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Why The Flipped Lecture Is Not A 'One Size Fits All' Solution To Undergraduate Medical Education.

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ABSTRACT

Lectures underpin most medical school curricula; however, due to their frequently didactic nature, their pedagogical efficacy and value are continually questioned. The "flipped" lecture is one approach with the potential to increase student collaboration and interactivity within the lecture theatre environment. Increasingly, medical teachers are introducing flipped lectures, reflecting the increasing use of active learning techniques and digital technologies across the higher education sector more generally. This intervention is seen as a solution to the problems of a traditional lecture, yet whether the use of flipped lectures in medical school programmes enhances learning for all students is not clear. This study investigates whether flipped lectures are perceived as a valuable learning resource by undergraduate medical students. By introducing a flipped lecture at two stages of the curriculum to three student cohorts, and determining students' observations and perceptions of each experience, we discuss why a flipped lecture does not always meet the needs of the increasingly diverse range of students in medical education and propose exercising caution when considering the introduction of flipped lectures to undergraduate programmes.

Keywords: flipped lecture, medical education, student engagement, student learning, active learning

Introduction

The use of flipped teaching has been welcomed across the Higher Education sector as a solution to the limitations of the traditional lecture format. Flipping the classroom is a pedagogical concept and method and is gaining popularity in medical education. Defined by Lage, Platt & Treglia (2000: 32) as "events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa", the flipped classroom replaces the standard lecture-in-class format with opportunities for students to build on course content and review, discuss, and investigate content with the instructor in class (Sharma, Lau, Doherty & Harbutt, 2014). The flipped classroom is said to fall within the constructivist model of learning (Strayer 2012), by providing a knowledge base on which to construct new understanding. Flipping a classroom, particularly when used for smaller group sizes, provides enormous scope to develop interactive opportunities in the 'live' session. Flipping a teaching event presents challenges for both teacher and student involvement, due mainly to student numbers and the teaching space, but usually involves the delivery of asynchronous on-line-based material prior to a 'live' interactive session. This session is then dedicated to more active learning processes such as, interactive consolidation of themes, formative assessment and feedback, or perhaps application of knowledge through collaborative problem solving or case-based scenarios. The rationale behind this approach is that teachers can use the face-to-face time supporting students in deeper learning processes and critical thinking. Flipped lectures are a variant of the flipped classroom in which students are given preparatory material prior to attending a timetabled face-to-face session in a lecture theatre. Flipped lectures support a wider approach of involving students in decisions regarding their learning by discouraging the student as a passive recipient of knowledge, instead promoting student engagement and increasing self-regulation (Sun, Xie & Anderman, 2018).

Numerous studies validate the implementation of flipped lectures, within courses, evidencing increased engagement, improved learning outcomes and higher student satisfaction connected with the ensuing participation in active learning (Burke & Fedorek 2017; McLaughlin, et al., 2014; Steen-Utheim & Foldnes, 2018). The higher levels of Bloom's taxonomy that relate to analysis and synthesis of information (Krathwohl, 2002) are particularly well-supported by the flipped approach. In terms of engagement, Ogden (2015) found that students had more time in a flipped setting to ask more questions about course content, and high levels of student satisfaction are achieved when a flipped approach was implemented (Critz & Knight, 2013; Gilboy, Heinerichs & Pazzaglia, 2015). Importantly, it must be acknowledged that approaches to flipping a

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teaching environment are highly varied in both design and implementation, and the methodology used to draw conclusions equally varied, so it is difficult to establish the efficacy of the pedagogical approach (Ramnanan & Pound, 2017).

Trends for reform in medical education and a move towards a more learner-centred approach to medical curricula aligns well with a move to introducing a flipped approach. The availability of new technologies to support flipped teaching approaches has enabled the promotion of active learning, as well as allowing more effective use of class times, by providing lecture material online in advance of face to face teaching. The review by Ramnanam & Pound (2017) revealed that flipped classrooms were almost universally well received by medical students, in both pre-clinical (Street, Gilliland, McNeil & Royal, 2015) and clinical courses (Morgan, McLean, Chapman, Fitzgerald, Yousuf & Hammound, 2015). Students value the interactive nature and the self-directed approach of a flipped classroom (Ilic, Hart, Fiddes, Misso & Villanueva, 2013; Morgan, et al., 2015).

