Head Over Heels in Gastrointestinal Anatomy: A Case Study

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Abstract

Background: The classical teaching model consists of lectures where students passively receive information. In the flipped classroom, lecture content is available for students online, and the lecture time is utilised for problem solving and active learning. This project set out to compare these models in a "traditional" anatomy course.

Summary of work: Activity logs for Year 2 recorded lectures in the anatomy of the gastrointestinal tract were downloaded from Moodle (VLE). Results of a mock topic test administered under exam conditions and student feedback were analysed.

Summary of results: 61 participants submitted voluntarily to the written test; 38 (62.3%) had watched the online lectures. No difference was found in marks between students who did/did not participate (54.0 +/- 18.6 vs 59.9 +/- 14.1, p=0.1699) respectively. The response rate was 73%: All watched online lectures, 70% used them to replace contact teaching entirely on at least some occasions. 60% preferred video lectures, 51.2% of whom preferred full-face video recording of the traditional lecture, 16% audio alone and 18.6% a full flipped classroom model. 39.5% felt their performance was negatively affected by this approach due to their lack of motivation to engage with the lecture videos.

Discussion: The similarity in student marks between the two teaching approaches suggests that the flipped classroom model may be a suitable alternative, especially when resources are limited. The preference of most students for the traditional model could suggest a reluctance to participate in active learning activities or room for improvement in the video lectures provided.

Conclusions: The majority of students accessed online lectures. Those who did performed as well as those who did not in a mock test.

Take home message: Flipped classroom teaching is an effective alternative to traditional anatomy teaching.
Introduction

Increasing course content and decreasing teaching time is a challenge facing medical educators worldwide (Prober and Khan, 2013). Our ability as educators to effectively disseminate increasing volumes of complex material is severely limited by available face-to-face time with students. The concept of the flipped classroom is attributed to high school chemistry teachers Jonathan Bergmann and Aaron Sams (2012), who started creating podcasts and screencasts for students in 2006. In 2012, they created the non-profit Flipped Learning Network (FLN) ([http://flippedlearning.org/](http://flippedlearning.org/)). The flipped learning model, which "flips" traditional in-class lectures with collaborative activities, has gained many followers in K-12 education (Educause), and has more recently been extended into medical education.

"Flipping the classroom" means that teaching and learning now takes place online in various ways, and that class time is used for active learning of concepts that require higher order cognitive skills. This reversal also flips Bloom's revised taxonomy, in that the lower level of cognitive work i.e., knowledge acquisition, is done by the students before they come to class, while students learn to work interactively with each other and their tutors to develop higher forms of cognition during class time (Pierce and Fox, 2012; Brame, 2015). This learning model also encourages students to learn from each other through increased peer-to-peer interaction and teamwork in a collaborative learning environment. At the same time, students are held responsible for their own learning in an active and engaged learning process to promote critical thinking skills.

Claims made about the effectiveness of flipped classrooms in medical education have been inconsistent, prompting the systematic review of Fei Chen et al (2017), whose examination of 118 previous studies showed that although there are generally positive perceptions of this approach, the effects on changes in knowledge and skills were less conclusive.

There is a particular paucity of evidence for the effectiveness of flipped classrooms in promoting knowledge acquisition of anatomy above and beyond the traditional learning methods. Both Veeramani and Chand (2015) and Whillier and Lystad (2015) examined the flipped classroom approach among medical and chiropractic students in a neuroanatomy course in Korea and Australia, respectively. In the former study, the majority of students felt that the flipped classroom approach was better at fulfilling the stated learning objectives than the conventional didactic teaching. Although there were significant differences between the pre- and post-test scores, suggesting that students learned new material during the sessions, it is quite possible that this was no more than short-term memory recall. In the much smaller study of Whillier and Lystad (2015), there were no significant differences between the two small cohorts following the flipped (n=23) and traditional (n=33) classroom approach in terms of final grades, self-rated knowledge, or overall satisfaction with the course. Nevertheless, both studies showed that this most difficult part of the anatomy curriculum lends itself well to this blended learning approach.

Jeavens et al (2013) similarly compared a cohort of undergraduate nursing students in a traditional anatomy and physiology class with a flipped classroom and found that although the latter improved student participation and learning, it had to be carefully managed so that staff and students understood roles and expectations.

