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Implementation and assessment of flipped classroom learning on medication distribution system to pharmacy undergraduates

BALAMURUGAN TANGIISURAN*, SOK CIN TYE, KHANG WERN TAN

School of Pharmaceutical Sciences, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia

Abstract

Background: Active learning using the flipped classroom model is an innovative and practical strategy to transform students learning experience in pharmacy education.

Aims: Implementation of the flipped classroom approach to teach medication distribution system for final year undergraduate pharmacy students and thereafter, assessing their acquired knowledge and perception.

Methods: Dedicated lectures on medication distribution system were uploaded online for students to engage in self-paced learning on an e-learning platform. A student-led scenario-based learning approach was exemplified as a classroom activity. Knowledge attained from the module was determined in a pre- and post-test. Students' perception of the flipped classroom approach was evaluated via a survey.

Results: The overall median post-test score was significantly higher (75%) compared to the pre-test score of 32.5% with $p<0.001$. Knowledge assessment in all four domains yielded significant positive outcomes ($p<0.001$). Students' perceptions towards the flipped classroom approach were highly favourable overall.

Conclusion: The flipped classroom model significantly enhanced students' learning experience and heightened their engagement in the classroom.

Keywords: *Flipped Classroom, Integrative Learning, Scenario-Based Learning, Pharmacy Education*

Introduction

The flipped classroom model, a blended learning paradigm using pre-session online videos reinforced with interactive small group discussion was first introduced by Bergmann & Sams in 2007 using live video recordings and screen casting software (Bergmann *et al*., 2012). This approach is an alternative to traditional lectures as it allows students to learn in a more versatile and engaging way. In this experimental study, the flipped classroom allows students to gain exposure to a new learning method on medication distribution system outside of a traditional classroom style at their own pace, commonly via pre-recorded videos, while class time is utilised for other interactive activities such as problem-solving, discussions, or debates to assimilate the related knowledge. A critical aspect of the process is designing experiences that will help students develop themselves into active learners rather than passive receptacles of information (Pierce *et al*., 2012). The flipped classroom is also a teaching method designed to stimulate higher level thinking and meaningful interactions between students in the class. The popularity and development of the flipped classroom have been fuelled by advancement in digital media, software, and increased access to the internet (Halili, 2015).

Fulton (2012) listed the following among the benefits of the flipped classroom approach: (1) It assist students to learn at their own pace; (2) Doing "homework" in class gives the lecturer better insight on the difficulties and learning styles of students; (3) Lecturers are able to customise and update curricula more easily and provide them to their students 24/7; (4) Classroom time is utilised more effectively and creatively; (5) It promotes students' achievement, interest, and engagement; (6) The flipped classroom approach is supported by literature; (7) This teaching method is appropriate for learning standards in the 21st century, drawing on the advantage of continuous advancing technology. Students nowadays are in a generation where computer and internet technologies are integral to their existence. They think and process information fundamentally in contrast to their predecessors (O'Flaherty *et al*., 2015). As such, they are accustomed to receiving information speedily and responding in similar fashion with technological aid.

With advancement in technology and development in pharmacy practice worldwide, including Malaysia, it is important for pharmacy educators to produce skilful pharmacy students of high competencies and ability to transfer learned knowledge and experiences to their future practice. It is critical, therefore, for pharmacy schools to continue to evolve in their educational approach by incorporating both modern pedagogy and new technologies. Currently, courses in medication distribution system are taught to undergraduates in a traditional lecture approach in Malaysia. The introduction of the flipped classroom approach will unveil a novel way

*Correspondence: Dr. Balamurugan Tangiisuran, *School of Pharmaceutical Sciences, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia; Tel: +604 653 2579; Fax: +604 657 0017. E-mail: bala@usm.my*

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to deliver the subject in the School of Pharmaceutical Sciences, Universiti Sains Malaysia. This study involved the implementation of the flipped classroom approach and thereafter assessing the knowledge gained by the undergraduates on medication distribution that employed this model. Their perception of this method was also evaluated and analysed.