Although a lecture provides a cost-effective way of delivering standardised teaching objectives to large classes, their limitations have been well-described (Brown & Manogue, 2001; Ramsden, 2003). The typical lecture format has a "one size fits all" approach and is simply regarded as a mechanism for the transfer of information. Student involvement is typically restricted, resulting in a strong reliance on the teacher to determine what is to be learned. Student engagement for an entire lecture is rare and the learning itself is predetermined, factors which encourage a surface approach to learning (Young, Robinson & Alberts, 2009). Although lectures are as effective as other methods at delivering information (Bligh, 2000), the acquisition of knowledge, or the construction of understanding, is less likely for passive recipients in traditional lectures that offer limited opportunity for collaboration between students (Tam, 2000).

In response to a growing evidence base that flipped teaching approaches support active learning and improve student outcomes, two flipped lectures were introduced into a medical degree programme and evaluated by examining how students engaged with this format. The research question of this study addresses whether the student-centred approach of the flipped lecture meets the diverse learning needs and expectations of all students. By examining student perceptions of the flipped lecture at different stages in their medical education, this study aims to identify the reasons why a flipped lecture might not be suitable for all students and considers how and when it should be used to deliver a curriculum.

Materials and methods

A qualitative approach was used to evaluate the student experience of the flipped lecture format. A single flipped lecture was introduced into years one and two of an undergraduate medical curriculum. This form of active learning was chosen to complement the existing undergraduate curriculum, which includes problem-based learning (PBL) as a key teaching modality. The constructivist nature of the flipped lecture aligns with the pedagogy of PBL and complements this student-centred approach. The flipped lecture format presents its own challenges, being constrained by the learning space (lecture theatre) and the large student numbers (approximately 240 students in this study).

Impressions of the flipped lecture from three different cohorts of students (cohorts 1-3), from years one and two of the undergraduate medical degree were explored and evaluated. Each cohort was exposed to a flipped lecture at a different stage of their university experience (Table 1). A lecture entitled Cells and Organelles was flipped for first year students and the same flipped format was delivered to year 2 students for a lecture entitled Development of the Central Nervous System. In both cases, the flipped lecture consisted of a 20-25 minute video for students to view in advance of the 'live lecture'. The live content consisted of quizzes, further application of content as well as discussion of any questions raised by students from the video.

Table 1 Summary of student cohorts and interventions.

Cohort 3-TL refers to students who indicated a preference for traditional lecture format; 3-FL refers to students who prefer the flipped lecture format.

	Cohort 1	Cohort 2	Cohort 3
Students	241 year 1 students	229 Year 2 students	237 Year 2 students (same students as cohort 1)
Intervention	Flipped lecture Cells & Organelles	Flipped lecture Development of CNS	Flipped lecture Development of CNS
When?	Year 1, week 1	Year 2, week 20	Year 2, week 20

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Previous exposure to university lecture format	None	All 1st year lectures delivered in traditional format	All 1st year lectures in traditional format & Flipped Cells & Organelles lecture in year 1
Survey response rate	88.4%	65.5%	70.9% 168 (110 3-FL, 58 3-TL)

Cohort 1 were students in the first week of the first year of their undergraduate degree. These students had little or no experience of lectures in any format (except for those who joined the programme as graduate students) and received a flipped lecture on Cells and Organelles. Cohort 2 were second year students who received frequent traditional lectures during their first year but had no prior experience of a flipped lecture. Cohort 2 received a flipped lecture on the topic of Development of the Central Nervous System. Cohort 3 were the same Cohort 1 students who had progressed to second year. This cohort had experienced the Cells and Organelles flipped lecture in their first year, with all subsequent lectures being traditionally delivered, until the delivery of a second flipped lecture, Development of the Central Nervous System, in year 2. Before each flipped lecture was implemented, information was provided to students, explaining how the flipped lecture would be delivered. In each case, students were asked to view an on-line pre-recorded lecture (20-25 minutes), which was made available on their virtual learning environment (VLE) a few days prior to the face-to-face session. At the conclusion of the recorded lecture, and in the general information provided about the format of the flipped lecture components, students were asked to email the lecturer with any questions, areas of difficulty, or areas for clarification. The purpose of this student feedback would be to customise the content of the live lecture. The live lecture also incorporated stimuli for student interactivity in the form of formative quizzes using class response software.

