

Implementation of Flipped Classroom Design in Transfusion Science Course

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Abstract Flipped classroom design is becoming a common trend in tertiary education. It has been shown active learning and improved student outcomes are associated with flipped classroom implementation. A flipped classroom design was implemented in Transfusion Science course, which is offered in third year as part of a Bachelor of Medical Laboratory Program at Griffith University, Queensland, Australia. Student performance in the flipped classroom across almost all assessments was improved when compared to the non-flipped classroom. Class survey showed 73% of respondents felt that the flipped classroom design was helping them learning the theory content of the course, while, 45% indicated that the flipped classroom delivery was helping their learning in practical component. Furthermore, all respondents either agreed or strongly agreed that the course was engaging and satisfactory. Our data suggests adopting a flipped classroom design in medical laboratory education enhances student outcomes with higher student satisfaction.

Keywords Flipped classroom, Active learning, Curriculum design

1. Introduction

The traditional face to face delivery of education has been shown to be lacking active learning and student engagement, and is mainly a teacher-centred approach. It has been demonstrated that through lecturing alone students lack the motivation needed to achieve effective learning and fail to develop deep and critical thinking skills [1]. Indeed, it has been shown that students' attention dramatically decreases 15 minutes after class begins [2] and students retain only 20% of information presented during traditional lectures [3]. Furthermore, students in long lectures lose concentration and motivation which can result in poor student outcomes [3]. Therefore, there needs to be a more effective approach to learning and teaching.

The need for an effective and student-centred learning environment has led to development and implementation of flipped classroom design [4]. Although the flipped classroom approach is not a new concept, it is becoming a common practice in the higher education sector. In the flipped class, lectures are pre-recorded and made available online through the learning management system (LMS) for students to watch in their own time. The lecture or in-class

time is then used to conduct student-centred learning activities, such as quizzes, cases studies, group discussion and problem-based learning [5]. The flipped classroom approach enables teachers to use the in-class time to engage with students and implement effective pedagogies that encourage student deep learning [6]. Central to the flipped classroom design is the focus on student-centred approaches and strategies. Key to this approach is that students must watch the pre-recorded learning materials before coming to class to ensure basic comprehension of the material, so that they can fully participate and engage in class activities such as group discussions, cases studies and quizzes.

Implementation of flipped classroom model provides an effective learning environment where students can participate in meaningful learning activities which are not available in the traditional face-to-face classrooms. Indeed, a growing body of evidence indicates that utilising the flipped classroom design is associated with improved student grades and better learning outcomes when compared to a traditional lecture-based classes [7,8]. Furthermore, it was demonstrated that students were more engaged and preferred flipped classrooms over the face-to-face passive lectures [9]. In addition, student participation and interaction with other students and teachers are reportedly enhanced resulting in more group discussion and group based skills [6,10]. In professional health courses, flipped classroom was shown to results in increased student learning [11].

There is a limited number of studies evaluating the implementation of flipped classroom strategy in medical laboratory science education [12]. Indeed, the majority of

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medical laboratory science program curricular are delivered via didactic courses with strong emphasis on the practical component and laboratory skill acquisition. Therefore, this study contributes to research on the usefulness of flipped classrooms design in medical laboratory education, particularly transfusion medicine education. Furthermore, the rationale for implementing the flipped classroom design in transfusion science was to increase student motivation to learn and participate in class discussions. Previous course offering which was traditional face-to-face lectures, student attendance was poor and there was a clear lack of recall of information during class discussion and interest in learning. Accordingly, the aim of the current study was to investigate the usefulness and effectiveness of a flipped classroom design in transfusion science course.

2. Methods

Transfusion science is a core 12 week course with both theory and practical components delivered in year three for students enrolled in the Bachelor of Medical Laboratory Science program at Griffith University, and is one of the most intensive courses. Students must pass every single assessment task to get an overall pass in the course. This is to reflect the zero tolerance for any error in real work force. In the previous offering of the course, the lectures (2-hours) were delivered “live” to the students. The lectures were recorded during presentation and were made available on LMS to students later to watch. There were no in-class activities such as quizzes or case studies.

In the flipped class room, all lectures were pre-recorded and made available on the LMS along with other associated study materials at least two weeks before class. The students were instructed to watch the recorded lectures before coming to class. The class time was utilised for various student-centred activities. In the first week students were informed about how the course was going to run and were provided with opportunities to talk to staff about any concerns.

