Full Flip, Half Flip and No Flip: Evaluation of Flipping an Introductory Programming Course

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Abstract

While some research has suggested that video lectures are just as effective as in-person lectures to convey basic information to students, not everyone agrees that the flipped classroom model is an effective way of educating students. This research explores traditional, semi-flipped and fully-flipped classroom models by comparing three sections of an Introduction to Programming (Java) course that were taught at the same institution in Spring 2015 by three different instructors using three different paradigms. The data and observations collected suggests that incorporating in-class activities improves student satisfaction but a semi-flipped classroom, including in-class activities, some outside-class lecture videos, and some in-class lectures, may generally provide the best overall experience for the students. However, while students may be more satisfied and get more programming practice in a flipped paradigm, overall student performance did not appear to be greatly impacted.

Keywords: Flipped Classroom, Inverted Classroom, Java, Introduction to Programming, Information Systems Education

1. BACKGROUND

The flipped classroom is an alternate teaching methodology being used in some high schools and college classrooms as a means of increasing student engagement and academic performance (Clark, 2015; Danker, 2015; Gunyou, 2015; Strayer, 2012; Vaughan, 2014). The flipped method operates by altering the traditional model of conducting lectures in the classroom, to one where lecture materials are distributed to students for their study outside of the regularly scheduled class meeting times, leaving in-class time for activities such as homework assignments. Lage, et al. define the flipped/inverted classroom as one in which the "…events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa" (2000, p. 32). Scheduled class times then involve students working individually or in groups, with computer and video technology on activities and assignments pertaining to the course subject matter (Bishop & Verleger, 2013; Clark, 2015; Gaughan, 2014; Herreid & Schiller, 2013; Vaughan, 2014). Findlay-Thompson & Mombourquette (2014, p. 64) argue that "a flipped classroom is most commonly described as

a reverse teaching model where the teacher uses various forms of technology such as videos to record the normal classroom lectures and students are required to view these recorded lectures outside regularly scheduled classroom time. This allows for the homework portion, or other interactive activities, to be completed within the classroom setting." Similarly Bishop & Verleger (2013, p. 4), suggest that the flipped classroom can be considered "an educational technique that consists of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom."

Prior research has suggested that video lectures are just as effective as in-person lectures to convey basic information to students (Zhang, Zhou, Briggs, & Nunamaker, 2006). Therefore, some believe that using class time to reiterate textbook material is not the most effective use of class time and may only encourage students to skip the reading entirely. There is an increasing number of faculty at various secondary schools and colleges that realize that the traditional lecture style of teaching has been ineffective in meeting the educational needs of students (Clark, 2015; Gunyou, 2015; Vaughan, 2014).

Researchers have reported a variety of positive aspects to the flipped model (Saulnier, 2015), especially in courses that can utilize lecture time for computer-based activities (Frydenberg, 2013). However, some research indicates that there are some potential negative aspects (Strayer, 2012) where students reported feeling lost and "…were more likely to disengage with the material sooner than students in the traditional class-room" (2012, p. 189).

2. INTRODUCTION

This research explores the impact of three different teaching models (traditional, semi-flipped and fully-flipped classroom) in an Introduction to Java programming course. This course is required in our Computer Science major as well as our Computer Science and Information Systems minors. Each course section meets for 3 hours per week in a lecture room (32 students max) and smaller groups (16 students max) meet for 2 hours per week in computer labs to complete programming activities. This research focuses on changing the lecture format. The labs were identical for all sections.

Three sections of the Introduction to Programming course were taught at the same institution in Spring 2015 by three different instructors; hereafter referred to as instructor T (Traditional course), instructor S (Semi-flipped course), and instructor F (Fully-flipped course). The formats were selected by the instructors strictly based on preference. Instructor F had never taught this particular course in a traditional format but had previously taught the course in a fully flipped format and had already developed lecture videos. Therefore, it was logical that instructor F teach the course in a flipped format again. Instructors T and S had both taught the course previously in a traditional format but instructor S was interested in trying the flipped format in combination with some traditional lecturing. This led us to a unique situation in which the three course sections in the same semester were offered in three different teaching styles.

