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The flipped classroom: A learning model to increase student engagement not academic achievement

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Abstract*

A decrease in student attendance at lectures both nationally and internationally, has prompted educators to re-evaluate their teaching methods and investigate strategies which promote student engagement. The flipped classroom model, grounded in active learning pedagogy, transforms the face-to-face classroom. Students prepare for the flipped classroom in their own time by watching short online videos and completing readings. Face-to-face time is used to apply learning through problem-solving with peers. To improve the engagement and learning outcomes of our second year cohort, lectures were replaced with short online videos and face-to-face time was spent in a flipped classroom. The impact of the flipped classroom was analysed through surveys, attendance records, learning analytics and exam data before and after the implementation of the flipped classroom. Results suggest an increase in student engagement and a positive attitude towards the learning method. However, there were no measurable increases in student learning outcomes.

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Student Success: ***A journal exploring the experiences of students in tertiary education***

Introduction

Educators have questioned the effectiveness of the traditional didactic lecture for many years (Davis, Hodgson, & Macaulay, 2012; Huxham, 2005; Lane & Harris, 2015; Mayer et al., 2009; Schmidt, Wagener, Smeets, Keemink, & van der Molen, 2015). The constructivism theory of learning describes learning as an active process whereby students construct their understanding of new information by reflecting on previous experience and knowledge (Baviskar, Hartle, & Whitney, 2009; Powell & Kalina, 2009). This contradicts the passive nature of the traditional lecture and highlights the need for educators to develop and deliver curricula that facilitates active learning and promotes holistic engagement. Research suggests that positive engagement with both the academic and social aspects of University life is an important predictor of student success and retention (Larmar & Ingamells, 2010; Lowe & Cook, 2003; Nelson, Quinn, Marrington, & Clarke, 2012). A decline in student attendance on campus nationally and internationally has been highlighted as a barrier to student engagement and achievement (Barlow & Fleischer, 2011; Huxham, 2005; López-Bonilla & López-Bonilla, 2015; Marburger, 2001; Newman-Ford, Fitzgibbon, Lloyd, & Thomas, 2008; Schmidt et al., 2015). There are a number of studies which suggest that attendance is positively correlated with academic success (Marburger, 2001; Newman-Ford et al., 2008; Yeung, Raju, & Sharma, 2016). Thus, to improve student engagement with university, educators need to deliver curricula which foster relationships and promote active learning

The flipped model and the university classroom

The flipped classroom model redefines student-educator contact in the learning space. Direct instruction, traditionally in the form of a lecture, is moved from the group space to the individual space (Jensen, Kummer, & Godoy, 2015; McLean, Attardi, Faden, & Goldszmidt, 2016). Students complete pre-class preparatory work, often in the form of short online videos or readings, designed to promote attainment of topic[1] content. Face-to-face contact time is then focused on problem-solving, application of learning, synthesis and collaborating with peers (Gillispie, 2016; McLean et al., 2016). This means that students are engaged meaningfully with the content, facilitating a deep understanding of the material. Importantly, in the flipped classroom model, students are provided with timely feedback on their learning as they are grappling with complex problems in the group space where the educator is present.

Recent research has investigated the impact of the flipped classroom model on student engagement and learning outcomes in a university context (Gillispie, 2016; Jensen et al., 2015; Mason, Shuman, & Cook, 2013; McLean et al., 2016; O'Flaherty & Phillips, 2015; Wilson, 2013). Studies suggest that students of the flipped classroom model value the opportunity to apply content and value the peer-peer and student-educator interaction (McLean et al., 2016). Students report deeper learning and high levels of satisfaction (Mason et al., 2013; McLean et al., 2016; Wilson, 2013). Studies also report higher student attendance rates and greater student engagement in the flipped classroom (Deslauriers, Schelew, & Wieman, 2011; McLaughlin et al., 2013).

[1] *Topic* is the term used in the university where the study was implemented to describe what is a semester-long teaching activity. In the higher education system, it is more commonly referred to as a *subject* and is synonymous with *unit, course* and *paper*.

