Flipping the Classroom to Improve Academic Achievement of Information Systems Students with the Support of Learning Management System (LMS)

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Abstract

This study aims to explore the effects of flipped classroom implementation on students' academic achievement. Three courses that was offered to Information System students implemented the flipped classroom approach with the support of ULearn Learning Management System (LMS) over twelve (12) weeks of learning. Students' coursework assessments and examination scores were compared between controlled groups that employed traditional teaching approach and experimental groups which introduced the flipped learning approach. The Mann-Whitney test was used to compare the median and mean total marks of the two learning approaches, as well as data consistency for the mean total marks. Results show that median and mean total marks were higher in experimental group when compared to the control group for Knowledge Management System (KMS) and Information System Strategy & Planning (ISP) courses. This is proof that flipped classroom approach is a potential student-centred learning approach that can improve students' academic achievement by encouraging students to be deep learners and promoting self-directed learning and life-long learning through the time optimization of out-class lectures and in-class active and collaborative learning activities.

Keywords: Flipped classroom, flipped learning approach.

Introduction

The call for transformation towards 21st century teaching and learning has been a challenge to educators globally. Educators are urged to design meaningful learning experiences to develop holistic learners who will be able to adapt with future challenges (Ananiadou & Claro, 2009). Educators are also recommended to shift their paradigm into adopting student-centred learning pedagogies and approaches which include problem-based learning (Barrows, 1996), project-based learning (Rani et al., 2020), game-based learning (Alam, 2020), service-based learning (Sigmon, 1994 and flipped classroom (King, 1993) as presented in the context of this paper.

The core challenge to this transformation lies in adopting and adapting to student-centred learning approaches to replace traditional teaching (Keiler, 2018). Many educators have not fully realized the potential of these approaches and often resist to adapt to these teaching pedagogies prior to their teacher-centred preconception (Radzali, Mohd-Yusof & Phang, 2018). Likewise, many students prefer the traditional way of learning which allows them to feel complacent as a knowledge receiver instead of an active participant or a problem-solver in classrooms (Snyder &Snyder, 2008).

Traditional teaching refers to long hours of lecture delivered by an instructor often in front of a classroom or lecture hall (Touron & Santiago, 2015). The lecturer act as the main actor in the classroom, who delivers the content often in a one-way mode of communication, with very minimal interruption and participation from students throughout the lecture session. All contents, materials and explanations are delivered during the lecture hour. Assignments are given as a take-home tasks and students are expected to submit the completed work on a stated due date. The work is then

marked and returned to students for revision purpose on subsequent weeks, sometimes very much later in the semester.

Flipped classroom approach, which is one of the student-centred learning pedagogies is found to be able to create meaningful learning strategies for students. Flipped or also known as inverted classroom approach, switches the traditional teaching and learning implementation from teacher-centred to student-centred (Bergmann & Aaron, 2012; Cole & Kritzer, 2009; Tucker, 1966). In the flipped classroom approach (as shown in Figure 1), traditional lectures that are often conducted in class are now delivered through electronic means such as pre-recorded videos that are uploaded in social media platforms such as YouTube, Facebook and Podcasts which are often available in the learning management systems (LMS). By watching and listening to the pre-recorded materials, students are guided to learn fundamental key concepts and terminologies independently before attending the physical class.

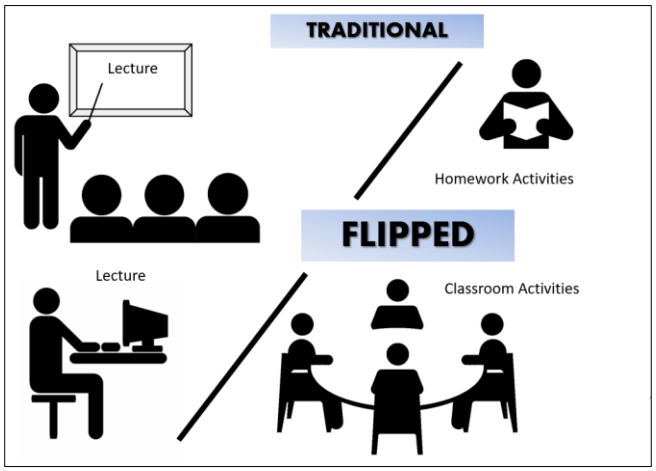

Figure 1. Flipped classroom vs Traditional Teaching – transformation to student-centred learning from teacher-centred learning.

