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Developing an Observation Protocol for Cooperative Learning

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Introduction

Use of structured roles to facilitate cooperative learning is an evidence-based practice that has been shown to improve student performance, attitude, and persistence [1]–[3]. The combination of structured roles and activities also helps build students' process skills including communication and metacognition [4]. While these benefits have been shown in a variety of disciplines [5], [6], most prior work has focused on in-person, synchronous settings, and few studies have looked at online, synchronous settings. With the ongoing COVID-19 pandemic, we need a better understanding of how cooperative learning takes place online and what differences may exist between online and in-person modalities. This work-in-progress serves to document our development of an observation protocol to help us answer research questions such as the following: Do group members participate equally? Do group members' contributions match their role? How do groups connect and bond with each other? How do groups seek help?

Literature Review

Cooperative Learning and Structured Roles

Cooperative learning is an evidence-based, active learning technique that has been shown to improve student performance, attitude, and persistence [1]–[3]. Cooperative learning centers around small groups working together to learn [7] and promotes positive interdependence and accountability [8]. Structured roles are one way to promote these key qualities of healthy cooperation, while minimizing problematic group dynamics, such as freeloading. For example, Jigsaw assigns students different readings, which they then share out to their group. Pair programming uses the "driver" (who types code) and "navigator" (who guides the driver) roles to separate responsibilities. Process Oriented Guided Inquiry Learning (POGIL) further separates responsibilities, for example the manager keeps the group on task and ensures everyone contributes, the recorder shares their screen and inputs answers, and the reflector ensures all members understand what's going on.

Compared to individual or traditional learning, structured roles have been shown to improve student performance [5], [9]–[11], interpersonal skills [9], affect and attitudes [11], and self-efficacy [6]. However, the benefits of structured roles depend on careful implementation. Prior work recommends small and diverse groups [4], [12], and individuals should be graded on both individual and group performance [13]. Furthermore, roles should be rotated to expose all group members to different skills and to avoid stereotypical role adoption (e.g., women frequently taking on the recorder role) [14], [15]. Yet even when implementations follow these guidelines, inequitable group dynamics can still emerge [16].

Observing Cooperative Learning

Due to the COVID-19 pandemic, students in our context worked online in groups with little instructor interaction. Thus, we aimed to capture general group processes between students instead of domain-specific practices. Additionally, the protocol needed to be applicable to both online and in-person settings to account for shifting course modalities. Many of the studies cited above rely either on quantitative data sources such as surveys (e.g., [6]) and test results (e.g., [10]) or on qualitative data sources such as ethnographic observations (e.g., [16]) and interviews (e.g., [15]). Thus, a common observation protocol provides a shared tool that bridges the strengths of qualitative and quantitative methods by allowing for quick analysis of group dynamics while still allowing for detail and depth.

Researchers have been developing observation protocols to capture group processing and dynamics; however, these protocols may be domain-specific, tend to assume strong instructor presence, and are typically for in-person contexts only. For example, COPUS [17] and 3D-LOP [18] were developed to capture in-person student and teacher interactions in undergraduate science, technology, engineering, and math courses. Similarly, OPTIC [19] was designed to document POGIL activities in the whole classroom, but has not yet been validated. COPED was developed to capture the engineering design process in K-12 science classrooms [20]. Other protocols focus on more specific characteristics such as equity (e.g., EQUIP [21]) or pedagogies such as active learning (e.g., ELCOT [22]; [23]).

Methods

Online Cooperative Learning

In response to fully online instruction during Fall 2020 and Spring 2021 semesters, professors from three CS courses (Computer Architecture, Numerical Methods, and Database Systems) restructured their courses into flipped classrooms with POGIL-inspired, in-class activities. These courses were technical, core courses with large enrollments (~400 students each), and all three were offered at the same large, public research university. Before virtual class meetings on Zoom, students were expected to complete short pre-class assignments individually. During synchronous class times, students worked on online POGIL-inspired assignments in Zoom breakout rooms. Students were encouraged to rotate roles throughout the semester.

Group Formation

During the first two weeks of the semester, groups were randomly assigned due to fluctuating enrollment. During these weeks, we collected informed consent and demographic data according to our IRB-approved process. After the first two weeks, students were allowed to pick a group of their choosing or were assigned to a group. For students who were assigned to a group, we formed as many groups as possible where women were not in the minority to minimize the chances of stereotypical role adoption [14], [15]. Once the groups were formed, students worked with the same group for 6-8 weeks then either continued with the same group or was assigned to a different group for the rest of the semester (15 weeks long in total).

