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Interactive Videos and ”In-Class” Activities in a Flipped Remote Dynamics Class

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Interactive Videos and "In-class" Activities in a Flipped, Remote Dynamics Class

Abstract

Flipped classes are relatively common in the engineering education community. In a flipped class, the lecture content is typically delivered asynchronously via videos, and the in-class activities are ideally redesigned to be more active. Due to COVID-19, many classes have become entirely remote. With classes no longer meeting face-to-face, what should the "in-class" portion of a flipped class look like? In this paper, I will discuss a flipped, remote dynamics class. Videos of lectures and example problems were watched by the students before the class met synchronously via Blackboard Collaborate during the regularly scheduled class times. In particular, I will present ways to enhance the out-of-class videos using embedded questions and the strategies that were used to engage students during class including activities such as grading the completed homework assignment, concept questions, and breakout rooms to work on the next homework assignment. Assessment data on students' perceptions of the class and which activities were most beneficial in the flipped, remote environment will also be presented.

Introduction

In spite of the prevalence of faculty members using a flipped classroom, there is a lack of consensus on what exactly constitutes a flipped (or inverted) classroom [1]. One definition of a flipped class is provided by Lage et. al. [2]: "Inverting the classroom means that events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa." For the purposes of this paper, I am defining a flipped classroom as one where the activities that used to take place in the classroom have been put online as videos and the in-class portion of the class is now focused on active learning activities. A summary of flipping classes in engineering and the type of activities used in-class is provided in Ref. 2. These redesigned in-class activities used by faculty members flipping their face-to-face classes include small group activities and working in teams on homework [1]. There have been a number of papers focused on flipped classes in dynamics [3-7], with the earliest paper on flipping dynamics dating from 2007 [3]. All of these papers discuss traditional ways of flipping a face-to-face course. Not discussed, however, is what should the active learning activities be in a flipped, remote class. Last semester at the United States Air Force Academy, I explored this question using a flipped, remote dynamics class. Videos of lectures and example problems were watched by the students before the class met synchronously via Blackboard Collaborate during the regularly scheduled class times. Each class was structured to have both in-class and out-of-class activities as shown below:

<u>Out-of-class activities:</u>

- A video lecture explaining technical material with a notetaker (i.e. a handout with blanks).

- Two videos of example problems with notetakers.
- An optional LearnSmart reading assignment using McGraw-Hill Connect.
- An optional practice problem in Connect.
- A homework assignment.

In-class activities using Blackboard Collaborate:

- A quick review of the key points in the video lecture.
- Explaining the homework solution and having students grade their own homework.
- One or two concept questions where I would present a multiple-choice question and students would choose an answer using the polling feature in Blackboard Collaborate. We would discuss the question after everybody in the class had answered it and the results had been shared with the class.
- Breakout rooms for the students to start the next homework assignment. They were encouraged to have the problems available before class in an electronic form (which was relatively easy since we were using an e-book for the class), so that when they were in breakout rooms, one student could upload and share this document with the group. Each student could then write on the uploaded document. Instead of doing this, most of the students just worked on the virtual whiteboard in the breakout rooms.

Objective

The primary objective of this study was to determine which of the activities in a flipped, remote dynamics class were most effective, in the students' opinions, in helping them master the course material. A secondary objective was to identify strategies for modifying or enhancing the activities to make them more effective. This information will be beneficial to faculty members who teach dynamics, or other technical courses, in a flipped, remote environment, both at the United States Air Force Academy and at other institutions.

Methods and Procedures

During Fall 2020, there was a single section of ME320: Dynamics with 28 students and one instructor. All of the course components were delivered through Blackboard. The class met a total of 40 times with each meeting lasting 53 minutes. Two short, optional questionnaires were posted on Blackboard the last week of class as part of normal course feedback. A total of 15/28 (54%) students completed each anonymous questionnaire. The first questionnaire provided feedback on the various components of the course, including out-of-class and in-class activities. The second questionnaire provided feedback on two interactive videos (with embedded questions) that were intended to help students review for the final exam. It was not possible to compare the performance of students taught in the remote flipped environment to students taught in a face-to-face environment since this was my first time teaching this course at this university.

