

Case 2: Facilitating Group Work

Overview

As is the case with all teaching formats, there are a variety of different things instructors can do and say to help students learn effectively while they work in small groups. This case provides opportunities to view and think about what two calculus instructors do and say as they interact with groups of students. In particular, the case is designed so participants can consider the non-verbal cues (e.g., physical gestures) as well as the verbal (i.e., spoken) cues used by each instructor to focus the students' attention on the mathematics and to encourage them to work collaboratively.

Learning Goals for Participants

- Become familiar with various ways to interact with groups.
- Understand how specific verbal and non-verbal cues shape student interactions.
- Develop a greater awareness of how the physical arrangement of students (and yourself) affects the interactions among students — and between you and them.

Video Content / Context

The video shows clips from two instructors' classes. Each clip is shown three times: audio only, video only, both audio and video. In Eric's Calculus I class, it is the first day of the semester. Students are working in groups at the blackboard and we see Eric interact with one of the groups on an activity to graph the height of a raised flag versus time. For Kristen's Calculus I course it is week 10 of a 16 week semester. Students are working in their seats and we see Kristen interact with one of the groups on an anti-derivative problem. In both classes, working in groups on problems is a typical instructional activity (daily for Eric, at least weekly for Kristen).

Activity Timeline (\approx 60 minutes)

Preview: 5 minutes

Activity 1: 15 minutes

Activity 2: 12 minutes

Activity 3: 15 minutes

Reflect & Extend: 10 minutes

Reminder: Case activities go more smoothly when you follow the *Visual Guide to Using Video Case Materials* at <http://collegemathvideocases.org/home/include/VisualUsersGuide.pdf>.

Leading the Case: Facilitating Group Work

Novice mathematics teachers' attitudes toward group work vary widely. While some have had numerous positive experiences, others view collaborative tasks as opportunities for the weaker students to unfairly leech off the stronger ones. The goal of this case is to look at nuances of how students respond to things teachers say and do. While group work is the context for the analysis, the focus is not, "Group work — are you for it or against it?" If some participants head for the front lines of the Group Work vs. Lecture battle, try to steer them toward a more targeted discussion of how teachers' words and actions (even subtly) can impact student learning.

The video in this case is taken from two instructors: Eric and Kristen, both teach at large public institutions. Both instructors often use group work in their classes.

Preparing for the Activity

As noted on the previous page, case activities will go more smoothly if the facilitator follows the preparation recommendations in the *Visual Guide to Using Video Case Materials* at <http://collegemathvideocases.org/home/include/VisualUsersGuide.pdf>.

Download, photocopy, and distribute the Participant Guide handout - a separate copy to each person. For each activity, allow enough time for reading by all, including those who are not native English readers. Though the video is captioned, the words go by quickly so transcriptions of the focal parts of the videos are included at the end of the handout. In this video case, participants are asked to read the discussion prompts for each set of video clips before viewing the clips, then re-read and discuss the prompts after viewing and/or reviewing video.

Finally, the authors welcome information from you on the kind of discussions that arise for your group! The online survey for this case is an ideal way for you, as facilitator, to communicate with the authors. Use the comments box at the end of the survey to identify yourself as a facilitator and provide details about how the case activity went for your group.

Facilitating Group Work

Learning Goals

- Become familiar with the different ways to interact with groups.
- Learn how different cues have different effects on students' work.
- Understand how specific verbal and non-verbal cues shape student interactions.
- Develop a greater awareness of how the physical arrangement of students (and yourself) affects the interactions among students — and between you and them.

Introduction

Most of us have experiences working on mathematics problems in groups. While the research clearly shows that collaborative work can improve student performance, retention, and attitudes, facilitating groups provides a whole new set of challenges for any mathematics teacher. In this activity you will analyze how different interventions and/or instructions can have different consequences for the direction or progress of group discussions.

This activity involves examining video from two first semester calculus classes. In these classes, students are working in groups on a set of tasks. Below you will have an opportunity to become familiar with the tasks the students were working on. After this you will analyze the two videos.

You will examine the two group discussions three separate times. First you will listen to the discussions without seeing the corresponding videos. The focus of this part of the activity is on the verbal cues — the things the instructor says to the students. Then you will view the videos without the audio playing and you will consider the non-verbal cues (e.g., the gestures, body language) the instructor uses while interacting with the students. Lastly, you will watch again, this time with both video and audio playing.

