

What is Process Orientated Guided Inquiry (POGIL)?

Diane M. Bunce
Chemistry Dept.
The Catholic University of America
Washington, DC

Process Orientated Guided Inquiry (POGIL)

POGIL is both a

- Curriculum
- Teaching Method

▶ POGIL is based upon

- Constructivism
 - Students construct their own knowledge
- Information Processing
- Learning Cycle
 - Exploration
 - Concept Invention
 - Application

- ▶ To understand POGIL, you must experience it
 - Warm up Activity to demonstrate the process of POGIL

- ▶ Arrange yourselves in groups of 4
- ▶ Each group should elect the following:
 - Leader
 - Facilitator (Reflector)
 - Recorder
 - Reporter

3 Minutes

Assign Group Roles

Leader

Keep group on task

Facilitator

Make sure that everyone has a chance to contribute

Recorder

Keep record of group's work

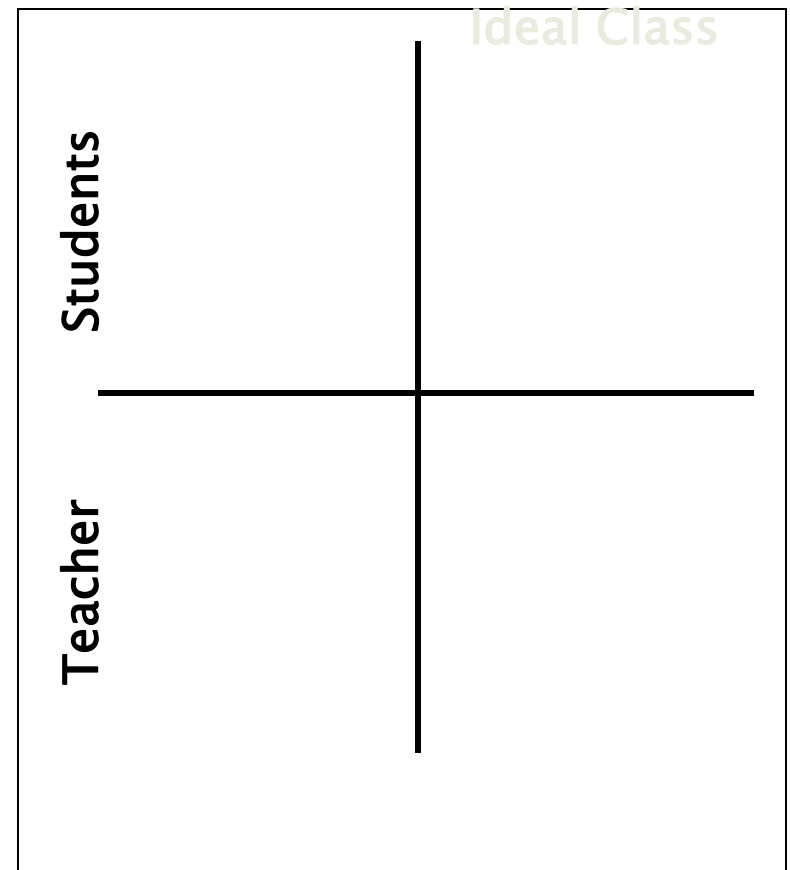
Reporter

Present group's work to the entire audience



Problem: Your *Real* and *Ideal* Classroom

- ❑ Draw two lines on a blank piece of paper
- ❑ Label the drawing as shown at the right
- ❑ Think about a particular class that you are teaching or have taught recently



Your *Real* and *Ideal* Classroom

4 Minutes

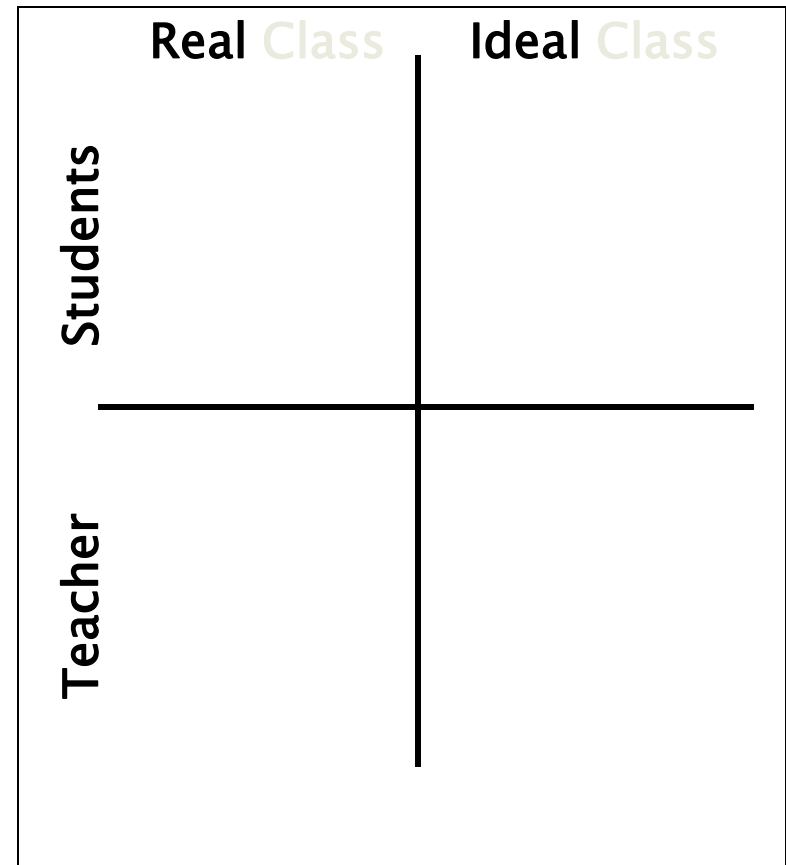
- ▶ In the upper two quadrants, list 3-6 verbs that describe what your students do (real), or what you would like them to do (ideal) during a typical class.
- ▶ Avoid the word “learn”. Be more specific

	Real Class	Ideal Class
Students		
Teacher		

Your *Real* and *Ideal* Class

2 Minutes

- ▶ In the lower two quadrants, list 3-6 verbs that you as a teacher do (real), and 3-6 verbs that you would like to do (ideal) during a typical class.
- ▶ Avoid the word “teach”. Be more specific



Real and Ideal Classroom - Reporting Out

Real Student Verbs

Ideal Student Verbs

Real and Ideal Classroom - Reporting Out

Real Teacher Verbs

Ideal Teacher Verbs

Barriers to the Ideal Classroom

- ▶ Individually identify barriers which prevent your “real” class from being “ideal”.

