Effectiveness of the Synchronous Online Flipped Classroom on Students' Learning During the COVID-19 Pandemic

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The flipped classroom approach is a pedagogical method for active learning and engagement in learning activities. Many Construction Management (CM) educators have adopted this pedagogical method and confirmed its benefits in classroom teaching. However, the effectiveness of the flipped classroom model on students' learning in 100% synchronous online courses, specifically for CM education, is not reported. CM educators need to understand the feasibility and effectiveness of flipped classrooms for online courses during the pandemic. This paper initially presents the technologies and methods adopted in this study to transform two online CM courses into a flipped approach. Later, the flipped classroom model's effectiveness is assessed through student feedback. The results indicated a mixed response from the students regarding the effectiveness of the flipped classroom model over traditional teaching. Although around two-thirds of the students recommend the flipped classroom model over conventional education, they now prefer conventional face-to-face teaching over the online flipped classroom.

Key Words: Pedagogy, Flipped Classroom, Synchronous Online Teaching

Introduction

The flipped classroom pedagogical model is a relatively new alternative to the typical lecture-based teaching approach. In conventional teaching, the students are taught course contents during class time, and they apply the learned concepts through homework, projects, etc., independently at home. This conventional approach is reversed in the flipped approach, where the direct instruction moves from the group learning space (e.g., classroom) to the individual learning space. The resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students to apply concepts and engage creatively in the subject matter. In simple terms, students must learn course contents before the lecture, and they apply the learned concepts in the classroom through diverse activities such as discussion, problem-solving, group projects, etc. Thus, students can expand their knowledge with active learning opportunities, apply it to real-world problems, and experience a better education (Mihai 2016).

The flipped model's benefit in enhancing students' learning experience has attracted many teachers to implement the flipped approach. Furthermore, this approach is practical for different modes of instruction such as traditional teaching (face-to-face), online format, or in a hybrid mode which is a mix of online and face-to-face instruction. While the success of flipped classroom model for face-to-face instruction which is the predominant teaching mode, is widely reported, there is limited reporting about the effectiveness of the flipped classroom model in an online format. However, there has been a sudden surge towards online education for the last two years due to the Covid-19 pandemic, and this trend of virtual education may continue in the future (Diederich et al., 2020). Hence, it is essential to understand whether the flipped classroom model, which proved to be an effective pedagogical method in conventional teaching, holds the same benefit in online education.

Implementing flipped model for online CM education may pose various challenges. First, the CM educators desire to facilitate an active peer learning environment in the classroom through hands-on and group activities (David and Cline, 2009; Hegazy et al., 2013). Online education may hamper such learning opportunities. Second, there is not exiting literature on which components of the course can be flipped and how strategically those components are planned for CM education. Third, does students' individual academic performance have an influence on how they perceive flipped approach? In this regard, this study aims to assess the effectiveness of flipped classroom model in online CM education.

Literature Review

Benefits of the Flipped Classroom Method

Mojtahedi et al. (2020) described that the flipped classroom model for Construction Education improves students' learning experience through collaborations and interaction between students. Lee and Kim (2016) argued that CM students' performance in a flipped classroom outperformed the traditional classroom model. Zapper et al. (2009) and Bishop and Verleger (2013) reported that students generally reacted positively to the flipped classroom model. Similarly, Mihai (2016) stated that the students acknowledged better education in the flipped classroom due to the more profound learning opportunities. Swithenbank and DeNucci (2014) showed the positive outcomes of the reversed pedagogical approach. Other reported benefits of the flipped classroom approach were: effectiveness in helping students apply fundamental concepts in solving cost engineering problems for Civil Engineering students (Ling and Gan, 2020), flexibility in the Civil Engineering class lecture time (Swartz et al., 2013), among others. Despite many researchers' reporting a wide range of benefits offered by flipped classrooms, most of the research was performed in face-to-face instruction mode. Does the flipped model hold the same benefit in online CM education is questionable?

