Exploring Teaching and Course Assistants' Interventions with Groups during Collaborative Problem-Solving

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Abstract: This study explores the task-related interventions of a teaching assistant and three course assistants with six small groups during collaborative problem-solving activities in undergraduate engineering classrooms. Results indicated that the majority of the interventions were not preceded by monitoring the group activity and were initiated by asking the groups a general question about their activity or progress on the task. The majority of the interventions were dominated by feedback moves which suggests that the teachers were using direct instruction strategies more than dialogic strategies when intervening with the groups' work.

Introduction

The role of the teacher in orchestrating collaborative problem solving activities in face-to-face STEM classrooms has received increasing attention in recent years (Gillies, in press). Research suggests that teachers must implement strategies that can facilitate student interactions and positively impact the group progress towards the goal of solving the task during these activities (Kaendler et al., 2015). Few empirical studies focused on the strategies that teachers use during collaborative problem-solving activities to intervene with group work. Similarly, studies that take place in higher education STEM classrooms and examine the intervention strategies that are implemented by graduate teaching assistants (TAs) and sometimes more advanced undergraduate students are equally limited. This study addresses this gap in the literature by exploring the interventions of a graduate teaching assistant and three undergraduate course assistants (CAs) with groups during collaborative problem-solving undergraduate engineering discussion sessions.

Effective teachers' interventions in group work are characterized by being contingent on any difficulties that the group is facing, but without taking away the need for students to co-construct knowledge as they solve the task (e.g., Hofmann & Mercer, 2016). In order for such interventions to occur, teachers must avoid immediately using authoritative or directive strategies (e.g., giving solution procedures). Instead, teachers must monitor the group activity to diagnose the difficulties that are blocking the group members from engaging in high quality interactions or making progress on the task (Kaendler et al. 2015). Then, teachers can initiate the intervention by asking the group members to describe what they are thinking about and actively listen to their thoughts and discussions (Hofmann & Mercer, 2016). This gives teachers the opportunity to further understand the group members' difficulties and be helpful without immediately evaluating their ideas or providing answers (Chiu, 2004). Also, teachers must implement follow-up strategies to facilitate the group work. These strategies can be direct instruction strategies such as telling the group the solution processes or giving the group hints. They can help the group in solving the task or focusing the group's attention on certain concepts or aspects of the task (Chiu, 2004). They can also be dialogic strategies such as asking questions to probe and explore the group's understanding of the task and pushing the group members to clarify and elaborate on their ideas. These strategies can engage group members in thinking together and can encourage silent group members to participate in the discussion (Hofmann & Mercer, 2016; Webb et al., in press).

Although we know a little about how teachers intervene in group work, we do not yet know how these interventions look like in actual collaborative problem-solving higher education STEM classrooms that are orchestrated by teaching assistants. This study explores the interventions of a teaching assistant and three course assistants (CAs) with six small groups during collaborative problem-solving undergraduate engineering discussion sessions. The study set out to answer the following research questions:

1) What were the initiating and follow-up moves that the teachers used when engaging in task-related interventions with groups?
2) What was the nature of the strategies that the teachers implemented during these interventions?

Methods

A qualitative exploratory design is used in this study, which is a part of a multi-year design-based implementation research project that aims to develop tools to support collaborative problem solving in undergraduate engineering courses.

Participants

Participants were one TA (Austin), three CAs (Tom, Jim, Ted), and 20 undergraduate engineering students (13 males and 7 females). The TA was a graduate engineering student and the CAs were undergraduate engineering students who had taken this engineering course in previous semesters. The TA and the CAs had no prior teaching experience when they started teaching the discussion sessions and had not attended any professional development on teaching in a collaborative problem-solving classroom. However, the faculty member responsible for the course met weekly with all the TAs to provide some framing for the learning and teaching goals of each weeks' task.

Data collection

The data for this study was collected during two 50-minutes discussion sessions that were a required part of an introductory engineering course at a large Midwestern university. Both discussion sessions took place in a laboratory classroom. In the first discussion session, four groups of undergraduate students, the TA (Austin), and the two CAs (Tom & Jim) were recorded using ceiling mounted cameras and lapel, table or hanging microphones. Similar recordings were collected in the second discussion session, from two groups of undergraduate students, the TA (Austin), and the two CAs (Tom & Ted). During both discussion sessions, students worked in small groups to solve the same ill-structured, authentic engineering task that was designed using the guidelines developed by Shehab et al. (2017). Students worked on 11-inch tablets with software built specifically for this project. Each student had one tablet; tablets of students in the same group were synchronized, so that members of each group worked on and contributed to the same document.