Whilst there is clear evidence that student engagement increases in the flipped classroom, it is less clear whether the flipped classroom model leads to an increase in measurable academic performance. A number of studies have reported a significant increase in student learning outcomes following the introduction of the flipped model through comparing exam scores and final grades (Deslauriers et al., 2011; Eichler & Peeples, 2016; Gillispie, 2016; Mason et al., 2013; Wilson, 2013). However, other researchers have found no measurable differences in exam or final grades in topics using a flipped model (Adams, Garcia, & Traustadóttir, 2016; Jensen et al., 2015; McLean et al., 2016). This highlights that the benefits of the flipped model on student outcomes may not be academic gains measured by exam scores or topic grades, but rather gains in engagement with academic content, educators and peers, leading to the strengthening of lifelong learning.

This paper discusses the transition from a traditional teaching model to a flipped classroom model in a core second year topic which is delivered on campus. It investigates the impact of this model on student engagement, attitude, achievement and success, and compares data from a traditional teaching model to a flipped classroom model. Whilst there is a large body of literature discussing the different facets of student engagement, the present study draws on the definition put forward by Fredricks, Blumenfeld, and Paris (2004) who define student engagement as a multi-dimensional construct with three components; behavioural, emotional and cognitive engagement. Whilst it must be acknowledged that these three dimensions of student engagement are equally important, in the present study, behavioural engagement, (time on task) and emotional engagement (interest) are measured through analysing attendance records, learning analytics, survey results and academic grades (Fredricks et al., 2004). These data suggest that the flipped classroom model improves student engagement but does not lead to substantive improvement in academic learning gains.

Methodology

Ethics approval

The research was approved by the Social and Behavioural Ethics Research Committee at Flinders University. Project 7355: An analysis of student learning strategies, engagement and outcomes in a core second year biology topic.

Topic design

Genetics, Evolution and Biodiversity is a core second year topic in the College of Science and Engineering with approximately 200 students which has been offered since 2008. The majority of students are enrolled in a Bachelor of Science, although a small percentage of students are enrolled in Bachelor of Education, Bachelor of Medical Sciences or Bachelor of Health Sciences. The topic has traditionally been taught through lectures, workshops and practicals. During the semester, students have attended two lectures a week, one workshop a fortnight and one practical a fortnight. While attendance at the practicals is mandatory to complete the topic, attendance at the lectures and workshops is encouraged, but not compulsory. In 2016, the traditional lectures were replaced by a flipped class. All other aspects of the topic remained unchanged following the implementation of the flipped classroom model. Students attended one of two flipped classes (called tutorials) capped at an enrolment of 110 students, held in a large lecture theatre. Attendance was encouraged but not compulsory. All pre-class preparatory resources were made available through the Moodle platform Flinders Learning Online (FLO). Students prepared for the weekly flipped class by watching short online videos and completing a summative quiz. There were 11 quizzes over the semester, together worth 15% of the topic grade. Each quiz was designed to test surface understanding of the topic content

and was limited to five multiple choice questions and one non-assessed reflection question. The quiz closed the day before the first flipped class of the week. This gave the facilitator of the flipped class the opportunity to review the quiz responses and address any questions or concerns raised by the students at the start of the flipped class. The remainder of the flipped class was spent working in groups through set problems which tested application and analysis of topic content.

Study design

To measure the impact of the flipped classroom on engagement in the second year cohort, students were surveyed through weekly reflection questions on their approach to learning and preparing for the flipped class. The weekly reflection question was included in the summative quiz as a non-assessed question. Responses to the reflection questions were de-identified and analysed using Nvivo 11 for Windows.

Engagement was further measured through flipped class attendance records and learning analytics retrieved from the Moodle platform FLO. The mean number of flipped classes attended and online videos watched were recorded for each final grade category [High Distinction (HD), Distinction (DN), Credit (CR), Pass (P) and Fail (F)]. Students were categorised as highly engaged, moderately engaged or poorly engaged based on the number of flipped classes attended (see Table 1). The percentage of students in each engagement category was calculated for each final topic grade category. Student assignment submission rates were compared for the traditional teaching model (2015) and the flipped classroom model (2016) student cohorts. Each assessment item submitted over the semester per student was recorded as one submission.