The 36 students in the dental anatomy course studied by Park and Howell (2015) viewed online materials before class and then participated in peer teaching and team discussions based on learning objectives under faculty supervision. The study design also included regular pre- and post-class quizzes to motivate student in-class participation and place learning accountability on the students themselves. Student feedback was generally positive.
but there was no evaluation of self-knowledge or exam grades to assess whether this approach affected the learning of dental anatomy.

Sawarynski et al (2013) examined the effect on student attitudes and perceptions of mastery of flipped, integrated sessions as compared to traditional lecture sessions. They replaced two traditional lectures on overlapping content, but from two different disciplines (cell biology, focusing on the cytoskeleton, and histology focusing on epithelia), with short video lectures for students to watch online. Although the sessions were well accepted, the students reported that the video lectures were less effective than traditional lectures, and generally came to class poorly prepared.

De Ruisseau (2013) reported that the mean score for the first undergraduate anatomy and physiology exam was higher than in previous years (79.2 vs 74.3; \( p < .01 \)) in a small study of 54 students who watched short (~20 min) e-lectures, worked through review questions before class and discussed parallel case studies in teams in class. Similarly, Tune et al (2013) reported that compared with traditional delivery, Year 1 graduate medical students in a cardiovascular, respiratory, and renal physiology flipped course did significantly better in the same final exam.

The academic performance of 24 Traditional Chinese Medicine (TCM) students following a flipped classroom format at Jinan University and 87 TCM students in a conventional histology curriculum were compared by Cheng et al (2016). The test scores for the flipped classroom participants were significantly higher compared to the control group suggesting that a flipped classroom approach can be used to improve histology education among TCM students.

In the study of Morton and Colbert-Getz (2017) the student performance on 28 MCQ anatomy items of knowledge (low cognition), application, or analysis (high cognition) were compared in two classes of just over 100 first year medical students receiving 30 hours of anatomy content using either the flipped or traditional lecture classroom model. This study showed that students in a flipped classroom model performed better on analysis items (\( U = 4243.00, P = 0.030, r = 0.19 \)), but there were no differences in performance for knowledge (\( U = 5002.00, P = 0.720 \)) or application (\( U = 4990.00, P = 0.700 \)) items. This supports the hypothesis that students exposed to learning anatomy in a flipped classroom model perform better when expected to analyse material.

**Methods**

The availability of archived video lectures on gastrointestinal anatomy presented the opportunity to investigate the effectiveness of a "flipped classroom" curriculum of gastrointestinal anatomy delivered to Year 2 medical students at our institution.

Students were instructed to view online presentations before class. The resources were available through the University's VLE (Moodle) in both downloadable and streaming MP4 formats. During class-time small groups of students participated in peer teaching and team discussions based on learning objectives under the supervision of the tutor.

All students had access to the laboratory practical classes that covered human prosection specimens, anatomic models, and living/functional anatomy as well as critical thinking tutorials in the gastrointestinal anatomy curriculum.

Evaluation of the effectiveness of the e-lectures and student performance was achieved by comparing marks in the
same mock topic test administered under exam conditions taken by students who did/did not watch the online teaching material. The test was administered approximately two weeks before the end of module final summative examination.

Student feedback on participation and satisfaction with the flipped classroom approach was collected by voluntary anonymous surveys.

The activity logs for the recorded voice-over slides in Gastrointestinal anatomy were downloaded from Moodle (VLE) and analysed statistically with Excel.

Results

110 students completed the gastrointestinal anatomy module in the second semester of the second year of a traditional 2+3 pre-clinical/clinical five-year medical course at the University of Malta. During the same semester, students were also taking courses in Head and Neck anatomy, Microbiology, Endocrinology and Metabolism as well as Ethics.

Each of the online presentations was approximately 30-45 minutes long and consisted of voice-over slides produced by the same lecturer who facilitated the flipped classroom activities that were held during regularly timetabled "lecture" hours. Students were instructed to watch the online materials before each class in order to prepare themselves to participate in class discussion, but they were given no incentives in the form of quizzes, worksheets or mark allocation to do so.

Sixty-one (58.2%) students attended the mock gastrointestinal anatomy test approximately two weeks before the end of module exam. Of these, 62.3% had watched at least one online lectures. There was no statistically significant difference (Figure 1) in marks between students who did/did not watch the online e-lectures: (54.0+/-18.6 vs 59.9+/-14.1, p=0.1699)

On average, each individual student accessed the same online lecture twice (range 1 to 7 times). Just under one third (31.0%) needed to log-in to the online module more than once during any given session, either due to technical challenges or because the e-leclectures were too long to view in one sitting.