Flipped Classroom in Online Synchronous Classes

The use of online formats for learning and teaching has become more prevalent in recent years due to the advancement of technology. Advanced technology allowed students access to instructional materials and lower costs associated with education (Taplin et al., 2013). Despite the emergence of cutting-edge online teaching technology, its usage was limited as the predominant teaching mode is face-to-face. Nevertheless, in the middle of Spring 2020, the Covid-19 pandemic forced all the instruction to shift online. This abrupt shift to online affected both the teaching and learning, such as less engagement in collaborative learning, student-faculty interactions, peer learning by interacting

with fellow students, and easy distractions in online format (Dumford and Miller, 2018 and Hiranrithikorn 2019). As the online mode of instruction was the optimal choice for many universities globally during the Covid-19, faculty need to contemplate ways to promote student engagement in online education.

In general, there are two significant ways of online instruction asynchronous and synchronous. In asynchronous mode, the faculty records the class lectures and makes them accessible to students. Students can access the recorded lectures through faculty-selected paths such as institutions learning management systems (LMS) like Blackboard ™, sharing the videos through YouTube ™, etc. This mode offers more flexibility to students as they review the lectures on their schedules. However, in this mode, students miss the interaction with faculty and fellow students, which may impact their learning ability.

In synchronous mode, the faculty and students meet online at the scheduled time using the communication platforms like Microsoft Teams ®, Zoom, Webex, etc. Thus, synchronous online learning involves a real-time, instructor-led learning environment where students can simultaneously engage with instructors and other students. The instructor has control over the interaction in the class. Therefore, research indicates that synchronous online learning allows students to keep focused on the contents or tasks, promotes students' participation, and could lead to better performance (Chen and You, 2007; Hrastinski, 2010). Considering the possibility of interactions between the faculty and students in synchronous online teaching, many teaching faculty across different degree programs anticipated that the Flipped classroom may suit the synchronous mode of online instruction.

Research Objective and Questions

This study aims to examine the effectiveness of the flipped classroom model in synchronous online CM courses. The efficiency in this study means that the students had a positive experience in flipped approach compared with conventional ones. Besides the effectiveness, this study is also interested to understand if there is any influence of the student's performance on how they perceive the benefits of the flipped approach. For example, diligent students adapt to different learning approaches comfortably compared with underperforming students. Hence, this study aims to determine whether all divisions of the student body feel that the flipped classroom model is effective or only the well-performing students. Therefore, this study aimed to achieve the research objective by addressing the following two research questions:

1. How effective is the flipped classroom model on students' learning in students' perception? This question is addressed by examining the effectiveness of the flipped approach on students' learning from students' perspectives.
2. Is the effectiveness of the flipped classroom in students' perception affected by their academic performance? The hypothesis for this question is that students with different academic performances differently perceive the effectiveness of the flipped classroom model.

Methodology

Design of the Flipped Classroom

In this study, three CM courses taught by one of the authors were redesigned to a flipped classroom model for 100% synchronous online classes. The courses were one section of the "Cost Estimating" and two sections of the "Construction Scheduling" courses. For these two courses, the student learning outcomes (SLO) were to 'create' construction project cost estimates and construction project schedules, respectively. According to Bloom's taxonomy creating is the highest level of learning outcomes. The courses include learning activities with problem-solving and the application of problem-solving skills into real-world problems. The three classes had been taught in the conventional learning method in 100% face-to-face format with lecture by the instructor, instructor-guided problem solving (or application), student-lead work example problems, and homework assignment before the COVID-19 pandemic. Before the Covid-19 pandemic, the instructor employed multiple methods like online quizzes, discussions, and problem-solving in the convention teaching setup. Moreover, students could work together on numerical example problems during class time, and grades were assigned for their classwork to encourage them to participate. However, when the instructor designed courses in the flipped classroom model for Fall 2020, the course contents were like the conventional teaching, except the activities were reversed. The differences between conventional and flipped classroom models are presented in Table 1.