The activity gives you opportunities to think about ways that instructors can use verbal and non-verbal cues to help facilitate and guide discussions that students have while they are working on a task.



Getting Started

Ask each person to read the first two pages of the handout. The first page includes an introduction to the task and its goals. The second page is a preview of the mathematics addressed in the video clips. Limit time spent discussing the two mathematical problems - see notes below.

Preview activity:

Eric's Calculus Class: Even though the handout does not ask participants to complete this task, you will find that most can't resist the allure of this simple question. The ambiguity of the question is intentional: are we just graphing a single raising of the flag? one day's journey up and down? the height of the flag over several days? Eric's goal is to solicit substantially different graphs from different groups so that the whole class can view and discuss the similarities and differences in graphs and in approaches to graphing.

Kristen's Calculus Class: This problem seems much more "typical" of a Calculus course. Some participants may assert that students should be told (by the instructor or the textbook) what the antiderivative is before asking them to calculate one. This is not Kristen's approach. Draw attention to the paragraph that explains this is a new concept for the students and the purpose is to get students talking about and using what they know to work backwards and come to an understanding of what an antiderivative is; Kristen's goal is to introduce the concept of the anti-derivative in a way that pushes students to tie antiderivative to their knowledge of derivatives. This approach makes the task a "group-worthy" task.

Moving to Activity 1

Have participants read page 3 in the handout (page 5 in this Facilitator's Guide). The page gives instructions about what to attend to in the first AUDIO ONLY versions of the vignettes.

Preview Activity

Below are the two tasks that students were working on in the classes. Read through each task to become familiar with the mathematical ideas they contain.

Eric's Calculus Class

This was the first problem done on the first day of a Calculus I class:

At summer camp, a child comes out every morning to raise a flag. Consider the height of the flag as a function of time. Sketch what such a graph might look like.

Kristen's Calculus Class

This problem appeared in a set of problems from a Calculus I class's first experience with antiderivatives. The students had not seen a lecture on antiderivatives, they had not read anything related to antiderivatives, and had not worked on any antiderivative problems.

Suppose $g(x) = x^5$ and $f'(x) = g(x)$. What could $f(x)$ be?

Activity 1: Verbal Cues

Listen—Eric's Class (2 minutes) Play the video—the screen will remain black throughout the clip, save for the subtitles at the bottom. Pause the video when asked to. Tell participants that transcripts also appear at the end of the handout. →

Sample responses to discussion questions—Eric:

1. “Is this everybody’s graph?” “If I asked any of you to explain this . . .” “Why don’t you start telling me the story...” (implying that someone else might continue — requiring everyone to pay attention). Toward the end of the clip, Eric reiterates that the goal is to convince each other.
2. All four.
3. Eric wanted to see if there was agreement, to reinforce the idea that they needed to discuss issues until everyone agreed. Alternatively, he could have asked “How are you doing?” of the whole group, not putting any one student on the spot.
4. Eric might want them to practice justifying their reasoning by convincing each other. Doing so avoids the “teacher as final authority” idea that keeps students from deeper mathematical thinking.

Listen—Kristen's Class (2 minutes) Start the clip again, pausing when instructed. Again, transcript appears at the end of the handout. →

Sample responses to discussion questions—Kristen:

1. She refers to the tools they have, without telling them which one to use. She repeatedly draws their attention to specific parts of the task, with questions, e.g., “How would you get rid of . . .”. To get them working, she focuses on procedures that sound like they might be familiar - find a place where everyone can access and go from there.
2. Two
3. Participants often remark that Kristen should tell students to use a particular rule. Some might suggest Kristen say “There’s an easier way” and walk away. While this might generate student discussion, it is just as likely to distract students from engagement in the task and refocus their energy on what is “easier.” Consider asking participants to think about what the consequences will be for student engagement and understanding if attention is focused on a search for a “better” or “easier” way (as opposed to having students pursue what they already understand in a mathematically correct fashion). Participants might also suggest she could ask if anyone else (e.g., nearby students) has a different method.

Activity 1: Verbal Cues

Introduction:

We are going to listen to a discussion from each of the two calculus classes described above. Listening to what each instructor is saying will allow us to focus attention on the verbal cues each instructor uses to engage their students.

Listen — Eric's Class:

The goal is to pay particular attention to how Eric interacts with his students. You need not focus too heavily on the context of the problem, just think about how Eric addresses the students and how what he says might influence the direction of the discussion or nature of the group's work.