2.1. In-class Learning Activities

The class time was divided into different activities aimed at reinforcing the main ideas of the topic covered and allow students to develop deep learning skills. The first 30-40 minutes of the class time was used to provide a summary of the topic and address any questions and queries students may have. This was conducted as a group discussion and students were asked to participate in the discussion. For the remainder of the in-class time students participated in multiple choice questions, short answer questions and case studies. The students were allowed to work on the questions and case studies individually or in pairs and then the answers were discussed as a group. Below are examples of discussion questions that were used in the class discussion.

A couple claim they have been given the wrong baby at the

hospital. The blood group of both parents is A. The baby's blood group is O. Can this couple have a child that is group A? How would you investigate this?

What is the rationale of red cell preservation?

What are the types of red cell storage strategies?

What is the effect of storage on platelets?

Determine the following blood groups

If a father is group B and the mother is group AB. What blood group/s will the children be?

If father is blood group A and mother is blood is B. What possible blood groups their children have?

Case study

A 45-year-old man is diagnosed with non-Hodgkin's lymphoma. His blood group is B pos. His brother is found to be HLA-matched, but is A pos. The brother donates peripheral blood HPC, The patient requires long-term transfusion support and receives 57 RBCs, 107 platelets apheresis, 30 FFP, and 6 cryoprecipitate.

Day post-transplantation	Ant-A	Anti-B	A cells	B cells
Day 117	0	1 (MF)	1	0
Day 147	0	Wk (MF)	2	0
Day 156	0	0	1	0
Day 200	Weak (MF)	0	0	1

Discuss

1. What is the interpretation of his ABO group on day 147?

2. What is the blood group interpretation on day 156?

3. Which blood group(s) should be selected for the RBC transfusions post day 200?

4. What is the blood group interpretation on day 200?

5. For FFP and platelets, which blood type(s) should be selected post day 200?

2.2. Student Performance

Student performance was assessed by comparing student marks in the assessment tasks and the overall grade of students in the flipped class to grades from students in previous traditional offering.

2.3. Student Evaluations of the Flipped Course and Data Collection

To assess the effectiveness of the flipped class, students were asked to complete two evaluation surveys. The first survey was conducted between weeks 6 and 8 of the semester. The first survey was designed to see if the flipped classroom design was making a difference in students' learning theory and/or practical component of the course. The second survey was completed during the institutional course evaluations at the end of semester. The aim of the second survey was to assess students' overall satisfaction with course. Both surveys were carried out in accordance with university's

policy. Student performance in the assessment tasks were compared between the flipped and non-flipped classroom.

2.4. Statistical Analysis

Students' performance in summative assessments are expressed as Mean and Standard Deviation. Student t-test was performed to assess any statistical significance using Microsoft Excel. A P-value of <0.05 was considered to be significant.

3. Results

In 2018, 19 students were enrolled the flipped classroom. Eleven (58%) of which responded to both mid-semester and end of semester anonymous surveys. In the mid-semester survey, table 1, 7 out of the respondents (64%) had indicated that they have been attending all classes. 73% felt that the flipped classroom design was helping them learning the theory content of the course, while, 45% indicated that the flipped classroom ideology was helping their learning in practical component. 27% felt that the flipped classroom was helping them in learning both theory and practical content, while 18% felt that the flipped class made no effect in learning either theory or practical content.

Table 1. Mid-semester survey

Survey question	11 respondents	
	Yes (%)	No (%)
Been attending all classes	7 (64)	4 (36)
Do you think the flipped classroom is helping you theory learning?	8 (73)	3 (27)
Do you think the flipped classroom is helping your practical learning?	5 (45)	6 (55)

In the end of semester survey, table 2, 55% agreed, while 45% strongly agreed that the course had engaged them in learning. For the overall satisfaction with the quality of this course, 55% strongly agreed and 45% agreed with being satisfied with quality of the course. Both course engagement in learning and satisfaction with overall quality of the course scored highly (4.5/5) indicating student overall satisfaction with course.