Since instructor F had taught the course most recently, it was agreed that all sections would use instructor F's course schedule so that exams, lab practical exams, and homework assignments could be similar across the sections. Unlike previous offerings of the course, students were allowed to select any lab/lecture combination. This meant they did not necessarily have the same lecture instructor as they did for lab. Tests were given during lab time to give students enough (and equal) time to complete the test (2 hours), since two sections had lectures twice a week (85 minutes each class session) and one (instructor T) met three times each week (60 minutes each class session). This made it critically important that all sections of the course stay on the same schedule, covering the same material at the same time.

The exams and lab practical exams were developed collectively among the instructors and were all very similar but not identical since the students were not all taking them at the same time. The five homework assignments and the final exam were also developed collectively and were identical for all sections of the course. The first homework assignment was similar to the in-class activities, including several small exercises to practice basic skills. The last four homework assignments were larger projects that allowed students to use the knowledge they gained to develop working games.

Students were unaware of the format differences prior to the start of the class so there was no self-selection for a particular teaching style during registration. Additionally, no students changed sections after the classes began.

3. METHODOLOGY & FINDINGS

Traditional Classroom (T)

Instructor T planned on delivering traditional PowerPoint and whiteboard-based lectures, with some class discussion and quizzes each week based on the text readings. Since no in-class activities were planned for this section of the course, Instructor T was not assigned any teaching assistants (TA's). Instructor T's section included 13 students with 8 CS majors, 1 CS minor and 1 Physics/Computational Science major.

About three weeks into the course, a major problem emerged: since most of the class time was spent on lecture, material was covered much faster than the fully- and semi-flipped lecture sections. Instructor T was already a chapter and a half ahead of the other sections and it was impossible to proceed at this pace since all instructors agreed ahead of time to give our students the same exams and the same labs.

Initially, the students seemed to be comfortable with the pace of the traditional course – two of the 13 students had a Java class in high school. However, the quiz results were disappointing – probably because students were not doing the reading assignments.

Before this semester, instructor T felt that students were getting enough practice programming through the labs and the five programming assignments given throughout the semester. Instructor T was compelled to shorten the lecture component and add a programming activity to each class session – this is what enabled the course to synchronize with the other course sections. While every student owned a laptop, sometimes they forgot to bring them or their laptop was being repaired. Fortunately, the department has five "loaner" laptops readily available.

The first in-class programming activity was end-of-chapter exercises as sometimes employed by the other instructors, but instructor T designed the rest to match the important points presented during the shortened lecture. Some activities built upon previous activities. All of the students immediately liked the programming activity, (student survey indicated 9.75 out of 10 – *strongly agree* that "in-class programming exercises improved my comprehension of the course material") even staying after class to complete them, and instructor T could give immediate help to struggling students. Students indicated that these should have counted for more of their grade, and instructor T agrees.

Another successful class activity was to play "The Good, the Bad, and the Ugly." The instructor selected excellent programs from labs or programming projects (the good), programs that did not work or had major problems (the bad), or mostly worked but were inefficient or hard to follow (the ugly). Student's names were removed from the code. The programs were projected on the screen, and students were invited to choose what category each example was from. The class would discuss why it was in that category, and explore ways to improve the code. Students actually requested this activity several times.

In previous semesters, there were a few students that failed to hand in programming assignments, usually resulting in lack of engagement and poor grades. To remedy this problem, instructor T would allow students to start their projects in class in place of the regular programming activity. This enabled instructor T to answer questions about the project that students encountered as they began coding. This resulted in less panicked students coming to office hours the day before the project was due, resulting in less stress for all involved.

A downside to having to readjust lecture time for programming activity was that the lectures were not as organized as they could have been; as recorded lectures for flipped classes tend to be carefully structured. However, it was liberating to be able to (mostly) abandon the slides and concentrate on key concepts.

In the future, instructor T plans to add in-class programming activities to other programming courses, along with fill-in worksheets to guide note taking during lectures.