Methods

At Universiti Sains Malaysia (USM), the Hospital Pharmacy Practice module is introduced to pharmacy undergraduates in their fourth year (final year). The medication distribution system, an integral component of the in-patient and ward pharmacy services, was selected as a pilot for the flipped classroom model. Complete lecture materials on medication distribution system were prepared by the module coordinator and presented in an audio-vision form, pre-recorded using the Articulate Studio' 13 E-Learning Software, Articulate Global, Inc (referred from this point onwards as online-lecture). The 35-minute online-lecture materials were for pre-viewing on the e-learning portal platform of USM a week prior to the active learning process involving in-class activity and was freely accessible thereafter. Students were informed to pre-view the online-lecture prior to the formal classroom lecture. To ensure students viewed all sub-components of the online materials, a tick-box at the end of the each component required students to complete the checklist before they were able to proceed to the following section.

Scenario-based learning was incorporated as an in-class activity in which three hours were dedicated to learning activities covering medication distribution system of the module. Two scenarios covering the learning objectives of the online-lecture and associated with situations that the students might face in future 'real-life' practice were pre-recorded and presented in short audio clips on the formal lecture day. Five questions were formulated for each scenario. The first scenario focused on problem-solving skills during the supplying of medication through a floor-stock system. The second required the students to determine steps and interventions that needed to be undertaken after receiving in-patient prescriptions from the ward.

The class of 104 students formed ten smaller groups consisting of 11 or 12 students each and were assigned a scenario. Each group was given 30 minutes for in-depth discussion among themselves, and/or with the lecturer who was an expert in the subject on the problems and solutions related to the scenario. Students were required to apply the information and knowledge gained through the online-lecture to provide the solution to all five questions for each scenario. Following the group discussion, two hours were allocated for the students randomly selected from each group, to make a presentation to the class on the proposed solution and feedback for situations in each scenario. This session was followed by a fifteen-minute 'question & answer' session on online lecture materials as well as in-class activity before the session concluded.

A pre- and post-test design was employed using the paper and pen format to assess the students' acquired knowledge from the flipped classroom model. The pre-test response of the participants was obtained on the first day (commencement) of the module on Hospital Pharmacy Practice and prior to the online-lecture being made accessible, while the post-test quiz was conducted four days after the students had completed the scenario-based learning session. The pre- and post-test questions comprised of three sections were identical. Section A consisted of basic demographic information. Section B was sub-divided into two parts: Part 1, comprising of ten short-answer questions and, Part II, ten multiple-choice questions with four possible response options on the knowledge of medication distribution system. Each question in sub-section Part I was awarded a highest possible mark ranging from two - five, where as a score of one was given for each correct answer and zero for a wrong answer in the multiple-choice questions in sub-section Part II. The maximum score was 40, and minimum zero. Section C measured the students' perception of their learning from the instructional approach using the eight items Likert scale.

The presented descriptive data were in percentages (for categorical variables), mean or median (for continuous variables). The difference between pre- and post-test score were analysed using Wilcoxon-signed rank test. *Chi*-square test was carried out to assess the association between gender and the students' perceptions towards the use of flipped classroom model, while the Mann-Whitney U test analysed the difference between gender and the extent of acquired knowledge acquisition in medication distribution system taught with the flipped classroom model. A p-value of <0.05 was considered as significant. The analysis was performed using Statistical Package for the Social Sciences (SPSS version 22), SPSS Inc., Chicago, IL, USA.

Results

One-hundred and four pharmacy undergraduates were included in the final analysis. Participants comprised of 75 (72.1%) female and 29 (27.9%) male students with the mean age of 23.1 ± 0.4 years. The overall median pre-test score was 32.5% (Inter Quartile range [IQR] 25.0 – 42.5) and increased significantly to 75% (IQR 67.5 – 82.5) for the post-test, $p<0.001$ (Table I).

Table I: The overall test score achieved for pretest and post-test knowledge assessment – median test scores (%)

	Overall Test Score Achieved (Median (Inter Quartile Range))	**Statistics (df)**	***p*-value**
Pre-test	32.5 (25 - 42.5)	Z= - 8.859	<0.001
Post-test	75 (67.5 - 82.5)		

The knowledge was further analysed by classifying the quiz questions into four main domains (Table II) and the results showed a significant increase in the post-test score in all domains after students were exposed to the flipped classroom method (p<0.001).

