A Flipped Classroom Setting Trial in GIS Course

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1 Introduction

Flipped classes have gained increasing popularity in undergraduate civil engineering courses [1, 2] This teaching approach allows students to actively participate in the learning activities while the instructors serve as facilitator assisting and guiding the learning process. This learning format provides various benefits for the instructors as well as students. Some of those potential benefits include flexibility [3], increased peers' interaction [4] and increased interaction with instructor [5]. Based on the benefits identified in previous studies, a freshman level civil engineering course was converted into a partial flipped format. This paper aims to evaluate student perspectives on partial flipped geographic information system (GIS) course.

Geographic Information system (GIS) is a freshman-level software-based course in the civil engineering undergraduate curriculum at the Rose-Hulman Institute of Technology. This two-credit course provides an introduction to GIS software, basic principles, methods and applications of GIS. It also teaches the students basics of tools and techniques for operating software. A couple of freshmen end up with internship opportunities because of this course. The students use GIS for their freshman design project and during their senior year during their capstone design projects, specifically for generating project site maps. In addition, the GIS skillset can be helpful to the freshmen in several of their upper-level courses such as water resources, soil mechanics, environmental engineering, geology etc. This is because the GIS database has a huge repository of real-world data such as demographics, environment, geology, hydrology, government, and infrastructures throughout the world.

Historically, this course has always been taught in a traditional lecture-based format in our department. The course meets twice a week, each with a duration of two 50- minutes classes. The class is structured in such a way that typically the first half of each session is lecture, and the second half is worktime. Table 1 shows the details of theory topics, practice session and workload associated with each topic. For every class, students have access to the lecture slides and are provided with a hard copy of the handout. A typical GIS class would start with a theory lecture followed by working on the sample problem along with the instructor. Then the students would work on classwork problems on their own. They also have to complete the homework problems based on the discussion in class.

Teaching this software-based course in traditional lecture-based format limits the effectiveness of the course. There were two main challenges while teaching this class in a traditional lecture-based format. They were: (1) Finding a common teaching style suitable both for slow and fast technology learners, and (2) Most of the class time was used for software familiarization, limiting the time that can be dedicated to the software's real-world application. Hence, the concept of flipped class was identified to be a suitable approach for this course. Flipped setting could resolve the issues helping the struggling students not only in class but also outside of class, while

also making the best use of class time. This would allow more time to focus on the real-world application of software during classes so that the students can see value in what they learn. As a first step toward flipping the course, we experimented by flipping one lecture of the course. So, the goal of this study in particular is to evaluate the effectiveness of a flipped setting for the GIS course by evaluating one flipped lecture of this course. The overarching goal of this study to flip the entire course in future so that the instructor serves as a learning guide rather than learning leader.

Table 1. Summary of lecture topics in each class

Meeting	**Topics**	**What is covered in lecture?**		**Assignments**	**Flipped**
		Theory discussion	**Practices session**		
1	Introduction	Co-ordinate system, Datum and Projection Basics about GIS background and its application Introduction of software	Familiarization to software platform Using basic navigation tool and basemaps	CW1 HW1	No
2	Shapefiles	Vector and Raster data Introduction to shapefiles Working with Attribute tables Query Operator and Conditions	Saving documents, generate PDF maps, Setup folder connections Attribute table exercies	CW2 HW2	No
3	New Shapefiles	Resources for GIS data Extracting data from a shapefile select by attribute Geoprocessing	Extracting data from a shapefile select by attribute Data Extraction using the Clip Geoprocess	CW3 HW3	No
4	Map Layout	Purpose of map Six Map Elements Examples of Map no-no's	Insert six map elements Checking Coordinate system of layer Adding Label on feature class Symbology	CW4 HW4	No
5	Exam 1	Four problems based on topic 1 through 4			

6	Geodatabase	File geodatabase, ArcCatalog and Metadata	Create a New File Geodatabase, Feature Dataset and Feature Class	CW5 HW5	Yes
7	Geo processing	Common Geoprocessing Tools ArcToolbox and Toolboxes Geoprocessing	Buffer, Intersect, Union, Merge, Dissolve	CW6 HW6	No
8	XY co-ordinate	Ways of Organizing data in GIS XY-Coordinates for locating an object	Join excel CSV data to our Attribute table Adding XY Co-ordinate Information Tracing the points on Basemap Auto generating the XY-coordinate	CW7 HW7	No
9	Digital Elevation Model	Statistical/Function Surface Digital Elevation Model Light Detection And Ranging (LiDAR)	Getting DEM from Opentopography Generating Contours, Slope and Hillshade	CW8 HW8	No
10	Exam 2	Comprehensive			

2 Methodology

Various assessment techniques including formative assessment, summative assessment, and student survey were employed to evaluate the flipped lecture. Formative assessment used was muddiest point. Muddiest point consists of asking students to write down about most confusing part of a particular lesson or topic [6]. In addition to pre-assignment students were asked to submit muddiest point for the lecture they watched. Summative assessments for the flipped module included a problem in the final exam and homework problems related to flipped lecture to evaluate students' understanding of flipped lecture. A survey (11 questions) was conducted to evaluate students' involvement and perception of flipped classrooms. The questions were related to students' experiences and opinion on flipped lecture, their efforts on watching video lectures, and associated assignments.

