Developing Emergent Codes for the Classroom Observation Protocol for Undergraduate STEM (COPUS)

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***Abstract*— This Research Work-in-progress paper presents a project that intends to increase student engagement, retention, and success through the implementation of a faculty development program focused on implicit bias and active learning. To assess the extent to which the program resulted in transformative changes in instructor teaching, the project team conducted classroom observations using minute-by-minute environmental scans and the Classroom Observation Protocol for Undergraduate STEM (COPUS). The project team found that the COPUS could not capture all the behaviors that needed to be observed to assess the faculty development project. Thus, 12 emergent COPUS codes were developed to code the required behaviors. Each code is defined, examples are provided, and excerpts of classroom observations with and without the emergent COPUS codes are examined. The project team thinks the emergent COPUS codes, generally focused on faculty behaviors related to classroom climate, will be useful in other classroom observation projects.**

Keywords—classroom observation, faculty development, student engagement, classroom climate.

I. Introduction

This Research Work-in-progress paper presents a project that seeks to increase student engagement, retention, and success by reducing the "chilly climate" that URM students experience and increasing active learning opportunities in the classroom [1], [2], [3], [4], [5]. To achieve these goals, the project team implemented a faculty development program focused on implicit bias and active learning. Ten faculty teaching first- and second-year engineering courses were recruited into the first faculty development cohort in summer 2017.

To assess the extent that there have been transformative changes in their teaching, baseline and post-intervention data were collected in Spring 2017 and Fall 2017, respectively. Classroom observations were conducted where faculty and student behaviors and their interactions were coded using the Classroom Observation Protocol for Undergraduate STEM (COPUS) [6].

II. Classroom Observation Protocol for Undergraduate STEM (COPUS)

The COPUS was originally developed as a means to describe how faculty and students spend their time in STEM undergraduate classrooms, with the distal goal of providing information to drive possible changes to classroom instruction to improve learning. It is an effective tool to help faculty evaluate how class time is spent and how active-learning strategies are used [6]. The original instrument includes 13 student behavioral codes and 12 instructor behavioral codes.

A concern that arose during the initial creation of the COPUS was that it was difficult for less experienced classroom observers to simultaneously code for student behaviors, instructor behaviors, and student engagement levels. Thus, the final version of the COPUS considered student engagement levels as optional, instead of required [6].

In order to capture the quality of activity and interaction among students and faculty in the classroom and to address

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the limitations of coding in real-time, the project team combined the COPUS with an environmental scan: minute-by-minute notes were made of what was happening in the classroom. The environmental scan was then used as the basis for the COPUS coding. Thus, the merging of COPUS coding and environmental scanning created a single observation process that captured teaching nuances that are supported by evidence-based practices, but are not necessarily captured through the sole reliance on the COPUS codes.

The environmental scan notes provided the basis for the COPUS codes by capturing student and instructor behaviors during each minute of class time. The classroom observers conducted the environmental scans in real-time and filled out the COPUS codes on the same form after the classroom period. Two observers agreed on the COPUS codes when completing the codes after the classroom period. This eliminated the concern regarding missing codes when attempting to code in real-time on the COPUS form.

III. Method

During the course of data collection, the project team found that the COPUS codes did not sufficiently capture all of the behaviors the team sought to observe. Specifically, the COPUS codes could not record some instructor behaviors that were anticipated to emerge as a result of the faculty development program (e.g., creating a positive classroom climate, providing resources to students, creating a sense of belonging). The original COPUS focused on classroom activity, but not on classroom climate. The project team developed emergent codes for the COPUS in an effort to capture the behaviors that were connected to teaching practices related to our study that stretched beyond the activities delineated by the COPUS.

The steps for emergent code formation were as follows. First, a member of the project team identified an evidence-based practice that enhances learning but did not have a code. This proposal could be top-down, based on the content of the faculty development program and what might be seen through applications of the content, or bottom-up, based in classroom observations of events that seemed important to observers but could not be captured with the extant COPUS codes. Then, the other project team members were consulted to see whether this behavior should be codified. If the project team achieved consensus to ratify the code, it was formalized and adopted. A constant comparative method was used to analyze the data from the environmental scan in an effort to develop the codes. The research team began gathering data based on initial research questions, and then formed core concepts to target moving forward after looking at collected data. The initial phase of data collection and modification of what to target remained open to change until the data revealed consistency across cases, which resulted in a new code.