Discussion and Results

To assess the various elements of the course described in the introduction, students were asked to complete an optional, anonymous questionnaire. The first section was focused on out-of-class

activities. Results from the question, "How carefully did you read the assigned section of the textbook before class?" are shown in Figure 1. Consistent with the author's experience teaching dynamics for over 30 years, over 66% of the students admitted they never read the book or only skimmed it.

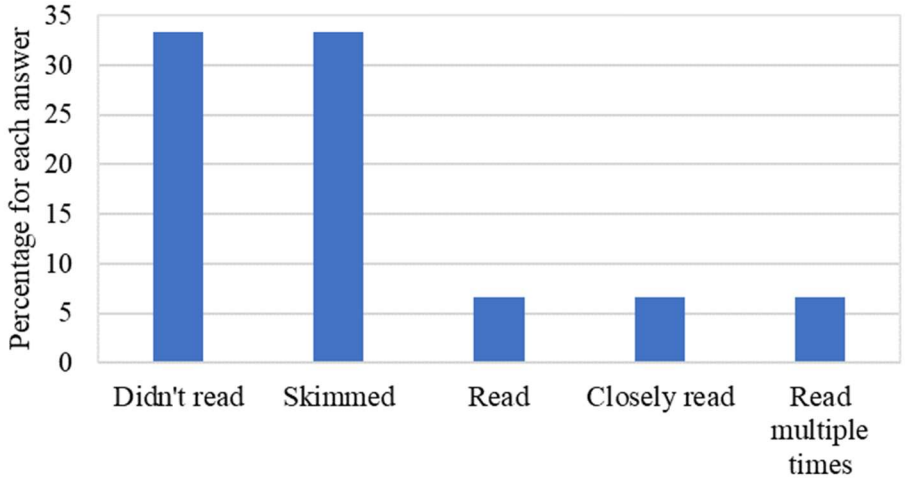

Figure 1 – Results from the question "How carefully did you read the textbook?"

Students were also asked to evaluate the LearnSmart reading assignment and practice problems administered using McGraw-Hill's e-platform called Connect. Results from the questions "Did you do the optional LearnSmart reading?" and "Did you do the optional problems in Connect?" are shown in Figures 2 and 3, respectively. These assignments were made optional after the first few lessons based on student feedback. Some students indicated that the time required to complete the out-of-class activities was excessive, and they felt that these two assignments did not add much value. The fact that these assignments were optional probably explains why over 73% of the students never or rarely did the LearnSmart reading and over 66% of the students rarely or never did the optional problems in Connect. When students were asked why they did not do these assignments, the two most popular answers were "I did not find them helpful" and "I did not have the time."

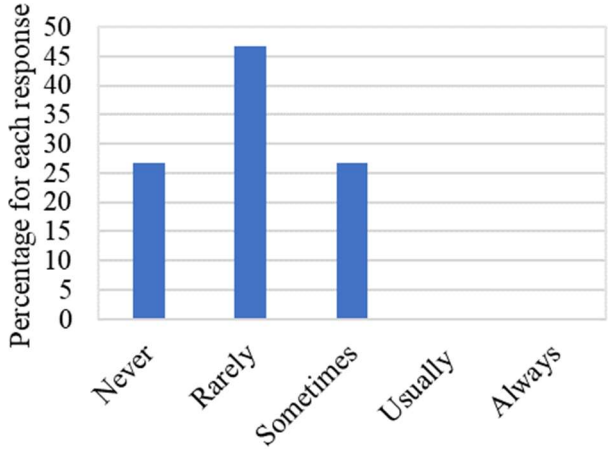

Figure 2 – Results from the question "Did you do the optional LearnSmart reading?"