This study was conducted with 30 students (8 females and 22 males) enrolled in the course during the academic year 2022-23. The flipped lecture consists of students watching three videos (5,9 and 35 minutes) prior to attending in-class session. The videos were created by the instructor using Panapto over Microsoft Powerpoint note slides. The recorded video lectures and lecture slides were available online a week before the in-class session. The videos were shared via course management platform Moodle which tracked each students' progress in the video. To verify that they had watched the video in preparation for each class, each video contained a quick pre-assignment and muddiest point before the in-class session. At the beginning of the in-class session, the student concerns regarding the Muddiest Point were discussed. Then after that students worked on some sample problems and homework assignments during the class based on the video they watched. At the end of the in-class session, students were asked to complete a survey on their perception of their learning in flipped format.

3 Result and discussion

3.1 Student survey

After the flipped lecture and associated assignments were completed, student survey was employed to collect students' perceptions on the experience. There was 100% response rate to the survey questions. Based on the student survey response 36% of students still feel the class should be taught in traditional lecture format (Figure 1). This finding indicates that, although the experience of flipping of one complete lecture, was mostly positive for the majority students, they are not yet ready to accept GIS as being taught using a fully flipped approach. Considering that the students were freshman and for majority of them this was the first flipped learning experience, this finding is not surprising. Anecdotally students here at Rose-Hulman Institute of Technology prefer face-to-face classes in comparison to virtual, flipped, or asynchronous lectures. This was one of the biggest hindrances to flip the entire course contents all at once.

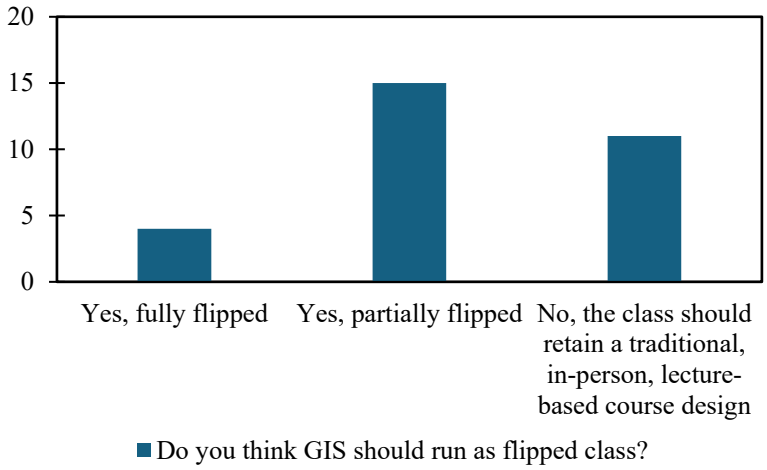

Figure 1. Students' perceptions of the flipped module for GIS course

On the brighter side the students did not have any significant input to the question "What do you like least about the flipped lecture?". A few of the students have pointed out lack of personal connection while watching the videos is their least favorite part. This shows that there is still a hope that the flipped lecture could be made palatable to students with some minor adjustments.

On average 96% of the class watched the video and completed the pre-assignment work prior to coming to class (Figure 2). The average minutes delivered by students on the videos were approximately 38-41% more than the actual video duration. Flipped lecture format provides them ability to move at their own pace. The student responses in the survey also highlights the benefit of flipped classrooms as the ability to watch lecture material multiple times and at their own pace. Below are some of comments from the student survey.

It gives me the freedom to engage in class content at my own leisure and also provides the opportunity to easily rewatch parts of lectures to refresh my memory as opposed to needed to rely solely on my notes.

Being able to do the lecture and work at my own pace and can go back, if need be, without having to disrupt class.

It is very flexible with my schedule and helps me learn at my own pace.

One of the nicer things about flipped lectures are the ability to work on the pre-class materials on ones' own time and at ones' own pace, since if there's anything that they don't fully understand they can always rewind and watch that part again.