The impact of the flipped classroom on student learning outcomes was analysed through a comparison of paired final exam multiple choice answers before (2015; n=168) and after the implementation of the flipped classroom (2016; n=195). Forty-seven paired multiple choice questions were used in the analysis (Paired Sample T-Test). The program IBM SPSS Statistics 23 was used to analyse the data. Final exam questions were further categorised using the Blooming Biology Tool, used to assess the Bloom's Taxonomy level of questions which are biology-related (Crowe, Dirks, & Wenderoth, 2008). Questions were defined as knowledge, comprehension, application or analysis based on the criteria outlined in Crowe et al. (2008).

Results and discussion

Student response to the flipped classroom

An analysis of the weekly reflection responses found that, in the first two weeks of the semester, students reported neutrally about preparing for the flipped class by reading through the resources, watching the online videos and completing the quiz (n=328; see Figure 1).

> My approach to preparing for my first tutorial is to work through all information provided on flo, such as all video links and the topic manual. I will also submit my first quiz which will help affirm what I've been looking at before the tutorial.

However, by week three the attitude of students towards the flipped classroom and the level of preparation required had shifted. Students highlighted that they didn't feel adequately prepared for the flipped class with one student stating, *"[I] will watch the given lecture material earlier as I struggled in the tutorial with a lack of preparedness".* Another student said;

> When preparing for the upcoming tutorial I am investing more time into reviewing the online lecture material. Previously, watching all of the videos and skimming through online content was sufficient but for this

tutorial I am taking more time to re-read and note down the concepts in preparation for the questions asked during class time.

Figure 1: **Text analysis of student responses in weeks one and two to the reflection question 'What is your approach to preparing for the tutorial this week'. 328 student responses were used in the analysis.**

A number of students commented that they were finding it difficult to schedule time to watch the online video resources before completing the quiz: *"…it difficult to find time to watch the videos for the tutorial quiz and fully understand the content before doing the quiz".* It was also noted that group experiences in the flipped classroom were varied. An analysis of the reflection responses for weeks three, four and five (n=422) found that 9% of students reported on their group experience (n=38). Sixty percent of these responses were positive with students reporting that group learning was beneficial for their learning, while 40% of these responses discussed negative group work issues including decreasing group size attributed to student attendance and contribution of group members.

As the semester progressed, students' attitudes towards the flipped classroom improved. In week nine, students were asked to reflect on the flipped classes they had attended and discuss how they had helped them to understand the material provided in the online resources. An analysis of their responses (n=59) found that 95% of students who responded thought that overall the flipped classroom had been a positive learning experience. Students commented that the flipped classroom encouraged them to apply what they had learnt, challenged their understanding of the material and gave them a forum to ask questions both of peers and educators. One student said:

> They have allowed me to not just have knowledge passed on in a passive manner, like most other topics, but instead apply what we are learning in a practical sense, in an environment where there is help available (both from other students and teachers). They have also made me feel better prepared for the exam.

Only 5% of student discussed the learning experience in the flipped classroom negatively. These students highlighted the issues with the learning environment; large lecture theatre, the pace of the flipped classroom; not all students learn at the same pace; and the lack of face-to-face lectures.

Overall, the analysis of the weekly reflection responses suggest that student attitude towards the flipped classroom model was varied initially with some students reporting positively about the flipped learning environment and other students reporting difficulties with the level of preparation required. However, as the semester progressed, students were overwhelmingly positive about the flipped classroom, in particular being provided with the opportunity to ask questions and apply content learnt in the individual space. These results are supported by previous studies which have found high levels of student satisfaction associated with a flipped classroom, although some initial resistance with the perceived increase in workload in the

individual space (Mason et al., 2013; McLean et al., 2016; Wilson, 2013).

