Process Oriented Guided Inquiry Learning in Computer Science

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CS&IT, Irvine, CA, July 2012
Overview

I. Introductions 10 min
II. Sample POGIL Activity 30 min
III. POGIL Concepts & History 10 min
IV. Discussion & Next Steps 10 min
Learners & teachers face a variety of challenges.

- Volume of content increasing; useful half-life of content decreasing.
- Pressure to add non-disciplinary content - e.g. communication, process, & team skills.
- Distractions increasing; focused attention decreasing.
Teachers want to help students:

• understand key concepts
• build on & extend what they know
• solve problems
• work in teams
• communicate (written & oral)

How well does teaching reflect this?
To improve teaching & learning, learners should:

• Work in **teams**.
• Combine content with **process**.
• **Connect** multiple concepts & representations.
• Receive prompt, regular **feedback**.
• **Reflect** on process & progress.
• Follow **learning cycle** to construct knowledge.

• e.g. Zull, *The Art of Changing the Brain*
Activities are designed with 6 stages to form a **learning cycle** (Karplus, Piaget).

1. **Orient**, motivate, prepare

2. **Explore**, observe, analyze

3. **Form concepts** (questions)

4. **Apply** in exercises & problems

5. **Close**, reflect, assess

- **induction**
- **deduction**
POGIL = Process Oriented Guided Inquiry Learning

• Learners work in teams of 3-5 on scripted activities that guide them through inquiries that model discovery to help learners construct knowledge.

• Teams follow processes with specific roles, steps, reports, etc.

• Activities are designed to achieve learning objectives (for content & process).
Simplified Example: Part I

1. Practice a 2 player game:
   a. A chooses a number (0...100).
   b. B guesses a number.
   c. A responds “high”, “low”, or “you win”.
   d. Guess & respond until B wins.

2. Describe 3-5 guessing strategies for B.
Simplified Example: Part II

3. Rank strategies by:
   a. How quickly they win the game.
   b. How easily they could be explained to a 1\textsuperscript{st} grade student (or a computer).


5. What are average & worst number of guesses for each strategy?
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II. Sample POGIL Activity

1. Form teams of 3-4 people.
2. Choose roles:
   - manager, recorder, speaker, reflector
3. Fill out header of meeting minutes.
4. Start working through activity.
   (expanded copy is available on request)
5. Raise hand if you have doubts or questions.
Sample POGIL Activity: Conclusion

1. What doubts or questions do you have?
2. Did each team member perform their role?
3. How could this activity be improved?
III. POGIL Concepts & History

• People learn better when they:
  – work in teams
  – combine content & process
  – construct knowledge
  – follow learning cycles
  – connect multiple concepts & representations
  – receive prompt, regular feedback
  – reflect on process & progress
Teams & processes enable students to learn from each other.

• Students teams learn, understand, & remember more.
• Processes provide helpful scaffolding.
• Students also learn process skills, such as communication & teamwork.
• Students can answer each others’ questions; teacher answers more difficult questions.
• The best way to learn is to teach.
Activities are designed with 6 stages to form a learning cycle (Karplus, Piaget).

1. **Orient**, motivate, prepare
2. **Explore**, observe, analyze
3. **Form concepts** (questions)
4. **Apply** in exercises & problems
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*Induction* → **Form concepts** (questions) → *Deduction*
Questions & problem solving move from simple to complex issues.

1. **Directed** - Develop context & confidence.
2. **Convergent** - Lead toward concept formation.
3. **Divergent** - Encourage future exploration.
Reporting & metacognition help students learn how to learn better.

• Reports help learners & teachers see & think about what happened in team.
• Getting learners to think about their learning is key to becoming better learners.
Responsibility & evaluation provide incentives & avoid problems.

• Each student has a role, and roles rotate.
• Students know they depend on each other.
• Free-loading is discouraged.

• Depending on the academic environment, reports may or may not be graded.
Summary: POGIL uses 7 key components.

1. Learning teams
2. Guided-inquiry activities
3. Questions to promote critical thinking
4. Problem solving
5. Reporting
6. Metacognition
7. Individual responsibility
8. Grades (when necessary)
POGIL has variations, pros & cons.

• Small & large courses (scales reasonably well).
• Daily, weekly, or occasionally.
• Paper and/or technology for activities & reporting.
• Adapts to varied languages & cultures.
• Teacher as “guide on the side” not “sage on the stage”.
• Harder to predict & control class.
• Requires time & effort to design activities.
POGIL evolved over many years.

- David Hanson, Stony Brook University, 1994
- series of 20+ NSF grants
- originally in chemistry, spreading elsewhere
- regular training workshops
- useful resources & active community: http://www.pogil.org
There is evidence that POGIL works.

3 sample studies

POGIL improves
- retention
- content mastery
- learning skills
- attitude & motivation

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My experiences with POGIL are recent & encouraging.

- 2009: attended ASEE POGIL workshop
  - led by Elliot Douglas, Materials Science & Eng.
- 2009-10: POGIL for soft computing, India
- 2010-11: attended POGIL meetings
- 2010-+: POGIL for other CS topics
  - software engineering, DS&A
- 2011-+: NSF TUES grant for POGIL in CS
  - seeking more reviewers & collaborators...
In India, POGIL for soft computing went (surprisingly) well.

- 2009-2010 Fulbright-Nehru Scholar, India
- ~18 master’s students
- POGIL was a big change from lectures
  - skeptical, then enthusiastic
- activities presented using PowerPoint
  - less paper, more flexible, manage pace & “reveal”
- fluent in English, prefer local language(s)
  - reduced potential language barriers
CS-POGIL: NSF TUES (Type I)

• Goal 1: POGIL activities for CS
  – Data Structures & Algorithms
  – Software Engineering & Project Mgmt
• Goal 2: Foster CS-POGIL community

http://cspogil.org
**Available Activities**

Note: POGIL activities involve students teams working with active facilitation by a trained faculty member. The POGIL Project offers facilitator training workshops.

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To date, we have drafted, piloted, & revised POGIL activities for:

**Programming**
- Unit Testing (JUnit)
- Error Handling & Exceptions
- File Input & Output
- Object-Oriented Design
- Object-Oriented Inheritance

**Data Struct. & Algorithms**
- Searching, Sorting
- Queues, Stacks, Linked Lists
- Maps & Hash Tables
- Sequence Analysis

**Software Engineering**
- Teams & Roles (introductory)
- Software Life Cycles
- Risk Management
- Scheduling (PERT, crit. path)
- UML Analysis Diagrams
- UML Design Diagrams
- Task Tracking
- Version Control
Developing a community of faculty, staff, teachers, & students.
CS-POGIL: Future Directions

• web-based activities
• Moodle enhancements
• bridge to other disciplines
  – e.g. engineering, business
• POGIL patterns

• most involve student researchers
POGIL Resources

• Clif Kussmaul  
  clif@kussmaul.org  
  http://cspogil.org

• The POGIL Project  
  http://pogil.org
  – Hanson. Instructor’s Guide to POGIL.
  – Hanson. Designing POGIL Activities.

• July 2012: Regional POGIL Workshops
  – essential if you want to get started

• Eberlein, Kampmeier, Minderhout, et al. (2008)
  Pedagogies of engagement in science: A comparison of PBL, POGIL, and PLTL.