Data collection and analysis

At the end of each flipped lecture, each cohort was asked to complete a survey evaluating the student experience of, and how they engaged with, the flipped lecture. Students responded using a 5-point Likert scale, recording agreement or disagreement with individual statements. Cohorts 1 and 2 received the same survey. The survey for Cohort 3 was modified to allow more detailed evaluation based on student preference. Two versions were devised; the variant each student answered was determined by their answer to the initial question: "I preferred the flipped lecture format (online lecture followed by live lecture)" (cohort 3-FL) or "I preferred the traditional 50-minute single lecture format" (cohort 3-TL) (Table 1). The final item in all surveys was a free text question asking for any additional comments. Responses to each statement were collected using EVASYS software. The software performs basic analysis for ordinal data sets. The response rates for each questionnaire are indicated in Table 1.

Results and discussion

Student engagement with the flipped lecture

Consistent with other published studies (Merlin-Knoblich & Camp, 2018; Dodiya, Vadasmiya & Diwan, 2018), across the three cohorts students enjoyed the experience of the flipped lecture. In Year 1, 79.5% of the respondents stated they enjoyed the flipped lecture. This could possibly be partly due to enthusiasm towards new experiences of higher education generally. In contrast, in second year, enthusiasm for the flipped lecture format dropped, with two thirds of both second-year cohorts reporting they enjoyed the flipped lecture. Interestingly, almost half of second year students in cohort 3 who expressed a preference for the traditional format (cohort 3-TL) still stated that they enjoyed the flipped lecture that was delivered (Table 2). This shows that despite it not being their preferred format, many students still acknowledge the flipped lecture as an enjoyable experience.

Table 2 Student enjoyment of the flipped lecture format. Data presented represents the combined data for students who selected 'agree' and 'strongly agree' from the Likert scale options.

	Cohort 1 n=195	Cohort 2 n=143	Cohort 3 n=168	Cohort 3 preferred FL n=105	Cohort 3 preferred TL n=53
I enjoyed the flipped lecture this week	79.5%	66.5%	69.6%	83.8%	41.5%

Student engagement with the online component of the flipped lecture

Across the three cohorts, between 50-69% enjoyed the option to view an online lecture component, rather than attend a lecture. The convenience and flexibility of interacting with the online component of the flipped lecture was a significant

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strength of the format. All cohorts valued and made use of the ability to stop and start the recording, for cross-referencing, or making notes as they continued.

I learn better when I watch online as I can start and stop (cohort 3FL)

A proportion of surveyed students indicated that they took the opportunity to view the online video more than once (cohort 1: 34.3%, cohort 2: 20% and cohort 3: 17.5%), with most students indicating that they replayed sections of the videos more than once (cohort 1: 78.9%, cohort 2: 69.2%, cohort 3: 81.7%).

It enables a better understanding of topic because it can be replayed (cohort 3FL)

Students also recognised the value of a short, concise lecture delivered online. The online component was approximately 25 minutes long (compared to a 50-minute traditional lecture), delivering key learning objectives which could be expanded on in the live component of the flipped lecture.

I liked the online lecture because it was short and focussed (cohort 3FL)

Although online lectures clearly provide flexibility, students expressed a strong preference for not all lectures being delivered online. In all cohorts, over 80% indicated a strong preference for having live lectures (Table 2).

I signed up for an engrossing university experience, not a disconnected …. university experience (cohort 3TL)

To fully engage with a flipped lecture to deliver the best learning experience requires students to participate in both the online activity as well as the face-to-face session. In cohort 1, 98% of first year students watched the video at least once. Similarly, 95.5% of second year students with previous experience of a flipped lecture (cohort 3) also engaged with the online material. In contrast, second year students encountering the flipped lecture format for the first time (cohort 2) engaged less with the online material, with 27% admitting that they had not watched the online part of the flipped lecture (Table 3).

Table 3 Student engagement with the online component of the flipped lecture.

	Cohort 1	Cohort 2	Cohort 3	Cohort 3(FL)	Cohort 3(TL)
Students who did not watch the online component of the flipped lecture	2%	27%	4.4%	3%	8%

This may be why fewer cohort 2 respondents enjoyed the flipped lecture (Table 2) as not all had experienced the full flipped teaching event. Accessing online material often mirrors attendance rates at live teaching sessions, so this could reflect a general decline in attendance patterns across a course (Jensen, 2011). The Year 2 students with prior experience of a flipped lecture (cohort 3) tended to view the online recording. One possible explanation for this might be that the positive experience of a flipped lecture in year 1 motivated students for a second flipped lecture.

Student engagement with the live component of the flipped lecture

The majority of students valued the diversity in the mode of teaching afforded by the flipped lecture but did not want the entire course to be delivered in this way.

