A First-time Flipped Classroom Experience: Measure of Outcomes and Challenges

Dr. Cedrick Kwuimy, University of Cincinnati

Dr. Kwuimy is currently Assistant Professor - Educator in the Department of Engineering Education - CEAS at the University of Cincinnati. His current interests is in the area of global competencies and e-learning. His has a background in the area of applied nonlinear dynamics and applied physics. Prior to joining the University of Cincinnati, Dr. Kwuimy was Research Fellow at the African Institute for Mathematical Sciences (AIMS) in South Africa and then worked for over 4 years on ONR funded research projects focus on the development nonlinear dynamics approaches for the detection of faults in bearing and gear systems at the Villanova Center for Analytics of Dynamic Systems (VCADS) in PA. He graduated from the University of Yaounde 1 in Cameroon and then completed a Certificate in Teaching Engineering in Higher Education at Villanova University.

Dr. Kwuimy is interested in vibration analysis and in the use of nonlinear dynamics tools to improve the early detection of fault in complex nonlinear systems. In the latest, his focus is on engineering systems (gear systems, bearings) and biological systems (vibration in human-arm, human diseases). In vibration analysis, his focus is on the conversion of mechanical vibration into electrical energy (energy harvesting). A key interest of Dr. Kwuimy is the development of active tools/methods to foster and enhance the learning experience for undergraduate students and, scale down cutting edge research challenges into undergraduate topics discussions.

Dr. Jeff Kastner, University of Cincinnati

Dr. Jeff Kastner is an Assistant Professor Educator in the Department of Engineering Education at the University of Cincinnati. His primary responsibility is to teach freshmen engineering classes which focus on hands-on experiments, basic computer programing, problem solving, and communication skills.

Dr. Yuan Chen, Center for Enhancement of Teaching and Learning, Chongqing University, China

Ph.D., Associate Professor, Project director of Center for Enhancement of Teaching and Learning of Chongqing University

A first time flipped classroom experience: Measure of outcomes and challenges

C. A. Kitio Kwuimy[a], Yuan Chen[b], Jeff Kastner[a] and Jason C. Heikenfeld[a]

[a] *College of Engineering and Applied Science*
University of Cincinnati, 2901 Woodside Drive, Cincinnati OH 45221
[b]*The Center for Enhancement of Teaching and Learning*
Chongqing University, Chongqing China

Abstract

The University of Cincinnati has a campus in the US and an international campus in China. Students in both campus take the same courses given by the same team of instructors. The purpose of this study is to evaluate the perception and feedback of these two students' populations taking a sophomore electrical engineering course in a flipped classroom setting. Data was collected in this study using both quantitative and qualitative surveys; a comparative analysis of the students' perception is performed. The result indicated that students in both campuses have positive perceptions toward the use of flipped. However, the data showed that, the international students had a different approach as compare to US students. Recommendations are made to improve their experiences with flipped classroom pedagogy.

Keywords

Flipped classroom; International education; Active learning

1. Introduction

Over the past years, engineering education has been challenged to embed more student-centered learning strategies. Inverted pedagogies also known as flipped classroom has been considered as one of these learning strategies. In inverted classrooms, events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa [1, 2]. Recent studies have demonstrated the effectivity of flipped classrooms for both local (US) and international students. Johnson [3] published the outcomes of a survey on students' perception of flipped classroom and concluded that the effectivity of flipped classroom requires interactive instructional videos, increased in-class learning activities, and alterations to assessment. A comprehensive list of recommendations for an effective design of flipped classrooms was proposed by Kim et al. [2] using a mixed methods study that examined three instances of the flipped classroom across unique disciplines. Bishop and Verleger [4] proposed a comprehensive review of published research on flipped classroom and concluded that future research on the "flipped classroom should employ controlled studies that objectively examine student performance throughout a semester, with both traditional and concept-inventory". International students' perception of flipped classroom has been analyzed in various case studies. For instance, Jamaludin et al. [5] studied the perception of Malaysian students on flipped classroom. In addition to the limitations and challenges reported by Johnson [3] and Kim et al. [2], Jamaludin et al. [5] found that international students faced the additional challenge of deciphering the language.