1 Minute

- ▶ As a group, identify your top three barriers from the individual responses in your group.

3 Minutes

Real and Ideal Classroom - Reporting Out

Barriers to the Ideal Classroom

Exploring the POGIL Curricula

- ▶ Structure of a POGIL Activity
 - Presentation of model or data
 - Critical thinking questions
 - Prompt students to analyze the model and/or data presented
 - Integrate knowledge
 - Exercises
 - Questions that allow students to practice using the integrated knowledge
 - Problems
 - Questions that apply knowledge to new situations

A POGIL Classroom Experience





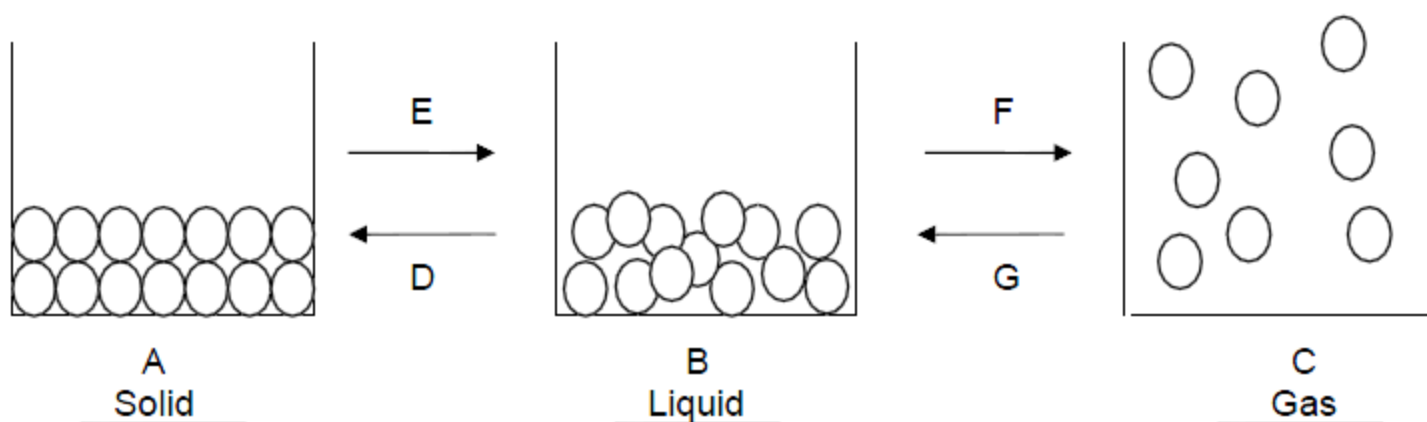
POGIL is currently used in several Chemistry courses

- ▶ Published book of activities
 - Preparatory Chemistry
 - General Chemistry
 - Organic Chemistry
 - Physical Chemistry
- ▶ In Development
 - Biochemistry
 - Analytical Chemistry
 - Secondary level (high school) chemistry

Secondary Level (High School Chemistry)

- ▶ Activities available for download at <http://www.pogil.org/resources/curriculum-materials/classroom-activities>

