WIP: Strategies for Engaging Students in Active Learning in Online Settings

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Abstract— **With the COVID-19 pandemic, efforts focusing on student engagement in science, technology, engineering, and math (STEM) courses have shifted towards engagement in online instruction, resulting in a need for increased understanding of how instructors adapt active learning from in person instruction to online learning. Active learning occurs in many different formats across different classrooms. Despite these broadly different formats, a common thread across all active learning is that using it in classrooms results in greater student engagement as compared to passive listening to lectures. Educational researchers have found that active learning has a positive impact on student outcomes, especially for underrepresented students in STEM.**

The research outlined in this paper seeks to understand how instructors are adapting from in person courses and the strategies they use to engage students in online STEM courses. To do this, we interviewed 20 instructors who were using active learning in teaching an online STEM course about the strategies they were using to engage their students in online activities. We coded these interviews using a grounded theory approach. After several rounds of coding, we found six overarching themes about how instructors viewed active learning in their online classrooms: Instructor Emotion, Instructor Strategy, Instructor Goal, Active Learning Example, Instructor Barrier, and Student Behavior. This paper focuses on the instructor strategy theme and its 55 individual codes.

Keywords—active learning, online instruction

I. INTRODUCTION

Active learning can be described as any time an instructor goes beyond simply lecturing to their students, the examples for which can be broad and varied, such as polling, think-pair-share activities, group discussions, peer review, gamification, etc. Research has shown that when active learning is used in the classroom, student outcomes improve in STEM courses, including higher retention rates, increased student motivation, higher passing rates improved learning, and greater student engagement [1-8]. Despite research demonstrating the positive effects of active learning, widespread adoption of these educational practices in face-to-face instruction (F2F) among STEM instructors has been slow [9-11]. A great deal of research explores barriers to active learning adoption in F2F STEM classrooms include instructors concerns about the efficacy of active learning, the amount of time it takes to develop the activities, concerns over being able to cover the whole course syllabus, and finally, students' resistance (e.g., refusing to participate, talking about non-classroom topics during the activities, etc.) to the change from lecture to active learning [5, 12-18]

With the onset of the COVID-19 pandemic in 2020, higher education instructors were forced to abruptly change their curriculum to an online format. This widespread change in the instructional environment shifted discussions from student engagement and instructor adoption of active learning in F2F classrooms to student engagement and instructor adoption of active learning in online instruction. Similar for F2F instruction, student engagement in online learning correlates with student motivation, student satisfaction, persistence, and academic performance, and online active learning has emerged as one way to better engage students during online instruction [19-21].

In the transition from F2F to online learning, researchers described how to implement active learning in an online environment and how to engage their students in these activities [21-23]. Some examples of online active learning activities are using an online whiteboard to have the students generate a document, using breakout rooms for think-pair-share activities, peer review, solving problems, discussion boards, etc. [23-26]. Many studies in online learning have focused on how to engage students in the online classes, but few have studied the challenges instructors face when transitioning from F2F to online [27, 28]. We seek to understand the challenges instructors face in adopting and/or pivoting active learning to an online environment, how they overcome them, and the strategies they use to promote student engagement during active learning activities in an online environment.

For F2F instruction, researchers recently created a framework for identifying the evidence-based strategies instructors use to reduce student resistance to active learning (i.e., increase student engagement) in F2F classroom settings. This framework theorizes three overarching categories of

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strategies: planning, explanation, and facilitation [29-31]. Instructors use many different *planning* strategies in F2F settings, including thinking through what worked and what did not when they tried similar activities, using student feedback, or thinking through how to best design or structure an activity. *Explanation* strategies identified in F2F settings include how an instructor explains an activity to their students, including what is expected of the students, why they are doing the activity, how they are being assessed or graded on the activity, and how the activity relates back to the overall student learning goals. Finally, instructors employ *facilitation* strategies during the activity. In F2F courses, facilitation strategies include an instructor walking around the room to check in on students, assigning points to an activity, leading students in a debrief following the activity, or asking for feedback from the students following the activity.

In this paper, we explore instructors' adoption of active learning in online environments and their strategies to promote student engagement during active learning in an online instructional environment. Through interviews with instructors at a diverse range of institutions, we explore their use of active learning in an online environment and the strategies they use to promote student engagement. These findings could provide research-based strategies to facilitate and guide STEM instructors seeking to adopt active learning and increase student engagement in online environments.

