The What, the How and the Why of the Flipped Classroom

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Abstract

This paper provides an introduction to, an overview of, and a consideration of some of the evidence for the adoption of flipped classroom techniques in higher education. Through a discussion of recent research papers on the subject, this paper concludes that there is strong evidence to support the adoption of flipped classroom techniques. However, the adoption of such techniques is worthwhile not because they can, in and of themselves, improve teaching and learning, but because they allow for more active approaches to teaching and learning to take place.

Introduction

One of the more discussed topics in education is the idea of the flipped classroom, or of students engaging in flipped learning. The purpose of this paper is to offer an introduction and explanation of the flipped classroom, and to argue that while there are possible teaching and learning gains from using a flipped approach, such gains are not likely to result merely from putting one's teaching material online. It is hoped that by focusing on some of the key, 'what', 'how' and 'why' questions, teachers interested in this subject may feel sufficiently informed to try out this approach. The paper is divided into two parts: in the first part the main 'what' and 'how' questions are discussed; in the second part some evidence answering the main 'why' question for flipping the classroom is discussed.

The What and the How of Flipped Learning

The first section of this paper will look at some of the key questions that teachers may have about the flipped classroom. No prior knowledge is assumed, and before going on to discuss some ideas about how one might go about flipping the classroom and what support is available for this approach, the flipped classroom approach will be outlined. Where appropriate, likely objections and criticisms will be considered, and an attempt will be made to respond to them.

When discussing online lectures or flipped lectures, what is meant by this term in the context of this paper is not the video recording of live lectures (usually known as lecture capture), but the creation of bespoke lectures recorded specifically for an online audience. These are often recorded using the same lecture capture technology as used for recording live lectures, but are recorded at one's desk and are intended specifically for an online audience (see, for example, Severance, 2013). While video recordings of live lectures can be engaging and effective for an online audience when produced to a sufficiently high quality (see, for example, Sandel, 2009), it is often technically easier and more effective to produce a good online lecture oneself at one's desk, rather than in the lecture hall. This type of lecture is often referred to as the flipped lecture, the mini-lecture or the lecturette – reflecting the fact that it is common practice to keep online lectures fairly brief. Depending on the technology available, such videos can be interspersed with quizzes which stop the video periodically and require students to answer questions before allowing them to proceed.

What is the flipped classroom and where does it come from?

The idea of the flipped classroom owes a great deal to the work of physics professor Eric Mazur, whose Peer Instruction method (Mazur, 1996; Lambert, 2012) formulated at Harvard in the 1990s evolved into what is often termed flipped learning. To use Mazur's terminology, what happens in a traditional classroom is that class time is typically taken up with knowledge transfer, often a lecture, and students then complete tasks outside of class in order to process and understand the subject matter, which Mazur terms knowledge assimilation. What Mazur proposed is that the knowledge transfer stage should be covered prior to attending class, so that the class time can be used to help students assimilate what they have read, watched or otherwise attempted to understand prior to coming to class. The so-called flip is simply that knowledge transfer now happens outside and prior to class, and knowledge assimilation now begins in class.

> Mazur's reinvention of the course drops the lecture model and deeply engages students in the learning/teaching endeavor. It starts from his view of education as a two-step process: information transfer, and then making sense of and assimilating that information. 'In the standard approach, the emphasis in class is on the first, and the second is left to the student on his or her own, outside of the classroom,' he says. 'If you think about this rationally, you have to flip that, and put the first one outside the classroom, and the second inside. So I began to ask my students to read my lecture notes before class, and then tell me what questions they have [ordinarily, using the course's website], and when we meet, we discuss those questions.' (Lambert, 2012)

One might suggest here that the flipped classroom is nothing new. It may be said that teachers have been flipping their classes for years, if not centuries. It has been standard practice for seminar readings to be distributed prior to the seminar, for them to be read by students, and for the readings to be discussed in the seminar. Is this not a flipped classroom?

One might also point to the method of tutorial teaching at the University of Oxford. This method of teaching typically involves one or a small number of students meeting with their tutor on a regular basis. Prior to the meeting the students prepare written work which is then discussed and analysed at the tutorial. This method appears to be particularly effective, as the average amount of preparation undertaken by students for each tutorial is thirteen hours (Oxford Learning Institute, 2016). Is this also a flipped classroom?