Table 1

Comparison of the flipped classroom model with conventional teaching model

Teaching Method	Before class	Activities During class			Activities After class
Prior to the pandemic	N/A	Lecture	Instructor-guided problem solving (*Problem A*)	Student-led work example problem (*Problem B*)	Application to another problem in a homework (*Problem C*)
Flipped Classroom Model	• Lecture videos (including instructor-guided problem solving (*Problem A*)) • Online quiz	• Review of the contents • Feedback on online quiz	Instructor – guided problem solving (*Problem B*)	Student-led work example problem (*Problem C*)	Faculty provides feedback on the student's work performed during the class.

The significant difference between both methods was that students needed to review the lecture videos and other course materials before the online synchronous class in the Flipped model. Also, the students must take a quiz before the online course. Mojtahedi et al. (2020) recommended pre-class activity like quiz for active engagement in independent learning. The quiz coerces students to review the material and ensures that students studied the material. Typically, the lecture video(s) introduces a new topic and includes simple examples relevant to the subject to help students apply basic knowledge and develop problem-solving skills. To minimize the distractions, the instructor ensured that the lecture videos were typically 10-15 minutes long. During the synchronous online session, the faculty reviews the topic and provides feedback on pre-class activities. These steps support the students to refresh their memory as well as summarize the concepts. Later, the faculty demonstrates the field application of the concepts through a numerical example or case study. Subsequently, the students either work individually or as a group apply their knowledge in solving a problem and submit their work. By the end of the class, students submit their work to faculty, who assess them. No separate after-class activities were required in the flipped instruction. The course elements were

reformatted and used for different purposes regarding students learning activities. The Problem A, B, and C in the Table 1 are just for illustration to show how differently the work problems were delivered in the flipped classroom model compared with conventional instruction method.

Tools for the Flipped Synchronous Online Classes

Since this study is applying the flipped classroom model for the 100% synchronous online courses, integrating different course elements with suitable technology is paramount. The selected technology shall support easy interaction and engage students in learning activities without any hindrances. Hence, the following list of technologies were used for the courses in this study:

- Sakai, a learning management system, was used for posting lecture videos, classwork problems, online quizzes, feedback to students, and their grades.
- The Zoom was a virtual space to facilitate interaction between students and instructors. The instructor also used the Breakout Room function for group work as needed.
- Microsoft Class Notebook was used for instant feedback of students' in-class work.
- An online whiteboard application (for example, Mural) was used to present solutions to problems such as network diagrams for construction schedule.
- Microsoft Stream was utilized to save lecture videos and to share them with students.
- Edpuzzle was used for adding interactive content such as quizzes in the lecture videos.
- Students' licenses for cost estimating computer software (OnScreen Takeoff, QuickBid, and Bluebeam Revu) were provided for installation on their computers.
- Citrix Remote Desktop and Virtual Apps were used to access the scheduling software.
- Microsoft Forms ® was used for collecting the feedback from the students.

Online Survey for Student's Perception on the Effectiveness of Flipped Classroom

This study addressed the research objective and questions by collecting and examining the students' responses through a questionnaire which focuses on addressing research question 1 (How effective is the flipped classroom model on students' learning in students' perception?). Students were provided the questionnaire through *Microsoft Forms* and the responses are analyzed in *Microsoft Excel.*

1. Which of the followings do you prefer for your classes?
   a) Traditional (non-flipped classroom) approach: class topics are introduced in the class, and in-class learning activities are performed
   b) Flipped classroom approach: class topics are introduced through pre-recorded lecture notes before class, more in-class learning activities during the class, and no additional homework is assigned.
2. How do you agree to the following statement? *The Flipped Classroom approach in this class has helped me learn in this class significantly.*
   - *Strongly agree, Somewhat agree, Neutral, Somewhat disagree*, and *Strongly disagree*
3. How do you agree to the following statement? *The Flipped Classroom approach in this class is more efficient learning module for me than the traditional (non-flipped classroom) approach.*
   - Strongly agree, Somewhat agree, Neutral, Somewhat disagree, and Strongly disagree
4. How would you recommend Flipped Classroom approach?
   a) I would NOT recommend the flipped classroom approach in any format of classes.
   b) I would recommend the flipped classroom approach both in the online class and in the in-person class.
   c) I would recommend the flipped classroom approach only in the online class.
   d) I would recommend the flipped classroom approach only in an in-person class.

