Flipping a Programing Class to Improve Student Performance and Student Satisfaction

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ABSTRACT

Flipped classrooms are an instructional strategy that is becoming popular in educational contexts, particularly higher education. The principle of Flipped Classroom is that events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa. Various studies have reported increased student performance and satisfaction after switching to a flipped classroom. However, most of these studies are based on students' perceptions of their own learning, not based on teachers' assessment of students' achievements. This article presents the results of flipping a computer programming course. It first describes how this course was flipped, then it presents the results of comparing the average marks awarded to students between those that took the course offering in flipped mode and those that took the course in the traditional mode. The comparison showed an increase in student performance in a flipped mode. Furthermore, the increase in student performance was sustained for 3 years, which is the full duration of this study. The comparison of student satisfaction showed an increase in student satisfaction in one campus, while the student satisfaction remained steady in another campus.

KEYWORDS

Active Learning, Blended Learning, Computer Programming, Flipped Class, Video Lecture

INTRODUCTION

The Flipped classroom is a relatively new blended learning instructional strategy. Flipped classrooms or simply 'flipped classes' have become a buzzword in academic circles (Bishop & Verleger, 2013) where there has been an increased number of publications on this topic (Uzunboylu & Karagözlü, 2017). Many of these publications report a positive impact as the result of the change to flipped class (Hung, 2015; McLaughlin et. al., 2014; McLean et. al., 2016; Sankey & Hunt, 2013). The principle of Flipped Classroom is that events that have traditionally taken place inside the classroom (e.g. lectures) now take place outside the classroom and vice versa (King, 1993; Lage et al., 2000).

There is no single model for the flipped classroom (DeLozier & Rhodes, 2017; O'Flaherty & Phillips, 2015; Tucker, 2012). Most descriptions of the flipped classroom involve some form of material presentation using prerecorded video (made available online) or other existing online resources. Students are supposed to study the material before class. During the class, student-centered activities are conducted such as working on problems, case-based presentations, team-based discussions, panel discussions, expert-led discussions, role-plays and student presentations, discussions, and debates. The flipped classroom model frees face-to-face contact time from the demands of pure content delivery (which is mostly passive on the part of the student) and makes the most of face-to-face contact to engage students in valuable learning activities.

The flipped classroom model allows students to benefit from both in-person and online learning. Allowing students to consume information online provides greater flexibility for the student. Students can peruse the content at any time that suits them allowing the student to fit their studies around other life activities and also reduces the transportation burdens of time and cost. Consuming content online also allows students to progress at their own pace and with their own style of learning. Students can also easily revise content that may not have been clear to them. These aspects may contribute to better student outcomes in flipped classrooms. It should be noted that the flipped classroom does not eliminate contact time between students and instructors instead the aim is to increase the value of the time students spend in the classroom with other students and instructors.

For the instructor, the flipped approach allows for greater scalability. In very large courses with more than one lecture, or courses offered across different campuses, or courses with an online cohort, prepared content made available via the web reduces unnecessary duplicate delivery of content for the instructor. However, producing high quality online content may require more time than typical lecture delivery, which may be an additional burden particularly for courses with content that changes frequently.

Despite many perceived benefits of flipped class, recent literature reviews on flipped class suggest that most of the researches do not provide direct evidence regarding student learning outcomes or academic performance in a flipped versus traditional (lecture-based) classroom (DeLozier & Rhodes, 2017; O'Flaherty & Phillips, 2015). Most of the research around flipped classrooms is based on student's perceptions of their own learning, which can be inaccurate as students are often unable

to assess their own learning. Hence, more studies are required to compare student performance between flipped and traditional course offerings on the basis of learning achievement.

In this paper, we present our results of flipping a traditional class. The class we flipped is a computer programming class for Information Technology/Computer Science students. We compare the average marks awarded to students between those that took the course offering in flipped mode and those that took the course in the traditional mode. Furthermore, we also compare student satisfaction between flipped and traditional offering.

This paper is a significant extension of our previous result published in (Chen et al., 2015).