Model 1: Representations of Molecules in Three Phases

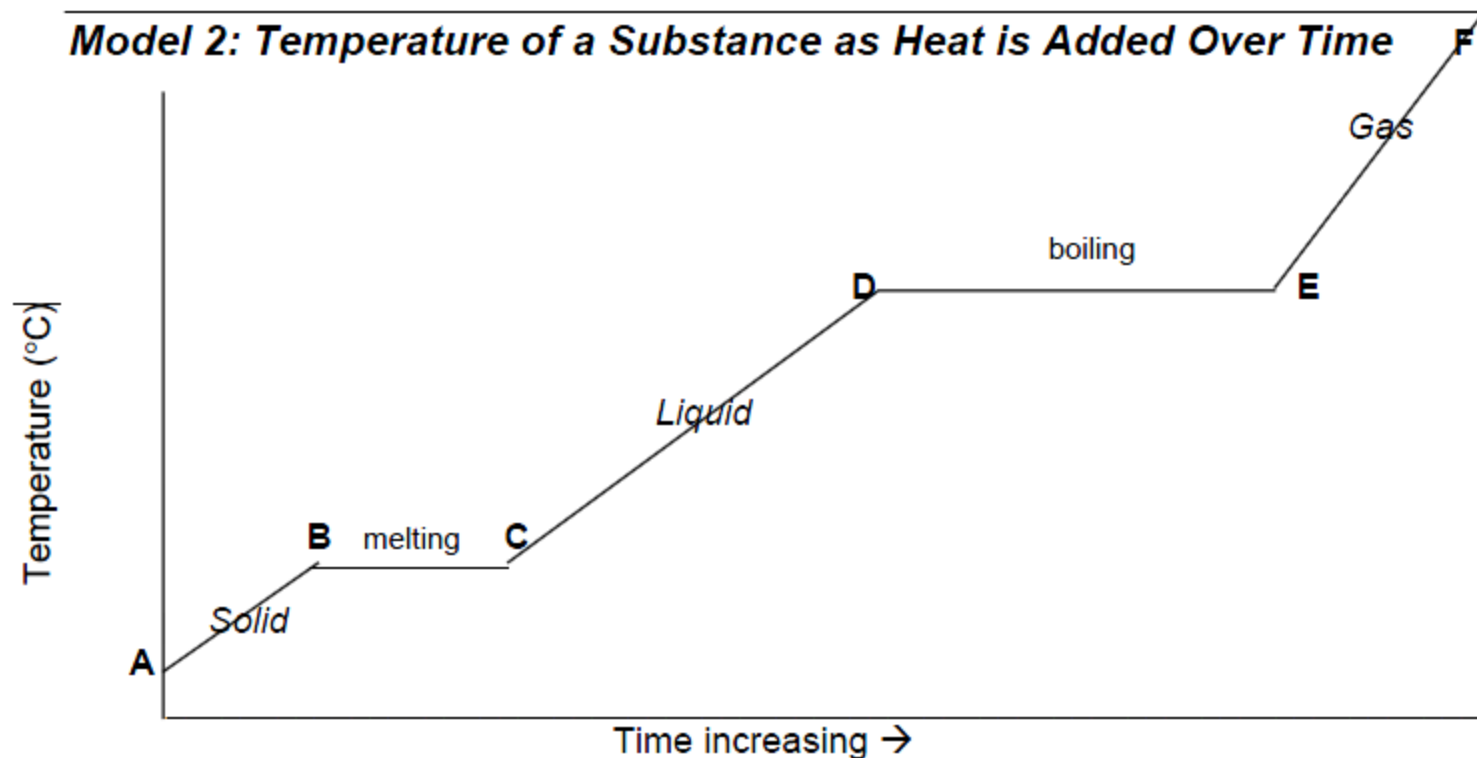


Task

Label each arrow (D, E, F, G) in Model 1 with the appropriate phase change (fusion/melting, solidification/freezing, boiling, condensation).

Key Questions

1. Which arrows in Model 1 indicate the addition of energy?
2. Which term, endothermic or exothermic, is used to describe the situation when energy is added into a system from the surroundings?



Key Questions

1. What is plotted on the x-axis and what is plotted on the y-axis of the graph in Model 2?
2. During which line segments does temperature increase?

Exercise

A sample of a mythical substance is cooled from a temperature of 250°C to 10°C in two hours. The boiling point of the substance is 175°C and the melting point is 22°C .

Using this information, draw a cooling curve for the sample.

On the curve clearly label the following items in the appropriate locations (use arrows as needed to indicate direction or exact location on the curve. Some terms may be used more than once, as needed.):

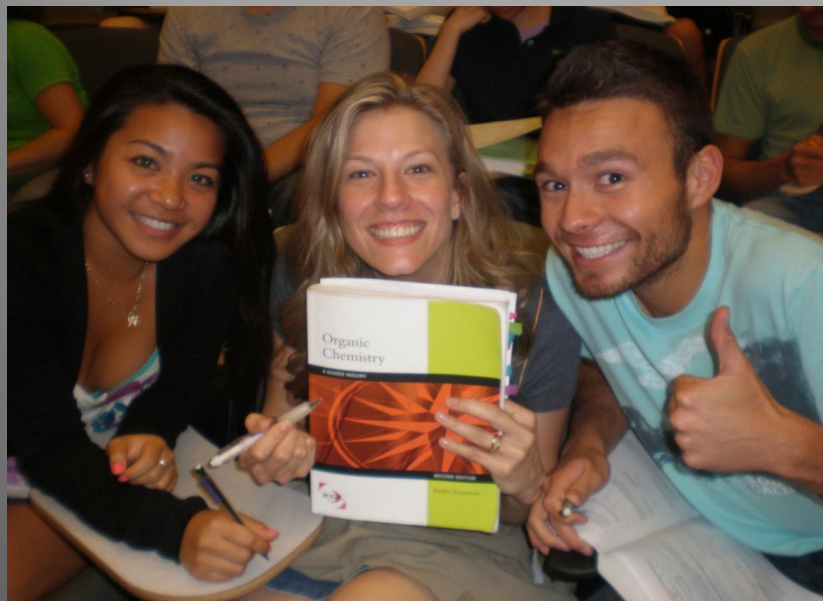
Solid	Freezing Point	Melting Point
Liquid	Fusion	Direction of endothermic changes
Gas	Solidification	Direction of exothermic changes
Condensation	KE changing	
Boiling	KE not changing	