In addition to students' responses to the survey questions, students' test scores were used to answer the second research question in this study. Is *the effectiveness of the flipped classroom in students' perception affected by their academic performance?* The courses (Construction Estimating and Construction Scheduling courses) for this study include one examination. The weight of the test is 20% toward the student's final grade in the Cost Estimating class and 25% in the Construction Scheduling class, respectively.

Data Collection

The students in the courses were asked the survey questions in an online *Zoom* class session toward the end of the Fall 2020 semester. The number of responses in each course is 19 responses out of 25 students in Cost Estimating class, 25 responses out of 26 students in Section 01, and 22 responses out of 23 students in Section 02 in Construction Scheduling class.

Results

Students' Perception of Flipped Classroom

Figure 1 shows the students' responses to the first and second questions of the questionnaire survey question on preference between the flipped classroom and traditional approaches. Out of the total 66 responses, 42 students (63.6%) preferred the conventional approach to the flipped classroom approach. In contrast to the first question response, in the second question, 50% of the students strongly agree or somewhat agree that the Flipped classroom approach helped them learn significantly. Like the second question, 56% of students responded positively to the third question (Figure 2), indicating that the Flipped classroom approach is a more efficient learning method than the conventional one. Similarly, two-thirds of the class recommends using the Flipped classroom approach either online or in in-person courses.
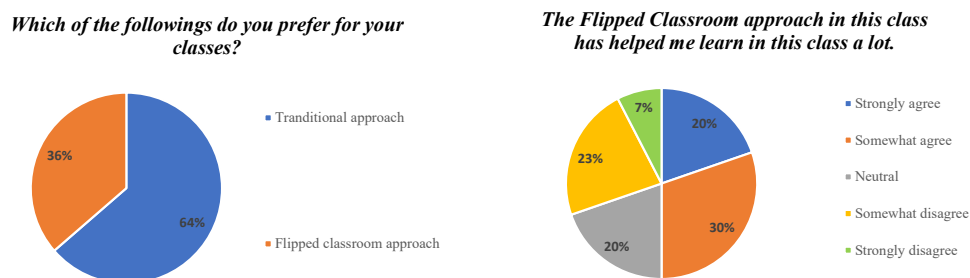

Figure 1: Responses to the Survey Question 1and 2

To address the second research question, we compared the students' test scores with their responses to question #3 of the questionnaire. In this analysis, this study categorized the students into various groups based on their responses to question #3. For example, all the students who responded strongly agree that the Flipped classroom approach is more efficient than the conventional method were considered one group. Later, each student's test score in that group was collected, and the mean and standard deviation of the group test score was calculated. Similarly, the scores of other groups were recorded.
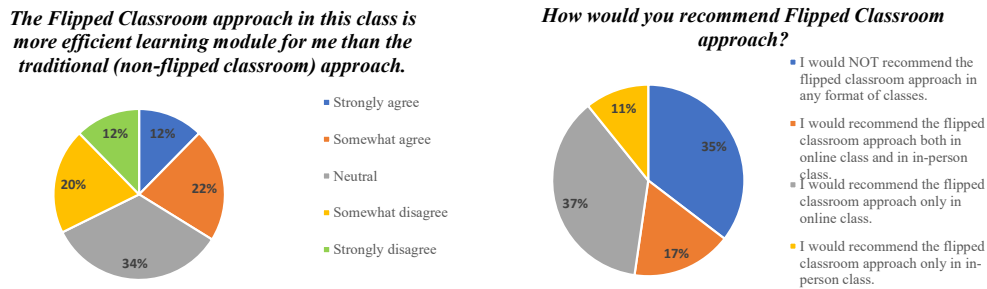
Figure 2: Response to the Survey Question 3 and 4