The answer is, of course, yes – these are both flipped classrooms. However, what the flipped model suggests is that flipping doesn't have to stop with the seminar and the tutorial; it can be done with the lecture too. Additionally, the flipped model usually makes the assumption that technology is the key to the successful flipping of the lecture.

How might I put the flipped classroom into practice?

Given that the flipped classroom is not, in fact, anything particularly new, it seems likely that most teachers working in higher education are already using the method to a greater or lesser extent. It is likely that very few teachers have taught only by giving pure didactic monologues. Nevertheless, Mazur's ideas can still be used to good effect to free up class time to spend with students helping them to understand the material and the subject in more depth.

If this approach is appealing, then a straightforward and increasingly popular example of how one could put it into practice is by pre-recording short versions of lectures and making them available online. The class time can then be used to engage students in activities and tasks which will help them to more fully understand and assimilate the material which was covered in the online lecture. As previously mentioned, the online lectures should be concise, fifteen to twenty-five minutes is often recommended (Dorussen, *et al.*, 2015). And supporting the video lectures will probably be some reading material, a book chapter or journal article perhaps. Students may watch the lectures a few times in order to get the most from them, and students for whom English is not their first language may benefit greatly from the ability to watch and re-watch the lectures (and possibly from the captions too if it has been possible to caption them). There is now extra class time to spend with the students, so what's the best way to use that time?

Well, there are many options here. One idea would be to ask students to complete a pre-class test or survey in order to find out where the gaps in their understanding are. A test may be devised so that the students' level of understanding can be determined. Alternatively, the students could determine for themselves what they did and did not understand, and could be asked to submit questions about the material prior to coming to class. The students' questions or their test results could then form the basis of a class session in which the teacher discusses and answers the questions that the students submitted in the survey, or provides further clarification on the things they got wrong in the tests. The basic idea here is that the teacher gets some information about the students' understanding of the subject prior to the class session, and can prepare, review or adjust

the planned class session as needed. This may mean spending more time on a particular activity, or starting the class with a detailed explanation of a troublesome topic, allocating additional discussion time, or simply skipping over something that had been readily understood by the whole class. This approach is often called Just-in-Time Teaching (Novak, 2014) as the teacher doesn't really know the exact details of the class session until the test or survey results have been submitted and analysed, and this may often be less than twenty-four hours before the class is due to start. If a class session that involves peer-to-peer interactions is wanted then a pre-class or in-class test could be used, and the students could answer their questions or correct their misunderstandings between themselves. This is the approach that Mazur uses, which he terms Peer Instruction.

> Mazur begins a class with a student-sourced question, then asks students to think the problem through and commit to an answer, which each records using a handheld device (smartphones work fine), and which a central computer statistically compiles, without displaying the overall tally. If between 30 and 70 percent of the class gets the correct answer (Mazur seeks controversy), he moves on to peer instruction. Students find a neighbor with a different answer and make a case for their own response. Each tries to convince the other. During the ensuing chaos, Mazur circulates through the room, eavesdropping on the conversations. He listens especially to incorrect reasoning, so 'I can re-sensitize myself to the difficulties beginning learners face.' After two or three minutes, the students vote again, and typically the percentage of correct answers dramatically improves. Then the cycle repeats. (Lambert, 2012)