Contrarily, in flipped classroom settings, the take-home assignments, homework, or projects are conducted as discussion during in-class activities (refer to Figure 1). The implementation of flipped classroom is claimed to improve learners' knowledge retention and transfer through active learning and collaborative learning during in–class activities (Estes, Ingram, & Liu, 2015). Instead of using the class time to explain the course contents during lectures, students are expected to engage with the contents in an online format prior to class, and thus be prepared to actively apply their newly acquired knowledge via peer interactions, work groups and activities that will take place in classroom. In this learning environment, the instructor's main role is to guide students in creating, applying and evaluating the fundamental concepts (Foldnes, 2016; Hwang, Lai, & Wang, 2015; Jamaludin & Md Osman, 2014; Milman, 2012; Phillips & Trainor, 2014).

It is worth noting that in flipped classroom settings a significant proportion of the in-class traditional lecture is shifted out of the classroom and should be accessed by students before the commencement of the actual class. The shift of lecture prior to class is expected to help prepare them with the knowledge required for application during discussion in class. Majority of the time spent in classroom is utilized for problem solving, analytical thinking and knowledge application. Bergfjord and Heggernes (2016) found that students who were better prepared for class, were more satisfied with the course, and achieved slightly better grades.

Based on the previous works mentioned, it motivates this study to further explore the factors that contribute to the success of flipped classroom towards students' academic performance. The main purpose of this study is to determine the effects of flipped classroom approach on undergraduate students' academic performance of three (3) Information Systems courses – Enterprise Architecture (EA), Knowledge Management Strategies (KMS) and Information System Strategy & Planning (ISP). Two different learning approaches were employed: traditional teaching and flipped classroom. It is expected that students in the flipped classroom will have higher course examination average when compared to those in the traditional teaching classroom. This study contributes to the computing field of education by measuring the effects of flipped classroom on the academic performance of students in three different Information Systems courses.

METHODS

A. Data Collection

Three (3) case studies of three different Information Systems courses at the undergraduate level were conducted as part of this study over two semesters in 2019 and 2020. These courses are normally offered to Computer and Information Sciences students of the Faculty of Science and Information Technology, in one of the private higher education institutions in Malaysia. The students participated in these courses were from different cohorts, majoring in Information Sytems. All courses were conducted over twelve (12) weeks in a full semester. The total number of students for each cohort registered in the courses varied in each semester as presented in Table 1. Data collection for the case studies were conducted following the ethics and procedures approved by the Centre for Excellence in Teaching and Learning of the higher education institution. The courses were delivered using traditional teaching in all control groups and flipped classroom were conducted in all experimental groups.

Table 1. Details of three (3) case studies conducted for three Information Systems courses over two (2) semesters.

Case Study	1		2		3	
Course Name	Enterprise Architecture (EA)		Knowledge Management System (KMS)		Information System Strategy & Planning (ISP)	
Course Code	SDB4313		SDB4413		TEB3043	
Group	Control	Experimental	Control	Experimental	Control	Experimental
Semester & Year	Sept 2019	Jan 2020	May 2019	Jan 2020	Sept 2019	Jan 2020
No. of Students	41	15	17	13	17	35
Gender	Male					
	14	11	7	5	8	14
	Female					
	27	4	10	8	9	21
Race	Malay					
	36	13	15	10	17	28
	Chinese					
	1	0	0	1	0	4
	Indian					
	2	1	2	1	0	1
	Others					
	1	0	0	0	0	1
	Non-Malaysian					
	1	1	0	1	0	1

The Enterprise Architecture (EA) course is designed to guide 4th year Information Systems major students towards applying their information technology (IT) skills to design robust enterprise architecture. Students are exposed to technical and business elements as well as the industry trends that include service level agreements and service-oriented architecture. Referring to Table 1, data was collected from the control group in September 2019 while another round of data collection was conducted in January 2020 from the experimental group.

The second case study was conducted in May 2019 semester and January 2020 semester involving the Knowledge Management Strategies (KMS) course which was also offered to 4th year students. The course provides fundamental understanding of knowledge management theory, framework, and architecture. Students are exposed to the concepts of data, information, and knowledge towards fulfilling an organization's competitive edge.

