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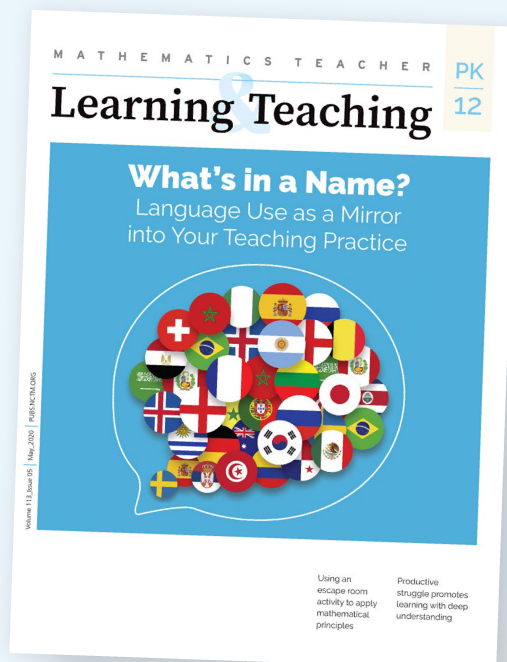
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Fostering Collaboration with the Flip

Encourage student collaboration in problem solving by altering the *who*, *when*, and *what* of the homework videos you use in flipped lessons.

Zandra de Araujo, Samuel Otten, Wenmin Zhao, Jessica Kamuru, and Jaepil Han

Teachers are increasingly adopting flipped instruction for individual lessons or even entire courses (Smith 2014). Typically, flipped instruction involves a teacher assigning videos for homework and then using in-class time for students to solve problems—that is, the settings for content delivery and completing assignments have “flipped.” We more broadly define a flipped lesson as any lesson that involves video or multimedia as the primary homework assignment. Mathematics teachers in our study told us that they adopted flipped instruction in hopes of meeting several different instructional goals (de Araujo,

Otten, and Birisci 2017a). One such goal was to free up in-class time to allow for more collaboration and discussions. Teachers also wished to have the class together while students worked so that the teacher (or peers) could provide support and to assure that any struggles were productive rather than frustrating. Teachers also noted that assigning videos for homework before an in-class lesson could provide students with some preliminary knowledge on which to build; it also might allow for personalized learning because students can then work at different paces or refer to videos as needed.

In studying a variety of flipped lessons, we found that teachers' goals of reserving more time for personalized learning and collaboration were not always met (de Araujo, Otten, and Birisci 2017a), partly because some of these goals were in tension with one another. Although flipped learning opportunities were personalized (e.g., students could watch videos at their own pace), students sometimes worked independently during class rather than talking collaboratively and building meaning together. Teachers sometimes felt separated from, rather than closer to, students as they worked. Ms. Schaefer, a pseudonym for one of the participant teachers in our study (de Araujo, Otten, and Birisci 2017a), shared her feelings about the loss of teacher-student interaction in her flipped lesson:

I feel like I am losing the connection with my students. When I was lecturing I could look around the classroom and see their faces to determine whether they were getting the concept or not. Now I just hope they get the concept or ask me if they are struggling with the material. (p. 67)

Even though teachers are present while students work, Ms. Schaefer's and others' flipped classrooms sometimes took on the feeling of a tutoring lab rather than a collaborative mathematics classroom. The collaboration that teachers had hoped for did not always occur.

One reason for this result was that teachers spent so much time creating videos that they did not have enough time left to prepare rich in-class tasks or plan for mathematical discussions (de Araujo, Otten, and

Birisci 2017a). Another reason was that the professional development that teachers receive related to flipped instruction tends to focus on videos rather than on the ultimate goal of building high-quality lessons that incorporate videos and in-class collaboration. Therefore, in this article, we present a few ideas for using flipped instruction to promote collaboration among students during flipped lessons.

RECONSIDERING FLIPPED INSTRUCTION TO PROMOTE COLLABORATION

When considering how to structure a flipped lesson to encourage students' collaborative participation in problem solving, we propose reconsidering the signature feature of flipped lessons: the homework video. In the following sections, we provide ideas for altering the *who*, *when*, and *what* of the videos that are used in flipped mathematics lessons.