Table II: Knowledge assessment of final year pharmacy students before and after the implementation of flipped classroom model based on question domains

Question Domain	Highest Possible Score	Pre-test Score Median (IQR)	Post-test Score Median (IQR)	Statistics (df)	*p*-value
Types of Drug Distribution Method	13	5.5 (4.0 - 7.0)	10.0 (9.0 - 11.0)	Z=-8.696	<0.001
Drug Management Cycle	14	5.0 (4.0 - 6.0)	12.0 (11.0 - 13.0)	Z=-8.835	<0.001
Documentation of Drug Distribution System	9	1.0 (1.0 - 2.0)	6.0 (4.0 - 7.0)	Z=-8.626	<0.001
Automation Used in Drug Distribution Process	4	2.0 (1.0 - 2.8)	3.0 (2.0 - 3.0)	Z=-6.386	<0.001

Table III: Perceptions of pharmacy students regarding the use of a flipped classroom model in exploring medication distribution system (n=104)

Questions	Strongly Agree/Agree n(%)	Neutral n(%)	Disagree/ Strongly Disagree n(%)
Viewing the online-lecture prior scheduled class greatly enhanced my learning at my own pace.	93 (89)	6 (6)	5 (5)
Viewing the online-lecture was important to enable me to participate successfully in the scenario-based learning.	92 (88)	8 (8)	4 (4)
I appreciate being able to view the online-lecture before the scheduled class as opposed to live class lecture.	65 (63)	28 (27)	11 (11)
Lecturer made meaningful connection between the topics in the online-lecture and the scenario-based learning.	93 (89)	10 (10)	1 (1)
I actively participated and engaged in the scenario-based learning.	75 (72)	27 (26)	2 (2)
The scenario-based learning enhanced my learning and knowledge in medication distribution system.	94 (90)	8 (8)	2 (2)
The scenario-based learning enhanced my understanding of the 'real-world' working scenario.	93 (89)	8 (8)	3 (3)
I wish the flipped classroom model will be used in other modules.	57 (55)	39 (38)	8 (8)

Table IV: Pharmacy students who strongly agree / agree towards the use of a flipped classroom model based on gender

Questions	Female (%)	Male (%)	*p*-value
Viewing the online-lecture prior scheduled class greatly enhanced my learning at my own pace.	69 (92)	24 (82.8)	0.169
Viewing the online-lecture was important to enable me to participate successfully in the scenario-based learning.	70 (93.3)	22 (75.9)	0.012
I appreciate being able to view the online-lecture before the scheduled class as opposed to live class lecture.	47 (62.7)	18 (62.1)	0.955
Lecturer made meaningful connection between the topics in the online-lecture and the scenario-based learning.	70 (93.3)	23 (79.3)	0.037
I actively participated and engaged in the scenario-based learning.	54 (72.0)	21 (72.4)	0.966
The scenario-based learning enhanced my learning and knowledge in medication distribution system.	71 (94.7)	23 (79.3)	0.017
The scenario-based learning enhanced my understanding of the 'real-world' working scenario.	70 (93.3)	23 (79.3)	0.037
I wish the integrated online-lecture with scenario-based learning will be used in other modules.	39 (52)	18 (62.1)	0.355

NB: 'Strongly agree' and 'agree' were combined as agreement and 'neutral', 'disagree' and 'strongly disagree were combined as others for Chi-square analysis.

All students completed the survey of their perception on the use of the flipped classroom model promptly after the completion of the post-test assessment. The Likert scale data was combined and presented as Agree (Strongly Agree and Agree), Neutral, and Disagree (Strongly Disagree and Disagree). The responses were summarised and presented as percentages (Table III). Overall, students' perceptions towards the flipped classroom model were highly favourable.

A significant higher number of female students agreed that viewing the online-lecture was important for their successful participation in the scenario-based learning activity (p=0.012) (Table IV). Female students were found to have a significantly more positive response towards the statement of 'lecturer made meaningful connection between the topics in the online-lecture and the scenario-based learning' as compared to the males (p=0.037). Additionally, a greater significant number of female students agreed that their learning motivation and knowledge in the medication distribution system module was enhanced by the flipped classroom and scenario-based learning (p=0.017). The study results also showed that significantly more female students, compared to their male counterparts, perceived that this new learning method had augmented their understanding of the actual working scenarios in hospital setting (p=0.037).

The mean rank value for the scoring difference between pre-test and post-test for female students was 57.7% and for male students was 39.2% (Table V). The difference in the extent of knowledge gained between female and male students after the use of flipped classroom model was found to be statistically significant, p=0.005.