II. Research Questions

We seek to answer two research questions*:*

1) What strategies do instructors use to engage students in active learning when they first transition to online instruction from F2F instruction?

2) Are the strategies instructors use to engage students in active learning similar to the strategies they use in F2F settings?

III. Methods

For this study, we recruited 20 instructors from 20 different institutions who were using active learning in their synchronous online STEM courses from four types of institutions (community colleges, bachelor's granting institutions, master's granting institutions, and doctoral granting institutions). This sampling was both convenience and purposeful, conducted in order to ensure generalizability of our findings across institution types. We focused on institutions within driving distance of Author 1 to ensure that we could follow-up in person, if needed. From there we compiled a list of possible institutions and randomly selected 20 to recruit from. We worked with the institutions' IRB offices to ensure that we had permission to recruit and collect data from their schools. Finally, we randomly selected one STEM instructor from these institutions to interview. If an instructor declined, we randomly selected a second (or third) instructor to interview.

During our recruitment, we sought to have an approximately equal number of instructors from each of these institution categories. Instructor demographics are shown in Table I. Given that lower-level courses typically have less student engagement than upper-level courses [32], we focused our recruitment on instructors teaching 1st- and 2nd- year courses. We reached out to instructors by email, recruiting one instructor from each selected regional institution so that we could also have a diverse a set of institutions. Instructors received a monetary incentive to participate.

TABLE I. Instructor Demographics

Instructors	***Number***
Gender	
Men	8
Women	12
Race	
White	12
Asian	8
Institution Category	
Community College	5
Bachelor's Granting	4
Master's Granting	6
Doctoral Granting	5
Total	**20**

In the Fall of 2020, we conducted semi-structured instructor interviews over an online meeting platform (remote interviews were necessitated by the pandemic). We adapted guidelines outlined by Maxwell [33] to create an initial interview protocol that we piloted prior to interviewing the instructors in our data set. The interview durations varied, ranging between 16 and 55 minutes (33 minutes on average). During the interviews, instructors were asked about the strategies they were using in their online classrooms to engage their students in active learning activities. We recorded the interviews to enable more accurate transcription. We used a protocol to initially guide questions, though allowed for flexibility to ask follow-up questions when strategies or activities were not fully addressed or understood. A full interview protocol can be found in the appendices.

Our approach to interview coding helped us address validity concerns. We analyzed our data by applying grounded theory [34]. For this, we transcribed the interviews verbatim, and from there, we selected one interview to be open-coded using the initial coding guidelines as outlined by Charmaz [34]. Two team members (authors 1 and 2) coded the initial interview, memoing throughout the process, then met to discuss discrepancies in the coding until agreeing on a preliminary codebook. This process was repeated for two additional interviews, refining our definitions for each code, and adding new codes after the second round of coding was complete. Again, if disagreements or discrepancies arose, the team members would discuss until agreement could be met. After establishing the secondary codebook, we coded the remaining 17 interviews, with either author 1 or author 2 doing an opening code and the remaining author doing a second, verifying code. We did not establish inter-rater reliability for this coding, as each interview was jointly coded and disagreements in the codes were discussed until they could be resolved.

IV. Preliminary Results

The interview protocol was designed to elicit strategies to promote student engagement in active learning, but given the transition from F2F to online settings, we also uncovered multiple approaches instructors were using to engage their students as well as issues they were facing in trying to use active learning in online settings. All-together, six overarching code themes emerged from the data: Instructor Emotion, Instructor Goal, Active Learning Example, Instructor Barrier, Student Behavior, and Instructor Strategy.

We created the *Instructor Emotion* theme to understand how instructors were feeling about their transition from F2F to online instruction, as they often mentioned their feelings, such as feeling overwhelmed or encouraged. Instructors also talked about why they were doing certain things in their classrooms and their overarching goals, such as student learning goals and student progress. These ideas are captured in the *Instructor Goal* theme.

The *Active Learning Example* theme encompasses the range of active learning examples that instructors chose to use in their online classrooms, such as peer instruction, group activities, and polling. Throughout our interviews, instructors discussed issues that were hindering them or preventing them from easily using active learning in their online classrooms, such as difficulties with student engagement, learning new technologies, and institutional policies. These examples were coded in the *Instructor Barrier* theme. The *Student Behavior* theme covers what the instructors' perceptions of students' reactions to the online active learning, such as improved class performance or increased engagement. Finally, the *Instructor Strategy* theme encompasses strategies instructors were using to implement active learning in their online courses and ways they were working to engage their students in these activities. Because it represents the largest and most encompassing them in our work, we focus on this theme in our work-in-progress paper, summarizing 12 of the 55 codes which emerged from this theme. Six of the codes describe strategies instructors use to develop and prepare activities for their online courses (Table II), and six describe strategies that map onto the framework we used for F2F instruction (Table III).