Student Outcomes

- ▶ **Other than content knowledge, what might your students gain from POGIL?**

Process Skills

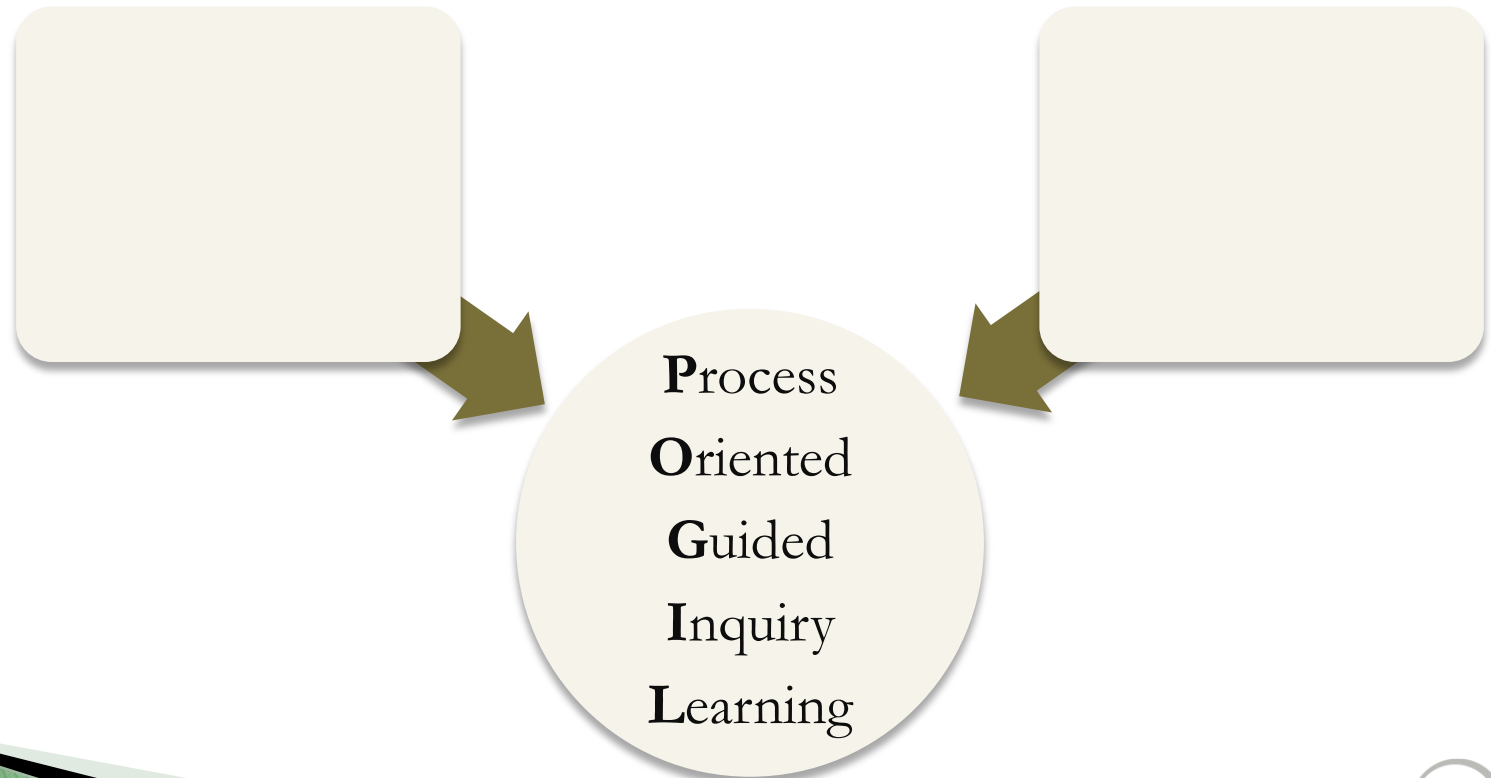
- ▶ Information Processing
- ▶ Critical Thinking
- ▶ Problem Solving
- ▶ Communication
- ▶ Teamwork
- ▶ Management
- ▶ Assessment