Observing Group Activities

Our protocol aimed to capture general group processes that allowed for ease of use and simple aggregation and analysis. To systematically record group activities, we designed codes for various activities of interest. The first prototype of our code book was designed before the Spring 2021 semester based on intuitions of what we anticipated students would do. For example, we expected that students would ask questions and type answers. We iterated on and revised the code book based on actual observations. Table 1 reflects the latest version of the code book.

The coding process was iterative. For each 30-second increment, we identified and classified each students' contributions using the code book, and within each increment, one kind of activity was only recorded once for each student to keep the observation protocol at a high level and for ease of recording observations. For example, if a student asked two questions within one increment, we only recorded "ask" once for this student.

Code	Definition
Ask	Person asks a question
Contribute	Person asks group or member to contribute (aligns with manager role)
Check	Person asks group or member if they understand (aligns with reflector role)
Confirm	Person asks for confirmation (e.g., "… right?", "does this look correct?")
Y/N	Person provides short response to "ask" or "confirm" (e.g., "yeah," "no")
Type	Person is visibly typing or annotating the screen (aligns with recorder role)
Read	Person is audibly reading or says they will read something on the screen
Explain	Person explains concept / answer, may be incorrect or not in response to "ask"
Casual	Person expresses emotion (e.g., "Yes! Full points!") or talks about non-activity related topic
Info	Person says they will search or actually searches for information in lecture slides, course forum, etc. or (talks about) asking for help

Table 1: Code book used to observe group activities.

Data Collection, Exclusion Criteria, and Interrater Reliability

In the Spring 2021 semester, we aimed to code different groups to explore the variety of group dynamics, so for each class meeting, a member of the research team visited a group where all members consented to participate in the study and had not been previously visited. Each member of the research team was responsible for individually coding their observations when they visited a group. Groups were video recorded for later validation of the protocol. Of the 77 recordings collected from the Spring 2021 semester, 41 of the recordings were from Computer Architecture, 19 from Numerical Methods, and 17 from Database Systems.

We set the following exclusion criteria because we were interested in real-time group dynamics and validating the observation protocol:

- Groups that completed a significant amount of the activity before class were excluded
- Groups that failed to share their screen were excluded
- Groups that mostly spoke a language other than English were excluded
- Groups where two or more members voices were indistinguishable were excluded

Of the 62 recordings that passed the criteria, 32 of the recordings were from Computer Architecture, 17 from Numerical Methods, and 13 from Database Systems. A subset of 22 recordings were randomly selected for interrater reliability validation, which is ongoing.

Preliminary Results

We present some preliminary results using our coding scheme. While the observation protocol is still undergoing validation, the preliminary results highlight some of the insights it can offer.

General Participation Trends and Role Alignment

The research team noticed differences between groups where all members participated and appeared actively engaged and groups where one member seemed to participate much less. For example, Figure 1a shows a group of three members where contributions were primarily from the manager and recorder. In contrast, Figure 1b shows a group of three where all members contributed throughout the session. Across most groups, role alignment (performing tasks associated with chosen POGIL-inspired role) seemed strongest for the recorder.

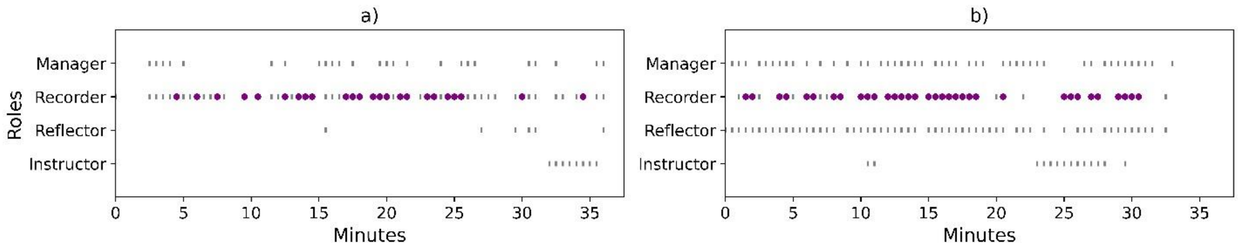

Figure 1: Common participation trends where a) one member does not seem to be participating as much as the other two and b) where all members seem to be participating equally. Gray ticks indicate at least one code applied to a member during a 30-second increment. Purple dots indicate presence of a role-aligned code (see Table 1).