These are not the only approaches though, and while there is no one correct way of doing things, we will see later that any approach which sees the students actively engaged in class is likely to lead to them learning more than when using an approach in which the students are passive. A visual idea of how the flipped classroom could work in practice is given in Figure 1 below:
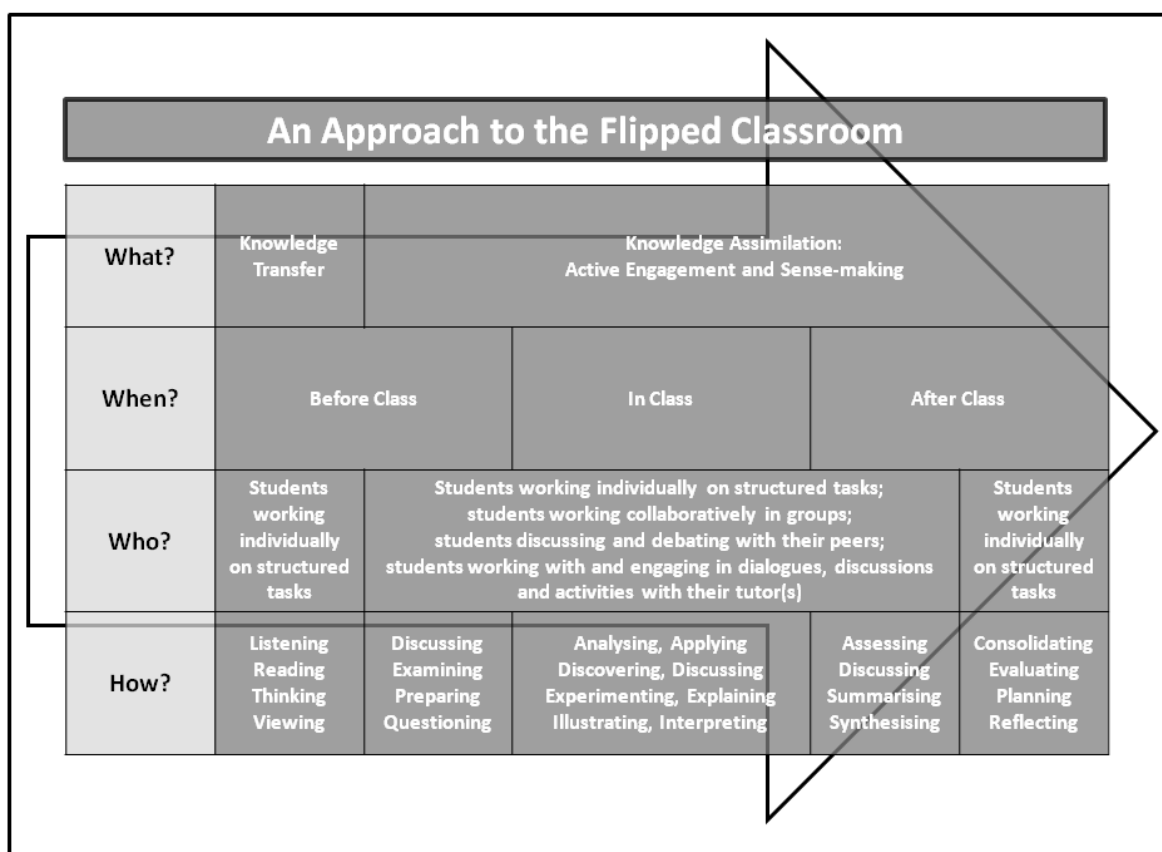
An Approach to the Flipped Classroom

What?	Knowledge Transfer	Knowledge Assimilation: Active Engagement and Sense-making			
When?	Before Class	In Class		After Class	
Who?	Students working individually on structured tasks	Students working individually on structured tasks; students working collaboratively in groups; students discussing and debating with their peers; students working with and engaging in dialogues, discussions and activities with their tutor(s)			Students working individually on structured tasks
How?	Listening Reading Thinking Viewing	Discussing Examining Preparing Questioning	Analysing, Applying Discovering, Discussing Experimenting, Explaining Illustrating, Interpreting	Assessing Discussing Summarising Synthesising	Consolidating Evaluating Planning Reflecting

Figure 1: An Approach to the Flipped Classroom

Will students complain if their classrooms are flipped?

Students may expect lectures and they may think that they learn from them. Students may also like lectures because they're easy: not much is expected from attendees at lectures as they are "the teaching moment that most promotes passivity and discourages participation." (hooks, 2010, p.64) If a flipped learning approach is adopted then students will have to work harder both in class and before class. This is a good thing though, and to counter objections from students who want a lecture, perhaps they could be referred to bell hooks' essay quoted above, *To Lecture or Not* (hooks, 2010, pp.63-68) where she tell us that "When we as a culture begin to be serious about teaching and learning, the large lecture will no longer occupy the prominent space that it has held for years."

Other useful sources which support the move away from lecturing are Gibbs' 1981 paper, *Twenty Terrible Reasons for Lecturing*, in which he explains and provides some evidence as to why lecturing does not "give students a rich and rewarding educational experience" (Gibbs, 1981, p.5). The recent National Union of Students' publication, *Radical Innovations in Teaching and Learning,* is worth referring students to, as it asked universities to, amongst other things, to consider what place the lecture has in "a modern, democratic university" (NUS, 2014). Hoxha (2015) provides a good account of lectures from a student's

perspective, and explains why some students find it beneficial not to attend lectures. And finally, Paul (2015) writing in The New York Times presents the case that,

> the lecture is not generic or neutral, but a specific cultural form that favors some people while discriminating against others, including women, minorities and low-income and first-generation college students. This is not a matter of teacher bias; it is the lecture format itself — when used on its own without other instructional supports — that offers unfair advantages to an already privileged population.