The common ground of the current literature has demonstrate that, despite some challenges, an effectively designed flipped classroom can present several advantages. These results have been obtained using either local population or international population. To the best of our knowledge, a missing component from this literature is a comparative analysis of US students and international students within a similar curricular setting.

The current study discusses the efficiency, the perception and the benefits of the flipped classroom strategy for international and U.S. student populations. The instructor and the student population considered were at their first experience with such teaching strategy. Moreover, the international students' traditional culture of learning has been mostly passive and instructor centered, with high focus on instructor talking time. Giving the fact that the common perception is to generalize the effect and outcome of inverted pedagogy in the learning process, there are evidence of disparities between observation made with student's population in USA, Asia and Europe [3, 4]. The other interest of the paper is to directly connect to international program. In fact, traditionally, international students (off-campus) are often subjected to the same teaching approaches and material as students in local campus (USA). That is, instructors teaching local students and off-campus (international students) generally use exactly the same material, methods and techniques for example. How is this efficient in the context of flipped classroom? Our interest here is to analyze to what degree are international student's engagement in learning influenced by inverted pedagogy; and to what degree are international student's perceptions about their learning influenced by inverted pedagogy. We will compare the statistics of data obtained from two populations.
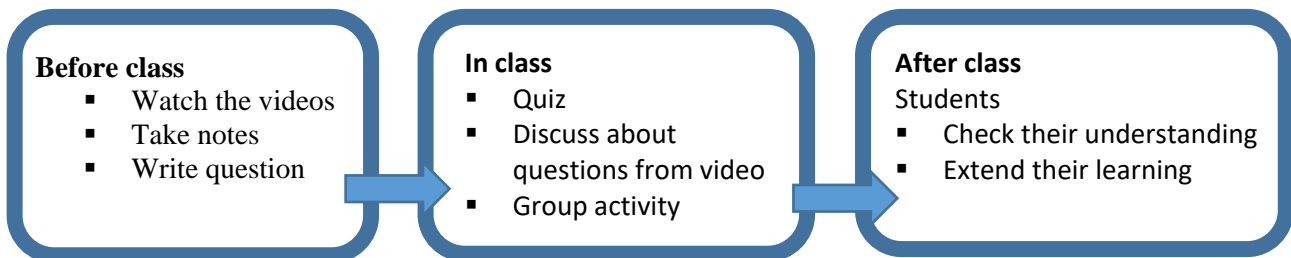
The context of this study is set as follows. In 2013, the University of Cincinnati's College of Engineering and Applied Science (UC-CEAS) partnered with Chongqing University (CQU) to introduce the first mandatory cooperative engineering education program in China, named the Joint Co-op Institute (JCI). Every semester, faculty from UC together with TAs (UC senior students) teach UC courses in China at CQU. For this study, 25 sophomore students (all native of Peoples Republic of China) were enrolled in the Semiconductor Devices class and were experiencing the flipped classroom for the first time. The videos were recorded by a senior faculty member with outstanding experience in active learning, and the instructor was a junior faculty member with limited experience in active learning. The class was taught during the Summer 2016 at Chongqing University in China. A comparison is made with students taking the same course on UC campus in USA. During the Fall 2016 semester, 19 students on the US campus took the same course using the same material. The instructor there was the one who recorded the videos.

Halfway through the semester, students were given a mid-term feedback from with three questions *(i) what do you like MOST about the pedagogy used in this class? (ii) What do you like LESS about the pedagogy used in this class? (iii) What can you do to improve your learning?* The observations made were used to adjust some points (allow more time for students to watch the videos, more students-students interaction, slow pace). One week before the final exam, students were given the survey used in previous study by Johnson [3]. The survey has two parts. The first part of the survey is qualitative and focuses on prior experience and perception of flipped classroom. The second part is a set of multiple choice questions. A comparative analysis is performed and sub-consequent lessons are deducted. The discussion in this paper are based on the second part of the survey. However, the discussions are built from the observation of the qualitative part of the survey.

