Guided Inquiry Learning for Computer Science

Session organized for the Computer Science Teachers Association (http://csta.acm.org)
2012 Conference (http://csta.acm.org/ProfessionalDevelopment/sub/CSITConference.html)

Category: Session (1 hour) 20% lecture, 50% hands on, 30% discussion
Author(s): Clif Kussmaul kussmaul@muhlenberg.edu Muhlenberg College
Tammy Pirmann tpirmann@gmail.com Springfield Township High School
Keywords: High School CS, Post-secondary CS, CS (intro), CS (advanced), AP CS, Hands-on, Teaching Practices

Audio-Visual Needs: We request a computer projector and screen, and a room in which participants can work in groups of 3-5 (e.g. at tables, not in fixed arena-style seating).

150 Word Program Description

This session introduces participants to **process-oriented guided inquiry learning (POGIL)** in computer science. POGIL has been developed, and validated over the last 15 years, primarily in chemistry education. In POGIL, teams of learners (typically 3-5) work on scripted inquiry activities designed to help them construct their own knowledge, often by modeling the original processes of discovery and research. Teams follow processes with specific roles, steps, and reports that encourage individual responsibility and meta-cognition. Studies generally find that POGIL significantly improves student performance.

We will begin the session with introductions and brief review of some relevant background. Second, teams of attendees will work through a sample CS-POGIL activity to understand how it works. We will conclude with a review of POGIL's key concepts, history, and supporting research; pointers to additional information; and general discussion.

Background

POGIL is based on learning science [11], shares characteristics with other forms of active, discovery, and inquiry-based learning [2], and synergistically combines effective learning practices. In POGIL, teams of learners (typically 3-5) work on scripted inquiry activities and investigations designed to help them construct their own knowledge [10]. The teams follow processes with specific roles, steps, and reports that help students develop process skills and encourage individual responsibility and meta-cognition. The instructor serves as an active facilitator, not a lecturer or passive observer; active facilitation is a key aspect of POGIL.

POGIL activities generally follow a *learning cycle* with 3 phases [1]. First, students *explore* models or data generate and test hypotheses to help understand or explain what they observe. Second, the patterns or hypotheses are used to *define or invent a new concept*; importantly, students have constructed understanding before the concept is introduced. Third, the new concept is *applied* in other situations or contexts to help students generalize its meaning and applicability. Thus, the scripted activity provides information and asks questions to guide students through the learning cycle and help them develop process and learning skills.

Activities involve three types of questions. *Directed questions* have definite answers, are based on material available to students, and provide a foundation for later parts of the activity. *Convergent questions* may have multiple answers, and require teams to analyze and synthesize information to reach non-obvious conclusions. *Divergent questions* are open-ended, do not have right or wrong answers, and may lead teams and individual students in different directions.

POGIL has been developed and validated over the last 15 years in both high school and post-secondary contexts, most extensively in chemistry. Multiple studies have found that POGIL significantly improves student performance, particularly for average and below-average students [3,6,9].

The POGIL Project (http://www.pogil.org) offers workshops to help teachers learn about theory and practice, including how to facilitate, evaluate, and develop activities.

The CS-POGIL Project (http://cspogil.org) works to develop activities for CS and related areas, and to foster a community of CS teachers using POGIL.

CS-POGIL has particular potential [7,8]. Software development is largely a team-based problem-solving activity, and CS-POGIL helps students to develop their problem-solving abilities and develop important team process skills. CS-POGIL also encourages students to collaborate and learn from each other rather than focusing on an instructor. However, CS-POGIL also presents some distinct challenges. Currently, not many effective CS-POGIL activities exist; thus, faculty need to invest significant time and effort developing them. CS courses and curricula are quite varied, and portions of the content change more rapidly, making it more difficult to adopt or adapt materials at other institutions.

Content

The session will be organized as follows:

1. (10 min) Introductions and brief review of some relevant background.
2. (30 min) Teams of attendees work on a CS-POGIL activity to experience how it works.
3. (10 min) Review of POGIL's key concepts, history, and supporting research.
4. (10 min) Pointers to additional information and general discussion.

Relevance

POGIL is widely used in both high school and post-secondary education, and helps students acquire knowledge, process skills, and meta-cognitive skills that will help them more broadly. This session will help attendees understand more about CS-POGIL and how it works, so they can decide if and how to incorporate it into their own teaching.

Outcomes

Attendees will:

- Experience how a POGIL activity works.
- Understand the key characteristics and benefits of POGIL.
- Learn about available POGIL activities in CS and POGIL workshops to learn more.

Handouts

Attendees will receive handouts including:

- The sample POGIL activity used in the session, and other examples activities.
- Papers with more details on POGIL in general and POGIL in CS in particular.
- Presentation slides.

Acknowledgements

Thanks to the National Science Foundation (TUES program) under grant DUE-1044679, and to the US-India Educational Foundation (USIEF) for a Fulbright-Nehru teaching award that provided opportunities and other support for this work.

References

1. Abraham, M. 2005. Inquiry and the learning cycle approach. In: Pienta, N., Cooper, M., Greenbowe, T., eds. *Chemists' Guide to Effective Teaching*. Prentice Hall; 41–52.
2. Eberlein, T., Kampmeier, J., Minderhout, V., et al. 2008. Pedagogies of engagement in science. *Biochemistry and Molecular Biology Education*. 36(4):262-273.
3. Farrell, J., Moog, R., Spencer, J. 1999. A guided-inquiry general chemistry course. *Journal of Chemical Education*. 76(4):570.
4. Hanson, D. 2005. Designing process-oriented guided-inquiry activities. In: Beyerlein, S., Apple, D., eds. *Faculty Guidebook - A Comprehensive Tool for Improving Faculty Performance*. 2nd ed. Pacific Crest.
5. Hanson, D. 2006. *Instructor's Guide to Process-Oriented Guided-Inquiry Learning*. Pacific Crest.
6. Hanson, D., Wolfskill, T. 2000. Process workshops - A new model for instruction. *Journal of Chemical Education*. 77(1):120.
7. Kussmaul, C. 2011. Process oriented guided inquiry learning for soft computing. *International Conference on Advances in Computing & Communication (ACC)*, Kochi, Kerala, India.
8. Kussmaul, C. 2011. *CS-POGIL: Process Oriented Guided Inquiry Learning in Computer Science*. Retrieved Nov 8, 2011 from http://cspogil.org.
9. Lewis, S., Lewis, J. 2005. Departing from lectures: An evaluation of a peer-led guided inquiry alternative. *Journal of Chemical Education*. 82(1):135.
10. Moog, R., Spencer, J. eds. 2008. *Process-Oriented Guided Inquiry Learning (POGIL)*. Oxford University Press.
11. Zull, J. 2002. *The Art of Changing the Brain: Enriching the Practice of Teaching by Exploring the Biology of Learning*. Stylus Publishing.