A unique aspect of this code formation process was the role of the undergraduate research assistants who conducted classroom observations as part of the research team. As students who were not in the classes being observed, but were in the same learning stage as the students in the observed classes, these research assistants were able to inform other project team members about the behaviors that were most salient and important from the perspective of an undergraduate student.

IV. Results

The project team developed 12 emergent COPUS codes over the course of two semesters (Fall 2017 and Spring 2018). Of these emergent COPUS codes, ten codes involved instructor behaviors and two involved student behaviors. They are grouped into four categories: innovative instruction, providing resources, affect, and classroom climate (see Table I).

TABLE I. Definitions and Examples of Emergent COPUS Codes

	Emergent Code	*Definition*	*Example(s)*
Innovative Instruction	Relevant Example (RE)	Instructor uses an example to relate the course material to real-life situations	Using speeches by different politicians to illustrate good and bad needs statements
	Big Picture Connections (BPC)	Instructor relates how the current lesson relates to other courses or industry	"This is a concept that you will need to remember for the rest of your careers and here's why"
	Linking Concepts (Lnk)	Instructor explains how the current topic is related to other topics within the course	"This is a different way to do the same calculations that we did last week"
Providing Resources	Recommended Resources (RR)	Instructor points students towards resources to help them be more successful in a specific course	Referring students to office hours, Academic Success Center, Writing Center, online resources, etc.
	General Student Development (GSD)	Instructor gives students non-course-specific advice to help them be more successful students	Giving students tips about teamwork; providing time management advice; showing students how to use a planner
Affect	Connecting (Con)	Instructor connecting with students over a non-subject specific topic	Calling students by name; chatting about what students did over the weekend
	Encouraging (Enc)	Instructor encouraging, validating, or coaching students	"Great job to [student] for working that problem out for us!"
	Discouraging (Dis)	Instructor discouraging or demoralizing students	"You shouldn't be struggling. This is high school level material!"
Classroom Climate	Disruptive Behavior (DB)	Student engaging in behavior that is distracting to others in the class	Watching movies or videos; answering a phone call in class
	Student Helping Student (SHS)	Student assisting another student during class	Students explaining concepts to each other while working on a group exercise
	Texas A&M-Related Terminology (ATM)	Instructor using language specific to A&M's traditions, school spirit, etc.	"We have to show everyone that Aggie engineers are the best!"
	Teaching Assistant Behaviors (TA)	Instructor assigning TAs to interact with students or facilitate a class process	TAs answering student questions, handing out materials, etc.

V. Discussion

The development of the emergent codes has allowed the project team to capture a richer picture of the student and instructor behaviors and interactions in the classroom. Specifically, the emergent codes allow us to code for the behaviors that we hoped would develop as a result of the faculty training program that could not be captured with the original set of COPUS codes. They also allow us to identify critical moments in the classroom that exemplify the climate. By incorporating the emergent codes, we are able to note behaviors related to innovative instruction, providing resources, student affect, and classroom climate.

An excerpt from a classroom observation for this project (see Table II) demonstrates that the original COPUS student and instructor codes capture some of the behaviors of the students and instructor in the classroom, but the addition of the emergent COPUS codes (**in bold**) provided a more holistic depiction of the classroom. In the first few minutes of this particular class, the instructor explained a concept that will be discussed in a future class (BPC; see Table I for a summary description of each code), gave students a tip about being good peers (GSD), and made a joke (Con). In that same time frame, the Teaching Assistants were engaged with the classroom (TA) and students helped each other with a classroom assignment (SHS).