Hopefully these ideas, when combined, may make a sufficient case for students concerned that they are losing out on learning by not being lectured.

However, it is essential to make it clear that the issue of lecturing or not lecturing is not entirely one sided. For example, Phil Race (2014, pp.132-163) presents a balanced view of lecturing in his book, *The Lecturer's Toolkit,* and includes a list of bad reasons for lecturing, and better reasons for lecturing (p.138). Hoxha's article contains well-considered counter-arguments from a teacher who makes the case for attending lectures, particularly those which are fairly active. And a month after the publication of Paul's article in The New York Times, the same paper published an article by Worthen (2015) in which she made the case that the traditional lecture still has many merits, especially in the humanities. Worthen (2015) argued that in the humanities "there are sound reasons for sticking with the traditional model of the large lecture course combined with small weekly discussion sessions. Lectures are essential for teaching the humanities' most basic skills: comprehension and reasoning ..." Worthen (2105) also warns the humanities against the "attempt to further assimilate history, philosophy, literature and their sister disciplines to the goals and methods of the hard sciences." But perhaps the most reasonable conclusion on the subject was drawn three-and-a-half decades ago by Gibbs. Contrary to what one might conclude from the title of his paper, *Twenty Terrible Reasons for Lecturing*, the paper is not one-sided, and nor is it wholly anti-lecture. Gibbs' point is not that there are never any reasons to lecture, or that lecturing should be permanently expunged from the teacher's toolkit; the point that he wants to make is just that there is "far more lecturing going on than can be reasonably justified from the evidence concerning the efficiency of lectures" (Gibbs, 1981, p.77).

How does putting my lectures online make them better than delivering them in person?

So far, we have considered the flipped classroom design primarily as one in which the teacher places his or her lectures online instead of delivering them face-to-face, usually in order to give more class time to the knowledge assimilation phase of learning. However, while the creation and delivery of content (which is what the online lecture is) is important, what students are asked to do with that content is of equal importance. An online lecture is not in and of itself better than a lecture delivered in person, and may be considerably less engaging and considerably easier to ignore.

An important consideration when contemplating using the flipped model is deciding what it is that students are required to do prior to the lecture. Earlier we discussed the Just-in-Time Teaching (JiTT) model, which required students to respond to the content in order that the teacher might have time to adjust his or her teaching session to give more or less time to the various aspects of the planned class session. This gives the teacher the advantages of having a reasonably clear idea of who has been interacting with the pre-class material, and of any problems with what has been learned. Similarly, Mazur, with his Peer Instruction approach, asks students to submit questions based on their understanding of the pre-class material. Both these methods mean that the teacher is not simply hoping that the students have done the pre-class work: in both cases the lecturers can begin the class knowing from the students' submissions that there has been interaction with the pre-class material.

Testing students on the material that they are supposed to have learned is certainly one way of encouraging them to interact with the content, as is asking them to submit questions about the content prior to class. Another way of encouraging students to engage actively with content (such as online lectures, or readings from book chapters and journal articles) is via the use of e-tivities (Salmon, 2013). E-tivities are short, structured activities which can be used to turn a more passive activity (such as watching a video or reading a journal articles) into a more active activity. They are defined as, "frameworks for enabling active and participative online learning by individuals and groups … [and are] based on the strong idea that knowledge is constructed by learners through and with others" (Salmon, 2013, p.5). While there is not the space here to go into detail about e-tivities, it is worth noting that they can be used alongside online lectures in order to promote greater active engagement with the lecture, perhaps by integrating the online lecture into a structured task and asking students to discuss and reflect on certain points in an online discussion forum. Teachers interested in alternatives to online lecturing may find it interesting to note that e-tivities can also be used in a flipped classroom instead of online lectures. However, regardless of whether or how e-tivities are used, the important thing to note is that an activity in which the student uses the passive content (online lecture, reading, etc.) to complete an active task (taking a test, submitting questions, contributing to an online discussion, etc.) is likely to be more successful than one that relies on the passive consumption of content alone.