The third case study is related to the Information System Strategy and Planning (ISP) course which was offered to 3rd year Information Systems students. The course reviews the concepts of information systems, organizational structures, and models. It introduces students to current issues and development of information systems and proceeds with planning, control, and evaluation of information systems.

It is important to highlight that the experimental group which was introduced to the flipped classroom approach were conducted by three (3) different flipped classroom practitioners who had completed flipped classroom trainings provided by the private higher education institution. These instructors have been practising flipped classroom delivery for more than three (3) years in various courses and have also been disseminating flipped classroom practices in series of community of practices (CoP), workshops and trainings, conferences, exhibitions, and various publication outlets. On the other note, the control group were under by three (3) different instructors who are familiar with the courses they taught. They have chosen to deliver the courses using traditional teaching delivery method.

B. Data Analysis

Students' academic results that include coursework marks, assessment marks and final examination scores were collected from all courses involved in this study. The control and experimental groups' academic results were analysed separately and compared at a later stage. Based on these data, the median grade, mean (average) marks and standard deviation were analysed.

A statistical test using comparison of mean was conducted to find answers to the stated hypothesis. Initially, data for each case study were checked and cleaned during the pre-processing stage and any missing data and outliers were identified. Next, checking for normality of student's performance using histogram and statistical test (Shapiro-Wilk) was conducted. The Shapiro-Wilk test was used as the sample size is less than 50.

Following this, the statistical tests for comparison of mean were performed for each course to compare students' performance between the two (2) different learning approaches employed in both control and experimental group. The Welch's independent T-test were performed for the cohorts that satisfied the normality assumption, while the Mann-Whitney test

were performed for the cohorts that did not met the normality assumption. The Welch's independent T-test was chosen over student's independent T-test due to the unbalanced dataset for each cohort in the case studies.

C. The Flipped Classroom Environment

The experimental groups who were introduced to flipped learning had weekly face-to-face sessions (180 minutes). At the beginning of the course, students were informed that the course will be adopting a flipped learning approach. Students are required to view online lectures, materials, and resources prior to the face-to-face class. This is crucial for them to be able to apply the knowledge and fully participate in the class activities. Students were given a brief introduction at the beginning of the semester to inform about the course's learning outcomes, topics, activities, and schedule for them to conduct self-learning at their own pace.

In this study, flipped learning were conducted with the support of using the ULearn LMS, which is a Moodle-based system, as shown in Figure 2. The online materials were readily accessible to all students registered for the course. When students entered the online course, they will be able to view learning materials and resources, pre-recorded videos, online quizzes, learning outcomes, announcements, sample answers and more. Students are expected to access these materials and resources related to the weekly topics prior to the face-to-face classes.

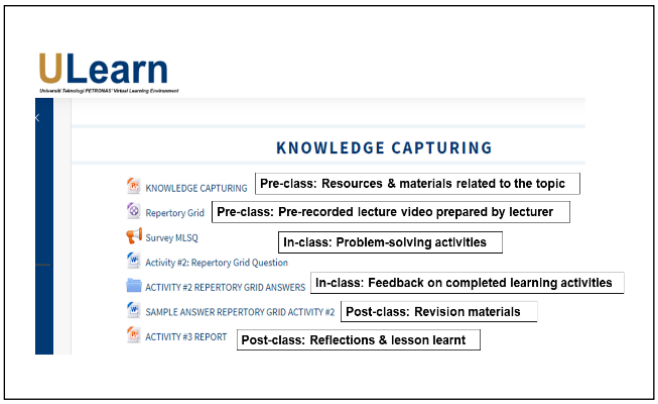

Figure. 2. Sample of the ULearn Learning Management System (LMS) interface for Knowledge Management System (KMS) course

Besides the pre-class materials, students were equipped with other learning resources that include in-class activities assessment rubrics, feedbacks on completed learning activities, revisions materials and students'/lecturers' reflections in the ULearn LMS (as shown in Figure 2).

As mentioned before, students were aware that lectures will not be delivered during the face-to-face class sessions. During each class, various active learning and collaborative learning activities were conducted in a dedicated flipped learning classroom with movable chairs and tables as shown in Figure 3. The classroom is equipped with Wi-Fi network, allowing students to access the resources and materials in LMS at any time. During collaborative activities, students were assigned to random groups of two (2) to four (4) members at a time. Activities in the classroom include individual quizzes, think-pair share and problem-solving tasks.