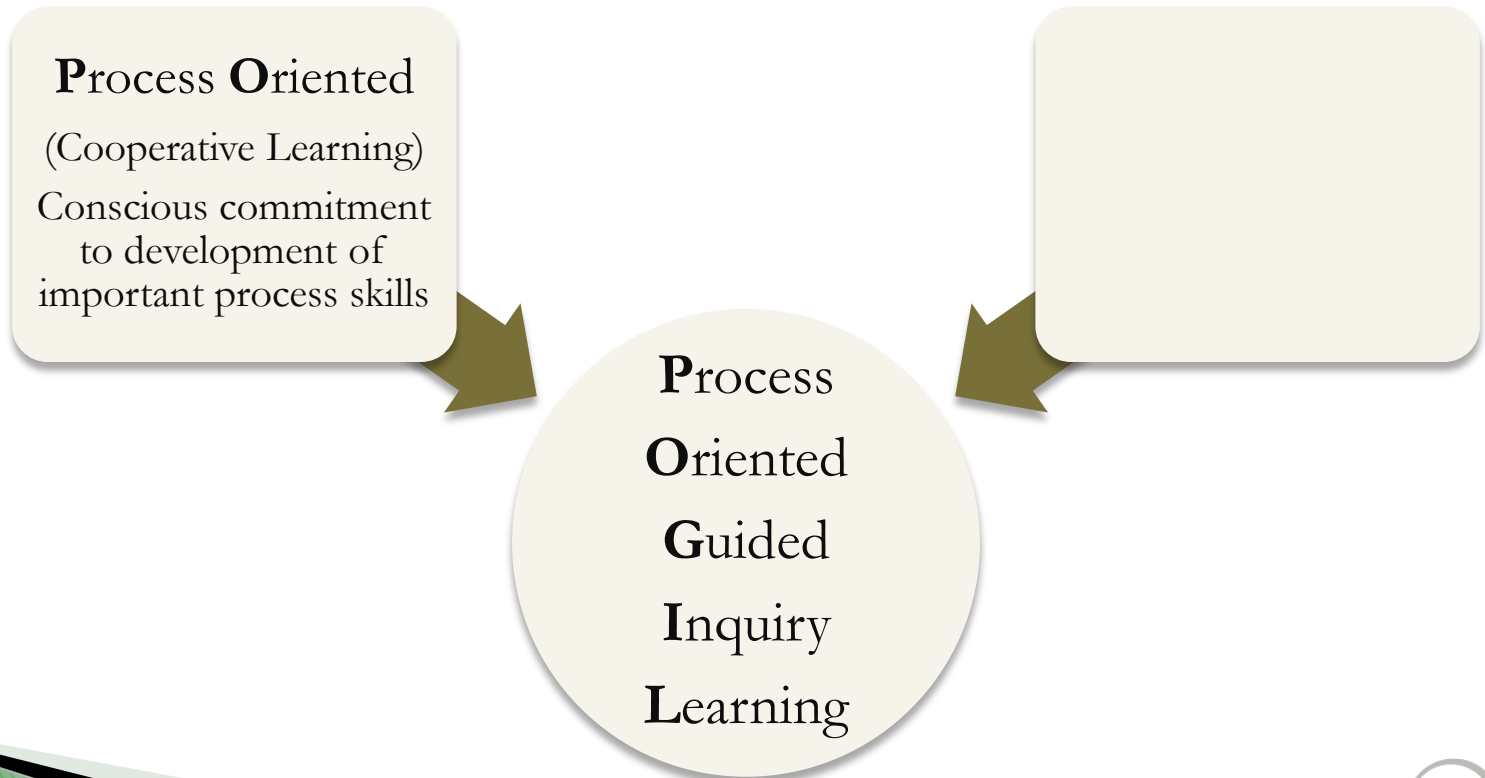
Re-examination of POGIL

- ▶ Process Orientated
- ▶ Guided Inquiry
- ▶ Learning

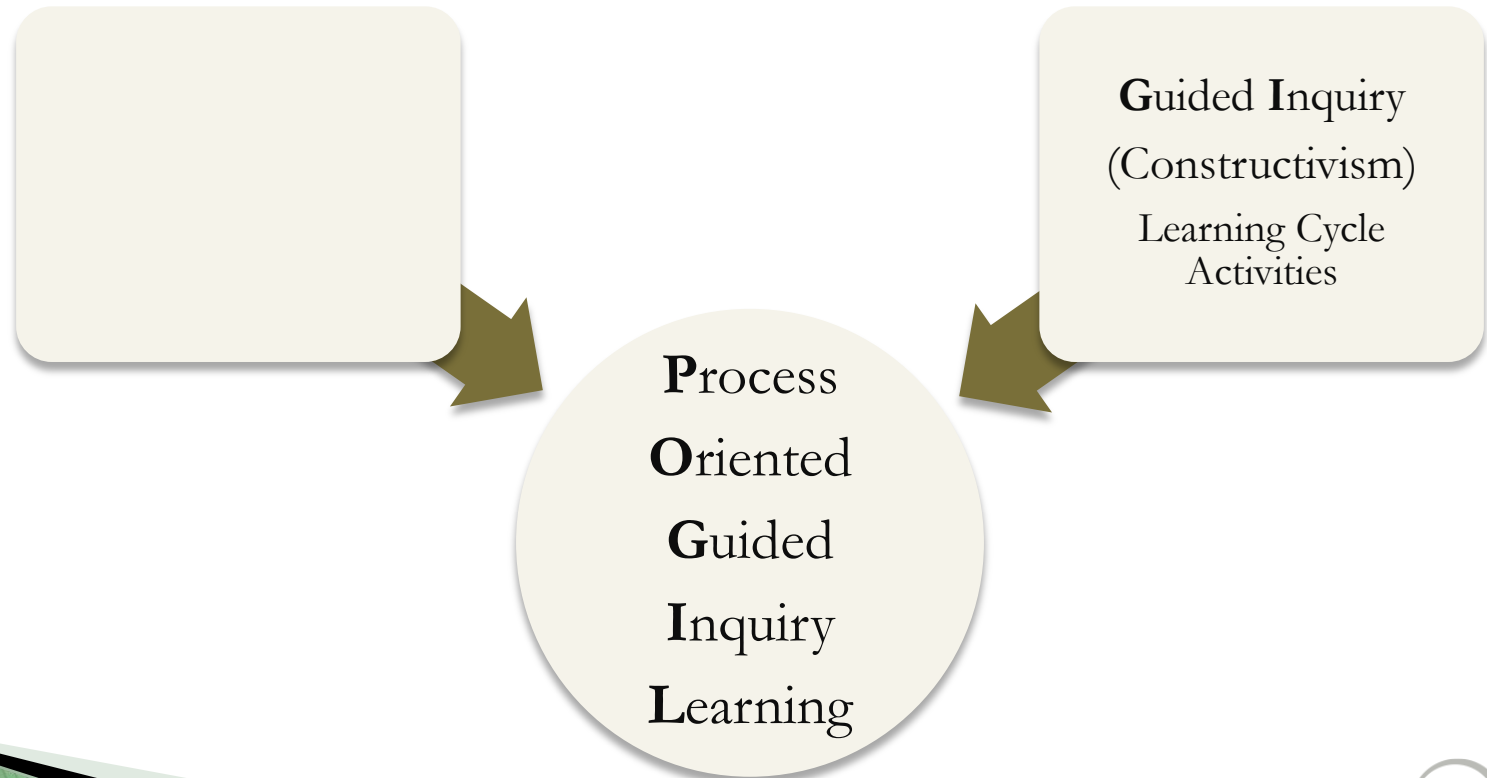
What is POGIL?



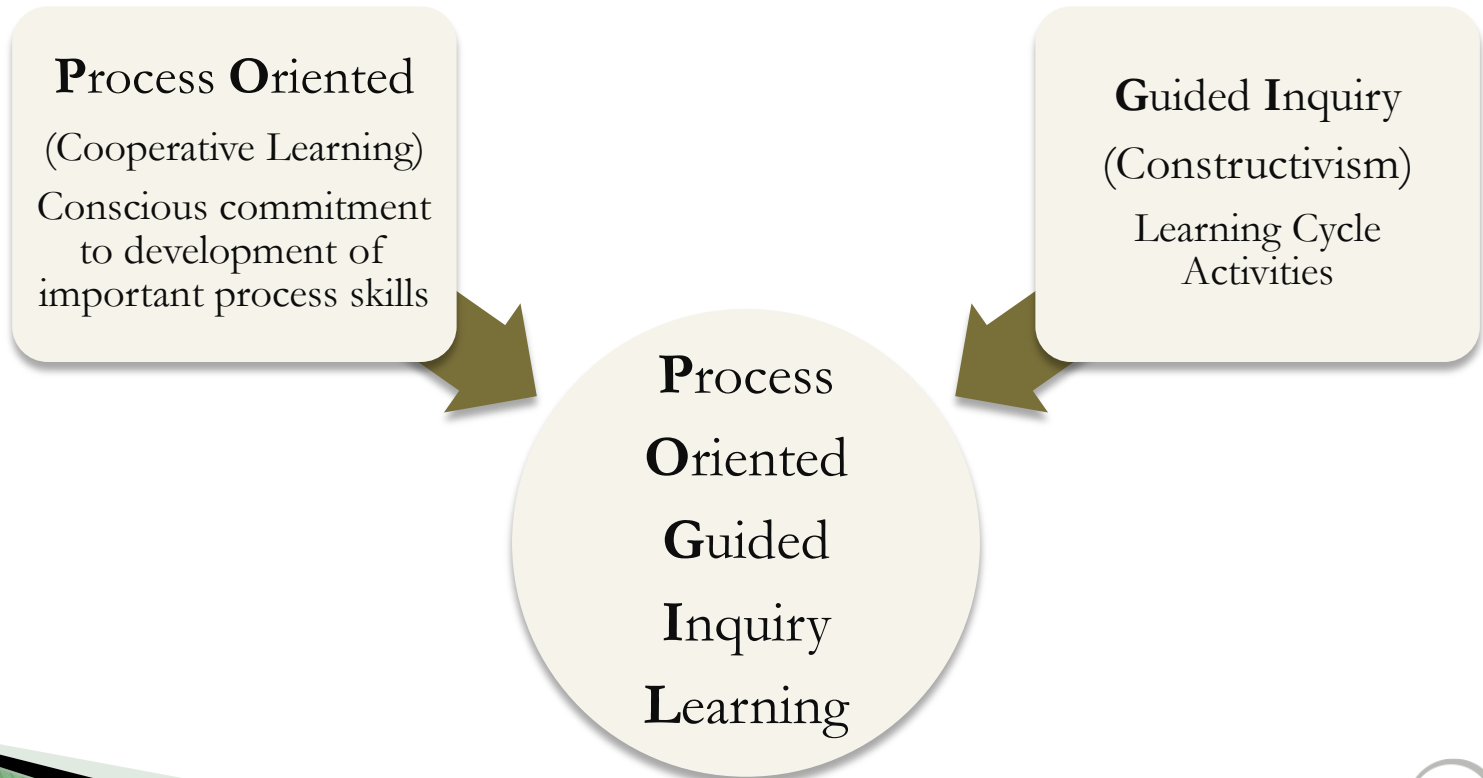
What is POGIL?