The paper is organized as follows. The next section gives an overview of the class organization. In Section 3, we discuss the results of the survey and provide a comparative analysis of the students' population perception of flipped classroom. The last section is the conclusion.

2. Class organization

Semiconductor Devices is a 3 Credits course within the Electrical Engineering curriculum. This course is said (by students) to be challenging and very fundamental. Students become familiar and get an understanding of the following concepts: (i) Fundamentals of semiconductor diodes and transistors; (ii) static characteristics, biasing, carrier flow and small-signal models; (iii) light emission and detection with semiconductor junctions. Students received videos weeks before the class and the average length of the video was 23 minutes. Some concepts were covered over 2 or 3 videos (to be discussed in a single class). The class was organized as described in the figure below.

Before class
- Watch the videos
- Take notes
- Write question

→

In class
- Quiz
- Discuss about questions from video
- Group activity

→

After class
Students
- Check their understanding
- Extend their learning

Flowchart: Organization of the class.

Before they come in class, students were required to watch the corresponding video and take some notes or write down their questions, to be discussed in class. Since the weekly schedules for both students population were vastly different (2 times per week, for UC and 3 times per week for CQU), might affect the data. Each class starts with a 5 minutes quiz (generally 2 or 3 multiple choices questions). After the quiz there is a discussion and clarification of questions from the videos. The last part of the class is a group activity. Students organize in group of 4 and work on the activities. They are encourage to discuss and interact within their group and beyond.

3. Analysis and discussion

The analysis and discussion of survey questions presented below are grouped in three main categories. The first group of questions are designed to test students' activities before coming to class. The second group of questions focuses on their activities in class. The last group of questions gives information about their level of confidence and their understanding of the material after class.

3.1 Student's activities before class

The questions used in this part were designed to capture students' self-motivation toward flipped classroom. This motivation was impacted by the structure of the classroom, their apprehension for the course and the teaching approach and the overall schedule.

Q1: Do you watch the flipped videos on time?

The possible answers were (1) Always, (2) Most of the time, (3) Some of the time, (4) Rarely and (5) Never. The data (see Fig. 1) obtained here are very interesting. Despite the difference in their weekly schedules, some students in the traditional passive learning environment were more likely to always remember (and manage their time) to watch their video on time. All students on average will watch their video before coming in class. In our CQU campus, some students will either never watch the video before coming in class, or watch it some time. In a qualitative question, students at CQU mentioned *Lack of discipline/self-motivation, language* and *the length of the videos* as main reasons for not always watching the video on time. This contrasts with the data obtained from the other pool of students and "confirms" a well-known stereotype of students in Asian culture of learning [6]. They are culturally known to be well disciplined.
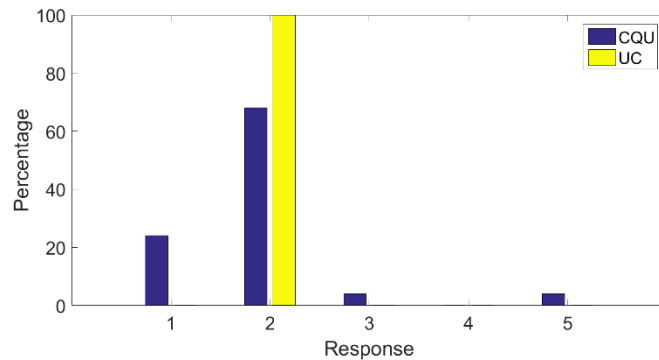

Figure 1: Question: Do you watch the flipped videos on time? (1) Always, (2) Most of the time, (3) Some of the time, (4) Rarely and (5) Never.

Q2: Please describe the amount of effort you have been putting in during your time OFF class?