While the traditional section did include the activity-based learning associated with a flipped lecture, this section did not include the video lectures of the fully- and semi-flipped sections, which enabled instructors S and F to devote even more lecture time to activities. Table 1 compares student evaluation scores for the last time instructor T taught the course (i.e. Fall 2005) versus the recent (i.e. Spring 2015) course. Instructor T did not teach this course between those two semesters (a 10 year gap) and thus, did not have the opportunity to refine or improve the course.

Measure	S 2015	S 2005
Classes helpful	7.8	6.8
Classes interesting	7.5	6.7
Course rating	8.1	6.8

Table 1. Instructor T Student Evaluation Scores

Semi-Flipped Classroom (S)

In 2010, instructor S was not satisfied with his student evaluations from this particular course and wished to improve student engagement. However, instructor S could not devote the time necessary to entirely flip the course and sought to create one video and in-class activity each week.

Instructor S's section included 33 students with 24 CS majors, 3 CS minors and 6 IS minors. This section's lecture was scheduled on Tuesdays and Thursdays for 85-minute sessions.

Instructor S narrated and produced videos using Camtasia that included the presentation of lecture slides and code demonstrations related to the assigned textbook reading for the week. While the videos were designed to represent what might happen in a single 85-minute lecture session, editing out pauses and the lack of student interaction allowed the information to be presented more efficiently in videos that ranged from 24 minutes to 50 minutes (45 minutes on average). Typically, the videos would be posted to the course website the Friday before a Tuesday activity session.

The instructor was able to create 9 videos and 10 in-class activities. During 10 of the 13 Tuesday lecture sessions, students were required to bring a laptop computer to take an online quiz using the Blackboard LMS and then complete a programming activity based on the reading assignment and video posted on Friday (see Appendix A for sample quiz questions and activity instructions). Students were asked prior to the first class if they had a laptop available to bring to class. All students reported that they did.

Each quiz consisted of 10 questions (mostly multiple choice). Students were given 10 minutes to complete the quiz then immediately begin a programming activity designed to fill the remaining 75 minutes of class time. The activity included a deliverable (typically a small working program) submitted to the LMS. The instructor was assigned two undergraduate teaching assistants with Java programming experience to help answer students' questions. During the semester, instructor S deployed 9 videos and administered 10 quizzes and 10 activities. During one week, the quiz and activity was based on the reading, as the instructor could not deploy a video in time. Three Tuesday lectures were used to review for exams or to give students special help with homework.

On Tuesday activity sessions, the instructor would use the podium computer and the LMS to monitor students' quiz grades as they were completed. Two to three quiz questions were designed to be trivially easy for those who watched the video. If a student got all the trivial questions wrong, the instructor would dismiss the student to a nearby lounge to review the reading and re-watch the video. Three students were dismissed twice in the first three weeks of the course. By the fourth week, these three students were getting the trivial questions correct. Two additional students were dismissed just once early in the semester. In general, the quiz setup proved valuable in immediately identifying students who were not watching the videos and helped correct this deficiency in a positive way. Students who did poorly on the quizzes were dismissed and lost valuable lecture activity time to get help from the instructor and student assistants. However, as long as students returned in a timely fashion, worked until the end of the period and submitted the activity by the next lecture period (Thursday), no penalties were given.

Thursday sessions were used for traditional lecturing, which instructor S used exclusively when teaching the course in Fall 2010. Traditional lecturing includes the presentation of lecture slides and programming demonstrations. By replacing 10 out of 25 (40%) lecture sessions with activities, instructor S yielded improvements in student evaluations. Table 2 compares student evaluation scores for the last time instructor S taught the course (i.e. Fall 2010), which was in a traditional format, versus the recent (i.e. Spring 2015) semi-flipped course. Instructor S did not teach this course between those two semesters. This change in student evaluation scores is the most significant improvement instructor S has achieved in 12 years of teaching. It is unlikely that such improvement is the result of simple instructor maturation.