What is POGIL?



What is POGIL?



Theoretical Basis for POGIL

- ▶ Constructivism
- ▶ Information Processing
- ▶ Learning Cycle

Constructivist Model of Learning

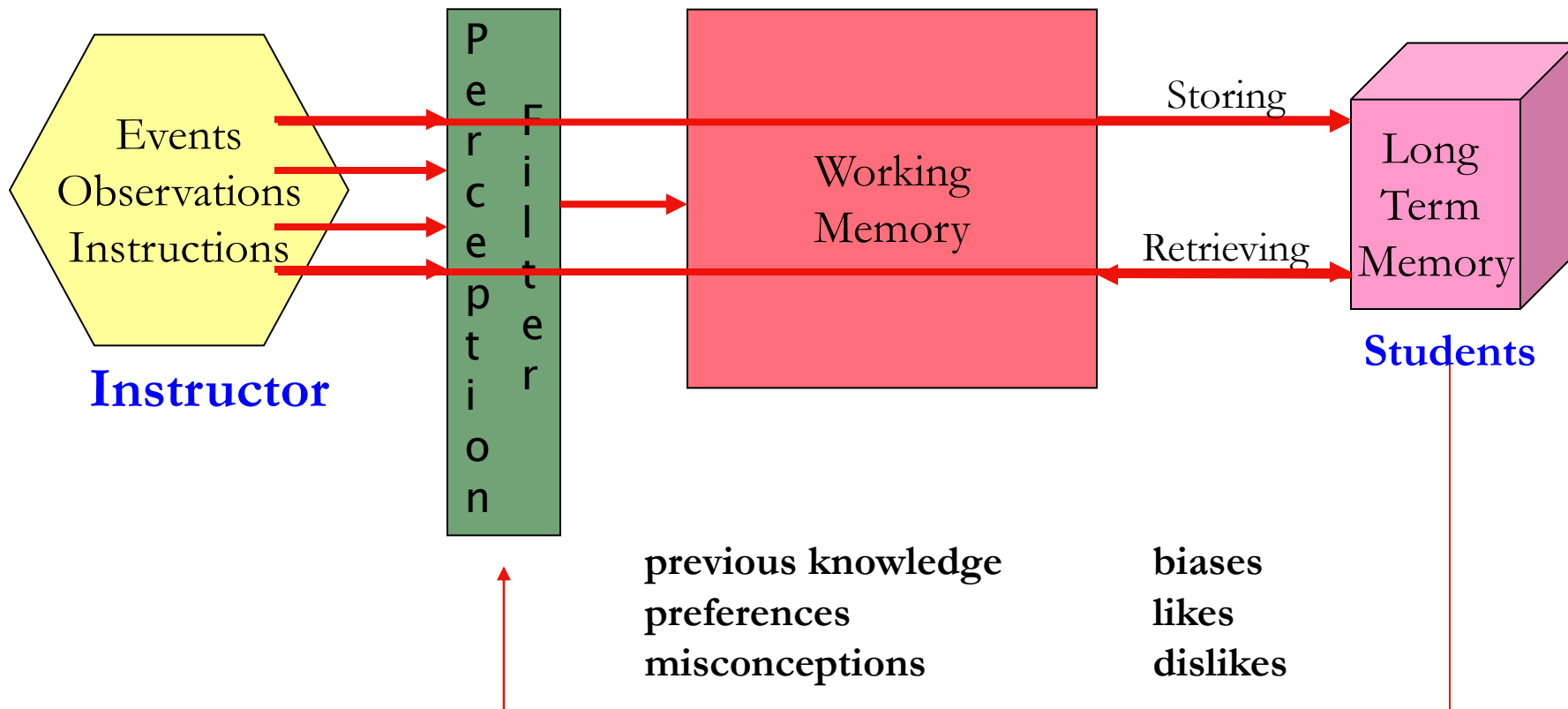
- ▶ “Learning is not the transfer of material from the head of the teacher to the head of the learner intact, (but) the reconstruction of material in the mind of the learner.”
- ▶ “It is an idiosyncratic reconstruction of what the learner...thinks she understands, tempered by existing knowledge, beliefs, biases, and misunderstandings.”

Johnstone, A.H. (1997). Chemistry Teaching- Science or Alchemy? *J. Chem. Educ.*, 74, 262 - 268.

Information Processing Model

•Johnstone, A.H. (1997). Chemistry Teaching- Science or Alchemy? *J. Chem. Educ.*, 74, 262 - 268.