Discuss — Eric:

1. What are some things that Eric said to facilitate the group's discussion and work on the task?
2. How many students contributed to the discussion?
3. Eric asks the group if the graph shown, "... is everyone's graph?" Why would he ask this question? How else could Eric have approached the group?
4. In line 8, Eric discovers that one student does not agree with her other group members. Instead of telling them who was right, in line 18 he instructs the members to "convince each other." Why would Eric want the group members to convince each other instead of convincing them himself?

Listen — Kristen's Class:

Listen to the sample taken from Kristen's calculus course and just like before, pay particular attention to how Kristen interacts with her students. Focus on how Kristen's intervention influences the group's discussion and progress.

Discuss — Kristen:

1. What are some things that Kristen said to facilitate the group's discussion and work on the task?
2. How many students contributed to the discussion?
3. When asked how to take the derivative of a function, one student wants to use the quotient rule. Kristen says, "... it's a lot of work, but you can use it." If Kristen feels that there is a more efficient way of solving the problem, how might she have elicited this method from the other members of the group?

Activity 2: Non-Verbal Cues

Moving to Activity 2

Have participants read page 4 in the handout. This page gives instructions about what to attend to in the VISUAL ONLY (no audio) versions of the vignettes.

Watch — Eric's Class: (2 minutes) Start the clip again, pausing when instructed to. This time, no subtitles appear so that we can concentrate on non-verbal cues. →

Watch — Kristen's Class: (2 minutes) Start the clip again, pausing when instructed. →

Discuss:

Eric's non-verbal cues include the things listed below. A more detailed list is shown in the first column of the table on page 10:

- Inserting himself into the center of the group of students
- Looking around at each group member - at eye level with them - making eye contact
- Pointing to what they have written on the board

Kristen's non-verbal cues include the things listed below. A more detailed list is shown in the second column of the table on page 10::

- Standing to one side and turning to face a subset of the group of students who are seated together
- Looking down at the students - she is standing over them - making eye contact with the two male students but not with the other three who appear to be in the group
- Leaning in to look at student work and gesture at their papers

Activity 2: Non-Verbal Cues

Introduction:

In this activity, you will analyze the non-verbal cues the instructors use while interacting with students. These cues include any gestures or movements of the instructor as well as how the students are arranged in the group. You will view each video and make notes about your observations and then you will discuss how the things you observed might influence student learning.

Watch — Eric's Class:

As you watch the Eric video (without sound), pay attention to the non-verbal cues and make notes in the table (next page). In particular, take note of the instructor's visual focus (where is he looking?), the instructor's gestures, and general position of the people in the discussion. There is also space for your observations about other non-verbal cues.

Watch — Kristen's Class:

Now watch the video of Kristen and take notes on the non-verbal cues she uses (you can add your notes to the table on the next page).

Discuss:

1. Discuss your observations of the non-verbal actions of each instructor. Explain what the action was and what message the students might have received.
2. Which non-verbal actions of the instructors seemed to invite or exclude members of the group from the discussion?
3. What other non-verbal things could the teachers have done to help ensure that students are all working collaboratively on the mathematical task?

Activity 2 Table - Facilitation Notes

Non-Verbal Cues		
<i>Notes for facilitators – to support discussion of the possible effect of the cues on the student group.</i>		
	Observations: Eric	Observations: Kristen
Instructor's Focus	<p style="text-align: center;"><i>The intent here is to have participants write their observations about where the instructor's attention is focused. They may also note the potential impact of that focus on the group interaction.</i></p> <p>Making eye contact with individual students and looking around to connect with each student. Looking at the board (at the students' graph). Gaze travels around the group and to the board.</p>	
		<p>Nodding and making eye contact with the two male students. Appears to ignore the other three that seem to be seated in the same group. Gaze is on the two students and their papers.</p>
Instructor's Gestures	<p style="text-align: center;"><i>Observations about instructor's physical movements (pointing, gestures, potentially distracting movements, etc).</i></p> <p>Pointing to board, open-handed (up-handed) gesture to students like an invitation.</p>	
		<p>Pointing to work of students.</p>
Instructor's Body Positioning	<p style="text-align: center;"><i>Observations about where the instructor faces during interaction with the group.</i></p> <p>All standing. Students are standing two to the left and two to the right near the board. He comes up and stands between students 2 and 3 (creating a curve), facing the board. Positions himself so he can pivot to see each person and they can all see him. Would be a different feel if he were at one end of the line of students.</p>	
		<p>Students seated, instructor standing. She is "looming" or leaning over to see the two male students, half turned away from the other three people seated in the group. Would be a different feel if she squatted/sat near them.</p>
Other	<p style="text-align: center;"><i>Other observations about non-verbal cues and potential effects of them on the group.</i></p> <p>Seems rushed [Note: Eric is in a classroom with 48 students in 10 groups, each with 4 or 5 members; Kristen's room has 36 students in 9 groups of differing sizes, some pairs/triples, some 4 or 5].</p>	
		<p>Scratchy noise turns out to be the paper she is twisting in her hands (fidgeting).</p>