The response rate of the participation and satisfaction survey was 73%. All respondents had watched at least one online lecture, and 70% had used them to replace contact teaching entirely on at least some occasions. Sixty percent of the respondents reportedly preferred video lectures over traditional face-to-face lectures, 51.2% of whom preferred full-face video recording of the traditional lecture, 16% preferred audio alone (ie podcasts) and 18.6% a full flipped classroom model. Almost 40% felt their performance was negatively affected by the e-lectures and flipped classroom blended learning approach due to their lack of motivation to engage with the lecture videos (Figure 2).

Student feedback from the flipped classes was largely negative. Although 18.6% of students reported that the flipped classes were more fun, interactive, and collaborative than traditional lectures, many more students preferred the traditional lecture format.
Figure 1: Mock test results in gastrointestinal anatomy

Figure 2: Student Feedback regarding flipped classroom

Figures 3 and 4 show the relative frequency of access of e-lectures by day of week and time of day. Tuesday and Thursday afternoons appeared to be the most popular, rather than the expected weekend.
In this study, students who watched online lectures before attending flipped gastrointestinal anatomy classes obtained very similar mock test scores in the topic as those who did not. Similar results in terms of final neuroanatomy grades were reported in the much smaller study of Whillier and Lystad (2015). By contrast, Cheng et al (2016), De Ruisseau (2013), Morton and Colbert-Getz (2017) and Tune (2013) reported higher mean scores in histology,
anatomy and physiology exams respectively in students exposed to a flipped classroom compared with the traditional approach. There are significant methodological differences between these studies and our own approach to blended learning which may explain the different results obtained. For example, given that the average attention span of medical students is much shorter than the traditional hour-long lecture (Stuart and Rutherford, 1978), the online audiovisual lectures we provided could have been more effective in engaging students had they been broken down into shorter and more frequent e-lectures.

Notwithstanding these differences, our hypothesis was that the flipped classroom approach would not detract from exam performance, and this was indeed shown to be the case. Therefore, although we cannot conclude that gastrointestinal anatomy learning is improved by utilising a flipped classroom approach, we can suggest that student learning is not impaired, at least in terms of mock exam performance. This has important implications for efficient use of resources especially timetabled face-to-face teaching/learning hours.

In this study, the mock test was assigned at the end of the module, approximately 2 weeks before the final exam. This suggests that whether students listen/watch an e-lecture or not, what influences the exam score is probably not the e-lecture itself, but rather the peer-to-peer interaction during the flipped classroom setting and/or self-study before the test.

Missildine et al (2013) compared traditional lectures only, lecture capture as an adjunct to traditional lectures, and lecture capture with interactive teaching activities (flipped classroom) on the academic success of baccalaureate nursing students in two adult health nursing courses, as measured by examination averages and student satisfaction. In spite of higher average exam scores, students were significantly less satisfied in the flipped classroom approach \( (p < .001) \). Similarly, our study showed very poor satisfaction scores.

The impact of substituting lecture capture for traditional lectures on exam performance is largely unknown. The question of whether an e-lecture in anatomy is as effective as a face-to-face lecture is not answerable by this study.

A little more than half (n=61) of the class cohort took the mock test two weeks before the exam. It is difficult to explain why this opportunity to take a module practice test was not availed of by more students, but the proximity to the final exams in several other concurrent modules is a possibility. Nevertheless, of these, just under two-thirds had previously watched the e-lectures, allowing for a meaningful comparison of the test results. No significant difference in marks between students who did/did not watch the e-lectures was noted, suggesting that the flipped classroom model may be a suitable alternative to traditional lecture-based teaching, especially when resources are limited. For example, one could envision a teaching model where good quality e-lectures taught by inspirational lecturers are combined with interactive discussions led by possibly other tutors who may be much better at engaging students in face-to-face learning. Indeed, many students already create that model by resorting to popular YouTube anatomy video channels to supplement their learning.