The possible answers were (1) I am trying as hard as I can (max effort), (2) I am putting in a good effort each day, (3) I am not really trying, (4) A little or no effort at all.

As seen in Fig. 2, over 80% of students are spending enough time working on their material (video, remaining activities) on both campuses. The remaining students were not really trying (probably because of their inconstant interest for the course and the schedule) or, trying just a little. Despite the linguistic barrier and the length of videos, students have demonstrated here a sentiment of acceptance of the flipped classroom pedagogy. This sentiment is illustrated here by the high percentage (80%) of students who were willing to spend considerable time in order to master the content of the videos before coming to class.
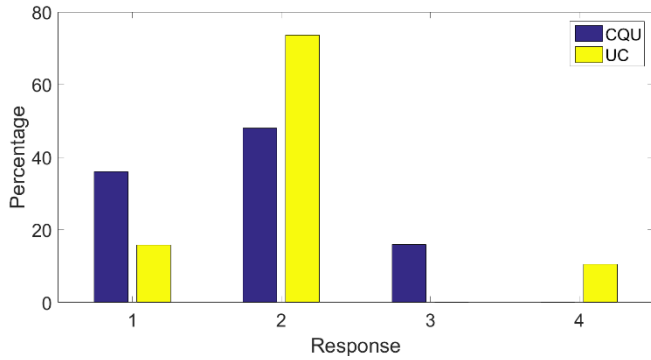
Figure 2: Please describe the amount of effort you have been putting in during your time OFF class. (1) I am trying as hard as I can (max effort), (2) I am putting in a good effort each day, (3) I am not really trying, (4) A little or no effort at all.

Q3: How confident do you feel about the material AFTER watching the video but BEFORE coming to class?

This question provides information about student's confidence. This also gives information about the quality of the video for the targeted student populations. The confidence appears to be affected by the video (language, length), complexity of the material, and personal schedule. The possible answers here were (1) Extremely confident, (2) Not very confident, (3) Somewhat confident but need more help.

From our observation of the classroom, students have expressed the need of regularly having the big picture of the class, how elements are connected and how to assess their progress. Also, as reported by Kim et al. [2], clearly defined and well-structured guidance for each video will help the students and especially second language students.
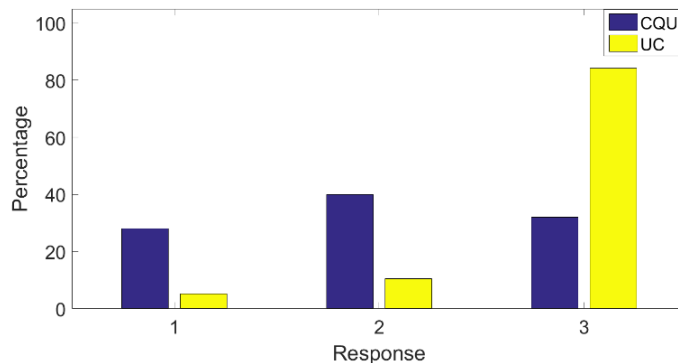

Figure 3: How confident do you feel about the material AFTER watching the video but BEFORE coming to class? (1) Extremely confident, (2) Not very confident, (3) Somewhat confident but need more help

3.2 Student's activities in class

Q4: Do you find the discussion and the review at the beginning of the class helpful?

The possible answers were (1) Always, (2) Most of the time, (3) Some of the time, (4) Rarely, (5) Never. The interesting part here is that, for both populations, no one was likely to agree that the