CONTEXT OF STUDY

Web Programming (WP) is a second-year undergraduate programming course taken mostly by students completing the Software Development major in the Bachelor of Information Technology (IT) at Griffith University. The objective of the course[1] is to teach students to build a database backed web application server. Examples of the web application students are asked to build in their assignments include simple versions of social media, e-commerce, online dating websites, etc. The main programming languages used in the course are PHP and SQL. As a prerequisite to this course, students taking this course should have completed two other first year level programming courses. WP is offered once a year in Semester 2 in two different campuses: Gold Coast and Nathan.

Up until 2014, this course has run in the traditional mode, where each week there is a two-hour in-person lecture presented by the course convenor, and a two hour laboratory classes run by the course convenor or tutor. The lecture presents course material, which contains a lot of programing details and examples. In the laboratory classes, students complete weekly laboratory exercises which are based on the material presented in the lecture. Students are supposed to apply what they have learnt in the lecture to complete the laboratory exercises. Students can ask the tutor for help if they are stuck with a problem. After students complete their laboratory exercise, they need to demonstrate and explain their submission to their tutor to get the exercise marked. To encourage students to complete laboratory exercises, a small amount of marks (2%) is assigned to each exercise.

The catalyst that drove the move away from the traditional mode of teaching is the lack of lecture attendance. Often less than 30% of the students attend the in-person lectures[2]. The impact of missing the lecture shows up very quickly when students start to struggle in completing the laboratory exercises. To help the students, tutors often have to re-explain the material that was covered in the lecture to each student during laboratory classes.

In addition to the lack of lecture attendance, there are also indications of ineffectiveness of the in-person lecture. With Web Programming, there are many

programming ideas that are covered in a 2 hour lecture. During the lecture there are only small opportunities for interaction between the lecturer and the student, most of the time students are watching and listening to the lecture passively. In addition, some students that claimed to have attended the lecture, but apparently still struggled with the material (that were demonstrated and explained in the lecture) in the workshops.

In fact, the likelihood of students following and understanding the whole in-person lecture is low. As lectures progress, the material presented builds on top of the material presented earlier, so students will not be able to follow the lecture if they: arrive at the lecture late, misunderstood one point, got distracted or lost concentration for a few seconds. The lecturer's content delivery method or style may also impact on the effectiveness of the lecture. In an in-person lecture it's possible that the lecturer could make a mistake without realising, or explain the material too fast (or too slow). All these factors lead to confused students.

The limited effectiveness of the conventional lecture is acknowledged across more recent literature surrounding learning and teaching in higher education (Schmidt, Wagener, Smeets, Keemink, & van der Molen, 2015). Relying on the transmission model, the underlying assumption is that students will learn simply by "being told" (Schmidt, Wagener, Smeets, Keemink, & van der Molen, 2015, p. 12). On the other hand, there is considerable literature supporting the learning effectiveness of approaches that require students to become active participants in the learning process.

FLIPPED COURSE DESIGN

Before the start of the 2014 offering, the teaching team re-evaluated the existing teaching method, and decided to make a change to how the lecture was conducted. Instead of the in-person lecture the team decided to pre-record the video lectures, and cancel the in-person lectures to make this a flipped class. However, we do not wish students to be watching the prerecorded lecture video passively, as this would not be any better (and possibly even worse) than watching the in-person lecture passively. We want students to be doing active learning as they watch the video lectures.

To this end, we designed the video lectures to contain coding demonstrations with verbal explanations. While students are watching the video lectures, we want them to also be programming, i.e. following the demonstrations, writing code, and listening to the explanations. To further encourage students to actively follow the lecture, the coding demonstrations are directly related to a part of the laboratory exercises students need to do. In this way, the video lectures themselves go beyond simply delivering content in a completely passive way. The video guides student activity. Furthermore, some studies have shown that despite the use of a flipped classroom, students remain poorly prepared for class (Akçayır & Akçayır, 2018). Structuring video lectures around coding activity helps bridge the gap between the 'transmission' of content in the video lecture and the construction of knowledge occurring in the face-to-face classes.