Table V: Comparison of overall knowledge assessment score between female and male students

Gender	Difference Score Between Pre-test and Post-test (Mean Rank Score)	Statistics (df)	*p*-value
Female	57.7	Z= - 2.806	0.005
Male	39.2		

Discussion

With student population in universities rapidly expanding and the changing facets of pharmacy education, there ought to be a parallel increase in momentum towards improving students' learning experience. It calls for an urgent need for educators to shift from a teaching-centred paradigm towards a learner-centred paradigm to engage every student in the classroom. The flipped classroom model was introduced to allow the learner to assimilate basic information (lower order cognitive skills) from material that is placed online, allowing asynchronous learning and creating quality interaction time in classroom for training of the student in advanced concepts (higher order cognitive skills) through interactions with their peers or instructor. (Kurup *et al*., 2013). This is parallel to the revised Bloom's taxonomy that emphasises the development of critical thinking among students based on the premise that there are distinct thinking behaviours involvement which are important in the learning process. Revised Bloom's taxonomy allows students to perform lower levels of cognitive activities (gaining knowledge and comprehension) outside the classroom and focus on higher levels of cognitive work (application, analysis, synthesis, and/or evaluation) in the class (Krathwohl, 2002; Crowe *et al*., 2008).

Previous research have shown that active learning improves students' understanding and retention of information and can be very effective in developing higher order cognitive skills such as problem-solving and critical thinking (Kvam, 2000; Lucas *et al*., 2013; Ofstad *et al*., 2013). In this course design, the reading, understanding and memorising of basic knowledge on medication distribution system was done via an online lecture prior to the face-to-face lecture taking place. Great emphasis is then placed on the scenario-based learning during the classroom session, with the aim of achieving the category of 'application level' as in the Bloom's Taxonomy of Learning. At this level, students are expected to select and use information (such as rules, methods, experimental approaches, and theories) in a new and concrete context (including solving problems and performing tasks) (Allen *et al*., 2002). Additionally, students are also required to directly apply their newly acquired knowledge gained from the online lecture in the subsequent classroom discussion session with their peers and lecturer in-charge. Students are guided to use their critical-thinking skills to analyse, evaluate key issues in the given scenarios, and suggest possible solutions. Students are also expected to synthesise all the information and generate appropriate solutions for each given problem. The hypothetical revised model of the flipped Bloom's taxonomy which shows significantly stronger satisfaction and positive effect on students' learning is explained in a study by Schneider *et al*. (2014).

Our general findings contribute and validate the growing evidence that the flipped teaching method is helpful in elevating students' overall learning experiences (Pierce *et al*., 2012; Kurup *et al*., 2013; Koo *et al*., 2016; McIver *et al*., 2016). A number of existing literatures clearly support active-learning pedagogies in future pharmacy education (Lucas *et al*., 2013). The impact of the flipped learning is most evident on questions relating to drug management cycle domain that involves a higher order of thinking skills. Examples of questions under this domain include screening of prescriptions and dosage calculations of an intravenous antibiotic for supply to a patient using unit of dose system and proposing an appropriate workflow to supply medication via a floor stock system simultaneously. These questions were closely related to the problems provided in the scenarios during classroom activity. The vast majority of students agreed that they had actively participated in the scenario-based learning and that the classroom scenario-based activity had improved their learning and knowledge in medication distribution system.

One of the weaknesses identified among the students was their ability to accurately identify the appropriate system between the choices of unit dose or floor stock system for the supply of medication in an in-patient setting. To overcome this, the lecturer further explained to students on various medication distribution systems and gave several examples of effective drug management processes in the classroom. Students were given the opportunity to ask questions and seek clarification, if they had any, concerning the module.

Similar to findings by Ismail (2009), the author believes that enhanced interaction between students and lecturer is essential to ensure that the teaching and learning process achieve the optimum outcome. The findings from our study further support the growing evidence of positive student perceptions with active learning pedagogies. Passive learning in long lectures is often boring and can deprive students from rich educational experiences (Bligh, 2000), as well as causing a quick drop of student's attention in class. MacManaway (1970), Stuart *et al*. (1978) and Hogan & Lundquist (2006) surveyed graduating pharmacy students using Likert scale response

about their perceptions of preparedness for advanced pharmacy practice experiences (APPEs) and the effectiveness of problem-based learning in their preparation. The vast majority of students in their study agreed that problem-based learning was a useful tool to prepare them for above-average performance during APPEs. The findings of this study suggest that pre-viewing the online-lecture was important to the students as it prepared them to engage more successfully in the classroom scenario-based activity. Similarly, Pierce & Fox (2012) found that with the use of the new flipped class model, pharmacy students had more opportunities to apply their knowledge directly in case scenario in class, thus fostering their critical thinking and problem-solving skills in formative assessments. Schneider *et al*. (2014) in his study employing a group of Master of pharmacy students also showed strong satisfaction and preference towards the flipped classroom.