Once in a while it's nice to have an online lecture … but I don't want this to replace real life lectures (cohort 2)

Attendance at each live lecture was compulsory, so we cannot draw any conclusions about the numbers attending this component of the flipped lecture. However, a relatively small proportion of students from each cohort felt that the live, interactive, lecture component should be optional to attend (cohort 1: 13.3%, cohort 2: 21.6% and cohort 3 TL: 29.6%).

Students value the enthusiasm or passion for a subject that a live lecturer can convey compared to online lectures. The enthusiasm and commitment of a lecturer are important factors that promote student learning and motivation, as well as a sense of connectedness (Hartnett, George & Dron, 2014), and are essential to develop and sustain interest to learn (Hidi & Renninger, 2006). This study also found that students valued the opportunity to receive formative feedback in the live lecture using interactive quizzes such as multiple-choice questions (MCQ). This is unsurprising as students appreciate any feedback on their learning and it is apparent that students value the chance to answer formative questions based on teaching to help prepare them for summative assessment. In this regard, the value of the live component of the flipped lecture is evident to students.

The MCQs were really worthwhile and I think more formative assessment like this would be good (cohort 2)

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Why a flipped lecture should be included in medical curricula

Students identified the flipped lecture format as particularly useful for teaching more difficult subjects, facilitating the opportunity to receive clarification and consolidation of difficult concepts. From Cohort 3 (FL), 72.7% recognised that a flipped approach was more useful for 'harder' topics. As cohort 1 students who had progressed to second year, they had received a flipped lecture on Cells and Organelles in their first year, which was intended to revise basic material, much of which is covered in secondary education curricula. Cells and Organelles could be considered a conceptually less demanding topic than the second year flipped lecture on developmental biology.

> *Useful for more difficult to understand topics* (cohort 3FL)

The flipped lecture was able to engage the students better than in a traditional didactic lecture.

> *It was really helpful being asked questions during the lecture so you actually had to think about the information* (cohort 1)

One reason for this could be the fact that the students knew there was going to be questions to answer about the material being presented, and so were more focussed.

> *Kept my attention for longer than 'traditional' lectures as knew I had questions to answer!* (cohort 3FL)

In other components of the medical curriculum, such as problem-based learning, interaction and collaborative learning are encouraged. Reinforcing this in lecture settings gives students more experience of this, and the flipped lecture is an ideal setting to achieve this, even when dealing with large class sizes.

> *Interaction is a massive part of learning ..... I feel I learn the most when we just chat about what we're learning, small bits of interaction here and there reinforces my learning. Not listening to someone speaking at me, ... doesn't really do anything for me. It does go in* (cohort 1)

Students felt having prior knowledge before a lecture supports deeper understanding.

> *Watching a lecture online first allows you to go into the 'live' lecture with a greater understanding which is useful for something like embryology which is typically quite a difficult subject* (cohort 3FL)

The undergraduate medical curriculum covers a large amount of material, much of which will be completely new to students. Exposing students to material before teaching sessions can build confidence in students, especially when more difficult topics are being taught.

This generation of students expects the use of technology and values any opportunity for interactivity within class (Hopkins, et al., 2018). Whether the use of interactive technologies actually benefits learning to any greater extent than a traditional lecture remains unclear but, as we move into a more technology-focussed era, it is now conventional to integrate digital resources into courses. However, in this study, 38.8% of students indicated they did not like excessive use of screen time – significant in the digital age!

Retaining the traditional lecture format

For those students in cohort 3 who stated a preference for the traditional lecture format (3-TL), 69.6% preferred a single teaching event, rather than two events for the same content. This could be simply due to the large teaching load that medical students have. Contact hours are higher than many other degrees, and students may feel that their time may be better spent revising or completing coursework than attending too many lectures.

> *The flipped lecture takes twice as long to get the information, which is the main reason for me not liking it* (cohort 3TL)

Although many students state that they value interaction, there is also a subset of students who feel that interactive elements of lectures can break concentration. The physical environment and design of the learning space can both support and inhibit learning (Brooks, 2011). The interactive element of the 'live' lecture engages the students by electronic voting, however this usually results in very high noise levels while students make their decision. If this is included a number of times across the live lecture, the potential for disengagement or breaks in concentration may increase for some students (and lecturers). Students also commented that note taking was more difficult and organising notes was awkward when the lecture format was disrupted.

> *The questions jumped around a bit, bit hard to follow topic to topic, had to find where to write stuff in my notes* (cohort 3FL)

In terms of the online component, it was noted that it is easy to forget to watch online material, and for those who watch the material, it could be difficult to maintain focus whilst watching online.