We are also aware that some students might fast forward the video to the end of a demonstration and simply copy the solution. Hence, the coding demonstration was

Figure 1. Traditional versus flipped class format. Traditional class involves a 2-hour passive lecture followed by actively solving programming problems. With the flipped class, students watch the Lecture Videos (LV) and actively work on the programming problems at the same time
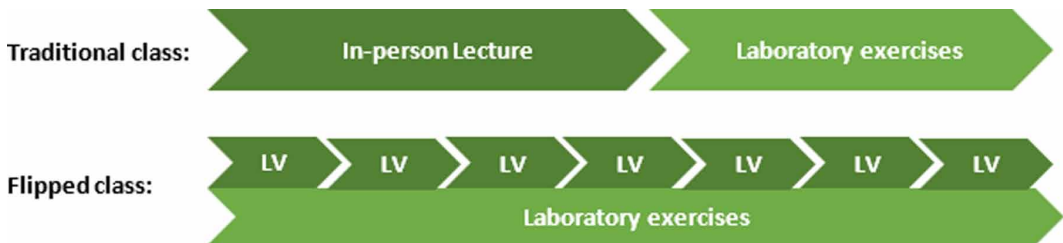
designed so that it does not demonstrate all the tasks students need to do for that week's laboratory exercise. There is always one or two tasks students need to complete independently which require students to reapply what they have learnt from following the lecture video demonstration. To further encourage student engagement, when marking students' laboratory exercises, students need to demonstrate their solution and explain their code to their tutor, then receive feedback through discussion with their tutor. Such a strategy not only enables the student to demonstrate understanding for the purpose of assessment, but also engages the student in thoughtful discussion with the tutor. The activity of explanation to, and discussion with, the tutor is conducive to engaging the student in reflection, evaluation and self-correction of their own understandings. In explaining their code, and articulating their thinking students are operating in the higher cognitive domain, in such a way as to support the development of self-regulation or learning independence capabilities.

As videos are difficult to search through, the videos are kept to around 15 minutes in length. Keeping videos relatively short (10-15mins) is a practice supported in literature. Students generally do not wish to watch long videos (Ng, 2018). One traditional lecture is thus divided into several 'mini' lecture videos. Furthermore, videos are carefully labelled with names related to the content they covered. This is designed to make it easier for students to find what they are looking for. In addition to the lecture video, the lecture notes, from which lecture recordings were made, are also available to students.

In implementing a flipped classroom approach, we were acutely aware that most students are not familiar with the strategy. In teaching it is important to make clear expectations to students hence the teaching team explains the flipped classroom approach to students in Week 1. The teaching team also explains the motivations and benefits for switching to flipped classroom, and also how we expect students to study. We scaffold the learning approach required in the flipped classroom. Hence, in addition to explaining the relationship between the video lecture and the laboratory exercises, we also advised students how to study for this course: we tell students that for each week they should start by looking at the laboratory exercise for that week, then start doing the exercise straight away. Since they have not leant what they need to know to do the exercise, they will soon be stuck on a problem. This is when they

refer to the video lectures. When students are watching the lecture videos, they have a problem (which they are stuck on) in mind they need to solve. So they should be actively thinking about the problem, and implement the solution as they are presented in the video lecture. Again, in this way video lectures do not become disconnected from the overall learning context and bridge the gap between theory and practice.

Given that the numbers of students attending lectures was minimal, we expected that the change from normal to flipped mode would not have a negative impact on students' academic performance. We were aware, however, that in terms of student satisfaction, some students might have a negative perception regarding the prerecorded video lectures in a flipped mode course.

FLIPPED COURSE IMPLEMENTATION AND IMPACT TO STUDENT RESULTS

The first offering of the flipped version of WP was in 2014 in Nathan campus. In that offering, the only in-person lecture was the first lecture in Week 1, which is to explain to students how the course will be run, i.e. in flipped mode. There was no other in-person lecture, but prerecorded video lectures were made available online in its place (as described above). Students are supposed to watch the video lectures and attempt/complete the laboratory exercises before attending the laboratory class for that week, which is still run in-person. In the laboratory class, students can also ask for help if they run into problem, in addition, students also need to demonstrate and explain their code to the tutor to get them marked (same as before). Due to the uncertainty of the impact of the flipped, the flipped version was only run in Nathan campus in 2014, but not in Gold Coast campus. However, from 2015 onwards, both Gold Coast and Nathan campuses ran the course in flipped mode.