Idea 1: Reconsider the *Who*

Often, teachers are the ones who create videos for their flipped lessons because they feel obligated to "teach" their students (de Araujo, Otten, and Birisci 2017a; Lo 2017). Creating their own videos allows teachers to personalize videos for their style of teaching and for their students. As we discussed above, however, teachers have limited time to plan for their classes. Creating videos can take a lot of time, leaving little time to plan in-class activities. Thus, we recommend teachers reconsider, at least some of the time, who creates the videos they assign so as to free up time to plan collaborative in-class activities.

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Literally thousands of free, online videos are available for most topics that teachers will teach. Of course, not all of these videos are well made, but some are. In selecting an existing video, the quality of a lecture video (de Araujo, Otten, and Birisci 2017b) can be determined by how well mathematical concepts are developed throughout the video, how the video's graphics are designed, and whether the video contains opportunities for student interaction during or after watching the video. High-quality lecture videos motivate and deliver mathematically coherent and correct ideas, contain logical placement of relevant information on screen, and include interactive elements such as opportunities for students to answer embedded questions (see video 1). Because our contention is that the productive use of in-class time is more important than the creation of personalized videos, teachers could consider using the above criteria to select or adapt premade videos, including videos developed by their colleagues, as a means of freeing up planning time. Working on an existing video or collaborating with a team could also lighten teachers' workloads so they can spend more time preparing for in-class activities.

Another way to rethink who creates flipped videos is to recognize that many students frequently create videos in their personal lives. This realization presents an opportunity to harness students' skills and enthusiasm by having *them* create videos to summarize what they learned from their in-class collaborations. For example, following a unit on fraction division (NGA Center and CCSSO 2010, NS.A.2), one teacher had her

students create videos that explained and illustrated fraction division. Students worked in groups to create videos and then commented on other groups' videos. The teacher then asked students to revise any unclear or inaccurate information in their videos in light of their peers' feedback. Experiences such as this one, in which students create videos to show their learning, allow teachers to see what students understand or have not yet grasped. In addition, allowing students to create their own videos can be a collaborative process that emphasizes "rough-draft talk" (Jansen et al. 2016). Mathematical ideas do not always need to be expressed perfectly the first time. As students are creating videos, they might draft a script, revise it, record, edit, and reedit, making ideas clearer along the way. This helps students embrace the inherent messiness of learning. Teachers can also strive to guide students' attention toward mathematical ideas, with an appropriate amount of creative production value. This iterative process encourages communication, creativity, learning from errors, and students' ownership of their ideas. Student-created videos might also be shareable with parents or on school district websites. Student-created videos are one way to conclude flipped lessons, but not only students can create these videos. Teachers can post concluding videos as well, which leads us to a reconsideration of *when* videos are assigned in a flipped lesson.

Idea 2: Reconsider the *When*

As described above, when working with flipped lessons, teachers typically assign lecture videos as homework before an in-class lesson and ask students to then further explore ideas from the videos in class. Nevertheless, one teacher we worked with had a different approach in which he assigned lecture videos *after* in-class lessons. He expected his students to be more involved in developing mathematical ideas and was committed to sharing authority over those ideas with his students. *After* students had explored and made sense of ideas through their collaborative discussions in small-group and whole-class work, the teacher assigned a video for students to watch as a way to formalize what they had investigated. The videos also introduced technical vocabulary or symbols students should know for the future. For example, rather than directly presenting students with the distance formula (NGA Center and CCSSO 2010, 8.G.B.8), a teacher could allow students to generate the formula by exploring vertical and horizontal distances between two points

Video 1 An Interactive Video on How to Represent Functions

LESSONS 4-2: RELATIONS & FUNCTIONS

GUIDING QUESTIONS:

1. What determines a function?
2. What are the different ways you represent a function? Which do you prefer?
3. How does the vertical line test help determine whether a graph is a function or not?

ENGAGE:

Functions can be represented many ways. A function is a relation where every input has exactly ONE output. Look at each situation on this page and determine if it IS or IS NOT a function. On the red check mark next to it to reveal the answer.

YES, this IS a function.
Each input (x-value) only has ONE output (y-value).

