

Conversations with a Prominent Propagator: Helen Hu

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Encouraging faculty adoption of transformative teaching practices in Computer Science (CS) undergraduate education requires sustained, intentional planning and effort. This article is the next installment in the series of interviews with *prominent propagators*: members of the CS education community who have successfully spread pedagogical or curricular innovations [1-3]. The goal is to capture knowledge and experiences that others can use to propagate their own teaching projects.

In this article, we interviewed Helen Hu, Professor and Chair of Computer Science at Westminster College. Helen is best known for her work promoting and developing Process Oriented Guided Inquiry Learning (POGIL) for Computer Science with Clif Kussmaul, Chris Mayfield, Tammy Pirmann, and others [4, 6–9]. POGIL is an instructional strategy in which students work in small, self-managed teams with specific roles. POGIL activities are designed to guide students through discovering key concepts, while developing skills such as critical thinking, problem solving, communication, and working in teams. Rather than lecturing, instructors act as guides through the process [5]. More about Helen's work on POGIL in CS can be found at introcpogil.org.

Below are highlights of the interview, which ran approximately an hour. The transcript has been edited for clarity and style.

Q: What does an instructor need to do to become a “user of POGIL”?

HH: POGIL has eight common attributes and four of them I personally feel are core characteristics to POGIL and non-negotiable. First, obviously they're using POGIL activities. Number two: the instructor is facilitating the classroom. Number three: the students are working in groups. Number four: student-centered learning. Those four are really critical. If you're not doing those four, I'm not sure you can call it POGIL.

So for number one, POGIL activities, we're not saying you have to use any specific set in particular, but you have to be using them more than once or twice a semester. We actually tell instructors in our project that they must use at least eight. Those of us who have completely embraced POGIL are often using them once a week or twice a week, which means we're using 15 to 30 activities in a semester. So eight seems like a low limit to require.

Q: Which characteristics are more negotiable?

Let's see, the other characteristics common to POGIL are: assigning roles, expecting students to complete the activities in class, using the activities as the first introduction to the topic, and not requiring prior work [on that particular activity] before class. The roles are probably the most contentious. I definitely know people who use POGIL without the roles. We've had discussions in our research group about whether roles are something that people adopt in their second or third semester of using POGIL when they realize that the roles help mitigate problems with groups.

Also, traditionally POGIL is a student's first introduction to a topic. I know some faculty don't do that because they want the flipped classroom. They still want to give extra reading before the class. I would say that's still POGIL. That the activity is completed in class seemed really important at one point, but

given COVID, people are definitely shifting that, so their students start activities in class and finish outside.

Q: I'm intrigued by this idea that people actually develop and use more POGIL practices as they become more experienced. Can you talk a little bit more about how that process plays out?

HH: I think that people are drawn to the concept of POGIL because of the activities at first. They're not really thinking about developing students' process skills. POGIL stands for Process Oriented Guided Inquiry Learning, but many people are more excited about the guided inquiry learning and they buy in a little more to the process-oriented part as they gain experience teaching with POGIL.

A lot of people hear about POGIL from our SIGCSE presentations and events like that, but if they really want to adopt POGIL, they should attend one of the three-day workshops the POGIL Project runs every summer. When they show up to that, they start to see the benefits of the focus on process.

Q: What specific activities or messages are given that encourage people to bite into it?

HH: The POGIL Project is a national project. They have been very careful to develop a workshop program that they think is successful, but they also protect it. It's all copyrighted. After attending the three-day workshop and implementing POGIL in our classes, my project team applied to and attended facilitator training. We were trained on how to run these workshops. So the three-hour workshop that we run at SIGCSE is straight from The POGIL Project. We order, purchase, and use materials and slides from them.

As part of every workshop, attending faculty get to experience POGIL as if they were students. Most of our attendees are STEM teachers. We use an economics POGIL activity, which most faculty are not comfortable with. The participants really get to experience what POGIL is from a student point of view. Then we introduce a MetaActivity and we go through that original activity as teachers, thinking about the teaching practices in the original activity. What types of questions did we just see? What order were the questions given? Finally we provide research, proof that POGIL works. Throughout these sessions, they're experiencing the roles and we discuss, what did students get out of these roles?

Q: How does the workshop lead to adoption?

The POGIL Project's three-day workshop does a great job of convincing people they want to use POGIL, but it doesn't help them with that next step. We introduced an extra day to the official workshop to show them what a POGIL activity looks like in Computer Science, because right now in the three-day workshop there's usually no Computer Science activities.