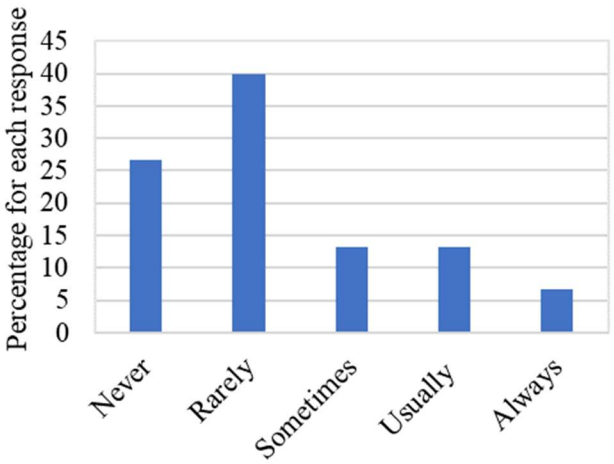

Figure 3 – Results from the question "Did you do the optional problems in Connect?"

There were usually three videos posted for each day's lesson. One video was a lecture over the technical material, and the other two were example problems. The videos were typically 7 to 10 minutes long, but some of the sample problems were as long as 15 minutes. Students were asked "Did you watch the videos before class?" and "In terms of learning the material, how helpful were the videos?". The responses to these questions are shown in Figures 4 and 5, respectively. As seen in Figure 4, 100% of the students said they usually or always watched the videos before class and over 93% said the videos were helpful or very helpful in terms of helping them learn the material.

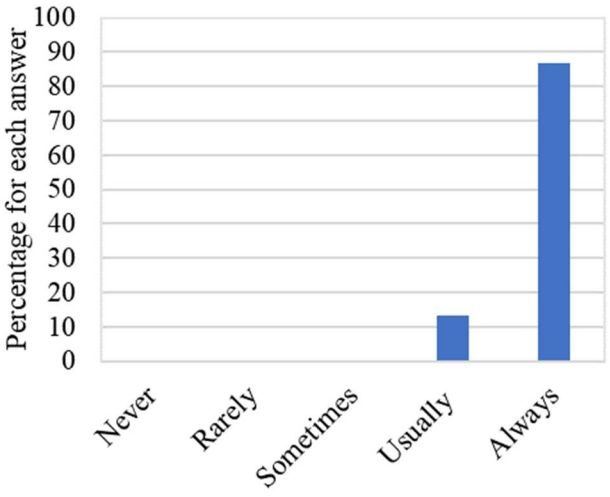

Figure 4 – Results from the question "Did you watch the videos before class?"

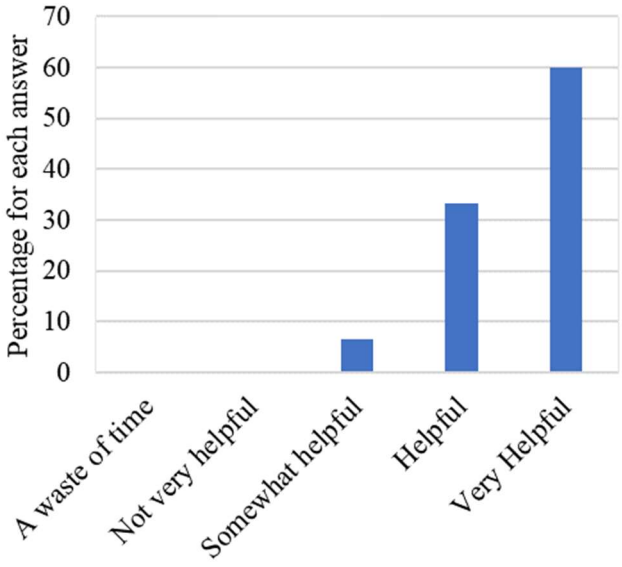

Figure 5 – Results from the question ""In terms of learning the material, how helpful were the videos?"

To help engage the students while watching the videos, and so they would have a neat set of notes, a notetaker was provided. For the lecture material, this consisted of a copy of the PowerPoint slides with blanks for students to write in key equations. For the example problems, the notetakers consisted of the problem statements and room to write down the solution from the video. Students were asked "Did you fill out the notetakers when you watched the videos?". The results from this question are shown in Figure 6. Although 80% said they did fill out the notetakers while watching the videos, it was surprising to learn that over 12% never or rarely filled out the notetakers.