Although the majority of students in this study acknowledged the benefits of viewing the online-lecture prior to scheduled classes, not all recognised that the online-lecture was important in assisting them to prepare and participate successfully in the scenario-based learning in class. A small number of the students were found to have not appreciated the online-lectures since the total positive response rate on students' perception towards the flipped classroom stood at only 63%. Pharmacy students reportedly experienced a higher level of stress relating to studies and personal life issues such as inadequate rest time and recreational activities, lacking time for family and friends, interpersonal conflicts and environmental issues, when compared to their age-matched peers.

In this study, the majority of the students appreciated high-quality engagement with their peers and the subject expert. However, they also expressed concerns about large group numbers and time constraints resulting in limited opportunity for all to exchange information. A minority of the participants disagreed that they had actively participated in the discussion. The study noted that slightly more than half of the overall participants actually desired the implementation of flipped teaching in other modules. This could be due to that fact that students are more accustomed to receiving information passively in a traditional classroom style teaching and this was their first exposure to a flipped classroom experience. Two studies where flipped teaching were implemented over longer periods of time (weeks to years) uniformly demonstrate a larger majority of students preferring the flipped classroom over a traditional classroom approach (McLaughlin *et al*., 2013; 2014). The flipped classroom approach in this study experimented with only one topic in the module. The introduction of this teaching method meant a departure from the traditional teaching method that students had become very accustomed to resulting in a mixed reaction to this sudden change. Given reasonable time, the flipped classroom approach may take root and yield higher rates of satisfaction and a greater preference such as observed in the study conducted using a renal pharmacotherapy module for pharmacy students (Pierce *et al*., 2012).

Overall, female students achieved higher baseline knowledge scores than their male counterparts. Their perception of flipped learning in this module was also greater compared to their male counterparts. Gender and learning differences already exist in literature. This may be likely due to different level of interest and acceptance between male and female students and the topics involved. As an example, the evaluation of gender differences in a flipped mathematics course revealed that emotional feelings were associated in the final grades in males, whereas course design predicted the final grades in females students (Chen *et al*., 2015). In contrast, no such difference existed among students enrolled in a microeconomic course with nearly all students responding that flipped learning was interactive and aided their learning (Roach, 2014). Some studies have shown that male students particularly develop gender stereotypes with a more outcome-oriented behaviour. Female students, on the other hand, tend to be more social and performance-oriented and have stronger motivation. Their overall ability, performance, and self-regulation results in them being more commonly successful in school performance than males (Sullivan, 2001; Honigsfeld *et al*., 2003; Lie *et al*., 2004; Weis *et al*., 2013). Thus, knowing the preferences of students' learning style is crucial when designing effective teaching approaches.

One of the limitations that could possibly affect the generalisation of this study is the lack of comparison using a control group in a traditional approach. Furthermore, the conduct of the post-test assessment took place only four days into the intervention and the level of knowledge the students acquired after this brief exposure may lack accuracy. A follow up post-intervention knowledge assessment test such as a situational-based quiz covering medication distribution system one month after the intervention would have better reflected a measure of long-term retention of knowledge, as well as long-term effectiveness of the flipped teaching method.

Conclusion

The implementation of the flipped classroom model using pre-recorded online-lecture and classroom activity using scenario-based learning provide different learning experience on the topic of medication distribution system among the pharmacy students in USM. Students' perception towards this instructional approach is positive. An evaluation on the effectiveness of the flipped classroom method involving other pharmacy modules in the local setting should be employed. Summarily, the flipped classroom method is an essential parallel move in tangent with the evolution of the pharmacy profession. It is also keeping up with the rapidly changing learning environment and behaviour of the young generation pharmacy students. So, let's flip the classroom!

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