Figure. 3. Active and collaborative learning during the face-to-face classes conducted in dedicated flipped classrooms.

During the flipped face-to-face classes, students were involved in activities that were designed to test their understanding of the topics and resources provided in the LMS. There were various problem-solving activities given to students over the twelve (12) academic weeks in a semester. Samples of problem-solving activities are displayed in Figure 4. Each task has different time limit to be completed depending on the type, complexity, and structure of the activity. In group problem-solving activities, each member plays a significant role in taking initiatives and effort to complete the group tasks. They could refer to online resources available on LMS and other sources as well through discussions with group members.

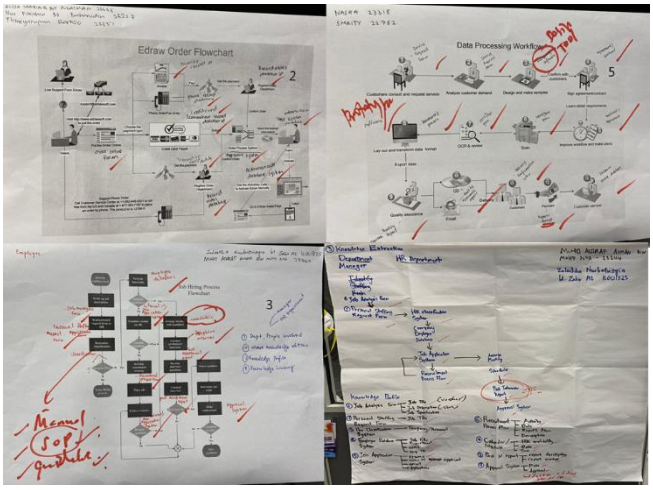

Figure. 4. Samples of students' answers for various in-class active learning and collaborative learning activities

Results And Discussions

The aim of this study is to explore the effects of implementing flipped classroom towards students' academic achievement by analysing the students' academic results between traditional teaching delivery and flipped classroom approach. Statistical analyses were performed to the academic results collected from the three (3) courses involved in this study. The normality test was performed using the Shapiro-Wilk test since the sample size for each group were less than 50. As presented in Table 2, it is found that some of the data were not normally distributed since the p-value for the Shapiro-Wilk were less than 0.05. Comparison of these results were also presented in graphical visualization using histogram to confirm the statistical test using Shapiro-Wilk (not a part of this paper).

Since some of the data for each group were not normally distributed, the analysis proceeded with the Mann-Whitney test to compare the students' academic performance when traditional teaching versus flipped classroom approach were employed. Referring to Table 3, the Mann-Whitney U test was performed, and it was found that there was a significant difference on median total score between the control and experimental group for KMS (SDB4413) course as the p-value was less than 0.05 [Mann-Whitney U: 59.00, p-value: 0.031]. However, it was also found that the median total marks for EA (SDB4313) and ISP (TEB3023) indicated no difference between the control and experimental group since the p-value for both courses were more than 0.05.

Further investigation on data consistency of the control and experimental group by courses were also conducted in this study. Referring to Table 4, the coefficient of variation was used to measure the consistency of data for each group in all courses. For the EA course (SDB4313), the mean marks were higher for the control group compared to the experimental group. It is also noted that the control group has a consistent data distribution as compared to the experimental group since the coefficient of variation was lower [CV: 13.24%].

Table 2: Statistical test on normality assumption between samples of traditional and flipped learning approaches.

Courses	Groups	Sample size (n)	Shapiro-Wilk (df[a])	p-value
EA (SDB 4313)	Control	41	0.958 (41)	0.135
	Experimental	15	0.555 (15)	<0.0001
KMS(SDB 4413)	Control	17	0.814 (17)	0.003
	Experimental	13	0.879 (13)	0.069
ISP (TEB 3023)	Control	17	0.902 (17)	0.074
	Experimental	35	0.976 (35)	0.611

[a]df - degree of freedom

Table 3: Comparison of median total marks of students' academic achievement between traditional teaching and flipped classroom learning approaches.