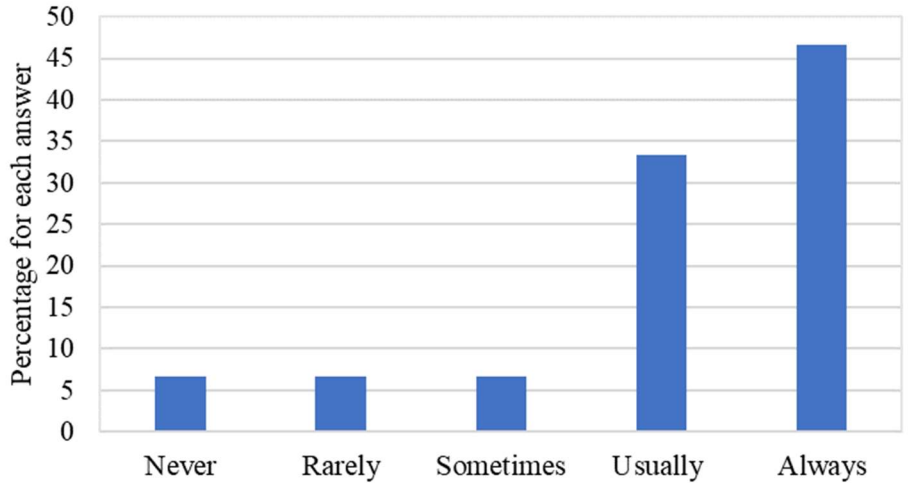

Figure 6 – Results from the question "Did you fill out the notetaker when you watched the videos?"

In addition to asking students about the out-of-class activities, I also asked them to evaluate the in-class activities. As mentioned in the introduction, the in-class activities included a quick review of the lecture material, grading the homework, concept questions, and breakout rooms. Figure 7 shows the responses to the question, "In terms of learning the material, how helpful was the quick review at the start of class, grading the homework, concept questions, and breakout rooms?" In general, all of these activities were viewed positively except the breakout rooms. Almost 67% of the students said the review at the start of class was helpful or very helpful. This review was typically just one slide with the key ideas from the lecture. About 80% of the students indicated that grading their homework was helpful or very helpful. For this part of the class, I would show my solution and then discuss how they should grade their own homework. Each problem was graded on a 10-point scale. I showed my solutions (rather than the solution manual solutions) in order to model the level of documentation and the problem-solving approach I expected them to use. Typically, I included one to three concept questions after grading the homework. These questions came either from the textbook or from the Concept Warehouse [8]. To administer the concept questions, I used the polling feature in Blackboard Collaborate. Students were asked to answer the questions individually, and then after sharing the results for the class, I would discuss the answers with them. This was a great way of making students aware of their misconceptions about dynamics concepts and helping them improve their intuition. Over 93% of the students indicated these questions helped them learn the material.