While the original set of COPUS codes may indicate that the class was moderately engaged because students were answering questions (AnQ) and the instructor was moving through the classroom and guiding students' learning (MG), the emergent codes allowed us to examine the behaviors the instructor engaged in to foster a supportive classroom climate. Thus, the revised and expanded set of codes enables us to demonstrate that it is not just the specific learning-based activities such as questions and answers but also the interactions between students, the interactions between students and instructors, and the support from instructional personnel that matter.

In another excerpt from the same class session (see Table III), we can see more examples of behaviors that were recorded using the emergent COPUS codes that would have otherwise gone unnoted by the original COPUS coding scheme. The instructor provided students with a preview of information that would be covered later in the semester (Lnk) and explained how this information was relevant for industry jobs (RE) and could affect them in the future (BPC). Furthermore, while the instructor was providing the students with this information, they showed school spirit (ATM) and were supportive of the students (Con; Enc).

If excerpt 2 had been merely coded with the original COPUS codes, it would appear that the instructor was simply giving three minutes of administrative information to the students. However, by including the emergent COPUS codes, we can more closely examine the climate of the classroom and note the relevance of the information that the instructor was imparting.

TABLE II. Environmental Scan with COPUS Codes – Excerpt 1

Min	*Student Codes*	*Instructor Codes*	*Environmental Scan*
0:05	L AnQ	Lec PQ **BPC**	Instructor asks a question, students answer Instructor explains that you can't mix columns and rows **Instructor explains what cross product is, but that this particular class section will not be talking about the cross product**
0:06	L	Lec Adm	Instructor asks students to create a function using MATLAB Instructor does not want the students to use built-in function, but wants to see where students are in skill level
0:07	L Ind	Lec Adm MG **TA**	Instructor: you can work in pairs, but I want you to understand how it's happening Students start working on the project in MATLAB Instructor walks around the room and checks on students **TAs walk around the room and checks on the students** Some students chatting about the assignment, but room is mostly quiet
0:08	Ind AnQ **SHS[2]**	PQ **GSD[1]** **Con[3]** MG **TA[4]**	Instructor: what should you be doing? (Students: making a loop) Instructor: **If your neighbors are struggling what should you be doing?[1] (Students: helping them.[2]) Why is it so quiet in here? Oh, (in a joking voice) MATLAB is still loading (students laugh at the joke)[3]** More students chattering and discussing the assignment **Instructor and TA walking around checking on students[4]**

TABLE III. Environmental Scan with COPUS Codes – Excerpt 2

Min	*Student Codes*	*Instructor Codes*	*Environmental Scan*
1:42	L	Adm **Lnk**	**Instructor: problem 3 is something we will cover later on in the semester.** I wanted to introduce this topic to you because it's relatively low stress
1:43	L	Adm **RE**	Instructor: you won't be given all of this information when you're doing these problems. The tools that we've been giving you (algebra) are helpful for you to solve these problems **Instructor shares how problem 3 was relevant for his previous job in industry**
1:44	L	**BPC[1]** **ATM[2]** **Con[3]** **Enc[4]** Adm	Instructor explains that **there are a lot of engineers who come out and don't know how to balance mass[1]**. We don't want you all to end up that way. **We want you to be Aggie engineers, synonymous with "the best"[2]. That is what I want you to be and I'm trying to help you get there.[3, 4]** Look at the mass balance problem more (problem 3) to make sure that the concepts make sense because you're going to have to work on these more.