•Gazzaniga, M. S., Ivry, R. B., & Mangun, G. R. (2008). *Cognitive Neuroscience: The Biology of the Mind* (3rd ed.). New York: W. W. Norton & Company.



POGIL's View of Learning

- ▶ Knowledge results only through active participation in its construction.
- ▶ Students teach each other and they teach the instructor by revealing their understanding of the subject.
- ▶ Teachers learn by this process...by steadily accumulating a body of knowledge about the practice of teaching.

TEACHING IS ENABLING.

KNOWLEDGE IS UNDERSTANDING.

**LEARNING IS ACTIVE CONSTRUCTION OF SUBJECT
MATTER.**

Elmore, R. F. (1991). Foreward. In C. R. Christensen, D. A. Garvin, & A. Sweet (Eds.), *Education for Judgment* (pp. ix-ixi). Boston, MA: Harvard Business School Press.

Guided Inquiry Approach

- **Students work in groups**
- **Students construct knowledge**
- **Activities use Learning Cycle paradigm**
- **Students teach/discuss/learn from students**
- **Instructors facilitate learning**

Research on Effectiveness of POGIL

- ▶ Effect of POGIL on student failure and withdrawal rates
 - Three single college experiments
- ▶ Effect of POGIL on student learning compared to NonPOGIL classes
 - One nationwide experiment

Research on Student Failure and Withdrawal Rates

Parameters of Research

- ▶ **Success in course is defined grade of**
 - C- or higher
- ▶ **Non-success includes**
 - grades of D, F, and withdrawals (W)
- ▶ **Statistical significance is determined by chi-squared analysis using two groups**
 - Grades of ABC vs. DFW

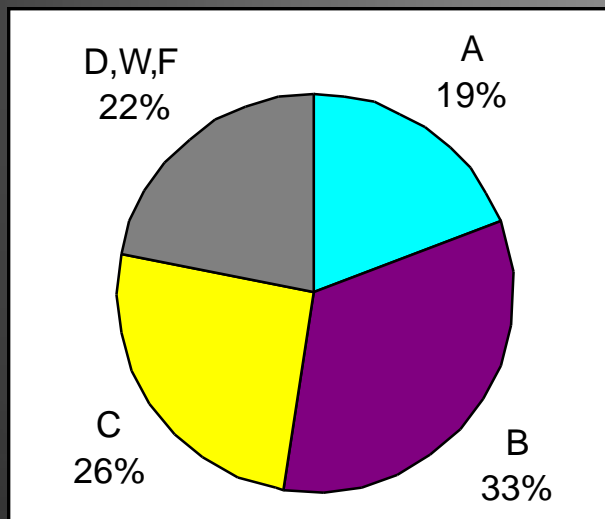
Experiment #1: General Chemistry at Franklin & Marshall College

- ▶ Sections of about 24 students
- ▶ Lecture F1990 - S1994: $n = 420$
- ▶ POGIL F1994 - S1998: $n = 485$
- ▶ Students randomly placed Fall semester
- ▶ Students selected section for Spring semester
- ▶ Same instructors “before” and “after”

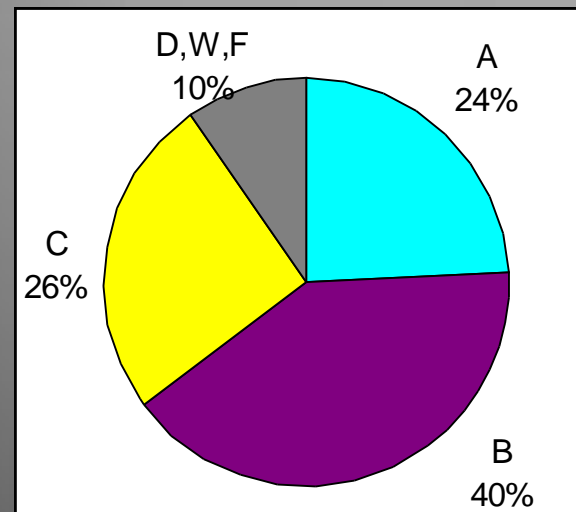
Experiment #1: General Chemistry at Franklin & Marshall College

8 years of data (n = 905)

Lecture



POGIL



Data from classrooms of Moog, Farrell and Spencer
Chi-squared = 40.9 alpha < 0.005

Farrell, J.J., Moog, R.S., & Spencer, J.N. (1999). A Guided Inquiry Chemistry Course. *J. Chem. Educ.*, 76, 570-574.

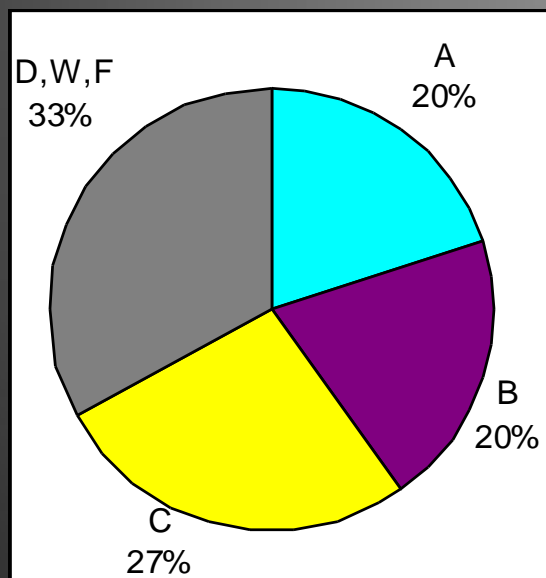
Experiment #2: Organic Chemistry at a Regional Liberal Arts College

- ▶ **Two sections - one Lecture, one POGIL - taught at the same time**
- ▶ **Students randomly placed in sections**
- ▶ **Common exams - prepared and graded by both instructors**