Activity 2 Table

Non-Verbal Cues <i>(notes used to support discussion of the possible effect of the cues on the student group)</i>		
	Observations: Eric	Observations: Kristen
Instructor's Focus		
Instructor's Gestures		
Instructor's Body Positioning		
Other		

Activity 3: Compare

Moving to Activity 3

Have participants read the Activity 3 page of the handout to prepare for viewing and discussing the full audio and video of the two vignettes. **Note:** Participants have probably already thought about similarities and differences. In this activity, they focus explicitly on comparing and contrasting the cues used by each instructor. Although it is natural for people to evaluate what each instructor did, the main goal is for participants to get a sense of the different **outcomes** that can result from different cues. Then, in their own classes, they can make conscious, informed decisions about cues they use to help students work well together.

Watch — Both Classes: (4 minutes) Play the next video segment. This one  includes both the video and audio for both classes, back to back.

Introduction. Common participant responses:

	Similar	Different
Verbal cues	Asking questions	(1) Noise level in the classroom - feels like Eric's is louder. (2) Orderliness - some may say Kristen's class was more organized. (3) Different kinds of ideas when the instructor left the group - what students were being asked or to be responsible for was different - in Eric's class they had to convince each other and move to another part of the task; in Kristen's class they had to figure out an answer.
Non-verbal cues	Using eye contact. Leaving the group.	(1) Eric has found at least one way to get people "up at the board" for all students in the room, simultaneously. (2) Eric seems rushed - may be useful to discuss the fact that Eric's class has 48 students in 10 groups (4 or 5/group), while Kristen has 36 students in 9 groups (2 to 5/group). (3) Kristen's repeated rolling/unrolling of paper. (4) Eric is physically part of the group - similar eye level (all standing), Kristen is looking down at students.

Discussion Questions:

1. Eric: "Is this everybody's graph?" promotes group ownership of work and conveys the message that they are expected to work together.
Kristen: Talking about "tools" promoted discussion in the group.
2. Standing: Eric could look around the room and see what each group was working on, getting a sense of the progress students made. The board created a shared space for the students to work and supported discussion of a group solution; standing discouraged students from working individually. Seated: Students could work on private solutions before sharing work with others, which may be more comfortable for some students.
3. Eric never answered a question from the group. Kristen's discussion of what tools the students had available to them seemed to help them make progress.

Activity 3: Compare

Introduction:

In this part, you will get to see the video again, this time with the audio accompanying it.

Watch — Both Classes:

As you watch and listen, make notes in the table below. This time pay particular attention to similarities and differences in how Eric and Kristen facilitate the group's discussion.

	Similarities	Differences
Verbal cues		
Non-verbal cues		

Discussion Questions:

Use your notes from the table above to answer the following discussion questions:

1. Considering all the non-verbal and verbal cues the two instructors used, which ones do you think were especially effective for promoting discussion in each case?
2. In Eric's class, the students were working on the blackboard and in Kristen's class they were seated at a table. Discuss the instructional advantages of arranging students in each of these ways.
3. Describe how the instructors addressed questions from students in groups. Did some approaches seem especially effective? How do you know?