Time (hr)	Water Level (ft)
0	50
2	40
4	30
6	20

Number of Coins

Hours	Amount of Coin (in \$)
0	0
3	2475
5	4125
8	6600

Function Table

x	y
-2	1
-1	2
0	4
1	8
2	16

Function Table

x	-2	0	-2	-3
f(x)	5	8	11	14

Watch the full video online.

and then progressing toward oblique points (Matsuura, Sword, and Finkelstein 2017). After students have built meaning for their distance calculations, a video could be assigned to encapsulate the distance formula in its conventional form.

Using lecture videos as a conclusion, rather than as an initiation, to a lesson allows students to think and discuss among themselves first and can provide experiences for them so that videos, when they do watch them, make sense. This addresses one of the main challenges that Lo (2017) identified for flipped instruction—namely, that students are not prepared for and have difficulty understanding prelesson videos.

Concluding videos may also allow teachers to maximize students' investigation time in class. Although teachers will need to have collaborative discussions to connect and clarify students' ideas, follow-up videos can help summarize and formalize ideas for students at home so that teachers do not feel as though they must complete the entire summary before the end of the class period. Teachers can rely on videos to do summary work after class as students watch at home. The use of concluding videos in this way also positions videos as reinforcing what was learned in class, rather than as a be-all-and-end-all content delivery mechanism that is sometimes suggested by having all lecture videos assigned before in-class lessons.

Regardless of when a video is shown, we suggest intentionally building a classroom culture that supports critical arguments, collaborative problem solving, and ongoing mathematical discussions. If a video is not helping teachers achieve these goals, then perhaps the video was delivered at the wrong time. Or perhaps it is simply the wrong type of video, which brings us to our final recommendation.

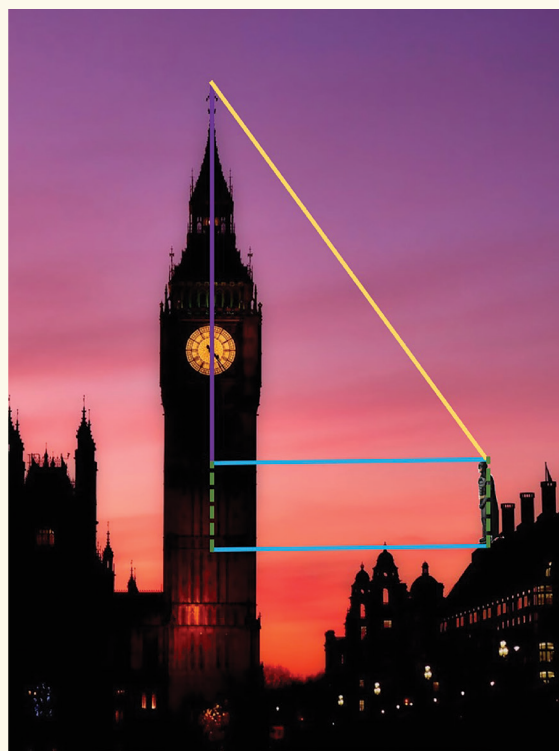
Idea 3: Reconsider the *What*

As we discussed above, flipped videos are typically lecture videos (de Araujo, Otten, and Birisci 2017c), which commonly replace in-person lectures and therefore focus on delivering content to students. Although these videos are useful, they do have some drawbacks. One drawback for teachers who plan to use inquiry-oriented activities in class is that lecture videos give away the outcome of the inquiry. In cases such as this, the use of lecture videos before an inquiry activity may decrease students' desire to collaborate on such activities because students who watched the video will likely feel as though they understand the objective of the inquiry before

completing the lesson. Rather than being confined to videos that deliver content (i.e., lecture videos), teachers might reconsider the purpose of videos.

Several teachers in our study have reimagined flipped videos as *setup/motivation videos* (de Araujo, Otten, and Birisci 2017c). These types of videos provide a context that sets up subsequent in-class activity. For example, a teacher could assign a video as homework that shows Batman using his grappling hook to travel between buildings. After students have watched the video, the teacher could ask students to create questions they could investigate related to the given situation. In this example, questions might include “What is the shortest distance Batman would have to travel to get from the building to the top of the clock tower?” (grades 6–12) or “How might we measure the distance Batman went?” (K–grade 5). Then, students could work in groups to determine what data they would need to calculate the distance (see figure 1). In this case, the video served as motivation for the next day's investigation.

Fig. 1



This is an example of a setup video.

