The CS POGIL Activity Writing Program

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Abstract

This evidence-based practice paper describes the CS POGIL Activity Writing Program (AWP), a faculty development program to help computing faculty create classroom activities for Process Oriented Guided Inquiry Learning (POGIL). In POGIL, student teams work during class time on activities that are specifically designed to develop concept understanding and skills such as critical thinking and problem solving. Research has documented POGIL's benefits for student engagement and learning. However, faculty can find it difficult to adopt POGIL, particularly if classroom activities are not available for the content they need. This program sought to increase the number of available CS POGIL activities by increasing the number of active qualified authors. This paper summarizes relevant background, presents the program's structure, and describes outcomes, evaluation, and directions for future work. During the program, 31 participants, experienced with POGIL, attended virtual meetings and workshops, including a virtual Kickoff Workshop, a hybrid Writers Retreat, and 1:1 coaching with the Project Coordinator and other writing mentors. By the end of the AWP, 27 authors had drafted 71 activities in 17 areas of CS. Fifty-eight activities were revised and approved by the program as ready for classroom testing. Almost all of the authors planned to use the developed activities in their classes (88%) and share them with others (78%), while 75% planned to develop more activities. Almost all (88%) felt that the writing process impacted how they teach with POGIL activities. Thus, the AWP is an effective model to support faculty and produce quality activities.

1. Introduction

Collaborative learning activities benefit student engagement and learning in the classroom [1]. However, well-structured activities are difficult to develop and write, and there are few faculty development programs to help aspiring authors draft and revise activities. This paper presents a program designed to help experienced Process Oriented Guided Inquiry Learning (POGIL) instructors to author new POGIL activities. POGIL activities are a unique type of instructional material that utilize a series of questions to promote the development of content knowledge and key process skills, including critical thinking, problem solving, teamwork, and management abilities. While this research-based pedagogy has been demonstrated to be effective across multiple disciplines (see below), a lack of available activities was identified as a barrier to wider adoption in computer science (CS) [2].

The CS POGIL Activity Writing Program (AWP) offered intensive training, hands-on coaching, and general support to experienced CS instructors who desired to become effective POGIL activity authors. The program sought to ensure that each author had a thorough understanding of the criteria for a well-structured POGIL activity. A secondary goal was to increase the number of POGIL activities for post-secondary CS courses. We developed a six-stage Activity Development Process, involving multiple rounds of reviewing overseen by mentors to ensure that each activity met all necessary criteria for POGIL activities. In Section 2, we review the background on POGIL and the professional development offered to POGIL instructors and authors. Section 3 provides details on our participants and interventions. The results are presented in Section 4, while Section 5 delves into the insights garnered, along with any limitations encountered. Finally, Section 6 concludes with some final insights.

2. Background

Active, evidence-based approaches to teaching and learning can improve all student outcomes and reduce achievement gaps for students from underrepresented populations (e.g., [1], [3], [4]). A variety of faculty development programs and other incentives have been used to help faculty change their pedagogy, primarily at the precollege level. In general, the most effective faculty development models focus on subject matter knowledge and student learning of a particular subject [5], combine curriculum and instructional practices [6], and are intensive and sustained [7]–[9]. However, adopting new teaching practices can be difficult [10], faculty development activities do not always result in improved pedagogy [11], and many faculty who claim to use evidence-based approaches actually omit key components [12].

2.1. Process Oriented Guided Inquiry Learning (POGIL)

POGIL is an evidence-based approach in which student teams work on specifically designed classroom activities [13]–[15]. Initially developed for chemistry courses (e.g., [16]–[19]), POGIL activities have been developed for many other disciplines, including material science and engineering [20], [21], computer science [22]–[26], and mathematics [27], [28]. POGIL helps students develop process skills such as teamwork, critical thinking, and problem solving with students working in teams with assigned roles (e.g., Manager, Recorder, Presenter); and the instructor acting as an active facilitator, not a lecturer or passive observer.

