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Introducing The Focus & Action of Students & Teachers Observation Protocol (FASTOP)

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Abstract

This methods paper describes the development, use, and initial findings for the Focus & Actions of Students & Teachers Observation Protocol (FASTOP). The ICAP model describes the benefits of interactive (I), constructive (C), and active (A) learning over passive (P) learning. However, instructors who seek to adopt more effective pedagogies often overestimate their use of such practices and/or omit key elements. Thus, our research seeks to enhance understanding of classroom practice by combining data from student surveys, instructor surveys, and classroom observations (both live and video recorded). This paper describes a new classroom observation protocol intended to monitor the focus (e.g., solo, pair, team, or whole class) and action (e.g., discuss, speak/present, watch/listen, or distracted) of both students and teachers (instructors). The paper summarizes relevant background on evidence-based learning, student engagement, and classroom observation protocols, describes the development and structure of FASTOP, presents results from different pedagogies (e.g., lecture, laboratory, POGIL), and describes lessons learned and future directions. Results show distinctive patterns of student and teacher behaviors for different pedagogies.

1. Introduction

The *ICAP* model describes the benefits of interactive (I), constructive (C), and active (A) learning over passive (P) learning [1]. However, instructors who seek to adopt more effective pedagogies often overestimate their use of such practices and/or omit key elements. Researchers often assume that classroom strategies are implemented similarly, but, a survey of engineering faculty and their use of research-based pedagogies found that *fidelity of implementation* ranged from 11-80% [2]; i.e. faculty are likely to omit critical components.

For example, *Process Oriented Guided Inquiry Learning (POGIL)* involves student teams, assigned student roles, specifically designed activities, active facilitation by the instructor, and an emphasis on process skills such as teamwork, critical thinking, and problem solving [3], [4]. POGIL faculty development workshops describe and model these practices. Similarly, in *Peer Instruction*, the instructor presents information, poses a question that students answer individually (often using clickers or other tools), students discuss their answers with peers, and then answer again [5]–[7]. However, there is limited data on what actually happens in classes that implement POGIL and Peer Instruction, and how practices affect student outcomes.

Our research seeks to understand what actually happens in classrooms that use different pedagogies, how these practices change over time (e.g., during an academic term), and the impact on student engagement, learning, and other outcomes. Research questions include: From a POGIL perspective, which practices are actually used in "POGIL” classes? Do instructors and/or students familiar with POGIL practices adopt some of them in “non-POGIL” classes? (There are anecdotal reports of students choosing to use POGIL teams and roles in laboratories.)

To explore the relationship between pedagogical approaches and student engagement, we seek to measure the engagement of the same students in different class periods. The students are taught by the same instructor using different pedagogies (e.g., POGIL, interactive lecture, and computer laboratory). We seek to enhance understanding of classroom practice by combining data from student surveys, instructor surveys, and classroom observations (both live and video recorded). The results should provide insights into how specific practices might impact teacher and student experiences, and should be important steps toward our long-term goal of better faculty teaching practices and better student outcomes.

This paper describes the development and structure of an observation protocol, which will be used to answer two long-term research questions. First, what is student engagement, and how does it affect learning? Second, what do faculty and students actually do in active learning classes? As described below, the *Focus & Actions of Students & Teachers Observation Protocol (FASTOP)* monitors not only *actions* (e.g., ask, answer, discuss, work) but also *focus* (e.g., individual, pair, team) for *students* and *teachers* (at any level). This paper is organized as follows: Section 2 reviews relevant background in engagement and observation protocols. Section 3 describes the structure of FASTOP with some examples. Section 4 presents some preliminary results, and Section 5 concludes with lessons learned and future directions.

2. Background

2.1. Student Engagement

As Sinatra, Lombardi, and Heddy ([8], p1) point out, “Engagement could be described as the holy grail of learning … because it has been linked to positive learning outcomes both in and out of school. Researchers have posited consistent engagement can lead to long-term involvement in schooling”. The literature on student engagement and student-centered learning suggests that when students actively engage — when students are given something to do, and concrete steps are taken to motivate and support them — students participate more in a classroom and report a better understanding of course concepts (e.g., [9]–[11]). Student engagement is strongly related to student achievement (e.g., [8], [12]). This is of particular interest in computer science (CS) where student engagement has been found to be lower than in other disciplines [13], [14]. However, the nature and extent of this engagement is not well understood in the literature. As Mandernach ([11], p1) points out, “Despite widespread agreement on the value of student engagement, assessing engagement in higher education remains a challenge”.