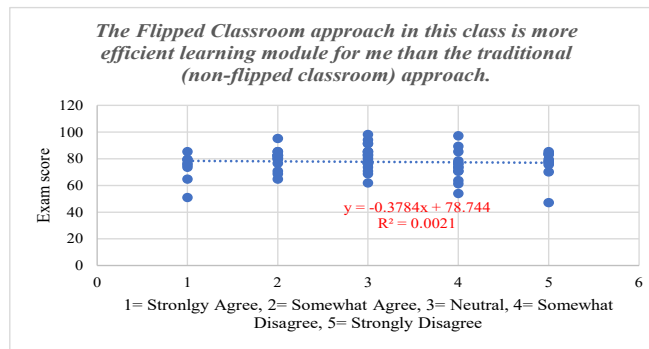*Relationship between Students' Perception and Academic Performance*

Figure 3: Response to the Question #3 vs. Exam Score.

Figure 3 shows the distribution of test scores for the students in the three courses. From a linear regression analysis as displayed in Figure 3, there is no strong relationship between the students' responses to question 3 and their test scores. Thus, the null hypothesis, 'The effectiveness of the flipped classroom model is differently perceived by students' academic performance.' should be rejected. Therefore, it is determined that students' perception of the effectiveness of the flipped classroom model was not related to their academic performance.

Discussion

The authors observed a mixed response from the students regarding the effectiveness of the flipped classroom model over traditional teaching. For instance, question 1 of the survey indicated that only one in every three students (~34%) preferred flipped classroom approach compared with the conventional one. However, a positive response to the remaining survey questions indicates that at least one in two students (>50%) liked the flipped classroom over the traditional approach and 64% of the recommended flipped approach over the conventional method.
The authors of the current study believe that the flipped classroom approach can help students learn and provide a better learning experience in a remote learning environment.

The authors believe one of the reasons for the mixed response is the timing of the study. This study was conducted in Fall 2020, where almost every course was offered online due to Covid-19. Based on the feedback received by the authors from students, most of the students indicated that they were

saturated with online teaching and desperate for in-person classes. Several students in the courses in this study reported that they got tired of working in front of computer screen all day. Also, several students in the courses reported technology issues such as unreliable internet connection, downtime for the LMS tool, and crashed computer software. Nevertheless, the authors firmly believe that flipping classroom is effective for online education. However, certain factors outside the school (like covid-19 induced circumstances) might influence this study, resulting in mixed responses. Future research on flipped online education is required to clarify its benefits over conventional classes when the current covid-19 induced uncertainties ease. As Mojtahedi et al. (2020) recognized, the flipped portion of students' learning, pre-class self-learning, is one of the critical success factors for the flipped classroom approach. While students in the courses in this study were encouraged to study the contents in advance by watching lecture videos and taking online quizzes, it was observed that some students took pre-class online quizzes without watching the related lecture videos. Coffey and Clarke (2021) identified that this is an ongoing issue with some students, specifically in the online teaching approach. Instructors need to motivate students better to finish required homework assignments to enhance students' learning.

The findings from this study are limited to relatively small data sample with 66 students in one semester. Thus, it is required that more data need to be collected from flipped online courses in the future. Also, the authors believe that future studies on what level of 'flipping' format is the most beneficial for CM education is needed.

Conclusions

- The flipped classroom approach is a relatively new pedagogical approach for active learning, students' engagement, and a better education experience. By reversing listening to lecture in the classroom to a self-learning assignment before class, more class time can be used for a more active learning experience.
- This study's findings based on students' perception reveal a mixed response on the effectiveness of the flipped classroom model for online education over the conventional method.
- Most of the students agreed that the flipped model is adequate. However, they preferred traditional teaching over flipped classroom model possibly due to the lethargy caused by the complete remote learning during Covid-19 in 2020.
- One of the key findings of this study is that the student's perception of the flipped classroom model is not based on their academic performance (Figure 3).

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