What support is available to teachers wanting to try out flipped learning?

Before we move on to consider the whys and the evidence for flipped learning, it is important to note that changing the way one teaches takes time, and without support from professional services staff, colleagues and managers, change is likely to be difficult. Change, especially radical change, also needs failure to be acknowledged as a possible and legitimate outcome, as not every new technique that is tried out will be a success. However, perhaps the flipped classroom offers a low-risk opportunity for change, for, as we shall see later, there is evidence that under certain conditions flipping the classroom does work well. Additionally, most UK HEIs employ learning technologists and have departments who

promote and support teaching and learning initiatives who are likely to be able to offer training for this type of teaching. A key text for anyone interested in producing multimedia resources, such as online videos, is Richard Mayer's book *Multimedia Learning* (Mayer, 2009) which sets out a number of research-informed best practice guidelines for the production of multimedia content. Mayer's presentation of these ideas at the Harvard Initiative for Learning and Teaching (Mayer, 2014) is also useful in this respect.

Other practical support may come from finding out more about the flipped classroom, and from viewing some flipped lectures. Eric Mazur's keynote speech for the Association of Learning Technology (Mazur, 2012) is certainly of value for those wanting to find out more about flipping the classroom, as is Simon Lancaster's keynote at Sheffield Hallam University (Lancaster, 2015). Dr Charles Severance is an experienced creator of high quality flipped lectures, and many of those he recorded for his free, online course, *Internet History, Technology and Security,* are readily available online (see, for example, Severance, 2013). Jonathan Thomas-Palmer's lectures, recorded for his Flipping Physics channel are an excellent example of how far it is possible to go with high quality flipped videos, and clearly took a lot of time and technical expertise to create. Of particular interest are likely to be his guides on producing good quality flipped videos (Thomas Palmer, 2014a; 2014b) and his guide on learning from flipped videos (Thomas-Palmer, 2015). What is particularly interesting about Severance's and Thomas-Palmer's online lectures is that one quickly gets the impression that they are both lecturers who enjoy the lecture as performance, and who have successfully managed to capture and maintain that enjoyment in an online environment.

Finally, and fortunately, it is worth mentioning that the concern that putting lectures online will lead to poor attendance at class looks as if it may be unfounded. A recent study by McGowan, *et al.,* (2015) which assessed the impact of lecture recording in computer programming classes found that, "there is no detrimental effect on attendance at lectures with video materials being used to support continual and reinforced learning with most access occurring at assessment periods." The study involved eighty students, of whom ninety-six percent said that the availability of online lectures had no effect on their attendance at classes. Of particular interest was the fact that the teachers were able to access the video analytics and were "able to analyse which parts of the video were rewound and replayed by students most frequently, allowing them to identify concepts that students found complex or confusing, and that might require reinforcement in later lectures" (Havergal, 2015). While the study by McGowan, *et al.,* focused on lecture capture rather than the flipped classroom, it seems reasonable to conclude that if students were turning up regularly for lectures which were being recorded anyway, it is also likely that they will not skip flipped classes simply because a flipped lecture has been made available online.

The Why of Flipped Learning

In this second section of the paper we will look at three recent studies concerning flipped and active learning, in order to consider some of the problems and advantages of this method of teaching. At the risk of appearing to concede defeat before we've even begun,

we will begin by looking at a paper which argues that flipping the classroom does not guarantee any gains in student achievement. Following on from this we will look at the extent to which the flipped classroom can support a more active learning environment. And finally, we will consider some research which strongly supports the case for active classrooms.

The key question that this section of the paper will attempt to answer, is 'will flipping my class lead to improvements in student learning?' The argument set out below will try to show that flipping the classroom is likely to lead to improvements in student performance and reduced failure rates only when it is used as part of an overall strategy to create a more active learning environment.

Flipping the classroom is neither a necessary nor a sufficient condition to generate improvements in learning

Improvements from a Flipped Classroom May Simply Be the Fruits of Active Learning, by Jensen, *et al.,* (2015), makes clear from the title what their findings are. They begin the paper by stating one of the main problems behind many of the claims that the flipped classroom improves student learning, which is that there are normally too many variables that have changed between the flipped and the non-flipped classroom to isolate flipping as the key variable. They note that flipping the classroom usually leads to more active learning taking place (indeed, this is often the reason that teachers want to flip the classroom in the first place), and they investigated the extent to which the increase in the amount of active learning, not flipping, is the key variable.