Data analysis

The videos were transcribed and analyzed. The analysis focused on the task-related intervention episodes that were initiated by the TA or one of the CAs. An intervention episode began when the TA or CA joined a group and ended when the TA or CA left this group. The TA or CA's activity was examined to identify if the TA or CA appeared to purposefully observe a group's activity before intervening. When this occurred, the researcher assumed that the TA or CA monitored the group activity. To evaluate interrater reliability, two researchers coded the TA or CA activity that preceded the intervention episodes of two of the six groups. Cohen's kappa was .90. Disagreements were discussed to reach agreement.

Two emergent coding schemes were used to identify the initiating move that occurred at the beginning of an intervention episode and the follow up moves that occurred during an intervention episode. The *initiating moves coding scheme* (see Table 1) was applied to the initiating turn by TA or CA. The *follow up moves coding scheme* (see Table 2) was applied to each follow up turn by the TA or CA that came after the initiating turn in the same intervention episode. To evaluate interrater reliability, two researchers coded all initiating and follow up turns of the intervention episodes of two of the six groups. Cohen's kappa was .90 for the initiating moves and .80 for the follow up moves. Disagreements were discussed to reach agreement. For the purpose of this analysis, the coded follow-up turns were categorized as moves that can be associated with *giving feedback* to group members (provided a simple answer, provided an elaborated answer, evaluated/judged, provided explicit tips/hints, provided an explanation or elaboration, and instructed student or group), and *prompting for a response* from the group members (repeated/revoiced, invited students to speak, explored students' understanding, challenged student idea, and encouraged students to collaborate).

Table 1: Initiating moves coding scheme

Code	Definition	Example
Asked a general question	The TA/CA asked a question that was related to the group's activity or progress on the task	*"What are you guys doing?"*
Asked a specific task-related question	The TA/CA asked a question that was related to a specific step necessary to solve the task	*"So, have you calculated the shear force?"*
Commented on collaboration	The TA/CA commented on the collaborative process of the group or the collaborative behavior of a group member	*"I notice you're not working with your group, how are you doing?"*
Commented on the group's work	The TA/CA commented on the quality of the group or student's work	*"Interesting work Marco!"*
Instructed group	TA/CA instructed one or more students to do or not to do something	*"Now you put down what you do to solve for it."*
Other	Inaudible talk	

Table 2: Follow-up moves coding scheme

Provided a simple answer	The TA/CA answered a student's question without any additional elaboration or explanation	*Student: "Is that talking about the shear or the normal force?"* *TA: "Shear force"*
Provided an elaborated answer	The TA/CA answered a student's question with additional elaboration or explanation	*Student: "Do we only get one of each?"* *TA: "Yes, so those are all the objects that you're working with. You put one of each of those on one of the shelves."*
Evaluated/Judges	The TA/CA evaluated or judged the group work	*TA: "No, what you guys did here is wrong"*
Provided explicit tips/hints	The TA/CA explicitly presented hints or tips on how to solve the problem	*TA: "Just put the books in the middle of the shelf and you are on the right track"*
Provided an explanation or elaboration	TA/CA explained or elaborated on certain concepts or problem-solving procedures	*"So for this case since we have zero axial or zero forces, it does not really matter"*
Instructed student or group	TA/CA instructed one or more students to do or not to do something	*"Okay so can all of you go to page three? I can explain this to all of you. And then just put your tablets down"*
Reacted to a student's statement	TA/CA simply accepted, confirmed, or rejected students' statements or made neutral statements	*Student: "So the shelf is held on the left and right side"* *TA: "Right, the shelf is held on the left and right side"*
Asked a student to clarify or repeat idea	TA/CA asks a question to clarify something related to what the student was saying	*Student: "So we are going to find the distribution that fails"* *TA: "Huh? say again"*
Repeated/ Revoiced	TA/CA repeated/revioced a student idea to give the student a space to follow-up	*Student: "We put everything in the middle and now we're going to calculate it"* *TA: "You are calculating it, okay."*
Invited students to speak	TA/CA invited one or more students to speak up to share ideas/thoughts/reasoning	*"So what do you guys think?"*
Explored students' understanding	TA/CA prompted students to say more about a certain concept or problem solving procedure	*TA: "If I cut it just to the right of that 62 newtons going down it, what would it be?"*
Challenged student idea	TA/CA challenged student's idea by asking a question or providing a counter argument that prompts student's thinking	*Student: "So this distribution will fail"* *TA: "Are you sure about that?"*
Encouraged students to collaborate	The TA/CA encouraged students to communicate/talk/discuss ideas with each other	*"Just discuss how you want to go about the problem and the assumptions that you want to make"*
Other	Inaudible or unintelligible	
No follow up moves	The TA/CA left the group without making any follow up moves besides the initiating move	