Measure	S 2015	F 2010
Classes helpful	9.1	8.3
Classes interesting	8.9	7.5
Course rating	9.4	7.4

Table 2. Instructor S Student Evaluation Scores

In addition to these improvements, a majority of the semi-flipped classroom students agreed (9.2/10 on Strongly Disagree to Strongly Agree Likert-scale) with the statement, *I like the*

"flipped classroom" teaching model. i.e. Watching the lecture videos outside of class and spending more class time doing team exercises. One student commented "I really found the video/activities helpful" (see Appendix A, Table I for complete comment summaries). But, not all students prefer the format (see Appendix A, Table II). One student stated "I really did not care for the videos at all. They really were just difficult to focus on and weren't very helpful." A vast majority of the 33 students strongly agreed (9.5/10 on Strongly Disagree to Strongly Agree Likert-scale) with the statement: *The in-class programming exercises improved my comprehension of the course material.* Not surprisingly, students tended to disagree (5.3/10 on Strongly Disagree to Strongly Agree Likert-scale) with the statement, *Prefer normal course over flipped*.

Fully-Flipped Classroom (F)

The fully-flipped section had 16 students, only 4 of which were CS majors. The instructor had created 54 lecture videos, each of which is approximately 10 minutes in length. The lecture videos were created using Camtasia. The videos included lecture narration of PowerPoint slides, coding demonstrations in BlueJ, and interactive quizzes. The quizzes did not count towards the students' grades; their purpose was to help the students assess their understanding of the concepts as they progressed through the videos. The flipped section's lecture was scheduled on Mondays and Wednesdays for 85-minutes each session. Before each class, students were required to watch ~2 lecture videos and read the related textbook sections. Finally, in addition to their textbook, students were required to bring a laptop to class. Similar to the semi-flipped section, students were asked prior to the first class if they had a laptop available to bring to class. All students reported that they did but again the department had "loaner" laptops available.

Instructor F used two techniques to strongly encourage students to watch lecture videos. First, students were required to enter their name and email address in order to watch the lecture videos. The instructor was then emailed a detailed report as to how much of the content each student watched. Students can play the video in the background and turn the sound off so certainly this is imperfect. Secondly, the videos contained secret phrases, which had to be submitted via a Blackboard quiz. The phrase could be given verbally or written on the slides and could change several times throughout the video; the intent being to check if students were actually paying attention to the video. Of course, students could share the phrase with each other so this is not foolproof either.

Each class session would begin by instructor F soliciting the students for questions regarding the lecture video and readings, which typically took only a few minutes. Once all questions were answered, the students took a short online quiz (via Blackboard LMS) to assess their knowledge based on the lecture videos and readings. Quizzes were automatically graded and solutions were given by the LMS. Students were encouraged to ask questions regarding the quiz. Quizzes were fairly low-stakes, similar to Bormann (2014). The quizzes only counted for 10% of their final grade and the 3 lowest quizzes were dropped. However, students were unaware that quizzes would be dropped until the last 2 weeks of the semester. The intention was to motivate them to watch the lecture videos and learn from the mistakes they made in the quizzes.

After completing the quiz and getting answers to their questions, the students would begin the in-class activity. The class activities were directly related to the concepts covered on that day's lecture videos and readings. Students were encouraged to work with their fellow classmates as they worked through the in-class activities. In addition to the instructor, a sophomore TA, that had taken the course last year, was available to help answer questions during class. The TA would complete the in-class activities a day or two before each class to prepare. Both the instructor and the TA would move about the room answering questions and checking on shyer/quieter students.

The class activities were developed to take the average student the entire class time to complete. Some students did require more time so all students were given until the beginning of the next class to submit the solution. All assignments were submitted via the LMS and graded within a few days so the students had quick and frequent feedback. Stronger students that could complete the activities quickly were allowed to leave if they completed all their work and submitted it for grading. In some cases, more challenging extra credit activities were offered as an option if they wanted to stay or they were free to use the time to work on homework. Some would even stay to help their fellow classmates work through the activity. This was encouraged but closely monitored to make sure the help was in the form of guidance not simply providing the solution. The only restriction was that students were not allowed to help each other with

homework; all homework questions needed to be asked of the instructor or an official departmental tutor.