Jensen, *et al.,* (2015) took a class of 108 students and divided them into two groups; one of fifty-three and one of fifty-five. One group had a flipped experience, the other a non-flipped experience – however, both sessions were very active. The flipped and non-flipped classes were compared with each other, and also with the previous year's class of ninety-four students, (referred to as the original class). While the content and the underlying structure of the teaching remained consistent, a great deal of time and effort was put into creating additional materials for the flipped and non-flipped classes, which is evident from reading the paper.

As will be clear from the title of the paper, the flipped classroom did not produce statistically significant learning gains or improvements in attitudes to learning over the non-flipped classroom, and neither the flipped nor the non-flipped classroom significantly outperformed the original class. The one area in which the flipped classroom did produce a statistically significant improvement was in final examination scores of low level items (e.g., remember and understand type questions) over the original class.

Regarding these results it is important to make at least two observations. Firstly, it should be borne in mind that the students in the study were high ability, highly motivated students attending a private university at which the average ACT score of students is 28 and average GPA is 3.82. To put this in context, an ACT score of twenty-eight would put a student in the

top ten percent and a GPA of 3.82 would be between an A- and an A. Whilst not necessarily Oxbridge students, they are solid Russell Group students, the kind of students who "virtually teach themselves; they typically do not need much help from us." (Biggs and Tang, 2007, p.9). Secondly, the original class appears to have been be a fairly active class already, certainly if judged by the standards set in the definition by Freeman, *et al.,* (2014) which we will look at below.

The study by Jensen, *et al.,* did come up with other interesting findings though. One finding (2015, p.8 and p.10) which reinforces the importance of time spent with lecturers was that, students "perceived their time with the teacher as more influential for learning, regardless of whether they were participating in [the flipped class or in the non-flipped class] … the presence of the teacher and/or peer interaction had a greater influence on students' perceptions of learning than the activities themselves."

Additionally, Jensen, *et al.,* were not dismissive of the potentials and advantages of the flipped classroom, noting (2015, p.10) that,

> If active learning is not currently being used or is being used very rarely, the flipped classroom may be a viable way to facilitate the use of such approaches, if the costs of implementation are not too great. As the research indicates, using active learning in the flipped approach can increase student learning as well as student satisfaction over traditional, non-active learning approaches.

The claim made by Jensen, *et al.,* that active learning is the key variable is certainly very credible, and, as we shall see, it is increasingly apparent in recent publications that flipping the classroom is a very popular way of creating a more active learning environment.

Flipping the classroom is a good way of making classrooms more active

The Flipped Classroom of Operations Management: A Not-For-Cost-Reduction Platform by Asef-Vaziri (2015), provides an excellent introduction to the flipped classroom, and the literature review gives a good overview of some recent publications on the subject. A wide variety of active learning ideas are discussed in the paper (pp.74-80) and they provide an excellent insight into the practical workings of Asef-Vaziri's flipped classroom. Right from the outset Asef-Vaziri (2015, p.72) makes it clear that the benefits of using the flipped classroom are because it allows more class time to be spent engaged in active learning:

> Class time is no longer spent teaching basic concepts, but rather on more value-added activities, such as problem solving, answering questions, systems thinking, and potentially on collaborative exercises such as case studies, Web based simulation games, and real-world applications.

Asef-Vaziri's classes were fully flipped in the autumn of 2012 (141 students) and 2013 (157 students), and the average grades were compared to those of the classes in the spring and autumn of 2011 (both with 160 students) which were not flipped. The results were as follows (see Table 1 below):

	Autumn 2012 flipped classroom	Autumn 2013 flipped classroom
Average grade increase over spring 2011 traditionally taught class	**+7.4%**	**+7.3%**
Average grade increase over autumn 2011 traditionally taught class	**+11.8%**	**+11.6%**

Table 1: Results of Asef-Vaziri flipped classes

The improvements in Asef-Vaziri's students' grades are undoubtedly impressive, and these high gains are likely to result from the significant amount of time and effort that Asef-Vaziri put into re-designing the course. However, it would have been useful to know how the same students performed in other classes in the autumn terms of 2012 and 2013 as compared with the previous cohorts of those classes.