The structure of a POGIL activity is particularly relevant for the AWP. A POGIL activity might look like a simple worksheet but is really more of a script or sequence of prompts for student inquiry and discussion. Each activity contains one or more *models*, which might be images, graphs, tables, diagrams, dialogues, sets of definitions, simulations, or other artifacts. A model is followed by a set of questions that follow *explore-invent-apply* learning cycles to guide students to develop their own understanding of new concepts. *Explore* questions prompt students to explore the model and notice key features. *Invent* questions prompt students to develop and articulate their own understanding of an unfamiliar concept. *Apply* questions prompt students to apply their new understanding. At the same time, a POGIL activity is designed to help students practice specific process skills. Writing an effective POGIL activity can be difficult and time consuming, but good activities are often readily adopted or adapted by other faculty who teach the same or similar content.

2.2. POGIL Faculty Development

The POGIL Project (http://pogil.org) has been identified as a "community of transformation" for its approach to STEM education reform [29]–[31]. It offers a variety of faculty development events, including webinars, in-person and virtual workshops, the *National Conference to Advance POGIL Practice (NCAPP)*, and the *POGIL National Meeting* (for community leaders). The AWP described in this paper leveraged materials developed by The POGIL Project.

For people interested in writing POGIL-style activities, there are *Activity Writing Workshops* and *Writers' Retreats* (both have been offered in-person and virtually). The three-day Activity Writing Workshop includes sessions on the structure of a POGIL activity, writing effective objectives, developing robust models, and providing quality feedback to authors. The workshop

also includes opportunities to draft and start to revise a new activity. For example, a writing "sprint" encourages authors to quickly draft an activity without trying to perfect it. The four-day Writers' Retreat includes review sessions similar to sessions in the Writing Workshop, writing sprints, time for individual writing and daily meetings with experienced coaches, and sessions to review and provide feedback on draft materials by other participants.

However, there is limited data on the quantity or quality of activities written by participants in these events, limited ongoing support for POGIL authors, and limited understanding on what is needed for authors to develop quality activities. In 2021, The Project started a program where practitioners meet in learning communities with a mentor, modeled in part on a earlier program for faculty adopting POGIL in introductory CS [32].

2.3. POGIL Activity Clearinghouse

The POGIL Activity Clearinghouse (PAC) (http://pac.pogil.org) is a recent effort by The POGIL Project to provide a structure and process for POGIL authors to submit activities in four different phases (concept, activity review, classroom testing, and formal approval by The POGIL Project). Authors who submit an activity for review receive feedback based on two rubrics [33]. The Learning Cycle Rubric evaluated the quality of an activity's content learning objectives, learning cycle structure, clarity, flow, and inclusiveness, while the Process Rubric assessed the process skills goals, process skills development, cooperative structure, and self-assessment.

The PAC regularly hosts workshops to familiarize authors with using these two rubrics. Before the workshop, participants use the rubrics to individually review a sample activity. During the workshop, they compare and discuss their rubric ratings. The CS POGIL AWP used the PAC trainings, its platform, and both rubrics as a framework for providing feedback for activities.

3. The Activity Writing Program

3.1. Participants

The AWP was widely advertised to the CS POGIL community (via a 150-person Google Group) from December 2021 to May 2022. 34 experienced POGIL instructors completed an application to express interest in the program. Three early applicants dropped out in January after more information about the program was shared. The remaining 31 participants (13 men and 18 women) were based in the United States and taught at 3 high schools, 2 community colleges, and 21 colleges and universities. All but one of the participants had attended workshops on POGIL pedagogy. 13 participants had previously participated in the IntroCS POGIL faculty development program [32] which provided additional mentoring and support during their first semesters teaching with POGIL. The one participant who had not participated in formal POGIL training had consulted with an experienced POGIL instructor from the Chemistry department at her institution and had multiple years of experience teaching with POGIL.

The AWP enlisted a team of experienced POGIL authors and instructors to assist the participants. Five POGIL activity writing mentors and 11 POGIL activity reviewers were recruited from the broader POGIL community, mostly from non-CS disciplines such as Chemistry and Biology. To ensure the accuracy and clarity of the CS content in the activities, the program also enlisted 11 CS content reviewers to provide feedback.

3.2. Faculty Development Events

The AWP leveraged materials and lessons learned from The POGIL Project's Writing Workshop and Writers' Retreat and relied heavily on the POGIL Activity Clearinghouse (PAC).

In January 2022, 13 participants attended a virtual **informational session** that provided an overview of the expectations and requirements of the AWP, as well as the six-stage Activity Development Process (detailed in Section 3.3). The session was recorded and shared with subsequent applicants. After the informational session, 11 early participants began submitting activities and meeting with the Project Coordinator.