review at the beginning of the class was not helpful at all, see Fig. 4. However, the mid-term and end-of-class surveys have shown that student from 'our CQU campus will prefer to have a global picture of the class structure, showing how all chapters and activities are connected, and eventually a daily progress.
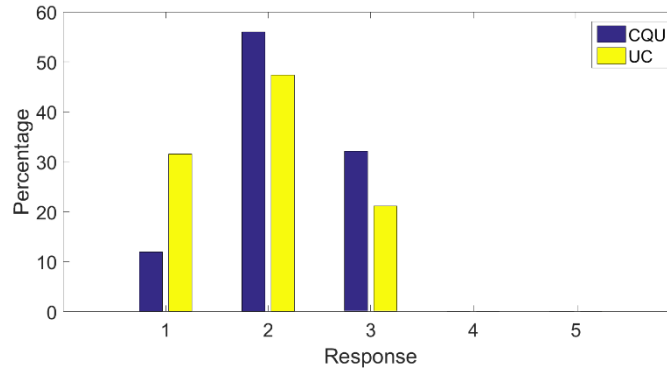

Figure 4: Question: Do you find the discussion and the review at the beginning of the class helpful? (1) Always, (2) Most of the time, (3) Some of the time, (4) Rarely, (5) Never.

Q5: Please describe the amount of effort you have been putting in during your time IN class?

Possible answers were (1) I am trying as hard as I can (max effort), (2) I am putting in a good effort each day, (3) I am not really trying, (4) A little or no effort at all. In contrast, all students in our UC campus were really giving good or a maximum effort during in-class activities (group discussion, group assignment), while about 20% (see Fig. 5)of students in our CQU campus were not trying (passive attitude in class, and then copy their classmates results.)
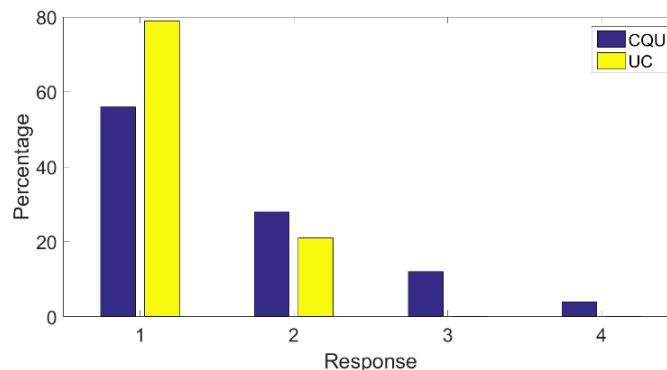

Figure 5: Please describe the amount of effort you have been putting in during your time IN class. (1) I am trying as hard as I can (max effort), (2) I am putting in a good effort each day, (3) I am not really trying, (4) A little or no effort at all.

Q6: Flipped classroom has improved my team work

One of the interests of active learning methods is to improve team work skills amongst students. The long term advantage here is their ability to effectively work in groups, which is one of the core competencies prescribed by ASEE and ABET [5, 7, 8]. Students were asked to select one answer

from the following list: (1) Strongly agree, (2) Agree, (3) Neither agree or disagree, (4) Disagree, (5) Strongly disagree.

The observations in Fig. 6 show that, students in an active culture of learning (students centered learning environment) are more likely to agree that flipped classroom contribute to increase their team work ability. Students from a passive culture of learning (teacher centered learning environment) are less enthusiastic about this teaching approach. The difference here can also be understood when considering the fact that, the student population in China were experiencing their first 100% students centered learning environment. Overall, the key point here is validated by all students who agreed that flipped classroom setting contribute to improve their team work skills. Similar observation was made with Malaysian population by Jamaludin et al. [5] and Attaran and Zainuddin [9] who studied the Malaysian students' perception of flipped classroom.
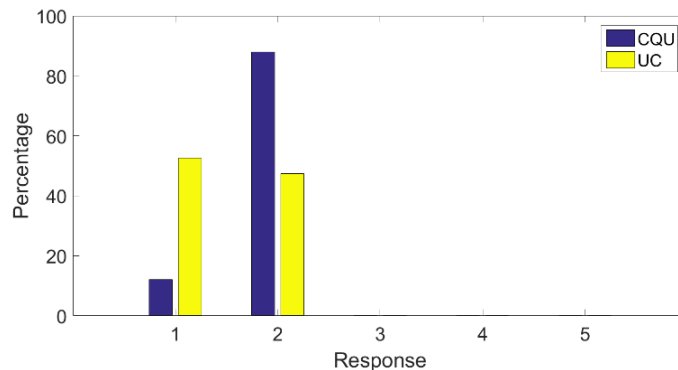