So the first thing we do is show them what a Computer Science POGIL activity might look like. Then we have a working session where they think about their syllabi and look at our POGIL activities. When we were in-person, we printed our POGIL activities in binders and handed them out, so participants can flip through, thinking about which ones might align with their classes and where they can add it. They're thinking about what they can take out of their current class in order to make time for POGIL. One of the first things that a CS 1 instructor is thinking about is, "Where am I getting this time so that I can introduce a 45-minute POGIL activity? Am I reducing my lecture time? Am I tweaking my lab time?"

Then we connect each participant with a mentor because we know that some people will get excited about POGIL and plan to adopt POGIL in the semester, but life happens and they don't do it. Other people will try POGIL in that first class and they weren't quite as prepared as they needed to be, so it crashes and burns. That's where we want that mentor to say, "It's okay, don't panic. Here's how we can recover from that". There's a limited window to recover when POGIL doesn't go well.

Q: How do you incentivize faculty to use POGIL?

HH: For our research study, they get \$4,000 for their first semester teaching with POGIL, attending mentor group meetings, filling out surveys, and having their students fill out surveys. If you give up on POGIL in the first week, you won't receive your stipend. At the same time, they are doing a lot; there's a lot of time, so the \$4,000 is absolutely merited. The stipend helps provide incentive to not give up on POGIL that first semester.

Q: Do you experience faculty pushback?

HH: Oh, absolutely. There are definitely faculty who attend a three-hour POGIL workshop and say, "I hate learning like this" because faculty are people who did well in school learning through traditional lecture and textbooks. There are definitely faculty who do POGIL and realize they don't want to teach that way. I find more success with faculty who show up because they want to, and not because their department chair told them they had to.

In more advanced CS classes, it's a lot harder to adopt POGIL because there's just fewer activities and it's hard to write activities. It's like Peer Instruction: the questions are hard to write—way harder than people realize. So adoption rates are going to be much better in classes where we've taken away that hurdle of creating questions. In POGIL, the adoption rates are going to be higher when there are more classroom-tested activities that already exist.

Q: Can you build writing POGIL activities into the program moving forward?

HH: The POGIL Project runs two types of summer workshops to support activity-writing. The Activity Writing Workshop has sessions going over the structure of a POGIL activity and things like that. It's a lot more facilitated. The Writers' Retreat provides a lot more free time and coaching: there's some guidance at the beginning but most of the benefit is giving you mentors who you can check in with and get feedback from on the activities that you are writing.

Q: What is the training process for becoming one of those mentors?

HH: POGIL is highly controlled by the national POGIL Project. There are benefits and problems with that. The benefit has always been that you cannot just call any activity "POGIL." If I write an activity, I can't just say, "Here's my POGIL activity." It's not a POGIL activity until it's been endorsed by the POGIL Activity Clearinghouse. Most of the activities on CSPOGIL.org are not endorsed by the POGIL project yet. This is the CS community: we just invent things and we put it out there to share with everyone. But we're working on getting more activities endorsed.

People who have endorsed activities are invited to become author-mentors. When I work with someone who is amazing at writing a POGIL activity, it is fantastic. Even if they don't know how to program, they know what to ask to encourage authors to create the right type of questions.

Q: What else makes a good POGIL activity in Computer Science?

HH: A POGIL activity begins with a model. In STEM, it's usually a diagram, but we have really struggled making good diagrams in computer science. You can have a diagram of the stack and the heap and stuff like that. Linked lists are great for diagrams. Sometimes a model is code and the output of the code.

So there's a model, followed by a series of questions. The first few questions are usually "explore" questions, which encourage students to identify the key parts of the model. Explore questions are supposed to be very straightforward. The second part is "concept invention" questions, which help with the guided inquiry: students discovering new concepts. And then the activity ends with the "application" questions, where students apply what they've learned, possibly by writing code.

The questions take students through a learning cycle. These questions need to be carefully worded so that the students understand them and they are introducing terms in the right way. When you have activities that use vocabulary that students don't understand, it gets overwhelming for students. There's a lot to writing these activities, which is why we want to give new instructors existing, classroom-tested POGIL activities to allow them to just adopt the activities for their first semester teaching with POGIL.

Q: What types of data collection and analysis of users are you doing?

HH: We have data about what faculty said about the workshops, and also what they said after a semester of teaching this content. We have a survey at the end of their first semester of teaching with POGIL where we ask them about their challenges adopting POGIL and which interventions were the most helpful.

