ADVANTAGES AND DISADVATAGES OF FLIPPED CLASSROOM: STEM STUDENTS´ PERCEPTIONS

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Abstract

An innovative teaching model, facilitated by recent advances in technology, is gaining popularity across college campuses, especially in college science, technology, engineering, and mathematics (STEM). This new model inverts or 'flips' the usual classroom paradigm, in that students learn initial course concepts outside of the classroom, while class time is reserved for more active learning. However, and despite all the advantages that this model could provide, to date there are still discussions regarding this model and its impact, which is more anecdotal than data driven. This study provides detailed insight of the student's perception of the advantages and disadvantages of learning by this model. Although this paper refers to a Flipped classroom model, the study focuses only in one aspect of this modality: the use of videos for flipping the classroom. The investigation was based on the question: What do STEM students perceive about learning with a flipped classroom model? The sample was taken from different engineering courses: Physics and Material Balances, with a total focus group of 150 students. The study was based on a qualitative approach (study case) and the instruments used for data collection were survey, videos, interviews and photographs. The analysis was made by the instructors involved in this study courses (to make the codes and categories by observation) and also the Qualitative Data Analysis & Research Software (ATLAS-Ti) was used for the same purpose. To validate the results, triangulation of the data was carried out, comparing information from the instruments. Some of the most important results show that the main advantages for students (according to their perception) are: flexibility to learn from the videos (77%), better comprehension of the content (73%), advantage because of previous knowledge to class (34%) and motivation for learning (29%). Among the disadvantages mentioned by the students are: technical problems (34%), in reference to internet, software, etc. Other students' negative perceptions were the lack of instant feedback and that they prefer shorter videos.

Keywords: Flipped classroom, STEM, students' perception, innovative teaching model.

1 INTRODUCTION

An innovative teaching model, facilitated by recent advances in technology, is gaining popularity across college campuses, especially in college science, technology, engineering, and mathematics (STEM). This new model inverts or 'flips' the usual classroom paradigm, in that students learn initial course concepts outside of the classroom, while class time is reserved for more active learning. An inverted or flipped classroom, where content delivery includes video lectures watched outside of the classroom, is a method that can free classroom time for other activities [1].

According to the literature, some of the advantages that a flipped classroom can provide to the learning environment are: 1) the inverted classroom allows the instructor to cover more material; 2) students participating in the inverted classroom performed as well or better on comparable quiz and exam questions and on open-ended design problems; and 3) while students initially struggled with the new format, they adapted quickly and found the inverted classroom format to be satisfactory and effective [2]. Another advantage is that this method could provide feedback and increased understanding; this was one of the main interests for the authors of this paper to include this method in their teaching processes and to do research on it. Above all, this generation of students *"were born in the technology era, and they are highly motivated when it comes to things they can see, do, and understand*" [3]. In other words, flipping the classroom could be a method that could help the learning environment and, at the same time, engage students on learning [4].

During the first two years of engineering education (freshman and sophomore years), there is an important need of understanding concepts [3]; therefore, the use of videos could aid in this sense.

Developing skills in engineering education are needed for professional practice [5] and professional success, and it is a key factor behind the emerging shift away from a traditional lecture [2], [7].

However, there are still issues of STEM retention in postsecondary education [6], and despite all the advantages that this model could provide to date, there are still discussions of the model, and its impact is more anecdotal than data driven [1].

Therefore, this investigation was based on the question: What do STEM students perceive about learning with a flipped classroom model? The study provides detailed insight of the student's perception on the advantages and disadvantages of learning by this model. Although this paper refers to a flipped classroom model, the study focuses only in one aspect of this modality: the use of short videos for flipping the classroom.

2 METHOD

2.1 Participants and Context

The investigation was based on the question: What do STEM students perceive about learning with a flipped classroom model? The sample was taken from two different engineering courses: Physics and Material Balances, with a total focus group of 150 STEM students at Tecnológico de Monterrey (ITESM, campus Monterrey).

Physics is a course that is taught to 1st semester engineer students (freshman) and at this level they need to understand basic concepts in order to solve basic physics problems. On the other hand, Material Balance is a course taught during the 3rd semester of engineering education (sophomore), where students still need to understand the concepts before doing calculations. In both courses the expected outcome to develop is the ability to solve problems related to the concepts taught in each course. Therefore, the students need all the creative ways the teacher can provide in order to be able to construct a learning environment that allows the student to build a bridge between the understanding of the concept and the development of the ability to solve the problem. Developing this ability is important, especially in college STEM [5], [7].

2.2 The study

The study was based on a qualitative approach (study case). The main concern of this type of studies is to understand the phenomena from the participant´s perspective [8]. The acknowledgement of the living experiences and the discovery of the meaning for each person of such experiences is part of this type of investigation [8].