Instructor F had taught this course the previous year in a fully-flipped format with zero in-class lecturing, other than answering questions. Instructor F was concerned that students may not be as connected with the instructor as they would be in a more traditional setting. Therefore, the first three weeks of the Spring 2015 course, Instructor F began each class with ~15 minutes of lecturing to supplement the lecture videos. During the fourth week, students were anxious to jump right into the class activities so the instructor decided to go back to the fully-flipped format, only answering questions at the beginning of class and discontinuing traditional in-class lecturing. The only exceptions were two exam reviews. Students were given a practice exam to complete several questions and then the instructor led a short review/discussion of the solutions.

A majority of the fully flipped classroom students agreed (8.93/10 on Strongly Disagree to Strongly Agree Likert-scale) with the statement, *I like the "flipped classroom" teaching model. i.e. Watching the lecture videos outside of class and spending more class time doing team exercises*. One student reported the following: "I absolutely LOVE the flipped classroom. The lectures outside of class were short, sweet, and to the point and I actually enjoyed going to class. The class activities were extremely helpful in understanding the material" (also see Appendix A, Table I). Nonetheless, not all students prefer this method of learning (see Appendix A, Table II). As one student stated on the evaluation, "I didn't like the reversed classroom experience. I much rather prefer to listen to a lecture in class and then do the homework on my own time." A majority of students strongly agreed (9.71/10 on Strongly Disagree to Strongly Agree Likert-scale) with the statement: *The in-class programming exercises improved my comprehension of the course material.*

The frequent quizzes were helpful in assessing if students are watching the lecture videos and completing the readings. This was also a good way to give immediate feedback to students regarding their progress. However, the volume of quizzes can be overwhelming to the students. As one student commented, "I did not like that we had so many quizzes. We had them in the required lecture videos, after the lecture videos, and in class almost every day. At times it seemed like too much." Nonetheless the same student acknowledged the benefit by adding, "However, I do think they were helpful (just tedious)". Table 3 shows student evaluation data for the two semesters where instructor F taught the course in a flipped format.

Measure	S 2015	S 2014
Classes helpful	9.4	8.86
Classes interesting	9.27	8.95
Course rating	9.47	9.29

Table 3. Instructor F Student Evaluation Scores

The Spring, 2014 section had zero in-class lecturing, while the Spring 2015 had 8% of its in-class time devoted to more traditional lecturing. This included the 15 minute sessions at the beginning of class during the first 3 weeks of the course and the exam review sessions.

Another item to note is that the Spring 2015 section had a high number of IS students versus CS students. Many of these students in particular expressed concern about the difficulty of the course material during the first week, but after a few weeks of in-class coding practice they seemed to gain confidence and ultimately did quite well. Four of the five A's on the final exam were achieved by non-CS majors.

There may be some value in doing some traditional lecturing during the first few weeks of a flipped classroom environment to connect with the students. While more empirical data is needed to confirm this, instructor F did feel more connected with the students in the Spring 2015 course. Having a short lecture at the beginning of each class during the first 3 weeks allowed the instructor to learn all the students' names and get a better sense of their abilities. This also likely allowed the students to get to know their instructor better and perhaps made them more comfortable asking questions.

General Observations & Challenges

The three instructors agree that the flipped model slows down the pace of the course. In practice, the flipped classroom students spend more time on in-class activities than listening to lecture making it difficult to cover as much content as a traditional course. While in principle one can add more video lectures to cover more content, this is difficult to achieve for many reasons outlined below. In practice, our observation was that students in the traditional lecture get exposed to more content and the flipped students get less exposure but get more practice programming.

Videos are extremely time-consuming to make. It was not uncommon for it to take 5-6 hours to

create a 10-minute video. Videos have no value unless students watch them. While students can also miss lecture, absences can be precisely measured whereas measuring whether or not students watch the videos is challenging. Instructors F and S used various techniques described in the previous section to mitigate this issue but no technique was perfect.