Figure 6: Question: Flipped classroom and team work skills. (1) Strongly agree, (2) Agree, (3) Neither agree or disagree, (4) Disagree, (5) Strongly disagree

Q7: Flipped classroom is more engaging

Student engagement is known to be a key element in achieving course outcomes. [4] According to Kim et al. [2] and Jamaludin et al. [5] the flipped classroom makes the teaching and learning processes more engaging. These studies consisted of observing a single student population or observing three classrooms across unique disciplines. The singularity of this analysis is that the observation is made with two student populations in distinct cultural environment taking the same course. Students were asked to select one answer from the following list: (1) Strongly agree, (2) Agree, (3) Neither agree or disagree, (4) Disagree, (5) Strongly disagree.

One observes from Figure 7 that the distribution is quite different from the impact of flipped classroom on team work skill. All students in an active culture of learning are more likely to agree that flipped classroom is more engaging (most of which will strongly agree) as reported by Kim et al. [2]. A considerable percentage of students in a passive learning environment are more likely to disagree. The reason of this distribution can be justified by the fact that some students were coming in class unprepared (not watching the video, see questions above) and relying on their group members to do the activities. (Recommendation: change group more often and define a strategy to detect non-participating students). In their paper, Kim et al. [2] recommended to provide a robust incentive for students to prepare for class, and reported that "Successful face-to-face interaction, in a typical flipped classroom, depends on the extent to which students have prepared before engaging with the in-class activities." This conclusion is thus, strongly

recommended for students who are used to a teacher-centered learning environment.
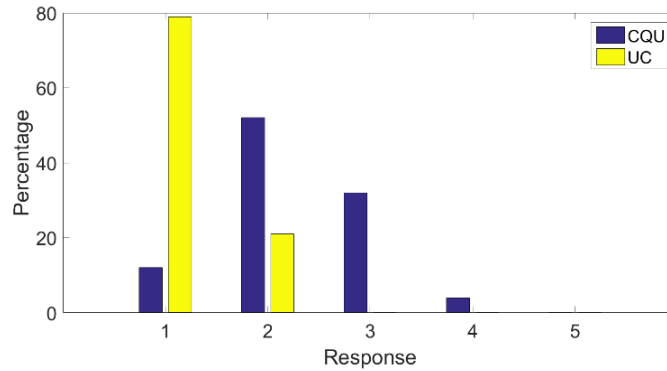
Figure 7: Question: Flipped classroom is more engaging. (1) Strongly agree, (2) Agree, (3) Neither agree or disagree, (4) Disagree, (5) Strongly disagree

3.3 Student's learning

Q8: How confident do you feel about the material AFTER watching the video and AFTER coming to class?

This metric essentially measure the affectivity of the method toward the student's self confidence in this topic. Responses were chosen from the following list: (1) Extremely confident, (2) Not very confident, (3) Somewhat confident but need more help.
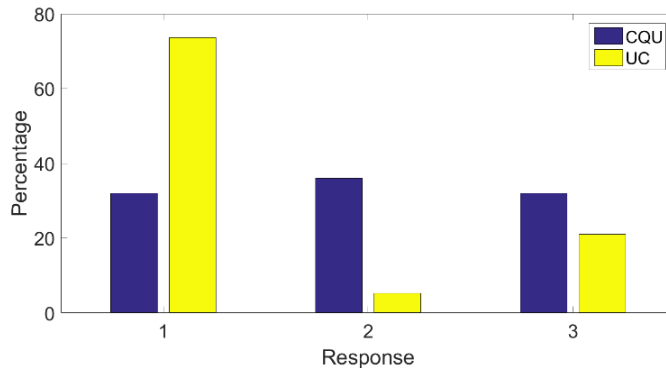
Figure 8: Effects of the in-class discussion and activities. How confident do you feel about the material AFTER watching the video but AFTER coming to class? (1) Extremely confident, (2) Not very confident, (3) Somewhat confident but need more help.