Table 2. End of semester institutional survey

Survey question	11 respondents		
	Agree (%)	Strongly agree (%)	Score out 5
This course engaged me in learning	55	45	4.5
Overall I am satisfied with the quality of this course	45	55	4.5

Student performance in the flipped classroom (n=19) across almost all assessments was improved when compared to the non-flipped classroom (n= 18), figure 1. Indeed, for week 4 test, students in the flipped classroom scored significantly higher than those in the traditional classroom, ($81 \pm 8.6\%$ for flipped class, and, $90.1 \pm 4.4\%$ for traditional class, $P < 0.05$). Similarly, in the final practical examination, students in the flipped classroom scored significantly higher than students in the non-flipped class, ($95.3 \pm 3.6\%$ for flipped class, and, $74 \pm 10.8\%$ for traditional class, $P < 0.05$). In addition, students in the flipped class scored higher in the mid-semester exam than those in the traditional exam, ($74.6 \pm 11.2\%$ for flipped class, and, $70 \pm 12.6\%$ for traditional class, $P > 0.05$). For the final theory examination there was no difference in class average for both flipped and non-flipped classrooms. However, the final mark for flipped classroom was significantly higher than the non-flipped class ($83.4 \pm 6.4\%$ for flipped class, and, $78.7 \pm 8.3\%$ for traditional class, $P < 0.05$).

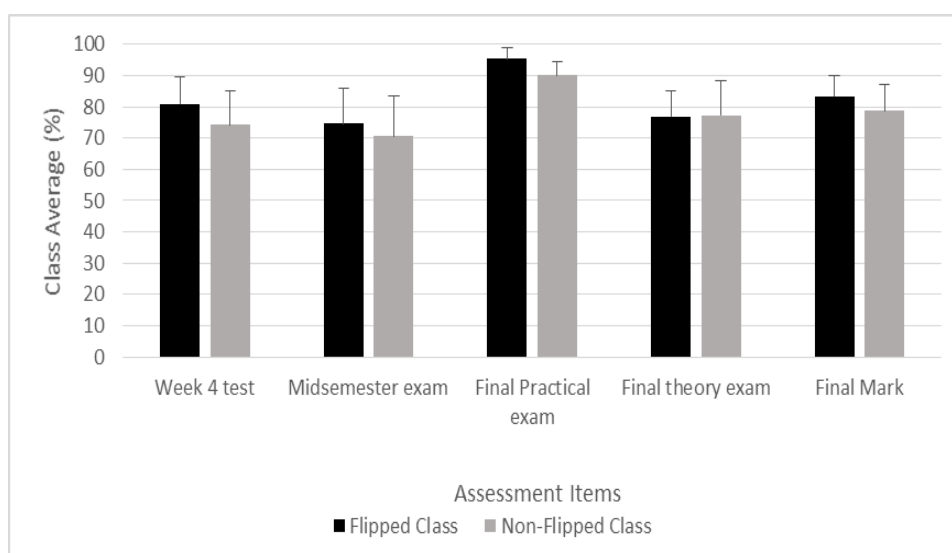


Figure 1. Class performance in the assessment tasks. Students in the flipped classroom (n=19) performed significantly better than students in non-flipped class (n=18) in weeks 4 test, Midsemester exam and practical exam

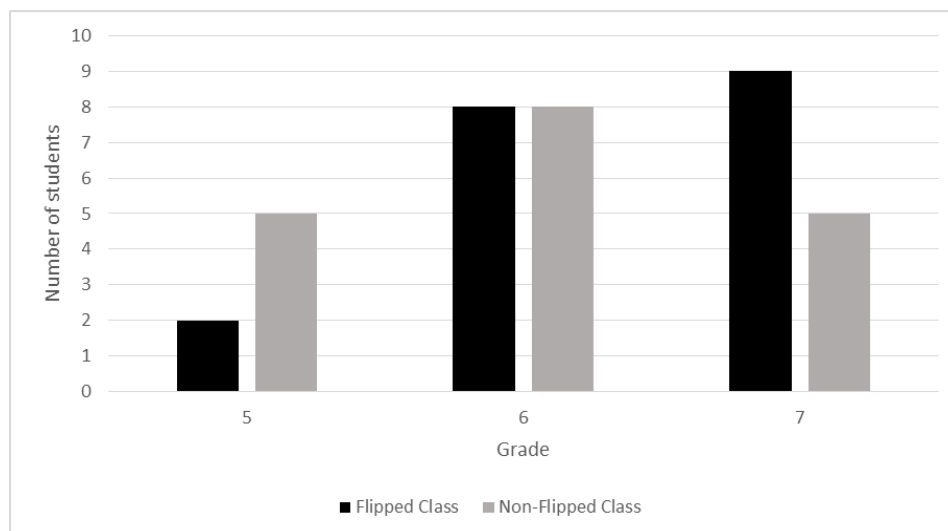


Figure 2. Overall student performance expressed as GPA. The number of students achieving maximum GPA was higher in the flipped class