> *I also forgot to watch it whereas I wouldn't forget to go to a lecture* (cohort 3TL)

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Flipping a lecture is challenging due to the lecture theatre environment that hinders peer interaction, and the scale of the audience. A number of studies have found that the flipped approach does not result in increased student satisfaction (Poniatowski, 2019; Strayer, 2012) nor does it necessarily result in improved student grades or performance (Poniatowski, 2019; Bossaer, Panus, Stewart, Hagemeier & George, 2016; McLaughlin, et al., 2013) when compared to traditional teaching approaches. This may partly relate to how the flipped teaching event was implemented. In addition, very little information exists on the effect of demographic factors (such as age, sex, socio-economic background and cultural learning styles) on the student experience of flipped lectures.

Conclusions

This study indicates that flipped lectures can be an enjoyable learning experience. However, caution should be exercised when considering their use. Not all students regard flipped lectures as beneficial – with the pre-learning component most frequently disliked (McNally, et al., 2017). It is likely that student preference for the proportion of a course that is delivered by flipped lectures will vary across student cohorts.

Our data raises the prospect that student-centred approaches, when applied to the lecture theatre format, may not be the most effective approach to support learning. Factors that can impact on the student experience, including inefficient use of time, high noise levels, distractibility, and student anonymity can all result in a poor learning environment. Indeed, a comparison of the effectiveness of student-centred and teacher-centred approaches by Fischer and Hänze (2019) showed that learning achievement was increased by teacher-centred approaches. Perhaps the interaction with an expert in a field of study, or the communication of passion and enthusiasm for a subject is a strong source of motivation for students.

Secondly, the marketisation of higher education, as a result of increased access to higher education, the implementation of fees, and increased expectation by employers that applicants will hold a degree, has resulted in a proportion of students attending university with less interest in the learning journey, and more focus on attainment (Molesworth, Nixon & Scullion, 2009). For such students, the focus is more on achievement or 'having the degree' and less on learning, and in such cases, the traditional format will meet their needs more efficiently and with less effort than student-centred approaches like the flipped lecture.

The assumption underlying the flipped lecture, and other 'active' approaches to learning is that students need to be physically engaged in order to learn. Bonwell & Eison (1991) defined active learning "as instructional activities involving students in doing things and thinking about what they are doing". However, is learning necessarily 'passive' in a didactic lecture? At the core of constructivism is that students actively construct new knowledge, however should active necessarily mean physical engagement with an electronic voting device or active participation in an activity? Active learning can occur through listening and in traditional learning environments (Renkl, 2009). The use of an electronic voting system, while physically active, does not guarantee engagement or learning, particularly when it potentially breaks student concentration. In one controlled comparison of an active and passive teaching strategy (Haidet, Morgan, O'Malley, Moran & Richards, 2004), assessment performance was not significantly different between the two groups, however self-perception of engagement was higher for the 'active' learning group, while those in the didactic group perceived their group had greater educational value. Many other studies summarised by Michel, Cater III & Valera (2009) show that it is far from clear that active learning approaches result in better learning outcomes for students.

The use of flipped lectures suits some students, but our data shows a number of students describe limitations with the format. Ultimately, students want feedback and the flipped lecture provides this in the interactive lecture component. However, as one student suggests, perhaps the flipped lecture is not the best way to provide this.

> I feel that a more productive method would be to have feedback lectures throughout the block, with MCQ and detailed explanations of the answers (cohort 3TL)

Going forward, caution should be used before using a flipped lecture given the extra time commitment required by students and staff, when student feedback can be provided through other more time-efficient formats.

While this study cannot draw firm conclusions about the quality of learning by students from the flipped lecture, our students overwhelmingly engaged well with the flipped lecture approach, but that this did not meet the needs of all of them. Based on this, this study recommends that curriculum design should draw on a portfolio of teaching approaches that support the increasingly diverse nature of students in higher education, with their accompanying diverse learning styles and motivations. Medical students, and indeed students in higher education more generally, are increasingly diverse, with international students from different learning cultures, students from socioeconomic backgrounds that have not traditionally engaged in higher education, and increasingly more students with additional needs that were not previously supported in higher education, all being welcomed. Further work to address whether one or some of these student groups prefer the traditional lecture format over the flipped lecture would further support the integration of students into higher education.

Ethical approval was granted by the University of Glasgow's Medical, Veterinary and Life Science Ethics committee prior to the commencement of the study.

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Biographies

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