Student engagement with the flipped classroom

Prior to the implementation of the flipped classroom, lecture attendance in the topic was approximately 10-15% of the student cohort. Lecturing staff had noted that attendance at the weekly lectures had decreased in recent years following the introduction of online lecture recordings. To measure student behavioural engagement with the flipped classroom model, weekly attendance was recorded and compared to final topic grades. The average weekly attendance was 61% (SD=14.80) of the student cohort (12 weeks; n=214). This was an increase from previous years. The average attendance rate for each final grade category was calculated (see Figure 2). It was found that attendance increased as topic grade increased, although no difference was seen between the High Distinction and Distinction grade categories (see Figure 2A). A similar trend was observed when the average video access was calculated for each final grade category (see Figure 2B).

There was an increase in video access as topic grade increased. These data suggest that increased engagement results in an increase in topic grade. It also reflects the high level of engagement traditionally seen in High Distinction and Distinction students. By second year, these students have already developed strong study skills which include regular attendance at live lectures even if they are available as an online recording. This is supported by a previous study by Yeung et al. (2016) which found that lecture recordings were used more frequently by students who regularly attended live lectures compared with students who were non-frequent lecture attenders. Nevertheless, one of the limitations of the learning analytics data, is that it is not possible to distinguish between whether students actually watched the online resources to completion, or merely opened the resources and allowed them to run while completing other tasks either online or offline. Even if the data included the amount of time the online resource was viewed, this still may not give a true indication of engagement. One of the strategies to overcome this limitation would be for students to report weekly on which resources were used and the amount of time that they

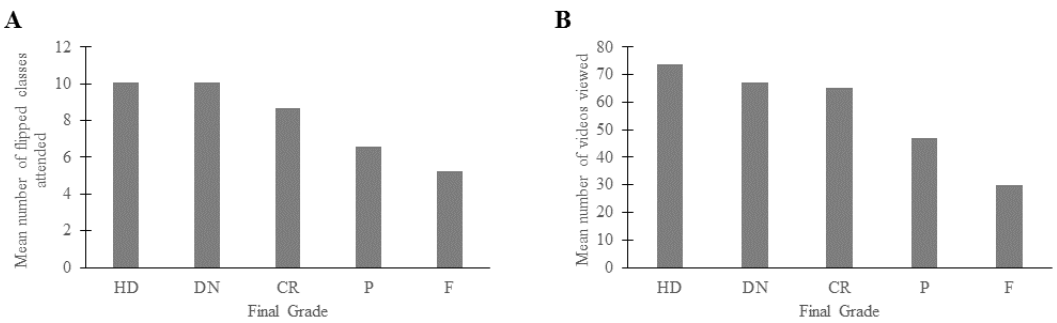

Figure 2: **Engagement in the flipped classroom measured by attendance and online video views. A) The mean number of flipped classes attended over the semester was calculated for each grade category. B) The mean number of videos watched over the semester was calculated for each grade category. HD=High Distinction (85≥), DN=Distinction (75-84), CR=Credit (65-74), P=Pass (50-64), F=Fail (<50).**

were viewed. This could be compared to the learning analytic data retrieved to get a clearer understanding of whether the resources are being watched in their entirety.

To analyse engagement further, students were defined as highly engaged, moderately engaged or poorly engaged, based on the number of flipped classes attended over the semester (see Table 1 and Figure 3). 88% of students who achieved a high distinction grade were highly engaged, compared to only 33% of students who achieved a passing grade (see Figure 3). Of the students who failed the topic, 57% were poorly engaged, while 20% were moderately engaged (see Figure 3). This suggests that attending flipped classes is strongly linked to learning outcomes and that students who are poorly engaged are more likely to fail the topic. These results are perhaps not surprising as previous studies have shown a strong correlation between attendance and topic grades (Deslauriers et al., 2011; Newman-Ford et al., 2008; Yeung et al., 2016). Deslauriers et al. (2011) reported an increase in attendance of 20% in a large enrolment flipped physics class coupled with a significant improvement in test scores.