The overall student performance as indicated by the grade point average (GPA) was higher for the students in the flipped classroom, figure 2. Indeed, higher number of students (9/19) achieved the maximum grade of 7/7 (high distinction) compared to non-flipped class (5/18). Furthermore, the number of students who scored a credit (5/7) GPA was lower in the flipped classroom (2/19) compared to the non-flipped class (5/18). There was no difference in the number of students who obtained a distinction grade (6/7) between the two classes.

4. Discussion

This aim of this study was to evaluate the effectiveness of implementing a flipped classroom design in an undergraduate Transfusion Science course within Medical Laboratory Science Program. Within a comparable group of third-year undergraduate students, the flipped classroom model was associated with improved overall student performance (Fig. 2) when compared to the non-flipped class. Indeed, the number of students achieved 7/7 GPA in the flipped classroom was higher than those in the traditional class. The overall performance reflects the enhanced performance of the flipped classroom across all assessment items (Fig. 1). Furthermore, there was a sharp decrease in the number of students achieving an overall credit (5/7) GPA in the flipped classroom. The finding of this study is consistent with previous studies showing improve student performance associate with the flipped class [13,14]. Furthermore, this study demonstrates that flipped classroom course design can be successfully implemented in Medical Laboratory education. The main contributors to this include, the high student-teacher interactions in the flipped class model and in class student-centred activities such as quizzes and group discussions. In this study, in class activities were MCQ, short answer questions and case studies as well as group discussion. During the in class activities, the majority of

students were actively participating. An interesting observation was that students were answering each other's queries and questions, this increased their cooperative behaviour and were more willing to assist one another.

One of the key findings of this study is that 73% of survey respondents felt that the flipped classroom design was helping their theory learning. This was due to the in class activities that promoted better understanding of the theory concepts. The MCQ, group discussions and short answer questions were designed to develop students' understanding and encourage critical thinking. Enhanced understanding of the theory content was reflected in the performance in the assessments. Indeed, student grades in the assessments that assessed theory comprehension in the flipped class was higher than the non-flipped. Furthermore, nearly half of the respondents indicated that the flipped classroom was helping their practical components. As the course has a major practical component, it was imperative that the in class activities included practical component to improve the understanding of the key practical skills. Therefore, the in class activities included a verity of case studies that required students to interpret laboratory data. Students found the case studies useful in improving their data interpretation skills and helped them perform better in during the practical classes. Furthermore, the performance in final practical exam was significantly better in the flipped class when compared to the traditional class, this is consistent finding that the flipped classroom ideology was associated with improved exam performance [15].

End of semester survey demonstrated student satisfaction with course design and delivery. The end of semester survey is administered by the university. The survey is voluntary and anonymous, students were encouraged to participate in the survey. Fifty five percent of the respondents indicated that they strongly agreed with the question "Overall I am satisfied with the quality of this course", while, the remaining 45% agreed. This was the only course offered as flipped classroom in third year.

One of the main aims of flipping the class is to increase student engagement. Indeed, studies have shown that in traditional classes student engagement is low [16]. Therefore, the in class activities were designed to increase student engagement by promoting student participation during the class. All students who responded to the end of semester survey agreed or strongly agreed (55 and 45%, respectively) that the course was engaging. Students commented on class participation and discussion in class activities was one of derivers for increased student engagement. Better student engagement meant students were more comfortable in participating in the activities and could retain the information through understanding the concepts which ultimately led to better overall performance.

This study has demonstrated implementing a flipped classroom ideology in a very hands on and practical oriented subject such as Transfusion Science was associated with better student outcomes and higher overall grades. Furthermore, the flipped classroom was associated with improved class attendance. In spite of the positive outcomes, there were some limitations associated with the study such as small cohort size. Furthermore, there some students who weren't comfortable with flipped approach showed some resistance by not attending classes and only relied on the recorded lectures. This is consistent with previous studies [17]. Therefore, it is essential that designing and implementing a flipped classroom ideology needs to be evidence based and based on student-centred learning pedagogies.

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