The data of Fig. 8 show that, students in an active learning environment are more likely to agree that in-class activities have a strong effect on their self-confidence. The percentage in the second group are nearly unchanged. That is, the confidence of student before and after the activities is quite the same in percentage. It is possible that the activities have no effect or have increased the confidence of some students while reducing the confidence of another group of students. Kim et al. in their paper concluded that, the confidence of the students is related to how the instructors interpret and apply "flipping" to their classrooms [2], they provided three recommendations for faculty to make the activities more effective: (i) *Provide a mechanism to assess student understanding*, (ii) *Provide enough time for students to carry out the assignments*, (iii) *Provide*

prompt/adaptive feedback on individual or group works.

Q 8: The in-class activities helped you improve your understanding of the lecture

This metric is directly connected to the first 4 discussed above. It directly gives the impact of the class structure and approach on the overall main goal which is student learning. Responses are chosen from the following list: (1) Strongly agree, (2) Agree, (3) Neither agree or disagree, (4) Disagree, (5) Strongly disagree.

Students from UC campus are more likely to agree that the activities in class have contributed to improve their understanding of the lecture. Similar observation was made for most students of the other campus. A percentage of students have disagree or were indifferent.
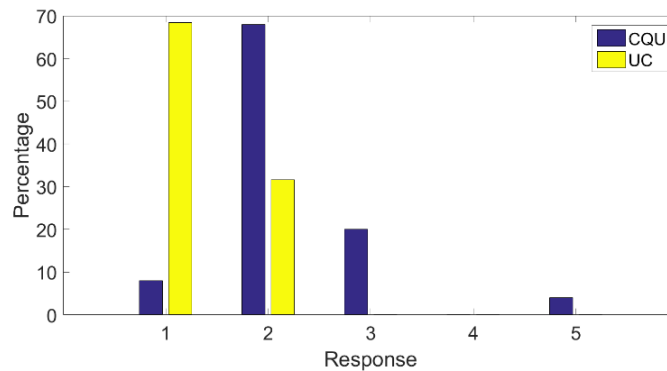

Figure 8: Question: The in-class activities helped you improve your understanding of the lecture. (1) Strongly agree, (2) Agree, (3) Neither agree or disagree, (4) Disagree, (5) Strongly disagree

3.4 Correlation analysis

To get more insight on the result, we consider questions having similar response scales and find the correlation between questions with consecutive events. The first analysis considers the correlation between the statistics of "Do you find the discussion and the review at the beginning of the class helpful?" and "Do you watch the flipped videos on time." The correlation coefficient in Table 1 (and all Tables in this paper) r is defined the strength of the correlation as follows: Weak or no correlation: $0 \leq |r| < 0.25$; Moderate correlation: $0.25 \leq |r| < 0.5$; Strong correlation $0.5 \leq |r| < 0.75$; Very strong correlation: $0.75 \leq |r|1$. In the tables, R1 and R3 refer to the distribution of the students' population in the first group (CQU, passive culture of learning) respectively for the first and second response. R2 and R4 refer to the distribution of the students' population in the second group (UC, active culture of learning) respectively for the first and second response. Thus the coefficient r is computed between R1 and R3 and then R2 and R4.

***Table 1: Do you watch the flipped videos on time? Vs Do you find the discussion
and the review   at the beginning of the class helpful?***

	R1	R2	R3	R4
R1	1.00		0.81	
R2		1.00		0.75
R3	0.81		1.00	
R4		0.75		1.00

The correlation matrix of Table 1 shows a very strong correlation between the behaviors of students at CQU for the considered questions. The corresponding correlation in our UC campus was quite strong. All students were more likely to watch their videos before class, this has impacted their interest of the in-class activities, and thus, they were able to master most of the knowledge.