From the beginning of the semester, the impact of changing the course to flipped mode is immediate. The help students needed from their tutors to complete the laboratory exercises was significantly reduced, and a greater portion of the face-to-face sessions were used for more productive thinking and discussion about the effectiveness of their programming solutions. During the early weeks, there were some students coming to the laboratory classes without having done any prior work (i.e. not started on the laboratory exercises nor watched the lecture videos). When these students ask for help, the tutor would simply direct them to watch the relevant lecture videos. These students soon realized that the tutor will not go through the lecture material in the laboratory; rather, students can and should find what they need to know from the lecture videos. This frees up tutor time so they can help students that really need help (e.g. stuck on something that is not so obvious), spend more time marking students' submissions (which include listening to student's explanation and discussing problem solving strategies), and more importantly provide feedback to students on how to improve.

A comparison can be made between the average student results between offerings run in flipped and normal modes. In 2014, while the Nathan offering of WP was run

in flipped mode, the Gold Coast offering was still run in normal mode. The difference between the two offerings only comes down to that the Gold Coast offering had in-person lecture, but there is no in-person lecture in Nathan. Other than that, the two courses ran in the same way, i.e. the same laboratory class format, including the same laboratory exercise, the same assessments, even the prerecorded lectures videos were made available to Gold Coast students.

The average student results between the two campuses are presented in Figure 1. In order to have a meaningful comparison between the results of the two campuses, the difference between the cohorts need to be taken into consideration. According to the average students results for each campus from 2010 to 2012[3] (in Figure 2), Gold Coast students have consistently performed better than Nathan students.

In 2014 when flipped class was introduced in Nathan campus, there was a dramatic increase in average student results compared to previous years, overtaking the Gold Coast campus which still runs the course in normal mode (as shown in Figure 2). This is a clear indication of the positive impact to students' results due to the change to flipped classroom. It should be noted that between years, there might be some changes to the assessment, e.g. different assignment questions, however, both campus offerings use the same assessment items.

The next year, 2015, Gold Coast campus also switched to flipped classroom. Again, there was a noticeable increase in the average student result, overtaking Nathan. This further confirms the positive impact of the flipped classroom to student's learning outcome.

STUDENT SATISFACTION IN FLIPPED COURSE

The teaching team was aware that for the implementation of flipped class was to be successful, we need to convince students from the beginning of the semester regarding the benefits of running the course in flipped mode. In particular, due to the general monetary value of "live" (event) being more valuable than "prerecorded", some students may feel they are short changed by only having prerecorded lectures. Hence, in the Week 1 in-person lecture, in addition to explain to students how to study for this course, we also explain to students the benefits of prerecorded over live lectures, such as:

- Students can study and follow the video lectures at their own pace (videos can be paused, and replayed).
- Students can study whenever and wherever they want to study, instead of studying when the lecture is on.
- Prerecorded lectures are of higher quality and more concise than live lecture. Things can go wrong in live lectures resulting in students being confused or at least time wasted. With prerecorded lectures, if something goes wrong during the recording, it will be re-recorded to fix the problem.