Student engagement is often measured by self-report and instructor perceptions. For example, a survey found that over 90% of faculty trained in POGIL indicated that students were more engaged in POGIL classes [15]. Researchers have expressed concerns about the validity and accuracy of such measures [11], [16]. Although time consuming and costly, structured direct observation and coding by trained observers can provide better information on student/student and student/instructor interaction and other observable behaviors. However, potential observer bias must be taken into consideration. For best results, the literature suggests that researchers combine multiple instruments to triangulate engagement [16]. For example, an ethnographic study triangulated nearly 400 hours of classroom observation with interviews, classroom documents, and other records to identify patterns of recurring communication [17].

2.2. Observation Protocols

To fully understand the complexities of student engagement and other factors in a class, the best research method is direct observation of students and faculty, defined as making a qualitative analysis of the setting and the interactions that occur in it [18]. Observation can reveal details that students and faculty might not notice during class or might not want to address in interviews or surveys. These observations, along with data directly collected from the faculty and students, can provide a detailed understanding of the learning setting, including the fidelity of implementation for specific pedagogical practices.

However, different observation protocols focus on different factors and can yield different results. For example, the *Reformed Teaching Observation Protocol (RTOP)* [19]–[21] includes 25 elements grouped into "Classroom design and implementation", "Content", and "Classroom culture", each rated on a scale from 0 (never occurred) to 4 (very descriptive). The *Teaching Dimensions Observation Protocol (TDOP)* [22], [23] identifies observed activities every two minutes, using codes such as "Lecturing while writing" and "Lecturing from pre-made visuals". The *Classroom Observation Protocol for Undergraduate STEM (COPUS)* [24] was adapted from TDOP, and includes Peer Instruction practices such as "individual thinking/problem solving" and "discuss clicker question in groups". The *Science and Engineering Classroom Learning Observation Protocol (SEcLO)* [25] focuses on K12 engineering education and includes categories for science content, engineering content, gender difference, and degree of frustration and understanding. The *Practical Observation Rubric To Assess Active Learning (PORTAAL)* [26] focuses on large classes, and the *Online Student Engagement (OSE)* scale [27] focuses on online courses. *The Engineering Learning Classroom Observation Tool (ELCOT)* [28] focuses on specific instructor and student actions, grouped into levels similar to the ICAP model [1]. The *Student Participation Observation Tool (SPOT)* [29] was developed for STEM courses in higher education and has codes related to 17 effective teaching practices in STEM.

Two protocols most affected the current work. The *Behavioral Engagement Related to Instruction (BERI) protocol* [30] is designed for large university classes and focuses on a ten student sample. BERI tracks student engagement using six *engaged* behaviors (e.g., listening, writing, engaged student interaction) and six *disengaged* behaviors (e.g., unresponsive, disengaged computer use, distracted). The observer randomly chooses a seat where they can clearly see ten students. Every two minutes (or at major changes in content or activity), the observer classifies each student, based on the behaviors, as engaged, disengaged, or uncertain. The observer also notes other classroom events and instructor behaviors. The *Observation Protocol for Teaching in Interactive Classrooms (OPTIC)* [31], [32], modeled on TDOP and COPUS, focuses on practices used in POGIL and forms of collaborative small-group learning. OPTIC has codes for three activity types (POGIL, other collaborative learning, individual student work), seven instructor actions (e.g., moving about the whole classroom, having student report responses to key questions, lecturing), and eight forms of interaction (e.g., students interacting within teams, team interacting with other teams, instructor interacting with a team). Every two minutes, the observer notes which codes they observe in the class, and the approximate fraction of students who are not participating or paying attention.