The methodology used consisted of the following steps: 1) Preparing short videos (no longer than 5 to 10 minutes) [9] that could give examples or explanation of the main concepts for the course [10] (the most difficult ones to understand, for the student and to explain, for the teacher). In this way the teacher could free time for starting each class with some previous knowledge from the students and to have more space for active learning [11], [12] and feedback. These videos were made by the own instructor of each course with a variety of computer applications but mainly with Camtasia program. 2) Organize one or two videos per week and ask the students to watch them before going to classes (Fig. 1). 3) Design a survey suitable for collecting data about advantages and disadvantages of flipped classroom: STEM students perception, 4) Applying a survey on website for the students, 5) Gathering all the comments from the students, 6) Grouping all the similar comments by categories, 7) Triangulation of the categories by pairs (teachers that participated in the study reviewed the categories).

Fig. 1 Photographs of some students watching the videos at the school cafeteria.

The instruments used for data collection were survey, videos, interviews and some photographs. The most important instrument used at this study was the survey because this was the main frame for the data analysis. The survey consists of three questions: 1) in your opinion the use of videos as a complement for your class helps your learning (YES or NO), 2) What was you liked best about the use of the videos for your class? (Write at least 3 comments) and 3) what is it you do not like or is a limitation that you see with the use of the videos? (Write at least 1 comment). These questions were provided in a web-site survey available for all students at any time.

2.3 Data Analysis

The analysis was made by the instructors involved in this study's courses to make the codes and categories by observation (See Fig. 1).

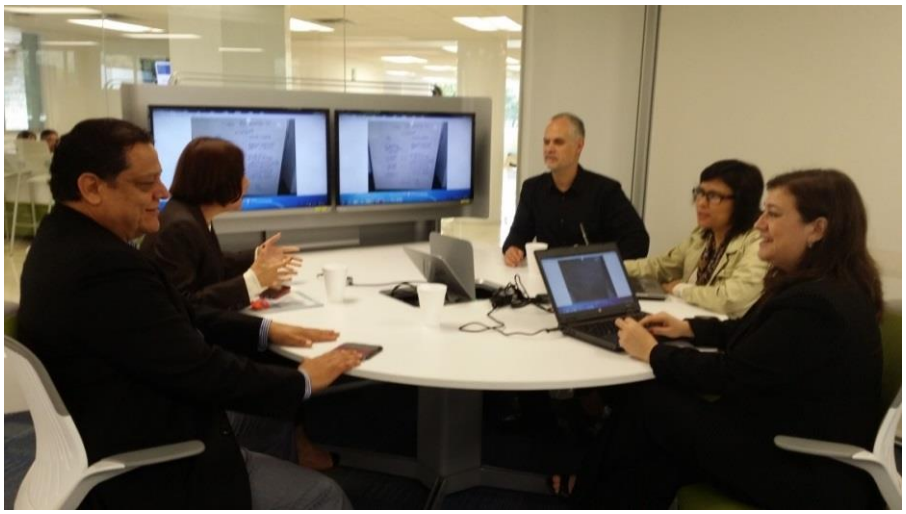

Fig. 1 Qualitative analysis made by the teachers for making the categories out of the student's answers.

Also, the Qualitative Data Analysis & Research Software (ATLAS-Ti) was used for the same purpose to validate the results. Lastly, triangulation data was carried out, comparing information from all the instruments.

3 RESULTS

The results of the study are presented next under each question of the survey. The sample was 150 but only 93 students answer the survey. The first question of the survey was made to have a yes or no answer. This was an ended closed question just to know the general perception of the students (Fig. 3). The questions are:

1) In your opinion, did the use of videos as a complement for your class help your learning? (YES or NO). This was a close ended question just to assess the general perception of the students. The results show that students preferable liked the use of the videos for learning.

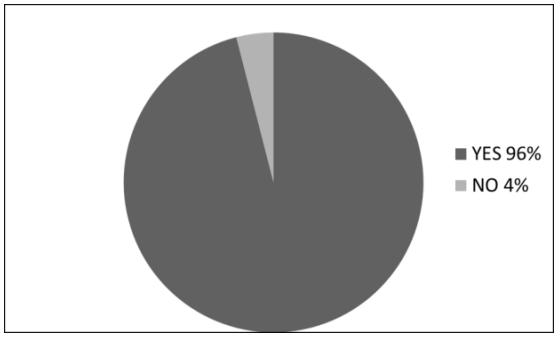

Fig. 3 Results of the first question of the survey applied to the students.

2) What did you like best about the use of videos for your class? (Write at least 3 comments). The intention of this question was to find out what did the students think about their experience with the videos, thus the question was open, but they had to think about at least 3 reasons why they liked them.

Some comments from the students were:

"*They are clear, I can watch them anytime I want to, I like the visual thing*"

"I am able to watch them whenever I want, it explains graphically and is fun, we are learning in another way"

"*I like the images*"

"*I understand the concept and the idea*"

"*They are easy to watch, everything is OK*"

"It helps to do the homework"

"I like that when I go to class I feel I know something"

"*It is easier to work and learn during the classes when you have seen the videos before*".

"*They are always available, short and concise*".