In developing and preparing active learning activities for their online classes, instructors use several types of strategies (translating F2F to online, adopting learning technology, engaging in training, choosing technology, collaborating, seeking out resources), as shown in Table II. For *translating to face-to-face to online* strategies, instructors discussed planning for class time by translating their F2F activities into online activities. They also shared the associated challenges (e.g., translating hands-on activities), time, and effort. For *learning technology* and *training*, instructors shared seeking out technology to help them create interesting activities for their classes and participating in training to learn new technologies to best fit their classroom needs. For *choosing technology* strategies, instructors discussed the importance of teaching those technologies to the students prior to in-class activities or using technologies for which instruction isn't necessary. Additionally, instructors shared talking with their colleagues and *collaborating* on ways to adapt active learning to their online classrooms. Finally, instructors discussed *seeking out resources* such as online videos and papers to help them adopt active learning in their online classes.

TABLE II. Teacher preparations to online teaching

Strategies in transition to online active learning		
Strategy code	***Definition***	***Example Quotes***
Translating face to face to online	Instructor talks through translating from F2F to online	"And I'm trying to think about all the things… and I'm trying to translate almost all my active stuff from my face-to-face classroom into the online synchronous environment."
Learning technology	Instructor learns various technologies to better engage students	
Training	Instructor attends training (workshop, class, etc.) in order to learn how to better teach something	"We were able to have like a workshop where they were able to give us more resources on how we can use maybe media site or screen cast, which is another free software that I'm using right now to record lectures, maybe in 10 minutes or 15 minute intervals, because I believe during that workshop, they said that students have an attention span of less than a couple of minutes."
Choosing technology	Instructor chooses a technology that will best engage their students	"And so I intentionally picked a virtual whiteboard that where It was easy for them both to write with like a stylist or to type math in a very user friendly way."
Collaborating	Instructor talks with other instructors about how to teach their course online	"I have talked to my friends you know regarding to the different things, but…"
Seeking out resources	Instructor looks up different resources that could be incorporated into their classrooms	"I've seen There's one professor who I follow at UCLA…"

Many strategies instructors shared that they are using to promote student engagement in online active learning are similar to those in F2F settings. Using the Planning, Explanation, and Facilitation framework, we align online strategies and F2F strategies instructors use to engage students in active learning (Table III). Again, in F2F settings, the strategies can be broken into three categories: Planning, Explanation, and Facilitation. In online courses, instructors use planning strategies, such as using student feedback (surveys, debriefs, etc.) and thinking through the different types of questions they would like to use during their active learning activities. Online instructors use explanation strategies such as explaining to students the reasoning behind why they are using active learning in their classes as well as ensuring that they give clear instructions on how to do the class activity. Finally, the instructors described facilitation strategies when they talked about monitoring their students during different activities and leading the whole class

in a debrief at completion of the activities. These show how instructor strategies to improve student engagement are translated from the F2F to the online environment.