Although the systematic review of Fei Chen et al (2017), (which included 118 papers of which nine used a controlled design), failed to provide empirical evidence of any strong effect of flipped classrooms in promoting knowledge acquisition above and beyond traditional learning methods in various medical disciplines, there is some limited evidence in small studies in neuroanatomy, histology and physiology (Cheng et al., 2016; De Ruisseau, 2013; Tune et al, 2013; Whillier and Lystad, 2015) that e-lectures followed by interactive class discussion with peer-to-peer teaching positively affects course grades in the basic sciences. The learning and teaching challenges posed by the vast anatomy curriculum at the University of Malta created an opportunity to examine this question in the context of the gastrointestinal module. By moving some of the learning online, we were able to firstly maximize
efficient use of limited face-to-face contact time, and secondly engage students in actively managing their own learning, a factor which has been shown to enhance retention and understanding (Chumley-Jones et al, 2002; Kurup and Hersey, 2013).

Unlike other flipped classroom studies among medical students (Whillier and Lystad, 2015), our blended learning design did not incorporate any incentives in the form of quizzes, worksheets or mark allocation. We simply informed students that they had to take responsibility for their own learning and work continually to keep up with the material. Based on the experience of Park and Howell (2015) during a flipped dental anatomy course, the use of online resources and quizzes before class were critical motivating factors that likely contributed to the increase in student participation in class and in overall student performance. It is quite possible that student exam performance among those who watched the e-lectures in our study may have improved had we utilised this approach.

Contrary to the findings of several other studies included in the systematic review of Fei Chen et al (2017) which concluded that there were generally positive student perceptions of this approach, our students largely disliked the new blended learning approach. Although they reportedly enjoyed watching the e-lectures, they found the flipped classroom learning format unsatisfactory. Some students reportedly found it difficult to determine whether the information presented by their peers during in-class discussions was reliable and felt the instructor could have provided more clarification. Enfield (2013) has also described the belief among some students that it is the tutor’s duty to teach rather than facilitate learning in an independent learning environment. Indeed, the preference of the majority of students in our study for the traditional lecture model would suggest a reluctance to participate in active learning, a preference for face-to-face lectures to keep them engaged or possibly the perception that the e-lectures are unimportant or of inferior quality. It is also quite possible that the heavy workload of the semester limited the students’ ability to access the online material in a timely manner, which may have led to them to feel unprepared for in-class discussions and hence unsatisfied with the overall learning experience (Sawarynski et al., 2013). We should also point out that the majority of our students join the medical course after 13 years of school education, without prior undergraduate education and may thus be less well equipped to read and understand complex medical subjects on their own. Either way, these students would naturally feel unsatisfied and concerned that their exam performance may be negatively affected by the new teaching/learning model.

Notwithstanding these poor satisfaction scores, given that there is some evidence that students for whom English is a second language may benefit the most from courses that offer online e-lectures (Shaw & Molnar, 2011), we intend to repeat this exercise among student cohorts with significant numbers of international students.

**Limitations**

Our students had no prior experience with this teaching/learning model, and may have found it difficult to adjust their expectations regarding the way class time would be used. Moreover, our study did not include incentives in the form of quizzes, worksheets etc. These limitations in our study design may perhaps explain the relatively high rate of dissatisfaction with the flipped classroom experience the high proportion (40%) of students who felt that this negatively affected their exam performance.

**Conclusion**

Our initial experience with a version of a flipped classroom model for teaching/learning gastrointestinal anatomy was largely positive from the point of view of exam performance, in spite of being generally disliked by the students.
Moreover, this pilot study has revealed several areas which could be improved. For example, the 30-45 minute long e-lectures could be converted into shorter segments that are easier for students to handle at any one sitting. We shall also be better preparing students to see the importance of each aspect of the work they are doing. Based on the literature, we intend to incorporate structured worksheets as preparatory work as well as in-class quizzes to better motivate student participation in classroom discussion with the ultimate aim to improve retention of anatomical knowledge beyond exam time.

Take Home Messages

Flipped classroom teaching is an effective alternative to traditional anatomy teaching.

Notes On Contributors

RS is a final year medical student; EC is a higher surgical trainee; IS is a Professor at the University of Malta.

IS conception and design of research; RS and IS conducted research; RS and EC. analyzed data; RS and IS interpreted results of experiments; RS prepared figures; IS drafted manuscript; RS edited and revised manuscript; RS and IS approved final version of manuscript.

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Appendices

Declarations

The author has declared that there are no conflicts of interest.

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