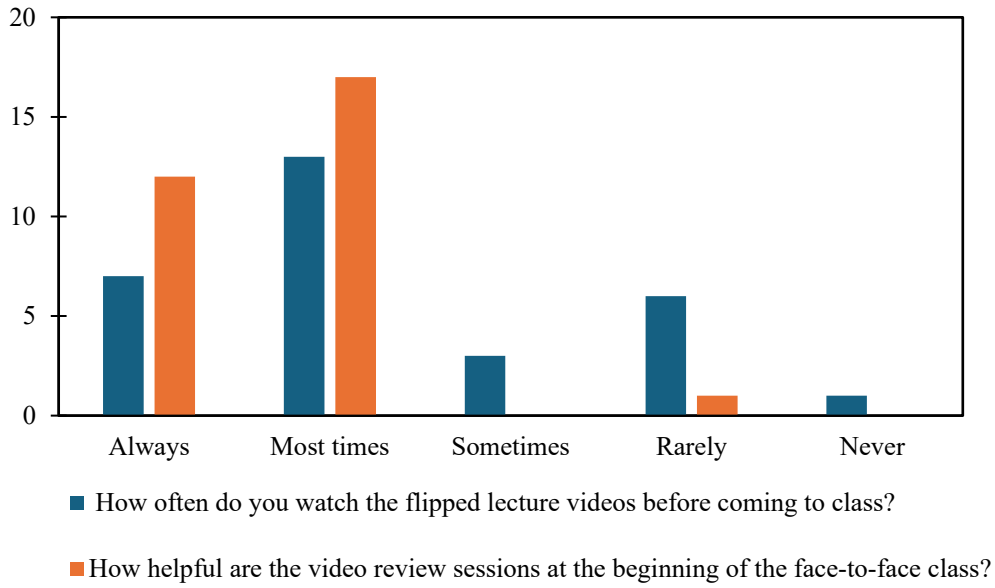

Figure 2. Student response regarding if they watch the video before class

Flipping the lecture allowed more work time during the class due to which more sample problems along with the homework problems could be covered in class. Also, it is remarkable that 93% of the students felt confident to work on in-class assignments after watching the videos (Figure 3).

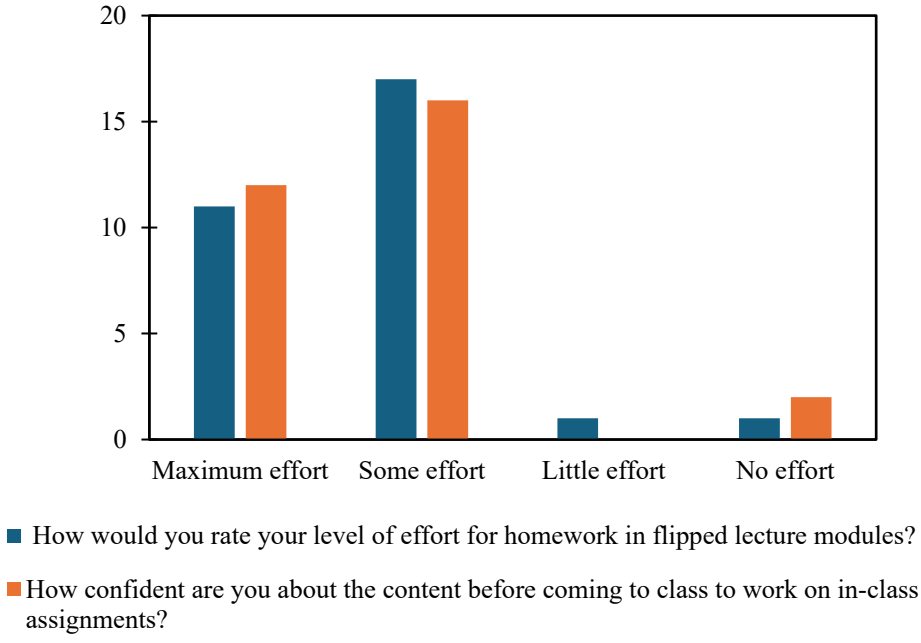

Figure 3. Students' attitude towards their understanding of flipped lecture and their effort

3.2 Quantitative Assessment

Students' performance on the preassessment, homework problems and final exam problem related to flipped lecture were compared to the previous year's results, when the topic was introduced using traditional lectures. Table 2 shows increased performance for students. experiencing a flipped methodology. This positive finding could be attributed to increased in-class activities such as more sample problem and discussion on muddiest points. The additional opportunity to work on homework problems allows them to revisit concepts together and engage in critical thinking.

Table 2. Performance for Students in Flipped lecture compared to traditional lecture previous year.

	Total points	Traditional lecture format	Flipped Lecture
Pre-assessment	10	7.65± 3.55	8.72± 3.24
Homework	10	8.65± 3.12	8.29± 3.55
Exam Problem	100	81.49± 15.77	98.17± 3.47

4 Conclusion

This study suggested that the flipped model can be very beneficial for GIS course. The students were cooperative and willing to put effort into the learning process although most of them had no prior exposure to flipped classes. Both the homework and exam problem provided a positive indication of the flipped learning process. After watching the recorded video lectures and completing the pre-assignment, students gained fundamental concepts which would otherwise be typically learned during the class in traditional lecture format. After addressing the muddiest point, students gained deeper understanding of the concepts which was strengthened by working on additional sample problems and homework assignments in class.

Directions for Further Research

The long-term goal of this study is to increase the number of flipped lectures gradually and then transition to fully flipped format. Gathering the evidence based on the student performance here at Rose-Hulman Institute of Technology would be the greatest proof of the concept for implementing the flipped format at our university for this course.

5 References

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