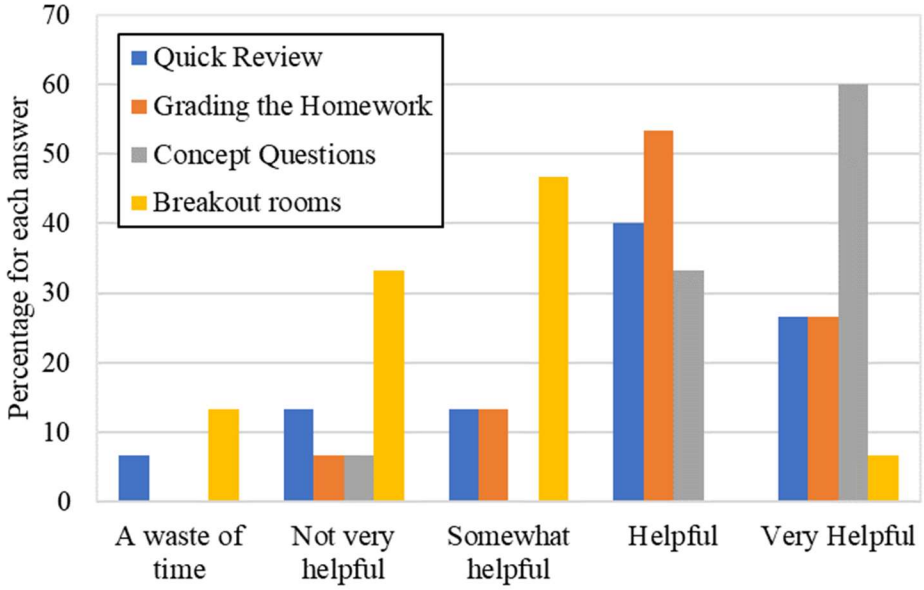

Figure 7 – Results from the question "In terms of learning the material, how helpful was the quick review at the start of class, grading your homework, concept questions, and breakout rooms?"

The element of the in-class activities that over 46% of the students said was "a waste of time" or "not very helpful" was the breakout rooms. Only one student who filled out the questionnaire indicated that they were "very helpful." The breakout room was intended to be a replacement for the group work that I would have used in a face-to-face flipped class. Based on student comments, the primary challenges with the breakout rooms were:

1. Some students did not all participate, and it was difficult for me to monitor the activities of all the rooms. It is much easier to look around a face-to-face class to see if everybody is participating in the group work.
2. The whiteboard in the breakout room was hard to use. Very few of the students had tablets, so they needed to write on the whiteboards using their computer mice.
3. In some rooms no one uploaded a copy of the homework problem statement so everybody could see the problem that they were working on.

In the comments, some students indicated that they felt that the breakout rooms should be optional or that they should be able to select the students in their breakout room. Unfortunately, there was not a convenient way of assigning specific students to specific breakout rooms, so each room was a random group of 3 students (typically). Students provided no actionable suggestions on how to improve the breakout rooms. After teaching this class, an article in the Chronicle of Higher Education [9] on maximizing the efficacy of breakout rooms was brought to my attention. It included useful suggestions such as assigning roles to students in the breakout rooms and making sure they use shared documents.

Of these in-class and out-of-class activities, students were asked to rank the top three activities that were most helpful in their learning of the material in this class. The list of activities they had to rank were:

1. Reading the book
2. LearnSmart readings
3. Connect pre-class practice problems
4. Videos
5. Concept questions
6. Homework grading
7. Doing the homework

The results from this ranking are shown in Figure 8. The activities that were most often in the top three were the videos, doing the homework, and the concept questions. The two activities ranked number 1 in terms of helping students learn the material were the videos (69%) and doing the homework (23%). The top item ranked number 2 was doing the homework. If the top three activities are lumped together, the most helpful activity for learning the material was doing the homework, followed by the videos, and then the concept questions.

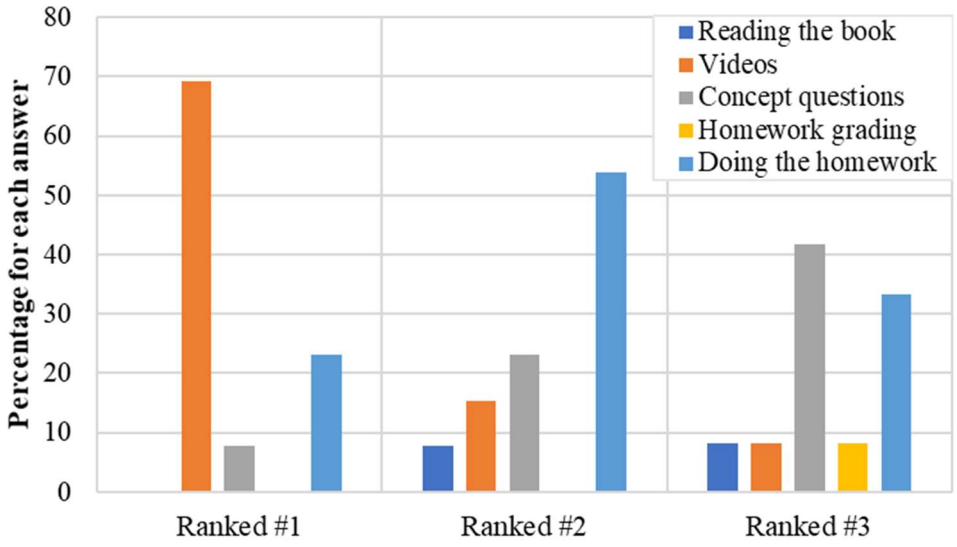

Figure 8 – Results from ranking the top three activities that students found helpful in learning the material.