Nevertheless, what comes across very clearly in Asef-Vaziri's paper is the idea that the flipped classroom offers the best of both worlds, creating increased opportunity to engage in active learning in ways that are difficult for the traditional classroom (due to lack of time) and difficult for online classes (due to lack of face-to-face interactions).

A cursory glance at a number of other recent publications about the flipped classroom makes it clear that a key motivation for using it has been in order to create more active learning opportunities. For example, in their paper, *Moving from Flipcharts to the Flipped Classroom: Using Technology Driven Teaching Methods to Promote Active Learning in Foundation and Advanced Masters Social Work Courses*, Holmes, *et al.,* (2015) state that the desire to engage in more active learning was the primary driver behind introducing the flipped classroom.

A number of other papers bear out the notion that flipping the classroom is a popular way of adopting a more active approach to teaching and learning, including: Gilboy, *et al.,* (2014); Hung (2015); Love, *et al.,* (2013); Roach (2104); See and Conry (2014); Simpson and Richards (2015); and Tune, *et al.,* (2013). All of these papers make the connection between the flipped classroom and increasingly active approaches to teaching and learning.

Hopefully the above discussion goes some way to making the case that the flipped classroom is a good (or, at least, a popular) way of creating a more active classroom. We will now look at some more evidence in support of the idea that adopting an active approach to teaching and learning is likely to improve student performance.

Active learning increases student performance

Active learning is certainly not a new idea. John Dewey knew that learning was an active process, and referred to it as such right at the beginning of the last century (1902, p.9). Some years later he stated that "Education is not an affair of 'telling' and being told, but an active and constructive process." (Dewey, 1916, p.46). Around a century later, Freeman, *et al.,* (2014) published an important meta-analysis of STEM education in which 158 active learning classes were compared with sixty-seven traditionally taught classes. Aleszu Bajak (2014), writing in the daily news site of the journal Science, summarised the paper as follows: *Lectures Aren't Just Boring, They're Ineffective, Too, Study Finds*. And Eric Mazur, cited in Bajak (2014), said "This is a really important article—the impression I get is that it's almost unethical to be lecturing if you have this data."

The results of the paper "indicate that average examination scores improved by about 6% in active learning sections, and that students in classes with traditional lecturing were 1.5 times more likely to fail than were students in classes with active learning" (Freeman, *et al.* 2014, p.8410). To get a sense of the significance of the results, the authors note (p.8413) that had it been a medical randomised control trial it may have been stopped early because of the clear benefit of the intervention being tested; in this case, the active learning. The authors also note that because the retention of students on active learning courses is higher, and because it is lower ability learners who typically drop-out, the positive effects of active learning could actually be greater than reported because the active learning classes were holding on to a higher proportion of their lower ability learners than the traditional classes. The paper also showed that active learning was shown to have "the highest impact on courses with 50 or fewer students" (p.8411).

One issue which may be useful is to define what is meant by active learning. For the purposes of their study, Freeman, *et al.,* (2014, p.8413-4) adopted the following definition:

> Active learning engages students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. It emphasises higher-order thinking and often involves group work.

Freeman, *et al.,* (2014, p.8410) state that for the purposes of their study the,

> active learning interventions varied widely in intensity and implementation, and included approaches as diverse as occasional group problem-solving, worksheets or tutorials completed during class, use of personal response systems [clickers] with or without peer instruction, and studio or workshop course designs.

Other studies about the effectiveness of adopting a more active approach to teaching and learning in STEM subjects include Hake's 1998 paper *Interactive-engagement vs traditional methods: A six-thousand student survey of mechanics test data for introductory physics courses.* The paper concludes that:

> Comparison of IE [interactive engagement] and traditional courses implies that IE methods enhance problem-solving ability. The conceptual and problem-solving test

results strongly suggest that the use of IE strategies can increase mechanics-course effectiveness well beyond that obtained with traditional methods.

Also of interest is *Peer Instruction: Ten years of experience and results,* in which Crouch and Mazur (2001) discuss the positive effects of replacing a more traditional approach to physics teaching with Mazur's method of peer instruction.

