"? Describe your impression of a magnetic field and draw a picture of it.
   - What are the differences and similarities between a bar magnet and an electromagnet?

- After hearing about Faraday's Law, a student suggests that maybe you could build a bicycle light using this idea. She has a light bulb, a magnet and a lot of wire. How would you design the bicycle light?
- Suppose the bike light was made, but it was not shining brightly enough. What are some ways that you could make the light brighter?
- When a magnet is moved next to a bulb that is attached to a wire coil, the bulb lights up. Describe (as precisely as you can) how you should move the magnet for the brightest light.
- A battery is connected to a coil of wire and held near a bulb (which is connected to its own coil of wire). When you change the battery voltage, the light bulb flashes. What causes the bulb to flash?

3. Explain: "Now we'll move to the desk, where we have real equipment similar to what's in the sim." Final question: Look at the lab equipment. Identify the following parts: compass, wire coil, bar magnet, and meter.
   a. If you connect the wire coil to the meter, predict what will happen when you move the magnet beside or through the coil. Explain your reasoning. Now check your predictions.
   b. Explain what is happening in the meter and coil as you perform the actions above. How would you change the apparatus to make the meter react more strongly?
   c. Suppose you hold the coil and magnet flat (horizontally) at the same height. [Interviewer will demonstrate.]
      i. What would you expect the meter to do when you move the magnet horizontally?
      ii. Suppose the coil is then rotated 90 degrees (but keeping the edge toward the magnet). What would you expect the meter to do when you move the magnet horizontally? Explain your reasoning. Now check your predictions.

V. Lenz's Law Activity

1. Explain: "You will now watch a video that teaches about Lenz's Law. This is a lesson that often comes soon after learning about Faraday's Law in a physics class. It is a difficult lesson, and it will only be presented in the video, without any further help or explanation. After the video, I'll ask a couple of questions about Lenz's Law with the sim and equipment."
2. Watch video (10 minutes).
3. Questions (using NM sim in the transformer tab, with compass selected):
   - Suppose the electromagnet is quickly brought close to the pickup coil. Predict the direction of the current in the pickup coil during the motion. Explain your reasoning. Now test your prediction. Predict and explain what happens when you move the electromagnet away from the pickup coil.
   - Suppose the electromagnet's battery voltage is changed from its current value (+10V) to zero. Predict the direction of the current in the pickup coil during this change. Explain your reasoning. Now test your prediction. Predict and explain what happens when you change the voltage from 0V to -10V (with the control at the left of the slider).
   - Suppose the pickup coil could be rotated by 90 degrees. Predict the direction of the current in the pickup coil during this change. Explain your reasoning.
4. Rank difficulty of learning Lenz's Law from 1-5.