All participants, reviewers, and mentors were required to attend a **PAC rubric training workshop**. A few participants, mostly POGIL reviewers, and all but one of the POGIL mentors were already active reviewers for the PAC and had participated in the PAC training prior to 2022. The two participants who did not complete the PAC training only submitted one activity each and did not complete their revisions.

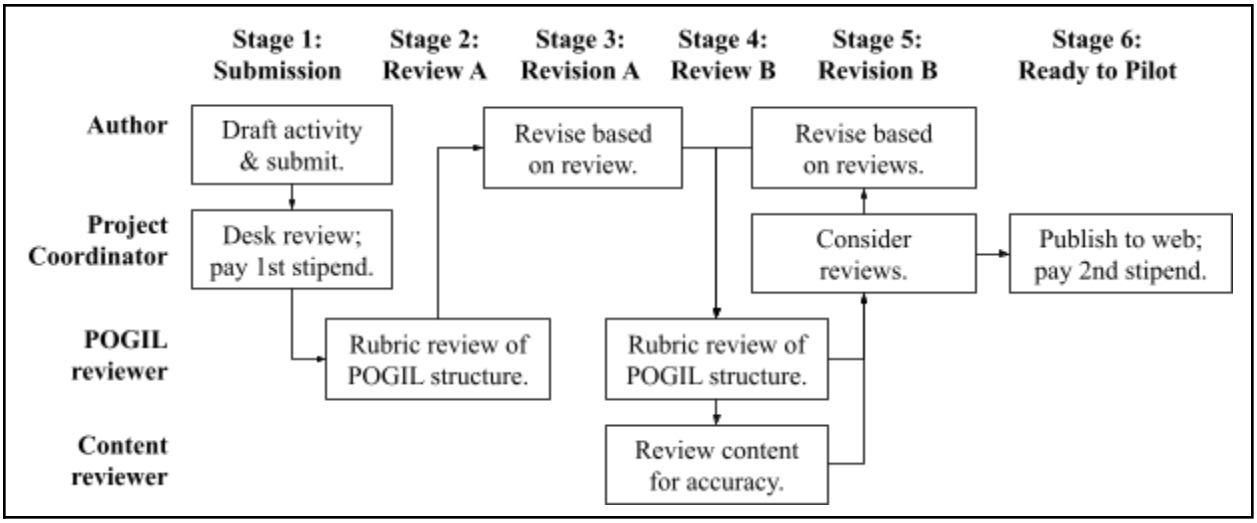
In May 2022, the program hosted a two-day virtual **Kickoff Workshop** with 20 participants. The event consisted of four hours of activity writing workshops each day, adapted from the POGIL Writing Workshop (described above). In addition, there was a short mixer event on the first day and a networking event on the second day. The networking event encouraged authors to meet with others interested in writing activities for the same CS courses (to avoid activities on the same concepts). It also offered authors an opportunity to form collaborations or writing support groups with other authors planning to write the same number of activities over the summer. Finally, the Kickoff Workshop included an AWP informational session on the first day and a Q&A session on the second day. All participants were asked to attend, and the events that were not adapted from the POGIL Writing Workshop were recorded for those with schedule conflicts.

In June, 20 participants attended a three-day hybrid **Writers Retreat**, adapted from the POGIL Writers Retreat (described above), but a day shorter, as most attendees had recently participated in the Kickoff Workshop with similar sessions. The four writing coaches consisted of the Project Coordinator who had authored multiple POGIL activity collections including one for introductory CS, two members of the project team who had authored numerous CS activities, and an author of Chemistry activities. Five participants attended the Writers Retreat in-person and 15 attended virtually. Five other participants registered for the Writers Retreat but did not attend. The Writers Retreat was not recorded.

3.3. Six-Stage Activity Development Process

A central goal of this program was to support authors through intensive coaching. Each activity went through a six-stage review and revise process, using the PAC's content and process rubrics. **Figure 1** provides an overview of the six stages. Each activity needed to proceed through the six stages from the initial submission of the activity (Stage 1) until it had been reviewed and revised at least twice (Stages 2-5), before finally being deemed ready for classroom testing (Stage 6).