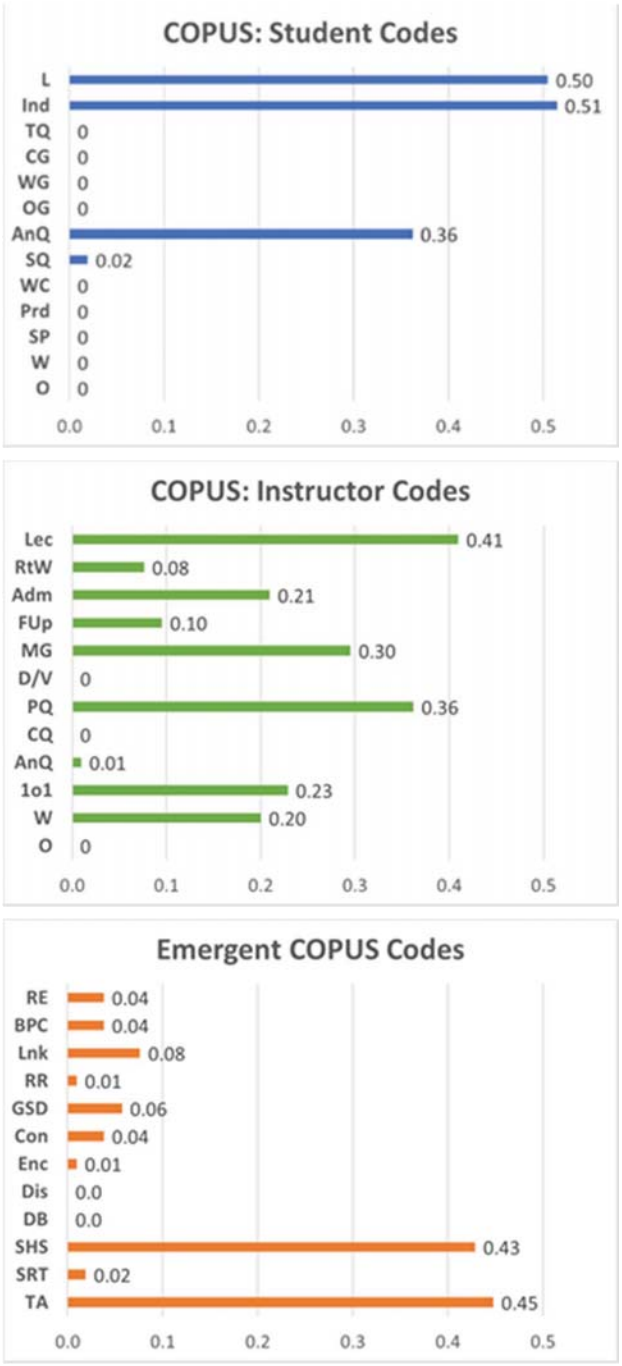

Fig. 1. The percentage of times student, instructor, and emergent COPUS codes occurred during a class.

After the completion of the classroom observation and COPUS coding procedures, the project team compiled the frequency that each code appeared in each class. Figure 1 provides the frequencies of original student, original instructor, and emergent COPUS codes for one class session. The frequency is expressed as a percentage of total class time, recorded in 2-minute subperiods as per the original COPUS. Percentages are used instead of counts because class lengths varied (from 50 to 120 minutes). In the class depicted in Figure 1, students spent 50% of the class listening, the instructor spent 41% of the class lecturing, and the instructor spent 4% of the class discussing relevant examples.

Ultimately, there appears to be a qualitative difference between examining the original COPUS codes in isolation versus combining the original and emergent COPUS codes. By including the emergent COPUS codes, the classroom observers can take a more nuanced look at the behaviors occurring in a classroom by noting the types of innovative instruction and resources that instructors provide to the students. Furthermore, the emergent COPUS codes allow the observers to capture classroom climate and affect, which cannot be done with the standard COPUS codes.

Based on the experiences of the project team in the development of emergent COPUS codes, depending on the purpose of the observation, the authors encourage the use of an environmental scan to capture more nuanced behaviors and interactions that impact student learning. By including a minute-by-minute record of what is happening in a classroom and then recording the relevant COPUS codes at a later time, the observers on the project team were able to account for a larger number of codes than could be reasonably handled by an observer using the traditional COPUS method. It also becomes possible to recode a classroom observation if additional codes were to emerge; coding for COPUS in real time would preclude this, as it would not describe in real language what is occurring but rather would only document the COPUS-listed behaviors. Additionally, it would prevent emergent codes because there would be no record of classroom activity to use to (a) identify codes, (b) propose codes based on the literature or consistent observation, and (c) come to consensus with experts and/or the literature. Future researchers could develop their own emergent COPUS codes based on the research questions and purpose of the classroom observations.

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