For the current project, we wanted to gather data on what instructors and students did during different types of classes, in ways that were consistent, repeatable, and readily analyzed, so we could compare observations to faculty and student reports of engagement. Thus, we considered existing observation protocols. At first, we planned to use OPTIC, but pilot observations at multiple institutions with POGIL, lecture, and laboratory classes, revealed that OPTIC works well for POGIL, but not for lecture. Similarly, COPUS focuses on practices involving clicker questions and Peer Instruction and is less suited for POGIL. Other protocols had similar limitations - SEcLo and ELCOT focus on engineering, while PORTAAL and OSE focus on specific settings. We liked protocols that coded widely used, lower-level practices (e.g., SPOT). We liked how OPTIC coded similar interactions at different levels — within teams, between teams, across the whole class. We also liked how BERI coded a random sample of specific students, rather than assume that all or most students do the same thing.

While the observation protocols we reviewed covered some of the content and processes we needed for this study, they were incomplete and did not have the level of content validity we needed. Building on their work, other literature, and our own experience, we sought to develop an interview protocol with strong content validity that covered student and instructor foci and activities related to engagement in both POGIL and non-POGIL classes.

3. The Focus & Action of Students & Teachers Observation Protocol

Protocols often use codes that represent multiple factors. For example, in COPUS, “individual thinking/problem solving” and “discuss clicker question in groups” specify both the number of students and what they do. However, in many cases, the action and group size can be separated. Thus, we identified a set of *actions* (e.g., ask, answer, discuss, speak, watch/listen) that could occur at multiple levels of *focus* (e.g., solo, pair, team, multiple teams, whole class) for both *students* and *teacher*. This led to our initial draft of the *Focus & Action of Students & Teachers Observation Protocol (FASTOP)*. We reviewed and discussed the focus and action codes, dropped some, renamed or clarified others, and piloted with some classroom video recordings.

Table 1 summarizes the FASTOP codes; we are currently developing a more detailed codebook. For simplicity, we use the same names for student and teacher codes, although the interpretation is sometimes different. For students, *focus* codes how they act: alone, in pairs, in teams, across or between teams, or as a whole class. For teachers, *focus* codes their attention: on one student, a pair, a team, multiple teams, or the whole class.

One collaborator described FASTOP as an “assembly language” for observations, in the sense that it codes lower-level practices that can be combined into higher-level practices. Table 2 shows some examples of FASTOP codes for some typical classroom activities. In a *traditional lecture*, the teacher speaks to the whole class, and many students also focus on the whole class and listen or take notes, but other students might discuss content in pairs, work alone on class assignments, or be distracted by text messages or web videos. In a *computer laboratory*, students work alone or in pairs that talk together, while the instructor monitors the whole class, checks in on students or pairs, or does other work. In *POGIL*, classes tend to alternate between two modes. First, student teams discuss and answer a sequence of questions about a diagram, graph, table, or other “model” which the teacher monitors class progress and occasionally interacts with teams to offer advice or answer questions. Second, the instructor occasionally has teams “report out” their answers to specific questions and might lead a short discussion if teams disagree or have further questions. In *Peer Instruction*, a set of steps (labeled a-f) repeat; (a) the instructor asks a question of the whole class (verbally or visually), (b) students answer individually, and (c) the instructor presents and/or describes the distribution of responses. Next, (d) students discuss the question in pairs, (e) answer individually again, and (f) the instructor again presents or describes the distribution of responses.

Table 1: FASTOP Codes

Code	Student Focus	Teacher (Instructor) Focus
Solo	Students act alone.	Teacher with one student.
Pair	Students act in pairs.	Teacher with pair of students.
Team	Students act in teams/groups (3–5).	Teacher with student team.
Teams	Students act across or between teams.	Teacher with multiple teams.
Class	Students act as whole class.	Teacher with whole class.
Code	**Student Action or Teacher (Instructor) Action**	
Answer	Answer question(s) posed by other(s).	
Ask	Ask question(s) and wait for other(s) to answer.	
Discuss	Talk back and forth (more than one question and answer).	
Speak	Talk by one person with no interaction.	
Manage	Pass out or collect papers, assign groups, take attendance.	
Distracted	Distracted or off task.	
Watch/Listen	Watch or listen (e.g., to lecture or presentation).	
Work	Write, take notes, work on computer, etc. (not ask, answer, or discuss).	

