Special Session: Process Skills in Computer Science

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ABSTRACT

Process skills (also known as professional skills, lifelong learning skills, workplace skills, transferable skills, or soft skills) are an important aspect of computer science education. Learning objectives for computer science courses often include the development of process skills like critical thinking, problem solving, and teamwork, but many instructors struggle with how to encourage and measure the development of these skills. This special session will introduce detailed rubrics for assessing process skills in a manner that will model POGIL (Process Oriented Guided Inquiry Learning) facilitation techniques. Presenters will demonstrate how to use one set of these rubrics in an active learning classroom (*i.e.*, POGIL) to provide students with feedback. The other set of rubrics assess process skills on student work and can be used with any classroom. Attendees will leave the session with a better understanding of key process skills in computer science, how to assess student interactions and student work for these skills, and how a POGIL classroom facilitates the development of critical thinking, information processing, and teamwork. This special session will appeal to any K-12 teacher or college instructor interested in developing students' process skills in a computer science class.

CCS CONCEPTS

• **Social and professional topics** → **Computer science education**;

KEYWORDS

Process Skills, Active Learning, Critical Thinking, Teamwork, POGIL

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1 OVERALL OBJECTIVE

Process skills are key to student success in school as well as their future career trajectories. This special session will disseminate state-of-the-art resources from multiple NSF-funded projects that focus on process skills development. It will be organized as a tutorial in which participants discuss how to teach process skills and practice

assessing student work in their courses. Participants will experience using the rubrics in an active learning classroom (POGIL).

The ELIPSS project (<http://elipss.com/>) has developed two sets of detailed rubrics for assessing process skills and providing feedback to students [1]. One set of rubrics is intended for assessing process skills on student *products* (e.g., programs and other student written work), and the other set is designed for student *interactions* observed during group work in the classroom. Instructors can further the development of their students' process skills by providing feedback that identifies strengths, weaknesses, and areas that need work. While the rubrics can be used in any classroom, they work especially well in active learning environments, such as POGIL.

The IntroCS-POGIL project (<http://introcspogil.org/>) has created a new professional development program for faculty wishing to adopt POGIL in introductory computer science courses. POGIL (Process Oriented Guided Inquiry Learning) engages students by grouping them in teams to work collaboratively through activities and construct their own understanding of computer science content. POGIL activities are carefully designed to foster student development of process skills like information processing, critical thinking, and teamwork. Each POGIL activity typically includes 2–3 computer science content learning objectives and 1–2 process skill goals. After completing the POGIL activities, students are often expected to reflect and report on their process skills used during the activity.

Both projects use the *Operationalized Process Skill Definitions* developed by the POGIL Project (see <https://pogil.org/educators/additional-resources>). The following table gives examples of these process skills applied to computer science courses:

Process Skill	CS Examples
Information Processing	Predicting effects of code execution Converting pseudocode to code
Critical Thinking	Identifying common syntax errors Writing test cases
Problem Solving	Developing pseudocode Debugging code
Oral & Written Communication	Presenting algorithms Writing documentation
Teamwork	Collaborative development Designing an API

2 OUTLINE OF SESSION

This special session will begin by clarifying how students might demonstrate process skills in a computer science class. Process skills rubrics will be introduced in a manner that will model POGIL facilitation techniques and provide an interactive venue for learning about POGIL and asking questions about developing process

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skills. Guidance on how to use these rubrics with students will be provided. The presenters will end the session with links on how to access the process skills rubrics (at <http://elipss.com>) and POGIL activities (at <http://cspogil.org>), and will provide information about the support available to computing faculty adopting POGIL for computing classes.

15 minutes	<i>Process Skills Discussion</i> Explore definitions and examples
25 minutes	<i>Introduction to ELIPSS Rubrics</i> Rubric exploration activity Practice applying the rubrics
20 minutes	<i>Interactive Classroom Activity</i> Experience POGIL as students would Discuss how to give students feedback
10 minutes	<i>Opportunities to Learn More</i> IntroCS-POGIL and ELIPSS Projects CS-POGIL activity collections
20 minutes	<i>Q&A Discussion</i> Likely to happen throughout the session

2.1 Helen H. Hu

In my introductory computer science classes, my students discuss the importance of process skills, and I use this discussion to motivate the group work and POGIL learning teams. I have found that the POGIL classroom structure has improved the collaboration and teamwork in my classes. During the first weeks of the semester, my students are expected to complete a reflective report on which process skills are strengths and which ones could be improved. I then introduce the ELIPSS rubrics to help students understand how to improve in each area. Since adopting POGIL, I have seen increases in student engagement levels as well as in my female students' pass rates [2]. My POGIL activities include instructor guides with tips on how an instructor should facilitate the activity and support the development of process skills.

2.2 Chris Mayfield

I teach with POGIL primarily in my introductory courses, and I find it rewarding to help students develop their process skills. It's important to make process skills an explicit part of your objectives and assessments; they won't just happen automatically. For the past several years, I have been writing new POGIL activity collections for CS1 in both Java and Python (available upon request). Each activity has a specific process skill goal that students make progress toward as they work through the questions in teams. Focusing on process skills enhances learning because it affects the way students demonstrate their mastery of the content. As a member of the ELIPSS collaboration team, I have facilitated multiple workshops on assessing process skills and providing feedback. This special session will be a unique combination of ELIPSS materials and IntroCS-POGIL resources, tailored for a CS audience.

2.3 Clif Kussmaul

I use POGIL activities across the curriculum, from CS1, through Computer Organization and Software Engineering, to Artificial Intelligence. I have also led POGIL workshops for faculty across the US and in other countries. In both classes and workshops, I observe that to play a sport or a musical instrument, people need to practice and develop specific skills, ideally with a coach, and often with other players. A good coach provides constructive feedback, but also assigns drills and other activities to help players practice skills before using them in more realistic settings. Computer science and other academic subjects should use the same ideas to help students practice and develop process skills both within and across disciplines.

3 EXPECTATIONS

This special session should appeal to K-12 teachers and university instructors interested in process skills development, especially but not limited to active learning classrooms. Attendees will experience how students discover computer science concepts for themselves and develop problem solving, critical thinking, and communication skills while working through POGIL activities. They will learn how POGIL and these rubrics have been used in CS classrooms, how to access rubrics and POGIL materials, and how to learn more through POGIL workshops and regional meetings hosted by the National POGIL Office (<https://pogil.org/events>).

4 SUITABILITY

The flexibility of the special session will allow for participants to engage in exploring the rubrics in a POGIL classroom environment. It is easy to briefly describe POGIL, but actually experiencing POGIL helps many teachers to really understand the key principles and practices. Similarly, POGIL is implemented in different ways depending on students, courses, and other factors, so providing multiple perspectives helps teachers understand the range of options. Thus, a special session enables us to help instructors better understand both the rubrics and the POGIL approach to support process skills development in any course.

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