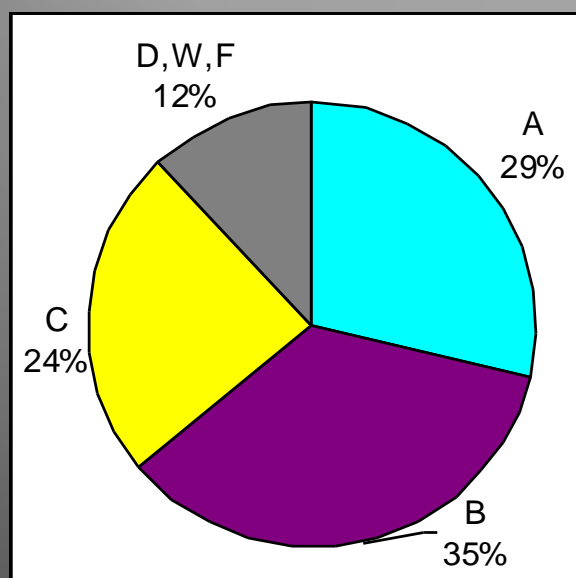
Experiment #2 – Organic Chemistry at a Regional Liberal Arts College

1998-1999, n = 40

Lecture



POGIL



Randomized enrollment, different instructors, single exam given concurrently, prepared and graded by both instructors

Chi-squared = 7.1 alpha < 0.01

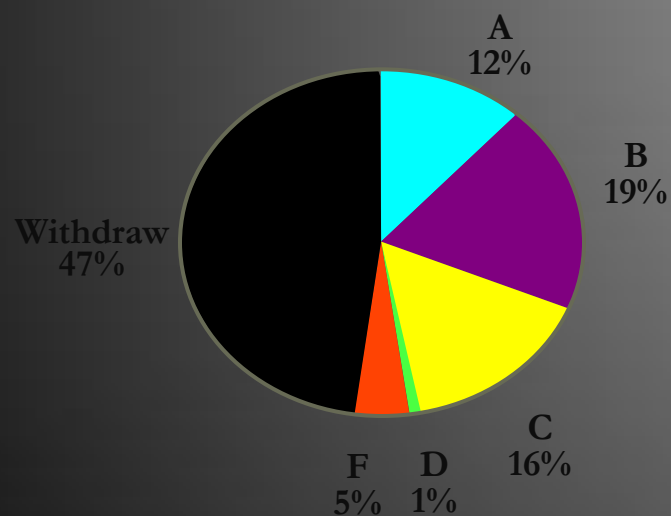
Experiment #3: Organic I at a Large Public University

- ▶ **Two sections (taught at same time)**
 - **Lecture**
 - **POGIL**
- ▶ **Students randomly placed in sections**
- ▶ **Final exam created by Lecture instructor**

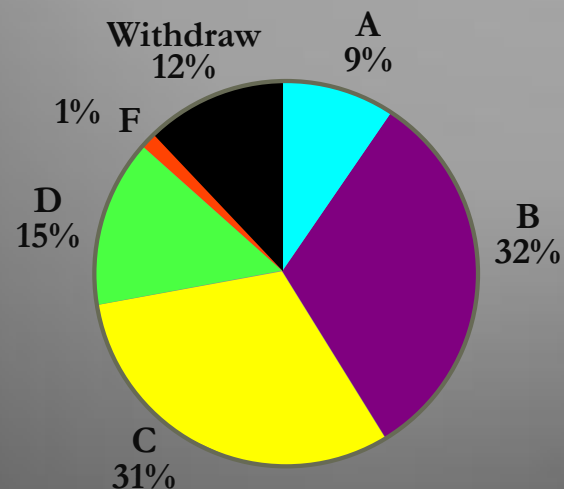
Experiment #3: Organic I at a Large Public University

Withdrawals and Common Final Exam Scores - Fall 2000

LECTURE n = 109



POGIL n = 75



Chi squared = 19.1 Alpha < 0.005

National Study of student achievement in POGIL vs. nonPOGIL classes

- ▶ Teachers selected questions from database of 24 questions that had been tested for validity and reliability
- ▶ 10 POGIL and 11 NON POGIL teachers
 - Representing 11 colleges and universities
 - implemented questions developed for this project on their
 - tests, quizzes or final exam

- ▶ Student participation
- ▶ POGIL: 2809 responses
- ▶ Non POGIL: 2102 responses

- ▶ Some teachers chose to use more than one question
 - Result
 - Some students contributed answers to more than one question

Data

- ▶ Twelve Chemistry topics were addressed spanning a full year of General Chemistry
 - 24 multi-part questions were constructed and tested for validity and reliability
 - The sub questions were analyzed using a Factor Analysis which showed two groups
 - **Achievement**
 - **Process Skills**
 - Critical Thinking
 - Problem Solving
 - Metacognition
 - Information Processing

Statistical Analysis

- ▶ One way MANOVA used per question
 - analyze the Overall Test Question
- ▶ If MANOVA was significant
 - **Achievement and Process Skills** Subcategories were compared between POGIL and nonPOGIL
- ▶ In some cases, MANOVA could not be used due to violations of the statistic's assumptions
 - ANOVA for Overall Test only was used
 - No breakdown for Achievement or Process Skills

Results

Questions	POGIL scored higher	NonPOGIL scored higher	No difference
Overall	50%	25%	21%
Achievement Subquestions	32%	27%	41%
Process Skills Subquestions	36%	9%	55%

Conclusions

Achievement

- ▶ POGIL and NonPOGIL have about the same effect
- ▶ Process Skills
 - POGIL has about a 36% advantage

Implications

- ▶ POGIL will
 - not harm the achievement scores of students
 - increase their process skills scores at least half the time
 - Offer a new curricula and a new teaching approach for those who are dissatisfied with lecture alone.

- ▶ POGIL can be implemented
 - Slowly
 - Some lectures
 - During recitation only
 - During Laboratory
 - Eventually leading to
 - Full implementation in all lectures, recitations, and labs

The POGIL Project

PIs and Senior Personnel

SF CCLI DUE – 0618746, 0618758, 0618800

- ▶ Rick Moog, Franklin & Marshall College, Lancaster PA
- ▶ Jennifer Lewis, University of South Florida, Tampa, FL
- ▶ Diane Bunce, The Catholic University of America, Washington, DC

NSF CCLI DUE – 0231120

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