Engagement was further measured by assessment item submission rates before (2015) and after (2016) the implementation of the flipped classroom. There was an improvement in assessment submission rates from 81% (2015; n = 187) to 86% (2016; n=214). This increase in submission rate by 5% provides some support for the hypothesis that the flipped classroom model leads to improved engagement with the topic.

The flipped classroom and student learning outcomes

The impact of the flipped classroom on student learning outcomes was analysed through a comparison of answers to the same final exam multiple choice questions (n=47) before (2015) and after (2016) the implementation of the flipped classroom. There was no significant improvement in answers to final exam questions in the flipped classroom student cohort (2015, M=58.52, SD=19.96; 2016, M=58.25, SD=21.45; p=.864; $t(46)$=.172; d=.013, see Table 2). The exam multiple choice questions were categorised using the Blooming Biology Tool to determine whether students performed better on questions which had higher levels of Bloom's Taxonomy (Crowe et al., 2008). Questions were defined as knowledge, comprehension, application or analysis using the criteria outlined in Crowe et al. (2008). Answers to questions in each category were compared before (2015) and after (2016) the implementation of the flipped classroom. There was no significant difference found in paired answers to multiple choice

Table 1: ***Engagement was categorised into three categories based on the number of flipped classes attended. There were 12 weeks of flipped classes over the semester.***

Level of Engagement	Number of flipped classes attended
Highly Engaged	9 or more
Moderately Engaged	6 to 8
Poorly Engaged	5 or less

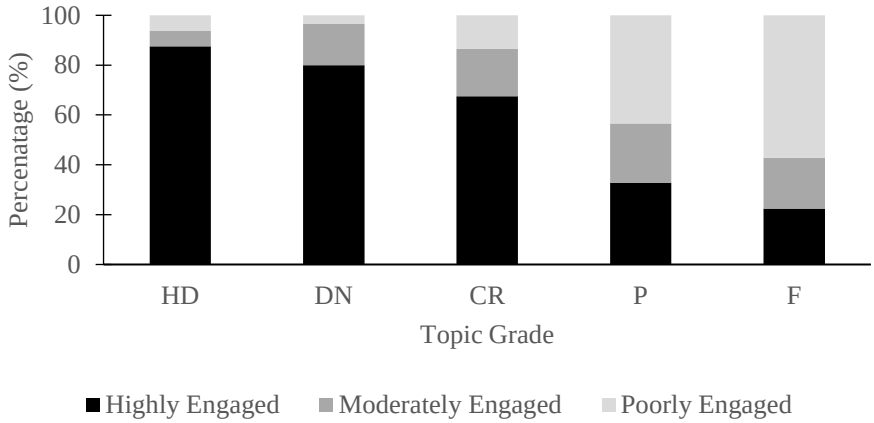

Figure 3: **Comparison of level of student engagement to final topic grade. Level of engagement was defined as outlined in table 1. HD=High Distinction (85≥), DN=Distinction (75-84), CR=Credit (65-74), P=Pass (50-64), F=Fail (<50).**

questions in either of the four categories of questions (see Table 2). Similarly, an analysis of final topic grades found no difference between the 2015 and 2016 student cohorts (2015 M=57.58, SD=23.19, n=187; 2016 M=57.20, SD=20.55, n=214; p=.865; $t(188)$=.171; d=.017).

The results of this study suggest that the flipped classroom model implemented had no measurable impact on academic gains. Interestingly, the average exam scores and final topic scores for both the traditional and flipped cohorts were very similar which suggests that student success was comparable across both years. A number of other studies investigating the impact of the flipped classroom on student success have found similar results suggesting that the findings of the present study are not unexpected (Adams et al., 2016; Jensen et al., 2015; McLean et al., 2016). Nevertheless, these results are in contrast to other studies which have reported a significant increase in student learning outcomes using a flipped classroom model (Deslauriers et al., 2011; Eichler & Peeples, 2016; Gillispie, 2016; Mason et al., 2013; Wilson, 2013). Overall this may suggest that academic gains measured by exam scores or final topic scores may not be an appropriate measure of the flipped classroom model on student learning (McLean et al., 2016). Thus, it could be argued that the impact of the flipped classroom model on student learning is through engagement with peers and educators which may not translate to measurable academic gains. This highlights a limitation of the present study as the level of engagement with peers and educators within the flipped classroom has not been analysed. Future directions of the research could include measuring student engagement in the flipped classroom using the Classroom Observation Protocol for Undergraduate STEM (COPUS) tool (Smith, Jones, Gilbert, & Wieman, 2013). This tool allows the user to quantify levels of student engagement with the learning material, peers and educators using predetermined categories of behaviour (Smith et al., 2013). The COPUS tool has been used to examine whether student-centred activities can improve student learning and attitudes in the biological sciences suggesting that it may lend itself well to measuring student engagement in