***Table 2: Perception of student's effort during the learning process: Amount of
effort OFF class Vs amount of effort IN***

	R1	R2	R3	R4
R1	1.00		0.72	
R2		1.00		0.08
R3	0.72		1.00	
R4		0.08		1.00

Table 2 shows the correlation of the statistics between the in-class effort and the out-of class effort. There was no correlation between the in-class activities and the out-of class activities for UC students in our UC campus. This indicates that, students in that campus are more likely to be 100% involved in-class than out-of-class. Group activities, peer discussion and student-teacher interaction appear to engage more students and stimulate their involvement and interest. The strong correlation observed for UC students in our CQU campus is a signature of the passive learning attitude where most of the learning is done individually out of the classroom (home, library, etc.). Students here are used to giving max effort at home (self-learning, reading, and homework), and with the group activities, peer discussion and student- teacher discussion, they also tend to provide max effort. Doing so might help them overcome some difficulties from the videos (language, video length, overview and big picture, adjustment to the teaching method, unclear concepts). The direct consequence is that, these students can be overwhelmed, and this negatively affect their perception of the pedagogical method, at least if UC model is strictly transferred to CQU.

Table 3: Effects of the in-class discussion and activities. Confidence about the material AFTER watching the video but BEFORE coming to class Vs confidence about the material AFTER watching the video but AFTER coming to   class?

	R1	R2	R3	R4
R1	1.00		0.94	
R2		1.00		-0.35
R3	0.94		1.00	
R4		-0.35		1.00

It is interesting to mention that, in a different study based on a population with similar culture of learning, Jamaludin [5] have concluded that "students' interactions and engagement in a flipped classroom had no correlation on the levels of achievement in class, which is correlated to their self-confidence.

The correlation coefficient of Table 3 show that, student's confidence after class activities is strongly correlated with their confidence before classroom. The distribution for our CQU students is quite similar before and after the in-class discussion despite the fact that they are giving max effort. A direct implication here is that, the in-class discussion (review, assignment, and peer-discussion) has no significant effect on student's confidence. One could suspect that the design of the class activities are not well structured for this student's population, or not well developed. This really contrast with students in our UC campus. Here about 80% of students were likely to say they are "somewhat confident but need help" before the in-class activities. About the same percentage was likely to say they are extremely confident after class. That is, the in-class activities has provided (in an effective way) the help they needed. This result can also be impacted by the instructor attitude and experience with inverted pedagogy. It is interesting the recall that, the UC population was taught by a senior faculty member with outstanding experience in active pedagogy, while the CQU population and their instructor were at their first experience with inverted pedagogy.

Table 4: Flipped classroom is more engaging Vs The in-class activities helped you improve your understanding of the lecture

	R1	R2	R3	R4
R1	1.00		0.94	
R2		1.00		0.98
R3	0.94		1.00	
R4		0.98		1.00

To understand the impact of the above metrics on students' understanding of the lecture,   we estimated the correlation between the data. As shown in Tables 4, for all students' populations, there is a clear and strong effects of team work, students' confidence and class engagement on the understanding of the material.

4. Summary and conclusion

The main objective of this paper was to analyze how international students commonly taught in a passive accept flipped classroom pedagogy; and compare their behavior before and during the class to the behavior of US students taking the same course. The major observations made are that, the students equivalently accepted the new pedagogy and there was a clear impact on their ability to understand the material and to develop team work skills. However, the data showed that, the international students had a different approach as compare to US students. This was interpreted as due to their past preference for passive learning, the language, the pace of the class. Key points for future improvements are (i): reduction the length of the video, (ii): provide more connections between the videos and the overall goals of the course; (iii) constantly motivate students to get out of their comfort zone.

The main limitation of the present analysis is that it is based on two experimental populations and limited to a single semester. Further analysis should incorporate the recommendations of Bishop and Verleger [4] and extend the results to larger students' populations over several years; and compare the statistical results to those obtained with traditional teaching methods.

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