Figure 2. Comparison of WP Gold Coast and Nathan students' average results from 2010 to 2016. The changing to flipped class (indicated in bold) resulted in increase in students' results.[2]
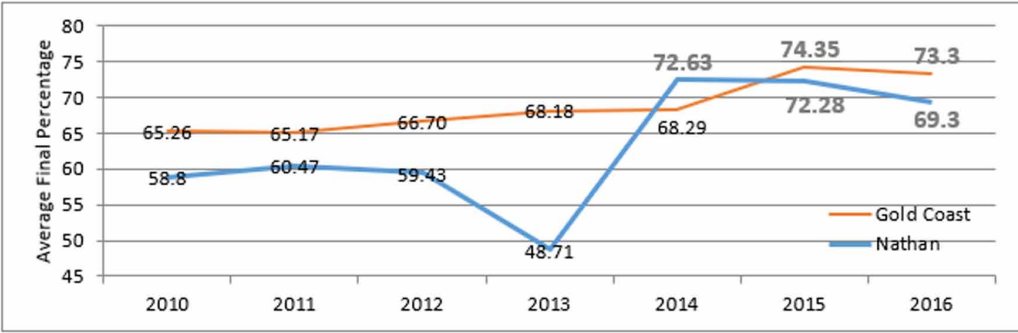
During the semester, teaching staff actively monitor students for any sign of disengagement due to the flipped teaching method. In particular, from 2015 onwards, an early student feedback survey was implemented early in the semester (around Weeks 4 to 5) in Nathan campus. This qualitative survey, conducted on paper during the laboratory classes, asks students to write down what they think are the positive, negative, and interesting aspects of this course. These written comments were analysed by grouping the comments on the same topic together and counting the number of times a topic was mentioned. The results indicate that the overwhelming majority of the students have positive view of prerecorded video lecture or flipped class as shown in Table 1. This result provided the teaching team assurance and confidence that the majority of the students accept the flipped mode of teaching.

The teaching team is aware that a small number of students are still against the flipped mode of teaching. We recognize that not all students will embrace this style of teaching.

An online end of semester Student Experience Survey (SEC) was conducted for each offering. The questions in this survey used a five-level Likert scale. We use the result of the following survey question to gauge student satisfaction with the course: "Overall I am satisfied with the quality of this course." The mean results for this question is as shown in Table 2.

By comparing the results from 2011 to 2016 between flipped and traditional offering, it is clear that the change to flipped course has not resulted in a drop of student satisfaction. In fact, in Nathan, there was an increase in student satisfaction as the result of flipping the course[4].

Table 1. Results of early survey confirm that the majority of Nathan students have a positive view of the video lecture and the flipped mode of learning

	2015	2016
Positive view on video lecture or flipped class	49	57
Negative view on video lecture or flipped class	3	10

Table 2. Mean overall student satisfaction from Student Experience Survey. Bold figures are for flipped offerings

Student Satisfaction Survey (Nathan | Gold Coast)	2011	2012	2013	2014	2015	2016
Overall satisfaction (out of 5)	3.7 | 3.8	4.0 | 4.4	3.0 | 4.4	**4.7** | 4.3	**4.7** | 4.3	**4.1** | 4.5
Response rate	19% | 35%	27% | 34%	34% | 43%	**57%** | 53%	**44%** | **51%**	**38%** | **53%**

DISCUSSION

The flipping of WP has been successful, and the result has been sustained from 2014 to 2016. Perhaps this is unsurprising as our flipped approach is based on well-known good teaching practices:

1. As described in the literature (Hung, 2015; Roehl et. al., 2013; Zappe et. al., 2009), active learning is an important part of flipped class. Hence our prerecorded lecture was designed with the laboratory exercises to give students a problem-based active learning experience. This type of learning experience would be difficult, if not impossible, to achieve during a traditional in-person lecture in a lecture theater.

    It should also be mentioned that unlike other flipped implementations, where students still watch the lecture video passively, and the active learning only happens during in class activities, with our flipped model, active learning starts while students watch the lecture video as they need to complete the laboratory exercises at the same time. In addition, active learning continues during class, where students need to reflect up on what they have done, present and explain their work, and receive feedback from their tutor.

2. This flipped class method achieves aspects of personalised learning. The prerecorded video lectures allow students to work/learn at their own pace, i.e. individualised learning. This property is even more important in a programming course where the students are trying to follow the lecture to implement a solution, where students could run into problems which could take unpredictable amount of time to fix.

3. This flipped class method contains the benefits of blended learning. The average human attention span is 10 to 20 minutes. Hence the likelihood for a learner to be able to focus continuously on the lecture for one or two hours without losing concentration or being distracted by something or someone is very low. In an in-person lecture, where the material being presented is build up on the previous material, if a student loses focus for a short time, the likelihood for this student to be able to understand the rest of the lecture is low. For a prerecorded lecture, students can pause the video to take a break, or rewind/replay the video if s/he failed to understand a point. Furthermore, students can study whenever they are ready to study (not when the lecture is on), and decide where they want to study.