Table 2: ***Paired analysis of exam multiple choice questions before (2015) and after (2016) the implementation of the flipped classroom. Standard deviation (SD) is shown in brackets.***

Exam Question Category	Number of questions	2015 Mean (SD)	2016 Mean (SD)	*p*	*t*	*d*
All questions	47	58.52 (19.96)	58.25 (21.45)	.864	.172	.013
Blooming Biology Tool Analysis of Question						
Knowledge	5	58.19 (22.04)	57.63 (21.70)	.865	.181	.025
Comprehension	6	73.31 (18.88)	75.98 (16.77)	.311	-1.123	.149
Application	14	53.92 (22.81)	57.57 (23.37)	.325	-1.024	.158
Analysis	22	57.48 (17.19)	53.99 (20.09)	.104	1.699	.186

the flipped classroom. Future directions of the research could also include measuring the impact of the flipped classroom on course completions. It would also be interesting to investigate whether the flipped classroom model leads to long term improvement in the ability to understand concepts as suggested by other researchers (Adams et al., 2016).

Conclusion

The flipped classroom model redefines the teaching space. Lectures are provided as pre-class online preparatory materials and group face-to-face time is used to problem-solve and discuss topic content at a deeper level. Proponents of the flipped classroom model argue that the success of the model is due to its foundations in active learning pedagogy (Adams et al., 2016; Eichler & Peeples, 2016; Jensen et al., 2015). Research comparing student success in a non-flipped class which used active learning strategies, to a flipped class which also employed these same strategies, found no difference in student learning outcomes or attitudes (Jensen et al., 2015). This provides strong evidence in support of designing curricula which is grounded in active learning pedagogy.

The implementation of a flipped classroom model in the second year topic Genetics, Evolution and Biodiversity has led to an increase in engagement as evident through increased student attendance and assignment submission rates. Students who were highly engaged were more likely to receive a passing grade in the topic. Although student attitude towards the flipped classroom model was varied initially, students were more positive about the flipped model as the semester progressed. Nevertheless, despite the increase in student engagement, no measurable increase in academic success, measured by final grades or exam scores, was observed for the student cohort. While this result was not anticipated, recent comparable studies have described similar findings (Adams et al., 2016; Jensen et al., 2015; McLean et al., 2016). Evaluation of the data presented here suggest that the flipped classroom model is most effective in implementing a cultural shift in students to encourage engagement with academic life, through spending time on campus and fostering positive relationships with both peers and educators. This cultural shift towards a more engaged learner is a key student attribute which has the potential to increase student retention at both the topic and course level.

Thus, the flipped classroom model provides a forum for students to grapple with difficult concepts in an environment where educators and peers are on hand to support learning. Whilst redesigning the curricula required to move a topic from a traditional to a flipped classroom model requires a considerable time commitment from the teaching team, the

benefits to both students and educators are substantial. It allows educators the opportunity to reflect on teaching practice, redesign curricula grounded in good practice and build a stronger rapport with students. Educators have the opportunity to reinvigorate their teaching, leave the lecture podium and use face-to-face class time to actively engage with students. Most importantly, gaps in student understanding are identified and addressed immediately, leading to an overall improvement in the student learning experience. The question now remains, how can more educators be encouraged to embrace the flipped classroom model in tertiary undergraduate education?

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