POGIL has eight characteristics. At the end of their first term, we asked them on a Likert scale survey, "Did you do each of the eight things?" We're following up on fidelity of implementation, although it's not completely accurate because it's self-reported. And then we ask what they thought about POGIL's impact on student outcomes as well. We follow up with them after the first time they've used POGIL and then we follow up with them after several semesters of teaching with POGIL. How did their opinions change?

Q: What strategies help ensure that instructors maintain the fidelity of POGIL activities?

HH: For the activities themselves, there's no control. Once someone leaves the workshop, they can do whatever they want with the activities in their own class. I know our participants are careful—more careful on average—because they recognize it's research and they want to make sure that the intervention is correct. I have certainly had faculty tell me that after their first semester, they start making it their own, and we encourage that. We say, "Use our activities with minimal changes the first time, because you may see a question that seems really easy and you won't realize it's necessary until you try it in the classroom. You may find out many of your students get that question wrong. Then you'll realize how essential it is."

Q: What obstacles prevent faculty from trying or using POGIL?

HH: I have a list of the things that faculty said were obstacles, and class time is at the top of the list. They say, "In order to fit in a POGIL activity, I have to take something else out." And everyone acknowledges it is always faster for me to explain a concept than for you to discover it yourself. It only takes me one minute on a PowerPoint slide to tell you about something. Now, whether you actually learned it... So what's your goal? Is your goal to *tell* the students everything you need to tell them, or for them to *learn* as much as they can? Unfortunately, every once in a while, you have faculty who say their goal is to cover all the concepts because they are one of five faculty teaching this class and have committed to covering all these topics, regardless of how well students learn the topics.

Q: What other hurdles are faculty talking about?

HH: The first one was class time and content. The next one was prep time. Difficulty adapting was the one after that. They do talk about student resistance. Lack of activities. And then the last one was colleague resistance. This was interesting because almost everyone said colleague resistance was not a problem in the first semester, but a few people said it was a problem in their second. What we've heard is that students like POGIL and then they go say to other faculty, "Why aren't you doing this?" The other faculty are like, "Why are *you* doing that? Because I don't want to do that."

Q: Can you tell us more about difficulty adopting or adapting?

HH: In CS 1, you have objects first, or objects last. Are you using media comp or not? Are you using this IDE versus that IDE? Are you covering that topic? There's a surprising number of people who are teaching CS 1 in two semesters, not one. We don't have the POGIL activities for all these different variations of CS 1.

Chemistry is a field where almost every department has their students take an ACS exam at the end of their first semester. So, general chemistry professors agree on what's covered in that class. We don't in Computer Science. We write these papers pretending that we know what CS 1 is, but then we go and run a study on CS 1 faculty and discover it's all over the place. This makes it difficult to support all CS 1 faculty.

Q: How easy is it to adapt POGIL activities to different CS 1 courses?

HH: Unfortunately the POGIL activities have to have a flow. Where did you introduce arrays? If you teach arrays in a different order than we assumed, you can't use our array activity because it assumes prerequisite knowledge your students won't have.

Clif Kussmaul is trying to keep CS POGIL activities centralized at CSPOGIL.org. It turns out it's extremely hard. We're even struggling within our own project. Chris Mayfield will write an activity. I'll adopt it, but I'll make my tweaks. Now, which one of those two activities stays in the repository for everyone? There are some people who are going to like mine and some people are going to like Chris's. He has a textbook so that makes it easier for Chris to say that if you use his textbook then you can use his POGIL activities, and they align perfectly.

Q: What has been the most rewarding aspect of trying to propagate your work and get more users involved?

HH: I love hearing from faculty that after they've adopted POGIL, they love it, their students love it, and it's transformed their teaching. That's fantastic, right? It's also great meeting so many other faculty, learning from them.

Q: What has been the most challenging aspect?

HH: The research has been really challenging, given how different everyone's implementation is. We went into this NSF project planning to do a multi-institutional study of how POGIL affects student learning. And that has been insanely difficult for various reasons: IRB, as well as differences in institutions, and differences in CS 1.

Q: What advice would you give to somebody starting out?

HH: We run POGIL workshops at SIGCSE that are all about what POGIL looks like and getting participants to try it out. I think that the next step after attending a workshop is considering how you can take existing activities and inject them into a course you're already teaching, or a course you're going to teach. Connecting with others who are teaching with POGIL can help support you in that step.

To learn more about POGIL:

POGIL for CS 1	introcspogil.org
POGIL through the CS curriculum	cspogil.org
The POGIL Project (All disciplines)	pogil.org

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