In this case study, it may seem that the only difference between our flipped course and the traditional course is that with the flipped course, in-person lectures are replaced by prerecorded lecture videos. All other aspects of the course, such as laboratory classes and assessments are identical between our flipped and traditional offering. So, can a traditional course be successfully flipped by simply prerecord the lectures? The answer is no, for the following reasons:

1. As mentioned before, the prerecorded lectures were carefully designed to work with the laboratory exercises to achieve active learning. The lecture was recorded using existing lecture notes (with small modifications), with added coding demonstrations related to the laboratory exercises. Admittedly, active learning was possible due to the practical nature of this course. For courses that have little or no practical elements, things would need to be done differently.
2. The format of our laboratory class and the type of assessments in our traditional offering happens to be suitable to for our flipped offering (for the type of course we teach), hence in our case, no change was needed. For other courses, this may not be the case. So, flipped course designers/developers may need to redesign their laboratory/tutorial classes and assessments to work with prerecorded lectures.
3. Students need to be told how to study in flipped mode by using the videos (and the laboratory exercises). This is indicated by the result of the 2014 offering between Nathan and Gold Coast. In 2014, Gold Coast offering of WP ran in the traditional mode with in-person lecture. However, the prerecorded lecture (used in Nathan) was also made available to Gold Coast students. Despite being able to study the course in flipped mode like the Nathan students, there was no improvement in the average result for Gold Coast students. This is an indication that simply providing the videos to students alone is in sufficient.
4. Students need to be convinced that flipped class is not a cost cutting exercise; rather it is designed to help students to achieve better results. If students are not convinced regarding this point, they will focus on what they missed out on (i.e., the in-person lecture), rather than the good teaching practice gained (active, individualized, and blended learning).

Finally, any teacher who thinks flipping a course would reduce their work load (by not having to running in-person lectures) is going to be disappointed. It took a huge amount of time to create the prerecorded lectures, far more than what it would take to prepare and present in-person lectures. However, if the videos can be reused for the next few years, then the initial effort put into create the video may be worth it.

In the case of WP, it is not the most suitable course for reuse of material as web development technologies frequently changes, resulting in frequent updates of the lecture notes and prerecorded lectures. Despite this, we found that even for a major update to the course material, some lecture videos or even parts a video can be reused.

CONCLUSION

In this paper, we presented our experience and results of flipping a second-year level programming course called Web Programming. We flipped the course by replacing in-person lectures with prerecorded lectures that is designed to achieve active learning. With this change, students also benefit from individualized and blended learning. The change to the course may appear to be limited just to the lectures, however, this course already has suitable laboratory format and assessments to work in conjunction with the prerecorded videos.

The change to flipped course was first implemented in the Nathan campus offering in 2014, where we saw an increase in student's average result compared to the traditional offering of this course in previous years and also to the Gold Coast campus in the same year. This result was verified in 2015 when we also implement the flipped offering in Gold Coast, where we also saw an increase in student's average result relative to the previous year's offering and also to Nathan campus result. Furthermore, the increase in student's performance was sustained for the duration of this study (to 2016).

In terms of student satisfaction, the change to flipped course saw an increase in student's overall course satisfaction in Nathan campus. However, in the Gold Coast campus, which already had a relatively decent student satisfaction figures with the traditional offering, saw no significant change in student satisfaction.

In the future, we will continue to offer courses in flipped mode and experiment with different methods to improve our course offerings. In particular, we are interested in incorporating peer assessments to work in conjunction with flipped course.

