Special Session: Helping Students to Develop Communication, Teamwork, and Other Process Skills with POGIL

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SUMMARY

Employer surveys and other sources indicate that CS students need process skills such as communication, teamwork, critical thinking, and problem solving. Further, the AP CS Principles practices include communicating and collaborating. POGIL (Process Oriented Guided Inquiry Learning) can be used to teach these process skills in high school or college courses. Instead of sitting in lecture or working together with minimal guidance, student teams work through POGIL activities to discover concepts on their own, while the instructor circulates and facilitates learning of key concepts and the development of process skills. Structured roles help students learn to communicate and work in teams more effectively. In this special session, attendees will experience a POGIL activity, learn how process skills are developed and reinforced by POGIL (through a POGIL meta-activity), and see the range of activities available at <http://cspogil.org>. We will share POGIL activities and discuss how POGIL can transform CS classes at all levels, from high school to graduate-level classes, from small schools to large universities.

Categories and Subject Descriptors

K.3.2 [Computers and Education] - Computer and Information Science Education - Computer science education, information systems education, literacy, self-assessment

General Terms

Design, Experimentation

Keywords

Active Learning; Cooperative Learning; POGIL; Teams

1. OVERALL SESSION OBJECTIVE

After this session, attendees will be able to describe:

- What process skills are and why students need them.
- How POGIL activity structure, team roles, teacher facilitation, and other scaffolding can help students to learn content and process skills.
- Where to find field-tested POGIL activities for CS and how to learn more about facilitating POGIL activities.

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Employer surveys and other sources indicate that CS students need to develop communication, teamwork, problem solving, and other process skills (also called professional skills or soft skills). For example, a survey of IT job opportunities found high demand for communication skills, and high or moderate demand for analytical skills, problem solving, being a team player, and other similar skills [2]. Further, the AP CS Principles Computational Thinking Practices include *P5: Communicating* and *P6: Collaborating* [5]. Some teachers expect students to develop these process skills through team projects and other assignments. Others have a course to help students improve these skills [e.g. 1, 3, 4, 8].

Students can also develop these skills across the curriculum via Process Oriented Guided Inquiry Learning (POGIL). POGIL is a research-based instructional strategy that encourages students to collaboratively construct their own understanding of concepts [14]. In POGIL, student teams work together on specifically designed activities that guide students to discover principles on their own. When students discover concepts, they remember them better.

For example, a POGIL activity on unit testing might use the following structure. First, teams study several Java methods and answer questions about how they work and handle errors. Second, they complete a table of test inputs and expected outputs, and describe reasons to develop test cases. Third, they write simple test methods, compare the effort for manual and automated testing, and describe the implications for large software projects. Fourth, they answer questions that guide them to identify repetitive elements of test code, and describe key elements of a test framework. Fifth, they study a JUnit test class, answer questions about how it works and why unit test frameworks are useful. Sixth, they reflect on what they have learned and how they could improve in the future.

POGIL has been used successfully since the 1990s in high schools, colleges, and universities. Initially used in chemistry, POGIL has been used in biology, CS, engineering, math, and other areas. Research shows that students learn content better [13], have higher pass rates [15], and prefer POGIL over traditional lectures [7]. Students also believe that POGIL promotes critical thinking and other process skills, increases engagement, and improves understanding [6]. The POGIL Project (www.pogil.org) provides a variety of resources, including workshops to help faculty learn about POGIL practice and theory.

The session leaders have used POGIL in a range of courses (see statements below). One of us (Kussmaul) is the PI on a NSF TUES grant to develop and disseminate POGIL activities. Another of us (Hu) is the PI on an AAC&U TIDES grant to develop POGIL activities for a CS Principles course to be paired with courses in other departments to broaden the appeal of CS.

Two of us (Pirmann and Kussmaul) are collaborators on a Google CS4HS grant to create a community of practice for AP CS Principles teachers using POGIL activities.

2. SESSION OUTLINE

This special session will be experiential. As summarized below, we will start with a brief introduction to POGIL and its effectiveness. Next, teams of 3-4 attendees will work through a POGIL activity and experience it as students. Third, the teams will work through a POGIL meta-activity designed to help teachers understand how POGIL can affect student process skills. Fourth, session leaders and other teachers who have recently adopted POGIL will describe their experiences. The session will conclude with a question and answer discussion. We will share links to POGIL materials for CS and provide information about upcoming POGIL workshops.

#	Time	Content
1	5 min	Introductions and overview.
2	20 min	Complete a POGIL mini-activity
3	20 min	Complete a POGIL activity on process skills.
4	15 min	Successes and challenges.
5	15 min	Q&A and next steps.

2.1 Presenter Statement - Clifton Kussmaul

I have created and used POGIL activities in CS II, Software Engineering, AI, and other courses [12]. I often use Google Docs for the activities, so teams can edit collaboratively and copy text to and from other tools. A key benefit of POGIL is that I can observe, provide feedback, and support student learning of both content and process skills. I can also see where students have difficulty and adjust the activity for future classes.

2.2 Presenter Statement - Helen Hu

I have adopted POGIL in multiple CS courses, including a CS0 in App Inventor [9], a traditional CS1 in Java for CS majors [10], and a CS1 in Python for science majors [11]. My students discuss the importance of soft skills, and I use this to motivate the group work and POGIL learning teams. Although they may feel artificial at first, I find that emphasizing the POGIL roles improves the collaboration and teamwork. I have seen increases in student engagement levels as well as in my female students' pass rates [10]. Most of my POGIL activities are at <http://tinyurl.com/CSPogil> and <http://tinyurl.com/CS1pogil>. I have started creating Instructor's Guides for each activity.

2.3 Presenter Statement – Tammy Pirmann

I have been using, adapting and creating POGIL activities for high school CS courses for several years. The process skills that are explicit in the CSTA K-12 CS Standards and the AP CS Principles framework are developed daily within a POGIL classroom. My students have many opportunities to practice collaboration, consensus building, communication, problem solving and critical thinking from within POGIL activities. Our POGIL-CSP team has created over twenty POGIL activities that align with the CS Principles Big Ideas and computational thinking practices.

3. EXPECTATIONS

This special session should appeal to teachers and instructors interested in incorporating more active learning in their

classrooms. Attendees will experience how students discover computer science concepts for themselves while working through POGIL activities. They will learn how POGIL has been used in CS classrooms, how to access POGIL materials at <http://cspogil.org>, and how to learn more through POGIL workshops and regional meetings hosted by the National POGIL Office (<https://pogil.org/events>).

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