4. Methods & Results

To date, we have used FASTOP to observe over 90 individual students in 44 class sessions of 10 sections taught by 6 instructors of 3 courses at 2 institutions. Near the start of each term, students in each section were shown a short video describing the study and invited to complete an informed consent form. A colleague collected the forms (so the instructor did not know which students consented), used the list of consenting students and the instructor's team assignments to select the teams to be observed, and gave the observer photos of those teams or students. At three points during the term (early, middle, late) the observer observed two class sessions (one POGIL, one non-POGIL).

In each class session, the observer coded the actions of the instructor and 8–12 students every minute. At the same time, a robotic camera tracked the instructor and recorded their actions; later, the same observer used the video to code the action and focus of the instructor and of the students in view as a group. Coding used an app funded by The POGIL Project to support OPTIC, which also supports TDOP, COPUS, OPAL, FASTOP, and user-defined protocols [33].

Table 2: FASTOP Examples

Activity	Teacher (Instructor) Focus: Action	Students Focus: Action
Traditional Lecture	Class: Speak	Class: Listen Pair: Discuss Solo: Work, Distracted
Computer Laboratory	Class: Watch Solo, Pair: Discuss, Work	Solo: Work Pair: Work, Discuss
POGIL Teamwork	Class: Watch Team: Discuss	Team: Discuss, Work
POGIL Report Out	Class: Ask, Discuss	Class: Answer
Peer Instruction a.	Class: Speak, Ask	Class: Listen
b.	Class: Watch	Solo: Answer
c.	Class: Speak, Ask	Class: Listen
d.	Class: Watch	Pair: Discuss
e.	Class: Ask	Solo: Answer
f.	Class: Speak	Class: Listen

To look at general patterns of focus and action in different pedagogies, we used the following procedure. First, we reviewed observation data, classroom videos, and observer notes to determine the times at which the class switched to a different activity, and time periods devoted to a specific activity. Second, for each activity, we gathered student and instructor codes from different instructors and classes, and averaged them together to calculate the typical distribution of focus and action in that activity. However, the observer often marked multiple codes, and a simple count would tend to overweight such codes. Thus, each code's weight was divided by the number of codes in that time period and category.

Table 3 summarizes some preliminary results. Each row is a FASTOP code grouped into student and teacher (instructor) focus, and student and teacher action. There are columns for six different classroom activities: class introduction, traditional lecture, interactive lecture, computer laboratory, POGIL teamwork, and POGIL report out. For each activity, the column lists the weighted averages; for clarity, the lowest values (1% to 9%) are replaced with an asterisk (*).

At the start of class, instructors usually focus on course management (79%) — reminding students of policies and deadlines, distributing or collecting materials, or describing the day's structure. Students often watch and listen (62%), but might be distracted (17%) (e.g., unpacking or texting) or working (14%) (e.g., starting the lab or POGIL activity). In a traditional lecture, instructors speak or present to the whole class (87%). Students watch and listen (51%) but are also distracted (24%) or working (20%). In an interactive lecture, instructors speak or present less (46%), ask questions more (31%), and watch or listen more (13%). Students watch and listen (40%) or work (20%), answer questions more (22%), and are less distracted (13%). Computer laboratories are quite different. Instructors focus more on individual students (58%) or pairs (23%), and often discuss (50%), watch and listen (17%) or answer questions (17%). Students focus more on themselves (61%) or a partner (33%) and work (35%) or discuss (34%).

As noted above, POGIL tends to alternate between two formats. First, student teams (88%) discuss (30%) and work (28%) while the instructors watches and listens (40%) or interacts (16% discuss, 13% ask, 12% manage) with teams (53%), the whole class (21%) or individual students (18%). Second, the whole class comes together (98% students, 92% instructor) so students can listen (45%) to each others' answers (27%), with moderation (41%), and mini-lectures (46%) by the instructor.