Finally, students were asked to provide feedback on two interactive videos that were posted to help prepare students for the final exam. I called these "What Strategy?" videos. In these videos, students were presented with a problem out of the textbook, and they were asked to identify the appropriate strategy or strategies to use to solve the problem, choosing from the following four options:

1. Newton's 2nd law
2. Work-energy
3. Impulse-momentum

4. Kinematics only.

If a question required more than one principle, they needed to select all that applied. Some problems had follow-up questions, such as "What coordinate system would be most appropriate?" They could not continue watching the video until they answered the question. Figure 9 shows the results from asking the students, "How useful were the 'What Strategy' videos?" All of the students said they were at least "somewhat useful," and over 85% said they were "useful" or "very useful," When asked if these types of videos should be included in the next edition of the textbook, over 85% said "yes." Students were also asked to write responses to the question, "How could I improve these videos?". The most common comments were that the videos were "good" or "helpful," but there were very few suggestions on how to improve them. One student suggested making them shorter, another wanted more complicated problems, and finally, one student asked for them to be even more interactive.

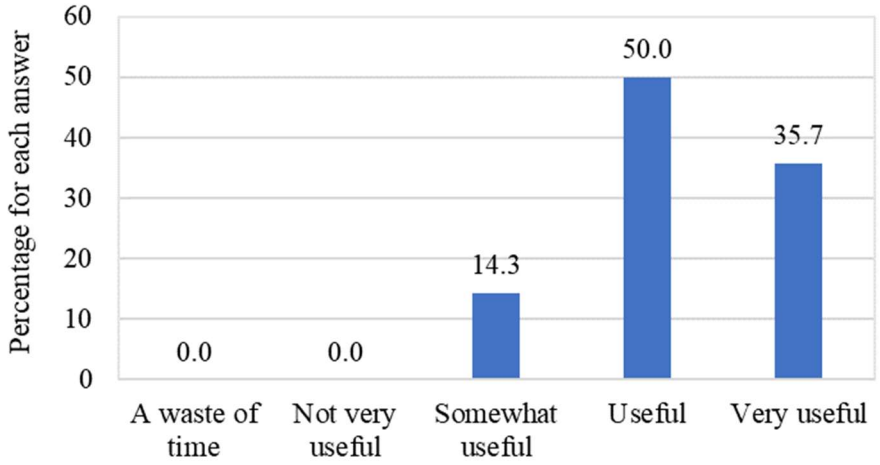

Figure 9 – Results from the question "How useful were the 'What Strategy' videos?"

Future changes

Based on the student responses to the questionnaires, the main activity in the course that need to be improved are the breakout rooms. In the future, I plan to give more instruction on their use, such as how to effectively work on the whiteboard and how to upload documents into Blackboard Collaborate. I will require one student in each breakout room to upload a pdf of the homework problem they are working on so that everybody can see it and everybody can write on it as they discuss how to solve it. I also intend to create more "What strategy?" videos to be used before exams and some interactive sample problems with embedded questions.

Conclusions

In this paper, I have discussed a flipped, remote dynamics class. Out-of-class activities included watching videos of the lecture and example problems, completing a notetaker, optional LearnSmart reading and Connect practice problems, and a homework assignment. In-class activities included a quick review of the lecture, grading the homework, concept questions, and

breakout rooms where students started the next homework assignment in groups. Interactive "What strategy?" videos were also used in the course. The assessment data on students' perceptions of the remote-flipped class indicate that the three activities that best helped them learn the material was doing the homework, the videos, and the concept questions. The activity that was viewed most negatively was the breakout rooms.

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