Courses	Groups	Median (IQR[a])	Mann-Whitney U	p-value
EA (SDB4313)	Control	75.00 (10.23)	307.50	>0.95
	Experimental	74.60 (10.50)		
KMS (SDB4413)	Control	72.05 (8.95)	59.00	0.031
	Experimental	78.91 (11.51)		
ISP (TEB3023)	Control	69.40 (16.92)	200.00	0.057
	Experimental	77.20 (12.00)		

[a]IQR - inter quartile range.

Table 4: Comparison of data consistency on mean total marks of students' achievement between traditional teaching and flipped classroom approaches,

Courses	Groups	Mean (sd[a])	CV[b]
EA (SDB4313)	**Control**	74.48 (9.86)	13.24%
	Experimental	70.98 (20.49)	28.87%
KMS (SDB4413)	**Control**	70.62 (10.53)	14.91%
	Experimental	77.35 (9.57)	12.37%
ISP (TEB3023)	**Control**	70.40 (9.67)	13.74%
	Experimental	76.04 (7.58)	9.96%

[a]sd - standard deviation
[B]CV - coefficient of variation. CV = standard deviation/mean *100%

On the other hand, referring to the KMS (SDB4413) course, it was found that the experimental group has consistent data distributions on student's total marks as the coefficient of variation was lower as compared to the control group [CV: 12.37%]. Lastly, for the ISP course (TEB3023), it is found that higher mean of total marks was noted in the experimental group. The data distribution for the experimental group was also consistent as compared to the control group since the coefficient of variation was lower [CV: 9.96%].

This concludes that the students' academic achievements were higher (higher median and mean total marks) when flipped classroom approach was employed in the KMS and ISP courses. It is one of the indicators to support flipped learning as the learning approach for these courses. This could be attributed due to the nature of the course, the content as well as the instructor's skills in flipped teaching delivery which are not part of this study. In conclusion, there is a significant improvement on student's academic performance when flipped classroom method was employed in the KMS and ISP courses. However, the same result was not found in the EA course.

Based on the findings of the three case studies, it is evident that flipped learning is a potential hybrid approach to learning that can improve students' academic achievement. It is a strategic learning approach that helps transform teacher-centred learning to student-centred learning by shifting the classroom lecture to take-home mode through proper technology and optimizing face-to-face session time for interactive learning. This study intends to highlight the two roles that contributes to the success of flipped classroom: educators'/course instructors' role, and students' role.

Educators'/Course Instructors' Role: Focusing on the educators' perspective, flipped classroom approach involves preparation of online resources and materials that are provided prior to a face-to-face class. Classroom time is utilized for discussion, clarification, problem-solving activities, presentations, and active learning that promotes meaningful and deep learning. It is important to note that educators should be equipped with the skills to conduct flipped classroom which include preparing teaching materials, resources, activities and assessments to be aligned with the course learning outcomes. Furthermore, it takes detailed and careful planning to prepare high quality materials and resources to engage students to be motivated to conduct self-directed learning. It is also important for the course instructor to be creative and at the same time flexible in designing the flipped classroom delivery that includes before, after and post learning to best suit the learning outcomes. The flipped classroom delivery should also take into consideration the topics and nature of the course, the type and number of students, the expertise of the course instructor and the availability of facilities and support.

Students' Role: Focusing on the learners' perspective, the advantage of flipped classroom approach is best seen in the context of students making effort and investing their time to be prepared before face-to-face flipped classroom takes place. This builds the skills of self-directed learning among students that promotes life-long learning and encourage deep leaners (Cevikbas and Kaiser, 2020. Nevertheless, students who refuse to embrace the spirit of flipped classroom and come to class unprepared will often be left behind (Lo and Hew, 2017). These group of students will find it particularly challenging to grasp the knowledge being discussed and will not be able to contribute, solve problems given, and understand the discussion in class. It is important to highlight that flipped classroom requires students partaking in both self-directed learning before class and active participation with in-class active and collaborative learning activities.

Conclusion

Earlier studies have focused on creating meaningful learning, including the use of various student-centred learning pedagogies and approaches. This study expands these efforts by presenting the success of flipped classroom approach in supporting students' academic achievement in comparison to traditional teaching delivery. Based on the results presented in this paper, it is proven that flipped classroom delivery contributed towards students' overall improved academic achievement.

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