Videos can be more engaging than reading the textbook and embedded quizzes can help verify that a video is being watched, but ultimately there is no way to verify that students are thoroughly watching the videos. Similar to text book reading, the benefits depend on the individual learner.

If the fully- and semi-flipped students watch all the videos and typically use the entire class period or more to complete the in-class activities, they could have more "seat time" than students in a traditional setting. In other words, the explicit time spent on lecture-related activities could be higher. These students definitely get more programming practice, in the form of in-class activities, than traditional students typically get but it is not necessarily the case that they are spending more time on the course. For instance, some students were able to complete in-class activities quickly and either leave class early or move on to other tasks (e.g. homework or watching lecture videos). It is also certainly the case that some students simply did not watch the lecture videos, reducing their "seat time". Finally, unlike traditional classrooms, students were given time in-class to work on homework assignments. Since they are able to get help from their instructor during this time, this could have significantly reduced the amount of out of class time students spent on these assignments versus traditional classroom students.

Whether or not fully- and semi-flipped students are actually getting more seat time than traditional students depends on a variety of factors such as lecture video length, student willingness to watch the videos, and student ability. Nonetheless, fully- and semi-flipped students may perceive that they have more seat time than a traditional class and may not like it. But, the student evaluation data and comments did not reveal frustration with increased time commitment. However, some students did report not liking the lecture videos (see Appendix A, Table II). Some of this could be related to the length of the videos. Instructor F's videos were typically ~10 minutes each, while instructor S's videos were 40 minutes on average.

Perhaps most importantly, the lecture format did not have an impact on students' performance on the final exam, which was identical for all sections. Table 4 shows how close the mean final exam scores were for students in the three different lecture sections.

Instructor F	Instructor S	Instructor T
84.3 (n=16)	84.5 (n = 33)	83.4 (n=13)

Table 4. Mean Final Exam Scores

4. CONCLUSIONS & FUTURE WORK

There can be an incredible start-up cost to creating flipped classroom materials. Creating the lecture videos is very time consuming but they can certainly be reused. Bergmann (2012) recommends short interactive videos that are 1½ minutes in length per grade level -- under 20 minutes for an introductory college level course. While some instructors may use generic lecture videos to flip their classroom, Sams and Bergmann (2012) recommend that instructors create their own. One possible danger is tying lecture videos too closely to a specific textbook (e.g. using textbook slides). This could make it difficult to switch textbooks or even go to a newer edition.

Our comparative evaluation of flipped versus traditional was consistent with previous work. We observed that flipped learning provides students opportunities to learn in a more differentiated manner than traditional linear and passive forms, which is consistent with Willey and Gardner (2013). We observed and informally measured that the vast majority of students completed the required prerequisite tasks on a fairly regular basis while only a very small portion did not, which is consistent with Davies et al. (2013), Gaughan (2014), and Murphree (2014).

The semi-flipped model is an effective compromise for an instructor who cannot devote the time needed to replace all lectures with videos. Based on our observations, the semi-flipped model produces similar positive impressions from students without the need to replace all traditional lecturing. However, instructor S notes that early in the semester students were confused about the format and it took nearly 3 weeks before the vast majority of students were coming to the activity session prepared, whereas, instructor F reports a quicker turnaround time with respect to student comfort and preparation.

We observed that flipped learning empowered students through more active learning, which is

consistent with (Lage et al., 2000). Specifically, students were held more accountable for studying material prior to coming to regular lectures. However, while we can conjecture that students in the semi- and fully-flipped sections may have more programming practice, and should therefore perform better when assessed, the average final exam scores shown in Table 4 indicate no significant difference in student performance based on the lecture format. More generally, whether or not semi-flipped yields a better understanding of the course material is yet to be determined.

It is also unknown what balance of flipped versus traditional works best and how to structure that balance. Instructor S had one day a week dedicated to lecture and one for in-class activities whereas Instructor F only did some short lecturing at the beginning of the semester and for exam review. While instructor T initially planned to stick with traditional lecturing in the classroom, the schedule forced some adjustment including incorporating programming activities during lecture time. Ultimately, this addition was well received by both the students and instructor.

