POGIL provides a research-based structure and methodology for changing the way you teach. It is a student-centered method of instruction that provides opportunities to teach both discipline content and essential learning-process skills simultaneously.

Students learn better when they are -

- Actively engaged and thinking in the classroom and laboratory.
- Drawing conclusions by analyzing data or models and discussing ideas.
- Working together in self-managed teams to understand concepts and solve problems.
- Reflecting on what they have learned and how to improve.
- Interacting with an instructor as a facilitator of learning.

The NSF-supported POGIL National Dissemination Project is directed at improving student learning by facilitating the use of process-oriented guided-inquiry curriculum materials and pedagogies.
A Research-Based Cognitive Model Supporting POGIL

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A cognitive model is

- a representation of mental processes.
- For example, the sage-on-the-stage model for learning.
  - Input
  - Storage
  - Output
A cognitive model guides

- development of curriculum materials.
- implementation of teaching strategies that enhance conceptual understanding and problem solving.
- design of assessment and evaluation.
- research on learning and teaching.
A cognitive model can be derived from

- research in the cognitive sciences.
- the continuum of changes that occur as novices develop and become experts in a discipline.
- experimental data testing the validity of proposed cognitive models.
Origins of the proposed model.

- Johnstone’s information processing model.
- Novice – expert comparisons.
- Research on visualizing and connecting macroscopic, particulate, and symbolic representations.
POGIL is based on research: people learn by -

- Constructing their own understanding and knowledge in a process involving prior knowledge, experiences, skills, preconceptions, attitudes, and beliefs.
- Following a learning cycle of exploration, concept formation, and application.
  - Perception Filter & Controller decides what gets through.
  - Librarian decides how to link new knowledge with existing knowledge and what gets retrieved.
  - Guided Inquiry exercises these units and forces them to make sense of new knowledge.
POGIL is based on research: people learn by -

- Discussing and interacting with others.
- Verbal Processor helps the Librarian.
- Learning teams provide opportunities to exchange ideas and confront misconceptions.
- Reflecting on their progress.
- Assessing their performance.
- Reflector carries out these functions and improves the performance of the Librarian and Perception Filter system.
- Reflector’s Report requires that the Reflector be utilized.
POGIL is based on research: people learn by -

- Visualizing concepts in multiple representations, for chemistry macroscopic, nanoscopic, and symbolic.
  - Visual Processor & Analyzer help the Librarian
  - Analyze models in different representations, change representations, and come to conclusions

- Interconnecting conceptual and procedural knowledge in a hierarchical structure.
  - Librarian decides how to organize knowledge in long term memory.
  - Learning Teams & Integrative Activities
Use the Verbal and Visual Processors

- Explaining to others
- Drawing pictures and diagrams
- Reorganizing in lists and tables

- Helps the librarian store and retrieve knowledge effectively and efficiently
Use the Reflector / Analyzer to strengthen brain processes.

- Think about what your are doing well and how you can improve.
- Such thoughts actually change the way the brain works.

*WSJ, 1/19/2007, p. B1*
So in a POGIL Classroom –

- Students work in self-managed teams
- on specially designed guided-inquiry activities
- to develop learning process skills in key areas
- and master course content
- with an instructor who is a coach or facilitator not dispenser of information.
Designing POGIL Activities
Stages of a POGIL Activity

- **Orientation**
  - Motivation, cognitive hooks, overview, prerequisites.

- **Exploration**
  - Generate a need to know.

- **Concept formation or invention.**

- **Application**

- **Closure**
Activity Types

- Exploration of a model.
- Writing assignment.
- Problem-solving session.
- Student teaching.
- Individual project or paper.
- Research project.
- Group discussion.
- Debate.
- Student presentation.
- Interviewing.
- Self-assessment.
- Peer-assessment.
- Reflection on learning.
- Team learning.
- Use of technology.
- Problem-based learning.
- Case studies.
Models to Explore

- Figure.
- Graph.
- Table of data.
- Written relationships.
- A methodology.
- Discussion.
- Demonstration.
- Examples.

- Laboratory activity.
- Student lecture notes.
- Student reading notes.
- Interactive computer simulation.
- Animation or film clip.
- Lecture or mini-lecture.
- Reading assignment.
Key Questions Guide Exploration

- Directed - Exploratory
  - Students process and recall information. Answer found directly in the model, information, or resources.

- Convergent – Concept Formation
  - Students make connections and reach conclusions. Answer not directly available, requires analysis and synthesis.

- Divergent
  - Students expand on their new knowledge by pondering, further exploring, and generalizing.
Examples of Key Questions

- What is the weakest type of intermolecular interaction identified in the model?
- What insight has your team gained from the model about why some materials are gases and others are liquids or solids at room temperature?
- What are other examples from your own experience of each type of intermolecular interaction?
Exercises and Problems

- Determine how much energy it takes to heat 100 g of water from 22 °C to 80 °C. The specific heat capacity of water is 4.18 J/g °C.

- Burning propane (C$_3$H$_8$) produces gaseous carbon dioxide and water. The enthalpy of combustion is -682 kJ/mole. Determine how much water you can heat from room temperature (22 °C) to boiling (100 °C) with 1 pound of propane. The specific heat capacity of water is 4.18 J/g °C.
Real-World or Level 2 Problem

- You are camping at your cabin in the woods. You have \( \frac{1}{4} \) pound of propane remaining in the tank. Will you be able to take a hot bath tonight?
Instructional Design Methodology

- **Setup**
  - Organize by topic and subtopic.
  - Identify learning objectives.
  - Identify success criteria.
  - Put together an appropriate activity.
Components of an Activity

- Establish a need to learn.
  - Why is this activity important.

- Make a connection to the research/technology frontier.

- Make a connection to prior understandings and knowledge.
  - What do you know about …?  
  - What do you predict for …?  
  - How do you explain …?  
  - Use the literature on misconceptions for ideas.
- Provide a guided inquiry.
  - Use key questions to explore a model.
- Provide exercises.
  - Simple or familiar applications.
- Check understanding.
  - Ask one or two concept questions in a *Got It!* section.
- Provide problems.
  - Complex applications.
  - Applications in new contexts.
Support problem solving.

- Students work together.
- Model and require the use of heuristics.
  - Understand & analyze, plan, execute, and validate & interpret.
- Model and require the use metacognition for both examples & problems.
  - Connect both conceptual knowledge and procedural knowledge to the solution.
- What was done?
- Why was it done?
Integrate the new knowledge with prior knowledge in a *Making Connections* section.

Reflect on how to apply the new knowledge in new situations in a *What If?* section.

Reflect on what was learned.

Assess how the learning process can be improved.

Provide readings, additional exercises, examples, and problems for reinforcement and practice.
Resources for Activities

- www.pogil.org
- www.pccrest.com
- www.pltl.org
- http://Bioquest.org
- Published materials, samples available.
- Use learning objects for exploration.
  - www.merlot.org
  - NSDL projects
  - Other internet sites