Results

The total number of task-related TA or CA intervention episodes was 29. Nineteen episodes were not preceded by monitoring the group activity; ten episodes were preceded by monitoring. Fifteen of the 19 episodes that were not preceded by monitoring the group activity were initiated by asking the group a general question. Of the 10 episodes that were preceded by monitoring, six were initiated by asking the group a general question and four were initiated by asking the group a specific task-related question. The 29 TA or CA intervention episodes included a total of 229 follow-up turns. Figure 1 shows the number of turns that were coded as moves that can be associated with giving feedback to group members and with prompting the group members for a response. Of the 29 episodes, Figure 2 shows the number of episodes that included only giving feedback moves, only prompting moves, a mixture of both, and only other or no follow-up moves.

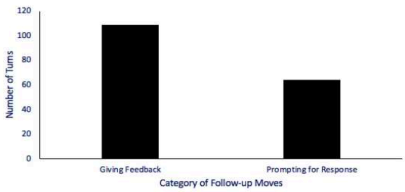

Figure 1. Number of Turns per Category of Follow-up Moves.

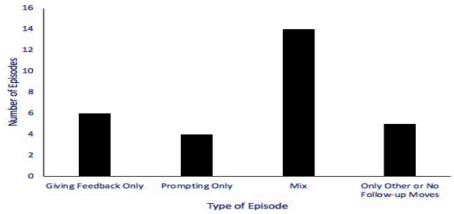

Figure 2. Type of Episodes.

Conclusions and implications

This study examined the task-related intervention episodes of one TA and three CAs with six small groups in two collaborative problem-solving undergraduate engineering discussion sessions. Results indicate that the majority (19 out of 29) of the intervention episodes were not preceded by monitoring the group activity. This suggests that the teachers did not diagnose the difficulties that may have been blocking the group members from engaging in high quality interactions or making progress on the task. Rather, TAs and CAs intervened to check on the groups' progress on the task as part of doing their job in managing the classroom. The fact that 15 of the 19 episodes that were not preceded by monitoring were initiated by asking the group a general question supports this claim. However, all 10 episodes that were preceded by monitoring the group activity were initiated by asking the group a question. This suggests that the teachers may have avoided intervening immediately with the groups' work before getting a sense of the students' thoughts and progress on the task.

Figure 1 shows that the number of follow-up moves that are associated with giving feedback to the group members are greater than the number of follow-up moves that are associated with prompting the group members for response. Figure 2 shows that the majority of the episodes (20 episodes) either included only giving feedback moves or a mix of giving feedback and prompting moves. Further examination of the sequence of turns of episodes that included a mix of giving feedback and prompting moves, indicated that even when the teachers prompted students for a response to explore their thinking or share their ideas, at some point during the intervention the teachers switched to answering students' questions, explaining the solution processes or giving the group tips that can help in solving the task. This suggests that the teachers tended to use direct instruction strategies more than dialogic strategies when intervening with the groups' work. Implementing these strategies kept the teachers in control of the problem-solving process and may have taken away the need for students to co-construct knowledge as they solved the task. Further analysis is needed to understand the impact of these strategies on variables, such as the quality of student interactions and progress on the task, that can influence what students learn during a collaborative problem-solving activity. In addition, further analysis of data that was collected from other discussion sessions that were taught by the same and different teachers is needed to better understand the differences in the interventions across the teachers and across the groups.

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