Table 3: Distribution of Focus & Action Across 6 Classroom Activities

		Class Intro.	Trad. Lecture	Inter. Lecture	Comp. Lab	POGIL Team	POGIL Report
Student Focus	Solo		41	*	**61**	*	*
	Pair				33		
	Team	*		13	*	**88**	*
	Teams					*	
	Class	**92**	**59**	**85**	*	*	**98**
Teacher (Instr) Focus	Solo		*		**58**	18	
	Pair				23	*	
	Team	*	*	*	*	**53**	*
	Teams				*	*	
	Class	**98**	**96**	**91**	13	21	**92**
Student Action	Answer	*	*	22	*	14	27
	Ask	*	*		*	*	*
	Discuss	*		*	**34**	**30**	*
	Speak				*	*	*
	Manage					*	
	Distracted	17	24	13	*	*	11
	Watch/Listen	**62**	**51**	**40**	16	9	**45**
	Work	14	20	18	**35**	**28**	14
Teacher (Instr) Action	Answer	*	*		17	*	*
	Ask	*	*	**31**	*	13	**41**
	Discuss			*	**50**	16	
	Speak	13	**87**	**46**	*	*	**46**
	Manage	**79**	*	*	*	12	*
	Distracted					*	
	Watch/Listen	*		13	17	**40**	*
	Work					*	

In addition, all consenting students were asked to complete a short survey at the end of each observed class session. The survey asked four questions about their participation in the class and had them rate the class in nine different areas. Students reported answering questions and/or contributing to the class ("very often" or "often") significantly more in POGIL than non-POGIL classes (49% vs 21%). The difference between their ratings for working in groups ("very often" or "often") in POGIL and in non-POGIL classes was even greater (87% vs 46%). This pattern stayed relatively constant across instructors and the three sets of observations and reflects POGIL principles, which might be an indicant to construct validity.

These preliminary findings were reflected in the student ratings. While ratings of the difficulty and length of POGIL and non-POGIL classes were similar (3.8 vs 4.0 on a scale of 1 "too easy" to 7 "too hard"; 4.0 vs 4.1 on a scale of 1 "too long" to 7 "too short"), students were much more apt to rate the POGIL classes as more collaborative (5.8 vs 4.9), another POGIL principle. Again there weren't major differences across the three sets of observations. While there were expected differences by instructor, there were minimal differences in student ratings of POGIL and non-POGIL classes in such areas as excitement, motivation and impact on skills. In the future, individual student self-report of their behaviors will be compared to their actual observed behaviors to explore concurrent validity.

5. Conclusions

This paper describes the motivation, development, and preliminary results for FASTOP, a new classroom observation protocol that codes the focus (e.g., individual, pair, team, class) and action (e.g., ask, answer, speak, listen, work) of students and teachers (instructors).

We have learned some important lessons. Initially, we expected that an established observation protocol would give us a solid foundation and basis for comparison, and we were surprised by the number and variety of protocols in the literature. However, it is important to look past the name, consider the intended purpose, and carefully review the set of codes and practices, since protocols are designed for specific contexts and to collect specific data. It is also important to pilot any protocol in multiple settings before deciding to adopt it. As a colleague remarked, "A bad measure of the right thing is often better than a good measure of the wrong thing."

For the FASTOP protocol, we plan to expand and refine the codebook to clarify code definitions and the differences or boundaries between related codes (e.g., discuss, ask, answer, watch/listen). We also plan to code the same class sessions (or videos) using multiple observers (to assess inter-rater reliability), and multiple protocols (to assess mappings between protocols). These and other steps will help us to formally assess the validity of FASTOP.

For the FASTOP observation data, we plan to expand the preliminary activity-level analysis (summarized in Table 4) with data from more observations, and more activities or sub-activities. We will look for meaningful differences by discipline, course, course level, institution, class size, instructor, etc. We also hope to extend the activity-level analysis to look at differences between teams and students. Anecdotally, POGIL teams exhibit varied behaviors: some actively discuss each question before writing an answer, some answer individually and then discuss, etc. Students also exhibit varied behaviors in different classroom settings. We look forward to seeing whether the FASTOP data reflect these variations.

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