The flipped model, whether full or semi, creates certain advantages that are difficult to achieve in a traditional model. For example, in a lecture only model, it is often not revealed that a student is lost until the first homework assignment or even the first exam. Doing poorly on these higher stakes items can have devastating effects on some students, crushing their confidence and willingness to keep trying. In a flipped or semi-flipped classroom, students can experience weekly or even daily feedback via low-stake activities and quizzes. This enables both students and instructors to get early and frequent feedback. Students who stumble along the way on low-stakes deliverables still have time to recover before higher stake exams. And, instructors can detect problems early and intervene quickly to get students back on track. In addition, as students work through the in-class exercises, the instructor can also detect students that need extra attention and identify general pain points for all students, which can then be addressed quickly via a short ad-hoc lecture or a supplemental lecture video.

While the quizzes and questions that encourage video watching are low-stakes with respect to grading, there are still consequences that encourage students to take them seriously. Many students naturally want to make a good impression with the instructor and are embarrassed if it is revealed that they are not prepared. When a student does poorly on a major test, it can be unclear to both the instructor and student if the poor performance is the result of a lack of understanding or a lack of preparation. Whereas, when a student fails to answer a trivial question that was directly answered in a video, the source of the student's problem is clearer to both student and instructor.

Another major advantage of the flipped classroom is that strong students are not held back during class activities. They are free to work as quickly as possible and, at least in the case of these course offerings, were allowed to leave if they completed all their work.

Based on our observations and survey results, the in-class activities associated with the flipped model had the most profound impact in improving students' impressions of the course, whereas the videos themselves were not viewed as positively. Thus, improvements can be achieved without flipping an entire course as instructor T and S learned by adding in-class activities without completely replacing traditional lectures with video. But, using lecture time for activities certainly decreased the amount of material that was covered in the course. This was true even when videos were used extensively. While video lectures can substitute for traditional lectures, in practice, this is challenging to achieve because some students may not learn the material as effectively from video lectures.

Since some students will prefer traditional lecturing, it might make sense to not only offer the different sections but also advertise them as such. This would allow students to self-select the teaching style that best fits their needs. Future research might include assessing student satisfaction after self-selection.

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Editor's Note:

This paper was selected for inclusion in the journal as a EDSIGCon 2015 Meritorious Paper. The acceptance rate is typically 15% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2015.

Appendix A – Sample Quizzes and Activities

Sample Quiz Questions from Semi-Flipped Class (week 2)

Question

Consider these four lines of code:

```
a. JPanel panel = new JPanel();
b. ImageIcon me = new ImageIcon("eric.jpg");
c. JLabel image = new JLabel(me);
d. panel.add(image);
```

Which line of code (a, b, c or d) uses a default constructor to create a new object with default values?

Question

Consider these four lines of code:

```
a. JPanel panel = new JPanel();
b. ImageIcon me = new ImageIcon("eric.jpg");
c. JLabel image = new JLabel(me);
d. panel.add(image);
```

Which line of code (a, b, c or d) uses a default constructor to create a new object with default values?

Sample Activity Segment from Semi-Flipped Class (week 2)

1. Download BasicPrograms.zip and save to an appropriate folder on your computer.
2. Unzip/extract the *BasicPrograms* folder. On a PC, right-click the zip file and select `Extract All`. On a MAC, double-click the zip file to extract the folder.
3. In BlueJ, open the *BasicPrograms* project. Select `Project --> Open Project` and then find the *BasicPrograms* project folder.
4. Modify the `AdLib` program so that it creates a humorous "ad lib" story. AdLib example
5. You should prompt the user for at least 7 words (nouns, verbs, adjectives, etc.) and output at least two sentences. Be creative and have fun, but do not spend more than 25 minutes on this part.
6. You should prompt the user for a particular word using `JOptionPane.showInputDialog` and store the word using a String variable.
7. You should output each sentence with a separate `System.out.println` statement.