Some of the most important results (Table 1) shows that the main advantages for students (according to their perception) are: flexibility to learn from the videos (77%), better comprehension of the content (73%), advantage because of previous knowledge to class (34%) and motivation for learning (29%).

Table 1 Results of the second question of the survey applied to the students

CATEGORY	ANSWEARS
Flexibility to watch the videos ("*You can watch the video any time you want to*"….)	77%
Helps **to understand** the content ("*It really helps to understand the concept*")	73%
It contributes to **previous knowledge** (before taking the class) ("*You can understand what is it about before going to clas*s")	34%
There is **motivation** while learning ("*You can learn and have fun at the same time*")	29%
Lasting **time** is adequate ("*They are not too long so they are easy to watch*")	18%
Others	7%

3) What didn't you like or what is a limitation that you perceive regarding the use of videos? (Write at least 1 comment). The same as question number 2, the idea here is to find out, with an open question, what is the student's perception regarding the negatives or limitations of using the videos as a complement for the learning processes.

Some of the comments were:

"*Sometimes they are very short or very long*"

"*Only in some browsers you can watch the video*"

"*We want more examples*"

"*Sometimes I forget I have to watch the video before going to classes*"

"*It is not possible to make questions to the teacher at the time*"

"*We only get a slightest idea of the concept when we are watching the videos; I would like a more deep explanation*".

Among the disadvantages mentioned by the students (Table 2) are: technical problems (34%), this refers to internet, software, etc. Other students negative perceptions were the lack of feedback at the time and that they prefer short videos than longer ones.

Table 2 Results of the third question of the survey applied to the students.

CATEGORY	ANSWEARS
Technical issues	34%
To have **examples** of solved problems ("*the videos are mainly about concepts and it would be nice to have some examples of problems- the whole mathematical solution*")	12%
There is **no instant feedback** ("When we watch the video there are some doubts and we cannot have feedback at the moment")	11%
They are too long	8%

4 DISCUSSION

For the question: What do STEM students perceive about learning with a flipped classroom model? The discussion of the study is based on the students' perception; the advantages and disadvantages of learning using this model.

The advantages found, according to the perception of the STEM students that answer the survey (presented in percentage of agreement) are:

1) Flexibility to learn from the videos (77%). Some of the students' comments were that they can watch the video at any time and place. They can also replay the video as many times as needed and this helps them to have more time to process the information and to understand the meaning of the explanation. Another feature the students really liked is that they can watch the videos prior to attending class, which gives them more time for doing more practice examples and to be prepared ahead.
2) Better comprehension of the context (73%). Some students need to process the information step by step and they believe that the videos provide the learning environment suitable for achieving a better performance. The instructor made short videos that the students had to watch previous to class, but also made some videos afterwards with information that provided feedback of some concepts the students did not understand.
3) Advantage because of previous knowledge to class (34%). Some students comment that they feel more secure and self-confident by having access to a more easy and familiar way of information.
4) Motivation for learning (29%). Most of the comments that were gathered in the category were: "*This way of learning is more fun*", "*It is more meaningful when you see a video than reading a book*", and *"The explanation is more interesting and understandable*".

Among the disadvantages mentioned by the students are:

1) Technical problems (34%). Some technical issues that prevented watching the videos were mainly because of bad internet connection and in some cases the need of special software for some devices (other than the computer) such as smart phones, tablets, etc.
2) To have examples of solved problems (12%). The first idea of introducing videos to the learning processes of STEM students was to deliver previous knowledge of basic concepts to the class in a more suitable way. However, during this implementation the students asked for more videos to show examples of problems and their solutions.

3) There is no instant feedback (11%). Some negative student perceptions were that sometimes they did not understand something just by watching the video and they did not have instant feedback. However, the instructor can always provide feedback on the class sessions.
4) They are too long (8%). Although the videos that the instructor prepared for the students were designed to be short, innovative, simple and concise with an average of time of 5 to 10 minutes at most, some students still thought that they were too long.

5 CONCLUSION

A basic component of engineering education and teaching STEM students is problem solving; this means that an engineering student cannot only read problem statements or solely attend a lecture. This is a main concern today. At the same time, an additional critical situation is that in-class lectures force an instructor to teach a certain amount of material in a limited timeframe irrespective of the rate at which each student can retain or comprehend that information regardless of the experience level of the student [13]. Therefore, the main conclusion of this study is that flipped the classroom for STEM students allowed space and time, and because of that, flexibility for a more suitable learning environment according not only to the literature review, but also very important, to the student perceptions of this study.

6 RECOMMENDATIONS

An inverted or flipped classroom can play a key role in modern engineering education by freeing time for learner-centered activities and encouraging students to become independent self-learners [2]. However, some recommendations for providing a more suitable learning environment with the use of this method is to make short videos (no more than 5-10 minutes long) and to be aware of students' needs and performance during the learning processes so that the instructor can modify, adapt or create new ones. Also, to make sure the technology is available for watching the videos.

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