Related Resources

- **Case: Inside the Group** — Provides opportunities to analyze how students interact with one another as they work collaboratively on a problem
- **Essay: Group Work** — Provides an overview/summary of research on approaches to groupwork and impacts on students
- **Emerging Scholars Programs (ESPs)** — Eric had extensive preparation for facilitating group work in ESP, a workshop-based approach to Calculus pioneered by Uri Treisman at UC-Berkeley and UT-Austin. More information about ESP is contained in the **Group Work Essay**

Extension activities

1. Hearing the videos first, then watching them later, what was your mental picture of the instructor? What was your image of the group arrangement? What things might you do in a class to arrange students in ways that make group work feasible?
2. After watching the videos with sound, what did you concentrate on more: the visual cues or the spoken language? What do you think your students concentrate on more? Have there been times when you used visual cues in your teaching that you felt were especially effective?
3. In Kristen's class, based on lines 14 to 23 of the transcript, how would you assess the student's understanding of taking an antiderivative thus far? How can you tell? Do you think Kristen's input helped the student understand the antiderivative? How do you know?

Eric's Class Transcript

Note: Students in this clip are identified by *S3*, *S4*, *S5*, and *S6*.

- 1 *Eric*: Ok, Um this is everybody's graph?
- 2 *Students*: Yes.
- 3 *Eric*: So if I asked any of you to explain this story to me, you'd be alright with it?
- 4 *S5*: Yes.
- 5 *Eric*: Why don't you start telling me the story.
- 6 *S4*: Ok so, ours is- initially we had two lines, a straight one and this one and we said that- that if the child is, is hoisting it up, it depends on what speed he's doing it at, if it's constant or not constant.
- 7 *Eric*: Ok. So is this graph, why don't you tell me [to *S3*], is this graph constant?
- 8 *S3*: Yeah.
- 9 *Eric*: So, this is a constant rate of um, of uh hoisting up the flag? (pause)
- 10 *S4*: No.
- 11 *S5*: No.
- 12 *Eric*: No?
- 13 *S5*: We're saying he got tired.
- 14 *Eric*: Oh.
- 15 *S6*: Actually, like, the child could tire out, because if it's an infinitely tall flag pole, the kid isn't gonna have the stamina...
- 16 *S5*: It's a really, a really big...
- 17 *Eric*: Ok. Why don't I come back in a minute and I'll ask you [*S3*] to make sure you agree with that. I mean it's ok to disagree, you can convince them of something else.
- 18 *Eric*: And when you're done convincing each other, start on this please.

Kristen's Class Transcript

- 1 Ted : ... power, like, there's some sort of constant in the front that's kind of..
- 2 Kristen: Yeah, that would make sense that it has to be x to the sixth cause then when you take the derivative, you lose a power.
- 3 T: Right. So it has to be - so that- the derivative would be equal to this and that So that's like the only thing you would know about this, is it's raised by the sixth power-
- 4 K (to Brad): So if your original, if your original function was x to the sixth, what's the derivative?
- 5 T: Six x to the fifth.
- 6 Brad: That would be six x to the fifth (pointing to $f(x)$, writes $f'(x) = 6x^5$), but-
- 7 T: Yeah, that's it, but it doesn't match up
- 8 K: So, so it's not quite-
- 9 B: [erases $6x^5$]
- 10 K: So you do you get rid of that x to- that 6 in front?
- 11 B: You, um, st- I don't know.
- 12 K: Well, so, x to the 6th was close. You want to still be thinking about those lines. But somehow you want to alter it a little. (pause) So how would you make-
- 13 B: (underlines 6) So, would you use a rule?
- 14 K: So, like how would you get rid of this 6? What would make it cancel out?
- 15 B: Divide by 6?
- 16 K: Good! What would happen if we divided the original one by 6?
- 17 B: Divide this by 6 (points to $g(x) = x^5$, draws bar under, and 6 below)?
- 18 K: Now what would the derivative be?
- 19 B: (pause) You would use one of the rules (points to the sheet of differentiation rules)?
- 20 K: Okay. So do that.
- 21 B: Like this one, use the quotient rule?
- 22 K: Sure, you can do that. That's a little more complicated than you need to do it. So remember, like, the 6 in the bottom, that's just a constant. (pause)
- 23 K: (to Ted) Do you know how to take the derivative of x to the sixth divided by six?
- 24 T: (laughs) Yeah.
- 25 K: So you have the tools.
- 26 T: Totally. I would just resort to the product rule, but that's a lot of work, but-
- 27 K: So go ahead-
- 28 T: I know how to use it-
- 29 K: It's a lot of work, but you can use it. So check.

This material is based upon work supported by the U.S. Department of Education FIPSE program, project number P116B060180. Any opinions, findings and conclusions, or recommendations expressed in this material are those of the authors and do not necessarily represent the official positions or policies of the funders; the reader should not assume endorsement by the Federal Government.