Moments of Team-Bonding

Conversations not explicitly about the assignment's content were coded as "casual." We observed that the "casual" code usually happened as the group submitted answers to the autograder and at the end of class. These times provided moments for team-bonding. Figure 2 shows a group that exhibited this behavior. For example, after their first attempt was correct, the recorder said, "Yay," the manager said, "Very nice," and the reflector said, "First try, so good." As the group wrapped up the activity, they talked about their exams, quizzes, emotional experiences in other courses, and had fun with submitting feedback on the reflector survey.

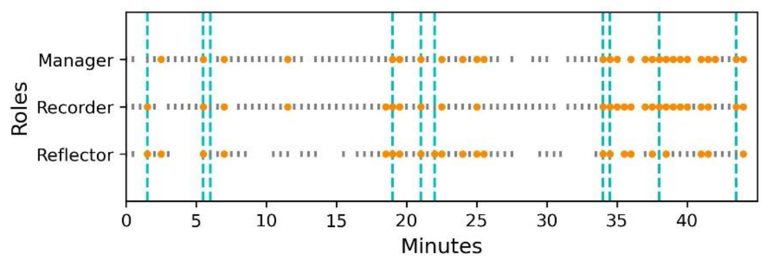

Figure 2: Common pattern of "casual" codes occurring after submission in response to autograder feedback and non-activity related talk towards the end. Orange dots indicate the presence of "casual." Vertical, dashed lines indicate an increment where a student submitted a solution to the autograder.

Help-seeking Patterns

The research team noticed two common types of help-seeking patterns. In the first scenario, students would get stuck on a question then discuss asking for help via the online queue. One group member would then offer to join the online help queue (i.e., digitally raise their hand), followed by instructor presence (see Figure 3a). In the second scenario, the recorder would split their screen to have the activity on one half and a resource on the other (see Figure 3b).

Limitations

Due to limitations of our IRB procedure, we were not allowed to record students' faces, so we were unable to incorporate gestures or facial expressions. Most students left their camera off by default, but this meant we were unable to differentiate between students who chose not to participate and those who were not given an opportunity to participate. Additionally, students may have changed their behavior due to having a researcher in the breakout room with them.

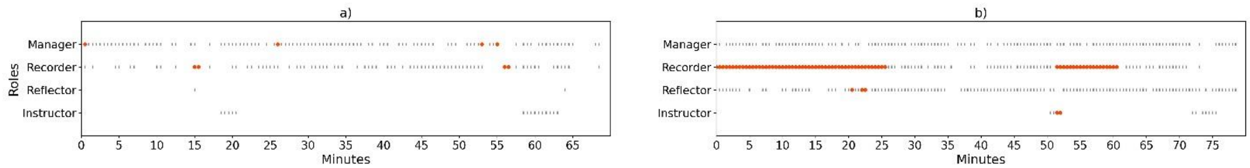

Figure 3: Two common types of help-seeking patterns: a) asking for help via the online queue followed by instructor presence and b) referencing a resource that was visible on the shared screen. Red dots indicate the presence of "info."

Discussion

The preliminary results highlight the range of possible questions about group process that our observation protocol can answer in both online and in-person settings. In-person settings can make gender and ethnicity more visually salient, increasing the risk of stereotypical roles, frequency of microaggressions, and potential for stereotype threat. Online settings may decrease these risks due to visual anonymity when video is turned off. Indeed, many students we observed defaulted to leaving their camera off, which showed a default Zoom profile to the breakout room. The research team did not observe microaggressions between group members, but due to our group selection process, we cannot say with certainty that no microaggressions or similar behaviors ever occurred. However, students completed sense of belonging surveys and peer reviews, and we hope to incorporate this in future work to further contextualize the data.

Conclusion

In this work-in-progress, we reported our progress toward developing an observation protocol to better understand how students work together in structured role-based cooperative learning. Preliminary results show that students seemed to align with the recorder role most easily, participation was either split evenly across members or left one member out, groups seemed to bond over waiting for autograder results and ended group activities with small talk, and groups asked for help or referenced an external resource when stuck. The observation protocol is undergoing validation, and the research team hopes to further contextualize the observations by using peer evaluations and surveys.

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