While a good deal of the most rigorous and credible quantitative studies into active learning have been carried out in STEM subjects, Hung (2015) makes the point in the paper *Flipping the classroom for English language learners to foster active learning*, that,

> it is evident that although the flipped classroom approach has mainly been conducted in STEM fields, its feasibility across disciplines (in this case, language education) should not be underestimated.

Conclusion, and some caveats

While this has not been a systematic study of every single recent publication on the flipped classroom, hopefully the paper has fulfilled its stated intention to answer some questions about what the flipped classroom is and how and why one might want to try such an approach. And while not all conclusions about flipped and active classrooms can be drawn with certainly, there are at least some that we can be confident about.

We can certainly be very confident that active learning produces statistically significant improvements in student achievement and retention in science, technology, engineering and mathematics, and that active learning in classrooms of under 50 students produces the largest gains. We can also be confident that even a small amount of active learning will produce positive gains in student retention and achievement.

We can be confident that lecturers in a variety of subject areas have successfully flipped their classrooms, and that flipping the classroom is a good way of creating a more active learning environment. Thus the likely explanation as to why flipped classrooms are proving to be successful is that the gains in students' learning are actually the result of increasing the amount of active learning taking place online and in the classroom.

We can be reasonably confident that the positive effects of active learning seen in science, technology, engineering and mathematics will be applicable to a variety of other disciplines. However, those other disciplines will almost certainly need to decide for themselves how that active learning is best made manifest in their subject areas. We can also be reasonably confident that a more active approach to teaching and learning will be of greater proportional benefit to the less academic, or non-traditional university students. This point is made by Biggs and Tang (2007, p.13) when discussing solutions to the 'Robert and Susan' problem.

> Susan is the sort of 'academic' student teachers dream about. She hardly needs teaching: she is motivated, knowledgeable and actively learning even in lectures. Robert is unsure of his goals, is doing subjects that don't really interest him and sits passively

in class. There is a large gap between Susan's performance and Robert's. In a class that requires students to engage in learning activities that directly address the intended learning outcomes … Robert is more likely to engage in the sort of learning that Susan does spontaneously.

Thus good teaching is defined as "getting most students to use the level of cognitive processes needed to achieve the intended outcomes that the more academic students use spontaneously." (Biggs and Tang, 2007, p11)

What is not yet clear are whether there are significant differences in the effectiveness of different types of learning activities, and whether there is an optimal level of student activity online and in the classroom. For example, is more activity always better, or are learning activities subject to a law of diminishing returns? Is there are point at which too many learning activities generate negative returns?

It is important to end this paper with two caveats. The first is to note the fact that the flipped classroom is just one approach to teaching among many, and to underline that it is more likely that any gains produced as part of flipping the classroom are actually the result of creating a more active learning environment. So while flipping might offer some good ways of creating an active learning environment, it is not the only method of doing so, and it is likely that a variety of approaches to teaching and learning will be better than just one. As Dorussen, *et al.* (2015) state,

> We have received overwhelmingly positive feedback from students about the approach and the use of new technology, but they still value traditional lectures and teaching methods (some have expressed a clear preference for them). The majority of students appreciate having the chance to learn in lots of different ways. So if you do flip the classroom, remember to flip back occasionally as well.

The second caveat is to recognise that although a lot has been said in this paper about flipped lectures and online videos, it is vital to stress that flipping the classroom is not simply about pre-recording one's lectures and making them available online. An effective flipped approach can be adopted without any video lectures at all, and teachers who would like to dispense with lecturing could use the flipped classroom to facilitate this (using an e-tivity driven approach, for example). As has been said, what is important is not just the content of the course, but what students do with that content. However, it is important to recognise that video can be an effective way of conferring a strong authorial voice upon a course, module or unit of study, and this can be important in the learning process. One of the ways in which online video lectures and courses such as Severance's *Internet History, Technology and Security* (2016), Sandel's *Justice* (2009) and Thomas-Palmer's *Flipping Physics* (2016) are successful is that one is able to connect with the teacher; one is able both to learn and to get a sense of from whom one is learning. This is important because learning is not a simply a dash through an educational supermarket in which one efficiently loads up one's trolley with as many facts and skills as possible before proceeding through the graduation checkout aisle. Rather it is a long, complex, highly theatrical and character-forming narrative, replete with a multiplicity of characters and full of sub-plots, reversals and

triumphs, in which, years later, we are likely to remember who taught us just as much as we remember what they taught us.

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