Figure 1: Six-Stage Activity Development Process



In Stage 1, the author prepared a first draft of an activity, including the student version, an answer key for the instructor, and the standard PAC submission form, which included information on prerequisite knowledge and an implementation plan for the activity. The author uploaded all of these materials to the PAC website. The Project Coordinator checked that the submission was complete, and then issued the first half of the stipend. In Stage 2 (Review A), the activity was reviewed for POGIL structure, using the PAC content and process rubrics. In Stage 3, the author revised the activity in response to the review. In Stage 4 (Review B), the revised activity was reviewed again for POGIL structure as well as for accuracy by a CS expert. In Stage 5, the author continued to revise their activity in response to these reviews until the Project Coordinator approved the revised activity as ready for piloting in a POGIL classroom (Stage 6), and issued the second half of the stipend. An author received $1000 (split between Stages 1 and 6) for completing a classroom-ready POGIL activity.

The process varied slightly based on how many activities an author had written. For the author's first activity, the Project Coordinator served as a primary coach. She completed the PAC content and process reviews for the first activity and then met virtually with the author to discuss the strengths of the activity and suggestions for improvements. The authors would then revise the activity repeatedly until the Project Coordinator determined that the activity had met all the criteria for testing in a POGIL classroom. An author was not allowed to submit a second activity until their first activity had reached this point.

Once an author completed their first activity, they were assigned a writing mentor. The mentor served as the sole reviewer for the author on their second activity, coaching the author much as the Project Coordinator had on the first activity. The mentor also served as the sole POGIL reviewer for Stage 4 (Review B) on all subsequent activities. The five mentors were essential to scaling the AWP to support the 31 participants.

Authors continued to receive feedback on subsequent activities from their assigned mentors, although starting with an author's third activity, the first review of the activity in Stage 2 (Review A) was completed by a reviewer in the POGIL community. These reviewers would

generally come from the PAC, although most authors who had drafted three or more activities participated in one or more collaborative peer review process with another author in the program, consisting of each author reviewing the other author's activity before providing that feedback in a virtual meeting attended by the two authors and the Project Coordinator. The expectation was that authors now had a good understanding of criteria for a POGIL activity, and should no longer require as much coaching for each activity. Authors who had reached this point were allowed to have up to three activities under review at one time.

4. Progress & Outcomes

Besides tracking the number of POGIL activities drafted and published by each author, the AWP solicited feedback from participants after each faculty development event. In addition, all participants were emailed a link to a survey after the end of the program. 24 of the 31 participants responded (77%). The survey found that respondents primarily joined the AWP to learn how to write POGIL activities and/or to receive the support, including mentoring and financial support. Over three quarters of the respondents felt that their expectations were met (19 / 79%) with one person feeling their expectations were not met (due to lack of time to write) and four others unsure.

All but one respondent felt the writing process as a whole was very positive (15 / 62%) or positive (8 / 33%), on a scale of 1 (very positive) to 5 (very negative). The most negative response was one person who viewed the process as neutral (3). The mean rating was 1.5 with a standard deviation of 0.6.

4.1. Activities Produced

Table 1 provides information on participants' training, the number of activities that reached key stages of the Activity Development Process, and the number of activities published. Four participants (13%) did not submit any activities. The remaining 27 (87%) submitted an average of 2.6 activities, for a total of 71 activities in 17 CS content areas. The areas with the most activities drafted were CS0, CS1, CS2, Computer Architecture, Databases, and Software Design.

Table 1: Progress by Authors & Activities

	Recruiting		Training			Revision				# Published								
	Applied	Accepted	PAC Training	Kickoff	Retreat	S1: Submit	S2: Review A	S4: Review B	S6: Publish	1	2	3	4	5	6	7	8	9
# authors	34	31	29	20	20	27	26	23	17	4	2	4	3	2		1		1
# activities						71	70	66	58									

Fourteen authors (45%) only drafted one activity - which was a requirement to receive an additional $500 stipend for participating in the trainings and completing the surveys. The 11 authors who authored three or more activities (35%) received a second $500 stipend as a bonus for high engagement in the AWP and participating in the collaborative peer review.