REFERENCES

Akçayır, G., & Akçayır, M. (2018). The flipped classroom: A review of its advantages and challenges. *Computers & Education*, *126*, 334–345. doi:10.1016/j.compedu.2018.07.021

Bishop, J., & Verleger, M. A. (2013), The Flipped Classroom: A Survey of the Research. In *Proceedings of 2013 ASEE Annual Conference & Exposition*, Atlanta, GA. Retrieved from https://peer.asee.org/22585

Chen, D., Faichney, J., & Jo, J. (2015). Flipping a Programming Course with Low Lecture Attendance. In *The proceedings of the World Conference on Education Media and Technology (EdMedia 2015)*.

DeLozier, S. J., & Rhodes, M. G. (2017). Flipped Classrooms: A Review of Key Ideas and Recommendations for Practice. *Educational Psychology Review*, *29*(1), 141–151. doi:10.1007/s10648-015-9356-9

Hung, H. (2015). Flipping the classroom for English language learners to foster active learning. *Computer Assisted Language Learning*, *28*(1), 81–96. doi:10.1080/09588221.2014.967701

Khan, S. (1997). Why don't they come to the lecture? In R. Pospisil & L. Willcoxson (Eds), *Learning through teaching: Proceedings of the 6th Annual Teaching Learning Forum*, Murdoch University, February (pp. 163-165). Perth: Murdoch University.

King, A. (1993). From sage on the stage to guide on the side. *College Teaching*, *41*(1), 30–35. doi:10.1080/87567555.1993.9926781

Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the classroom: A gateway to creating an inclusive learning environment. *The Journal of Economic Education*, *31*(1), 30–43. doi:10.1080/00220480009596759

McLaughlin, J. E., Roth, M. T., Glatt, D. M., Gharkholonarehe, N., Davidson, C. A., Griffin, L. M., & Mumper, R. J. (2014). The flipped classroom: A course redesign to foster learning and engagement in a health professions school. *Academic Medicine*, *89*(2), 236–243. doi:10.1097/ACM.0000000000000086 PMID:24270916

McLean, S., Attardi, S. M., Faden, L., & Goldszmidt, M. (2016). Flipped classrooms and student learning: Not just surface gains. *Advances in Physiology Education*, *40*(1), 47–55. doi:10.1152/advan.00098.2015 PMID:26847257

Ng, E. (2018). Integrating self-regulation principles with flipped classroom T pedagogy for first year university students. *Computers & Education*, *126*, 65–74. doi:10.1016/j.compedu.2018.07.002

O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. *Internet High. Educ.*, *25*, 85–95. doi:10.1016/j.iheduc.2015.02.002

Roehl, A., Reddy, S. L., & Shannon, G. J. (2013). The flipped classroom: An opportunity to engage millennial students through active learning strategies. *Journal of Family and Consumer Sciences*, *105*(2), 44–49. doi:10.14307/JFCS105.2.12

Sankey, M. D., & Hunt, L. (2013). Using technology to enable flipped classrooms whilst sustaining sound pedagogy. In Proceedings Ascilite 2013 Sydney (pp.785-795).

Schmidt, H., Wagener, S., Smeets, G., Keemink, L., & van der Molen, H. (2015). On the use and misuse of lectures in higher education. *Health Profession Education*, *I*(1), 12–18. doi:10.1016/j.hpe.2015.11.010

Tucker, B. (2012). The flipped classroom. *Education Next*, *12*, 82–83.

Uzunboylu, H., & Karagözlü, D. (2017). The emerging trend of the flipped classroom: A content analysis of published articles between 2010 and 2015. *Revista de Educación a Distancia*, *54*, 1–13. doi:10.6018/red/54/4

Zappe, S., Leicht, R., Messner, J., Litzinger, T., & Lee, H. W. (2009). Flipping' the classroom to explore active learning in a large undergraduate course. *American Society for Engineering Education Annual Conference*, Portland, OR.

ENDNOTES

[1]   At Griffith University, the name "course" is used to denote a single unit of study. In other universities, a course may be called a unit or subject.

[2]   The low lecture attendance problem is neither new nor unique to this course (Khan 1997).

[3]   In 2013, there was a once-off change in Nathan teaching staff due to the regular teaching staff being on leave. This resulted in a steep drop in average result for this offering.

[4]   The 2013, Nathan student satisfaction figures should still be treated as an outlier due to the once-off change to the teaching staff.