TABLE III. SELECT ONLINE STRATEGIES THAT FIT WITHIN THE FRAMEWORK FOR F2F STRATEGIES

Comparison to of Online Strategies to F2F Framework		
Strategy Code	***Definition***	***Example Quote***
Planning		
Using Student Feedback	Instructor uses student progress or student feedback to adjust what they are teaching (Including the use of surveys)	
Preparing Discussion Questions	Instructor creates questions with the goal that it will prompt discussion (e.g., use real-world scenarios, open-ended questions, difficult questions, etc.)	"I try to make sure and identify questions that are going to get… I mean, if I ask them a question, that is, is very straightforward, a simple recall answer, that's going to be pretty boring. Because they're going to get into their group and they're going to say, okay, yeah, I got, I got this. And everybody else says, yep, that's what I got to. And then they just sit there. So, if I give them something that is a question and maybe would have, like I said, multiple different answers or there isn't a clear right answer, or it's not something that we've explicitly discussed before."
Explanation		
Explaining Reasoning for Active Learning	Instructor explains to the students what they are doing or why they are doing it	"I often share a lot of reasons for the types of questions I use or the pedagogy behind them. Why did I ask you to do this question… What did I want you to get out of it… But I usually have them do it first and then explain afterwards, those pieces."
Giving Clear Instructions	Instructor gives clear instructions on class activities and structure	"… this is all discussed on the first day itself. And when my email goes out. I keep it really friendly, but I do pinpoint very precisely the expectations. And they should not expect that it's going to be a good two hour lecture and they'll be sitting and yawning. That's not going to happen."
Facilitation		
Monitoring Students	Instructor monitors shared documents, breakout rooms, etc. to see what the students are doing or to monitor their progress	"…because I have them working either doing the assignment in my math lab or doing the assignment in Canvas. And so I can monitor their progress on the back end, as well as going into the groups to make sure that they're talking."
Debriefing Groupwork	Students and/or instructors have a debrief of the groupwork after returning to the whole class	"…after we come back from the breakout room when it's not a clicker question we ask for volunteers to see what did your group come up with."

V. FUTURE WORK

We are currently refining our codebook by condensing codes and altering code definitions for clarity and precision. To do this, we are reviewing each coded text of the transcript and comparing it to similarly coded items, looking for alignment. Additionally, we are checking each code to ensure that the definition encapsulates the instructors' meaning. Given the large number of emerging codes (~100 in total, of which we've presented 12), we are systematically reviewing the code to ensure consistency throughout the codebook. This paper has focused on 12 of the 55 Instructor Strategy codes, as this theme is the furthest along in this process. We plan similar refining of the remaining code themes of Instructor Emotion, Instructor Goal, Active Learning Example, Instructor Barrier, and Student Behavior.

Once complete, our work will help researchers better understand what is motivating instructors' strategies in adapting and creating active learning in their online classes. Our future work seeks to tie these individual themes into a better understanding of what in instructor is choosing to do, and why they are choosing to do so. Additionally, we aim to further understand instructor strategies used specifically in online settings.

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VI. APPENDICES

Interview Protocol

Part 1: Informed Consent

Part 2: Active Learning

To begin, I'd like to get to know a bit more about your teaching experience using synchronous online active learning (S-OL-AL). For our purposes, we define S-OL-AL as any online activity which requires the students to do something in real-time other than listen to lecture and take notes. For example, S-OL-AL might include using breakout rooms in class or having students contribute synchronously to a shared google document

Prompt 1: Can you briefly tell me (1) how many years (or months) you've taught using OL instruction, *wait for answer* (2) how many years you've been using S-OL-AL - Thank you for doing that.

Prompt 2: Ok, so now can you tell me about an example of active learning you have used in your online synchronous classroom. (*** THIS EXAMPLE TO BE REFERENCED LATER***)

Part 3: Strategies

Thank you. The purpose of our interview today is to learn about strategies you might use to promote student engagement and reduce student resistance while using S-OL-AL. We have a broad definition for strategies that includes the way instructors plan for an activity, introduce the activity to students and describe its purpose, and promote engagement and keep the activity running smoothly once it has begun. For instance - again, I'll post these examples in the chat - when using AL, an instructor might (1) give students concrete/clear instructions for completing the activity or (2) join breakout rooms to check in on student progress.

Examples of strategies:

- Give students concrete/clear instructions for completing the activity or
- Join breakout rooms to check in on student progress

So now, in terms of the (***REFERENCE ACTIVITY THEY MENTIONED***)

Prompt 3: Could you tell me one strategy you used to ensure that students were engaged in the activity? (other related notes: was there anything specific in the way you planned for an activity, introduced it to students, or kept it running once it had begun?)

Prompt 4: What was your goal in using this particular strategy

Prompt 5: Do you think this strategy was effective?

Prompt 6: Repeat 3-5 as time permits (can you tell me another strategy you used to ensure they were engaged in (***REFERENCED ACTIVITY THEY MENTIONED ***) - maybe prompting the interviewee to consider planning, explanation, and facilitation or reminding them about some strategies they mentioned when they very first described the AL. You may need to push back if someone says they don't use any strategies --- they may not recognize what they do as a "strategy")

Prompt 7*:* Thanks! Now, is there another example of active learning you have used in your online synchronous classroom? (repeat prompts 3-6 as time permits)

Prompt 8: Are there other strategies (that you aren't using) that you think might be useful to promote student engagement and/or reduce student resistance during S-OL-AL??