All but one of these activities received Review A feedback, completed Stage 2, and reached Stage 3. (That one activity was submitted on the last day of the program.) 66 activities were revised in response to Review A feedback and received Review B feedback, completed Stage 4 and reaching Stage 5. 58 activities satisfactorily responded to Review B feedback and were deemed ready for classroom testing and published by the POGIL Activity Clearinghouse as a special issue of its open journal. Of the 27 authors who submitted at least one activity, three (11%) did not revise their first activity in response to Review A, and another six (22%) did not revise their first activity in response to Review B.

All participants were asked to attend at least the first 45 minutes of the virtual Kickoff Workshop, although a few were unable to attend due to schedule conflicts. The 20 participants who attended at least one session of the workshop submitted an average of 2.5 activities, whereas the 11 participants who did not attend submitted an average of 2.4 activities. (We recorded two hours of the Workshop, but did not track who watched the recordings.)

The Writing Retreat was offered as an optional hybrid event for participants. Twenty participants attended at least one day, submitting an average of 2.6 activities, whereas the 11 participants who did not attend submitted an average of 1.7 activities. The five in-person participants who attended all days wrote an average of 3.8 activities versus the virtual participants who wrote 2.2 activities (some of whom attended fewer days of the Retreat).

4.2. Survey Rating AWP Elements

In the end-of-program survey, participants rated all elements of the AWP on a scale of 1 (very positive) to 5 (very negative). **Table 2** lists the elements from most positive to least positive. Respondent ratings of the various aspects of the process were very positive especially the meetings with Project Coordinator. The ratings were also very high for the work with their mentors; however, a large proportion of respondents rated that question as not applicable (8/33%), indicating they had not written enough activities to be matched to a mentor.

Table 2: AWP Elements from Most Positive to Least Positive

	Mean	SD	Not Applicable
Meetings with Project Coordinator	1.0	0.2	1
The Writers Retreat	1.4	0.6	6
The Kickoff Workshop	1.4	0.7	2
The feedback (Review A and Review B)	1.5	0.8	2 no response
Your mentor	1.5	1.3	7 + 1 no response
The Six-Stage Activity Development Process	1.6	0.8	2
Collaborations with other authors	2.2	1.4	6

4.3. Two-Day Kickoff Workshop

After the end of the Kickoff Workshop, attendees were asked to identify a strength, an insight, and an area for improvement (SII) [34], and 15 of 20 participants (75%) responded. Being able to work collaboratively was the most frequent strength mentioned from the Kickoff (7) followed by the tight timeline and organizational structure (6). Specific comments about the strengths also emphasized the collaborating and networking with other participants:

> *Matching us into breakout rooms based on the activities we plan to write. It was useful to be in a room with the people interested in the same topics, and we may collaborate on some of them.*

Only 8 of the 15 respondents had suggestions for improvement. These included spending more time in groups (3) and grouping participants with similar topics (2). Insights included participants' better understanding of the POGIL writing process and the time and effort it takes to write a good POGIL activity. Some insights went far beyond the writing process, as the following quote shows:

> *... This seems to demonstrate that a POGIL activity will keep students thinking about the new concept after the activity is over. The exercise was helpful to me because it focused on the invention part of a POGIL activity, which is something we're not used to. I mean, we talk about "flipped classrooms," but this is the real flip:* ***Instead of an individual student observing a well-known concept discovered ages ago, a student in a group context invents a concept, maybe even in a new, productive way.***

4.4. Three-Day Writers Retreat

After *each day* of the Writers Retreat, the 20 participants were asked to provide SII feedback. Eight provided feedback after Day 1, 12 after Day 2, and 11 after Day 3. On multiple days, multiple respondents mentioned strengths that included getting feedback from peers, time for writing, and coaching sessions. One in-person participant summed up the entire Retreat:

> *Getting started is hard. This is why sprints are great. But this retreat is kind of like a sprint for the entire project. By the end of the retreat, I have my first activity just minutes away from submission (... before I get on the plane tomorrow) AND a full scheduled flow for the other ones I want to write. I would not have had this done if I hadn't participated [and being here made a world of difference]. Also, community is important. Being here made for a wonderful (if small) sense of community. It was great to meet other CS peeps and connect with others that are working on similar activities.*

Suggestions for improvement from multiple respondents were to make better use of team time, shorten the plenary sessions, and add writing time. After the last day, one participant noted:

