Designing Guided Inquiry Activities

Introduction

Teaching philosophies are becoming institutionalized into effective paradigms based on educational case studies, supplied by commercialized resources, and supported by a broad community of professional instructors. One example includes the well established POGIL approach, or Process Oriented Guided Inquiry Learning, used by chemical educators at both the high school and college level (the main site can be found here). POGIL's mission is to assist small student groups with individual roles through a learning cycle of exploration, concept invention, and application in carefully designed classroom activities. These notes are based on a presentation given by Dr. Renee Cole (renee-cole@uiowa.edu) at the University of Iowa (4 Mar., ’13) as part of a Center for Teaching event.

A simple question to ask before incorporating an activity into the classroom is:

- Have you completed the activity yourself and found it to be an adequate representation of the material?

Your answer to that question gives insight into how that activity is reflected in your course; it either serves as a grade item or reference tool.

Modeling Learning

There are three phases to the Learning Cycle that frames a POGIL activity:

1. Exploration (E): Collecting information, and examining data in the model.
2. Concept Invention/Term Introduction (I): Finding patterns in the data and converging on the concept by asking questions that analyze, compare, and contrast.
3. Application (A): Testing of the concept through application to new contexts.

It is interesting to note that an instructor will often progress through this same cycle when creating the first draft of an activity. However, the last portion of the diagram requires that activities be continually reworked as students present new challenges and classroom environments.

Students are introduced to these new concepts in small groups of three, with designated roles so that they may work efficiently from one packet of exercise material. These roles are similar to those identified in the Active Learning scheme (Manager, Scribe, Sceptic found here) used by the University's Astronomy Labs and are defined below:

- **Manager:** organizes the activity of the group and assists in completing questions
- **Reader:** reads questions out loud to help keep the group together
- **Facilitator:** indicates when to proceed to the rest of the activity

The model defines the basic unit of a POGIL and it functions as a representation of reality that will be explored by the students. Examples include the nuclear atom, a physical specimen, or a graph of limited data. These models do not have to be perfect, they are meant only to introduce the main concept to students and help them to reach a specific learning objective. Often, it is necessary for the instructor to proceed in designing an activity iteratively (through trial and error) or in reverse (by starting with learning objective and working backwards to prerequisite knowledge). Students are encouraged to explore the model and use it as a workspace for the activity.

Once an example is introduced, critical thinking is controlled by the order of questions as they appear in the exercise handout to guide the students’s thought process with a scaffold ending in the learning objective. The wording of these questions is very important and successful strategies can only be identified after the development, implementation, and assessment of an initial idea. Pre/Post lab quizzes may also be employed as an additional metric for assessment. Does the students’ feedback match with your expectations?

Types of questions can be divided into three categories:

- **Directed (D):** fixed answer identified through recall, assesses prerequisite knowledge, short phrase is sufficient answer
- **Convergent (C):** fixed answer identified by the synthesis of knowledge, reflects a group's development/discussion of a conclusion using known facts, longer answer requires argument to be defended
- **Divergent (V):** multiple possible solutions limited only by the exploration of the students, answers can be opinion based or supported by external research

As an Exercise, identify how each question below may be classified:

- What is the mathematical relationship represented by the data points on the graph?
- What is the charge on a sulfate anion?
- What type of bacteria is found on this plate?
- How might scientists experimentally determine the mass of a proton?
- Which molecule in the list would you predict to have the highest boiling point?
- Where would be the optimal location for a new water treatment plant?

The motivation for using a model-based approach in an activity with ordered questions is to guide students to the completion of a specific learning objective. However, these learning objectives must be measurable and therefore require an assessment system (see Bloom's Taxonomy). As an additional Exercise, examine a class activity of your own:
• Describe the structure of your activity. How are the questions sequenced and what is their relationship to the information in the model or presented material?
• Assign to each of your questions a label for the question type (D,C,V) and level of understanding (Bloom's Taxonomy)
• Identify the question in which a concept is first defined/introduced as a specific term. Should this appear sooner or later? Or has it already been discussed in lecture?
  • In which question are students likely to first develop the concept associated with that term?
• How might a divergent question fit into your activity? Can such a question function as an out of classroom extension of the material?
• Step back from the activity and locate where students follow the three phases of the Learning Cycle (E,I,A)

Ending with a caveat, a quick Google image search reveals that "learning cycle" includes any set of words whatsoever that you wish to throw into a trendy circle. You may include whatever terms you like so long as they conceptually function for your teaching style and your student's educational needs.