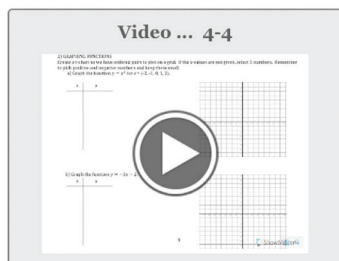
Fig. 2

LESSONS 4-4: GRAPHING FUNCTIONS**GUIDING QUESTIONS:**

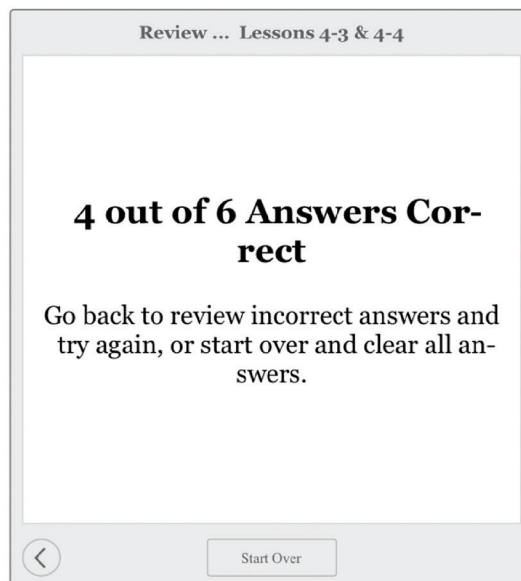
1. How can you use a t-chart to help you graph a function?
2. After a t-chart is created, what steps do you need to take to get the graph created?
3. How can you determine if a graph is a linear function or a non-linear function?
4. What are the essential pieces to have labeled/drawn on your graph when graphing a function?

EXPLAIN:

Here is an explanation of how to graph functions. Sometimes the input values will be given, sometimes they will not. You can always choose any values for the inputs. Make it easy on your self by choosing smaller numbers. Be sure to include both positive and negative numbers as well.

**EVALUATE:**

To see if you understand a few of the basics, take this 6 question review.

**EVALUATE:**

When you are ready, please take your quick check!



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An excerpt from an iBook (Maynard 2015, p. 8) contains text, video, and embedded questions.

In addition to setup/motivation videos, teachers might also consider embellishing their lecture videos with interactive features (e.g., Lim and Wilson 2018). Many forms of interactive features are freely available online. One teacher we interviewed made iBooks (a digital book format) that included videos as well as a range of interactive features such as quizzes and applets (see figure 2 and video 1). Students were able to work through the iBooks at their own pace and know the overarching goals of the lesson by reading the “Guiding Questions.” The iBooks also included embedded “Quick Check” items (the green part of figure 2) that students submitted digitally, allowing the teacher to see their responses. The teacher had students investigate their quiz responses in small groups the next day. Used in this way in conjunction with lecture videos, interactive features foster a more active experience and more

accountability for students at home. In addition, teachers can then plan collaborative activities that center on students’ responses or investigations for subsequent in-class meetings.

FINAL THOUGHTS: VIDEOS SHOULD SERVE PRODUCTIVE IN-CLASS ACTIVITIES

In this article, we discussed alternatives to ways teachers typically use videos in flipped lessons. Our overarching goal was to maximize students’ opportunities to collaborate in class (see table 1). By reconsidering the *who*, teachers can free up planning time for themselves or they can give students more authority over their learning. By reconsidering the *when*, teachers can use in-class time for rich collaborative investigations that are then formalized by videos. Finally,

Table 1 Summary of Considerations for Video Use to Encourage Collaboration

	<i>Who</i>	<i>When</i>	<i>What</i>
Typical Flipped Lesson Videos	Teacher-made	Before in-class lessons	Lecture/content delivery videos
Possible Alterations to Flipped Lesson Videos	Premade or student-made	After in-class lessons	Setup/motivation and interactive videos

by reconsidering the *what*, teachers can use videos to motivate subsequent investigations.

In-class learning time is at least as important as, and likely more important than, time spent outside of the classroom (de Araujo, Otten, and Birisci 2017a). Students benefit from working with peers to engage

with mathematical material (Moore, Gillett, and Steele 2014). As mathematics teachers plan and implement flipped lessons, rethinking the *who*, *when*, and *what* of flipped videos will not only free up teachers' planning time, but it will also increase their in-class time for more collaborative activities. [___](#)

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