> *I don't think you can make significant adjustments that won't hurt some people at the expense of the people you help. This schedule is great. The process is complete. I really truly felt like I was being led to the stage of being ready to submit.*

Insights were similar to the Kickoff with an emphasis on getting feedback and the amount of time and effort writing a POGIL activity takes. Other respondent insights included:

> *Need to have a way for students to recognize that they are developing process skills.*
>
> *Early feedback on models, for me, is more helpful than later feedback. It kinda cuts me off before I feel emotionally committed to a particular type of model or features of one particular model.*

On the last day, some respondents reported broader insights including:

> *I don't honestly know if I will become a POGIL enthusiast for life. But I do know that I will seriously try it for a while. No matter WHAT happens the learning I have done in this process has improved my teaching. Period. Thank you.*
>
> *I am really bad at pedagogy - creating lesson outcomes and scaffolding. This really helped me learn the difference between and Explore, Invent, and Apply question. It also helped me learn how to backwards engineer a lesson from what I want the students to know, so I can develop the activity to get the student there.*
>
> *I have a tendency to provide verbose explanations; I learned that in many cases I can turn some of those explanations into exploration questions. This is helpful because students can be intimidated by large blocks of text, so breaking up explanation into smaller chunks including questions will improve students' experience with the activities.*

4.5. Overall Insights of AWP

The benefits respondents listed from participating in the AWP focused on having a better understanding of POGIL and more confidence in their ability to write and implement POGIL in their classroom. They also appreciated getting feedback on their work and collaborating with others in the same discipline. Specific comments included:

> *I feel like I have a MUCH better understanding of what POGIL activities should look like and how to go about writing them. It was also great to have one fully completed POGIL activity and one that`s almost ready to be submitted.*
>
> *Collaborating with colleagues that are interested in the same discipline, and at times in the same subject was great. … the workshop was extremely productive for me.*
>
> *Each of my activities were vastly improved by having multiple reviews and revisions. And the biggest benefit will be being able to use them in my own classes!*

Seven respondents (29%) felt time was the major challenge to participation in the AWP with another citing personal burnout. Three others (12%) mentioned confusion about the learning cycles and how to apply them. Individual challenges were the lack of a sense of community, confusion about project expectations, and "trying to figure out when POGIL helps my students and when it hurts my learning outcomes."

Only one respondent was unsure if they would use the activities they and others developed in some ways. Most (21 / 88%) planned to use them in their own courses and share them with others (19 / 79%). Eighteen (75%) also planned to develop additional activities. Fewer planned to use activities developed by others (11 / 45%) and share their activities with others (4 / 17%).

Most (21 / 88%) of the respondents felt the writing process had an impact on how they teach with POGIL activities, while two felt it had no impact and one was unsure. Their most frequently reported impact was that there were more activities to use, followed by having a better understanding of the learning cycle. As one participant explained:

> *The project helps me understand POGIL better. Each question has a purpose in the learning cycle. No unnecessary questions are included. This helps me appreciate POGIL more and at the same time helps me feel more confident about using this approach in the classrooms - POGIL may take a little more time than lecturing but it is worth it.*

For some the writing program has had a variety of impacts on them. For example:

> *Many of the POGIL activities I have been using are lacking important steps of the learning cycle. There seem to be a lot of apply questions. The writing training gives me much better ideas on how I can quickly improve a POGIL activity before throwing the students on it. Another thing that I hope to do is require team summaries from each activity that I will correct and grade. I think the invention questions would be the best thing to put in the summaries, so I have a chance to correct misconceptions from students. In the past I have not graded the POGIL activities at all, because grading all the questions for all the teams is daunting.*

5. Discussion

The Activity Writing Program was created to help CS faculty develop and disseminate high quality, open-source POGIL activities. It was designed to be flexible enough that authors could write activities when they had time and energy between January and August 2022. The six-stage Activity Development Process was developed to support authors as they focused on writing one strong POGIL activity, before proceeding to draft additional activities, and relied heavily on the POGIL Activity Clearinghouse and its two rubrics used for reviews. Because authors often have the same flaws in most of their activities when submitting an entire collection for review, AWP participants had to revise one POGIL activity until reaching the sixth stage before they could submit additional activities. This requirement prevented an author from submitting numerous POGIL activities for review and never revising any of them. By the end of the program, 87% of participants had drafted a complete POGIL activity, and 55% had revised at least one POGIL activity until it was deemed ready for classroom testing by other POGIL instructors.