Sample Quiz Questions from Semi-Flipped Class (week 11)

Question	If you did not know the exact size of an array called nums, how could you access the last value?
Answer	nums[nums.length]
	nums[nums.size]
	✓ nums[nums.length-1]
	nums[nums.size-1]

Question	Which code shows how to declare an array called nums for storing 10 integer values?
Answer	int nums = new array[10];
	✓ int[] nums = new int[10];
	int[10] nums = new int[];
	int array[10] nums;

Sample Activity Segment from Semi-Flipped Class (week 11)

1. In the array project, create a new class called `IfStatement`
2. Replace all the code inside the class with one `main` method that does the following:
    - Prompt the user to type the temperature and their mood
    - Store the temperature as a double and the mood as a String
    - Print "play" if the user's mood equals "happy" and the temperatures is between 50 and 90 (inclusive)
    - Print "play" if the user's mood is not equal to "happy" and the temperatures is between 75 and 85 (not-inclusive)
    - Print "stay inside" if the user's mood equal "sad" or "average" and the temperatures is below 75.
    - Print "unsure" if all of the above conditions are false.

Appendix B – Student Evaluation Open-Ended Questions

Table I: Liked about course/instructor

Traditional	• He was enthusiastic about the class and took the time to explain how to make our code better. He would help us with any problems on our activities as well and explain the solutions thoroughly. • The in class activities were key. That's where I learned most of the material. • I enjoyed the activities that the professor gave at the end of class. I found that they really helped me learn the material. • I think this way of running the class was effective.
Semi-Flipped	• Interacting and working with classmates at least once a week was helpful and productive. • I really found the video/activities helpful and his attitude toward wanting each individual student to succeed. • I liked the activity sessions of the course, and I thought that they were very helpful. • I think that the course was fine. I liked the lecture style of the instructor and it helped me a lot. • I learned a lot despite the incredibly fast pace. If I didn't understand something, the assignments were designed to let me figure it out on my own. • the homework. I like to do the homework
Fully-Flipped	• exercises in class helped alot • I really enjoyed the flipped classroom setting. The videos gave me the right amount of information and then being able to go right into class and do the exercises helped to make the concepts clearer. Also hiving the time do homework in class was very helpful, the homework was challenging, and having the ability to ask questions made it less frustrating • I liked that the class is completely hands on, with this type of course it is extremely helpful to be constantly practicing the material because being lectured on it won't make sense unless you are actually being challenged to figure out what the material means. • I liked that it was a lot of hands-on activities rather than lectures, I think it suits well with the course material. • I enjoyed the … and the flipped classroom • The homework assignments were the best part of the class because it really tested you on the material. • I really liked the format. Watching the videos before class and then getting straight to work. In practice it was kind of like having two lab classes. • I absolutely LOVE the flipped classroom. The lectures outside of class were short, sweet, and to the point and I actually enjoyed going to class. The class activities were extremely helpful in understanding the material.

Table II: Disliked about course/instructor

Traditional	• I did not like the quizzes we had in the beginning, those were tough. Also, I wish the activities counted for more than just participation points. • Progressed through concepts slowly. • Sometimes the lectures seemed unorganized but I think that is because we didn't go over every slide and instead skipped around. All the important material was still taught so it was not much of a problem.
Semi-Flipped	• Online videos were an interesting idea but it was difficult to understand the concepts at times and the quizzes were sometimes difficult. • I really did not care for the videos at all. They really were just difficult to focus on and weren't very helpful. • I also feel like there was too much material in the traditional lectures. I think that watching someone code for an hour and a half doesn't really help me at all. • I think that it would have been more helpful if the material had been presented and then we worked with partners or in small groups to practice the code. • There definitely needs to be traditional lectures to introduce things like arrays, Java in general, etc, but I really think that watching someone else doing a program really isn't practicing anything.
Fully-Flipped	• videos outside of class • I did not like that we had so many quizzes. We had them in the required lecture videos, after the lecture videos, and in class almost every day. At times it seemed like too much. However, I do think they were helpful (just tedious). • I didn't like the reversed classroom experience. I much rather prefer to listen to a lecture in class and then do the homework on my own time.