A central element of the AWP was the intensive coaching of authors on their first activity by the Project Coordinator. These meetings were rated as the most helpful element of the AWP). The authors revised this first activity with repeated feedback from the Project Coordinator until it met all the criteria to be ready for testing in a POGIL classroom. These criteria were described in the Learning Cycle and Process Rubrics, including clear learning objectives, one or more learning cycles, logical flow, explicit process skill development, and self-assessment questions. The

rubrics also included standards for diversity and inclusion. In essence, the activity that reached the end of the six stages was polished to the point that further refinement would only come from using the activity in a real classroom with students.

There is some evidence that authors sometimes struggled to respond to feedback to revise their first activities. In one author's own words after the Writers Retreat, they would "feel emotionally committed to a particular" model or set of questions, and it was difficult to rewrite them in response to feedback. This might explain why 10 of the 27 authors (37%) who submitted a first activity did not revise them in response to either Review A or Review B. It is unknown whether these 10 authors stopped due to lack of time, disappointment and/or frustration with the feedback, or not knowing how to revise their activities in response to the feedback.

While the 1:1 coaching meetings with the Project Coordinator were extremely effective, they were unsustainable for the Project Coordinator if they continued for authors' subsequent activity. To reduce the workload on the Project Coordinator and to test the six-stage Activity Development Process with other coaches, coaching responsibilities were switched to writing mentors after authors submitted their second activity (which 13 of the 17 authors who completed their first activity did). To further explore scalability, authors were matched to other authors to provide collaborative reviews of each others activities on their third or fourth activities. Participants rated their writing mentors and their reviewers' feedback less helpful than meetings with the Project Coordinator, but more helpful than meetings with other participants.

Because we did not track who viewed the Kickoff Workshop's recordings, it is difficult to assess the effectiveness of the Kickoff Workshop. The in-person Writers Retreat participants wrote more activities by the end of the program than the virtual participants, who were also more productive than those who did not attend the optional Writers Retreat. This effect might also be that in-person attendance was a strong measure of a commitment to summer writing (and virtual attendance a lesser measure of the same).

By the end of the program, most participants reported having a better understanding of POGIL and more confidence in their ability to write and implement POGIL in their classroom. Almost every author planned to use and share their activities and develop additional ones.

6. Conclusions

Efforts to create learning material repositories (e.g., [35], [36]), have had mixed success, in part because of the differences between materials that work well for one instructor and materials that are easy for many instructors to adopt and adapt. Most faculty development seeks to help faculty improve themselves and their teaching. However, the AWP was unusual and possibly unique in its strong emphasis on supporting faculty to develop broadly reusable materials. The AWP provided extensive coaching for authors on their first activity and a six-stage process to prioritize the *quality* of POGIL activities over the *quantity* of POGIL activities. The central goal of the project was to increase the number of CS activity authors who understand the criteria of a well-written POGIL activity, which it succeeded at in supporting 17 authors in completing at least one POGIL activity ready for classroom testing.

The AWP followed best practices for faculty development [5]–[9] in offering participants intensive and sustained training opportunities, including multiple opportunities for networking to build community. While participation decreased slightly with each level of training and each stage of the six-stage process, a high percentage of participants gained experience in developing their own POGIL activities and a large number of POGIL activities reached the sixth stage.

The AWP relied heavily on the broader POGIL community, in particular The POGIL Project's writing workshops and retreats and the rubrics and review structure from the POGIL Activity Clearinghouse (PAC). Since the public launch of the PAC in Fall 2020, the AWP served as the first stress test for the PAC, greatly increasing the pace of submitted activities and doubling the number of activities published in the PAC's open journal. The success of the AWP has led to the PAC to recognize the importance of author coaching, and they intend to increase the amount of author coaching that PAC curators provide to all POGIL authors (beyond computer science). The PAC is developing a new pilot program that will pair interested authors with a PAC curator who will serve as a writing mentor.

In future work, we hope to track our participants to see how many participants continue to author activities and share them with the community. With more time, we will also be able to survey our participants to better determine the impact of authoring POGIL activities has on teaching with POGIL in the classroom.

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