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Flipped Fun: A Reflection on Five Flipped Classrooms with Diverse Student Cohorts in STEM Disciplines

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Abstract

Flipped learning approaches have had a significant impact on teaching practices more recently than the traditional teaching strategies in higher education and STEM disciplines. This paper describes how the concept of flipped learning, the role of the lecturer and practices around assessments are used in large and diverse online student cohorts. This paper presents the experience of academics from Nursing, Information Technology and Sports Science use of flipped classroom strategy and their designed flipped approaches for their units of teaching and student cohorts. The lessons learntarereported of the flipped learning innovations from a multidisciplinary, science-focused, scholarly community of practice referred to as 'iScholar' in a regional Australian university.

For the academics, sharing experiences in practice allowed appraisal of the differing flips and flops of the blended learning platform. Additionally, they were able to explore the role of the lecturer in these blended learning modes and evaluate learning experiences of different student cohorts. The lecturers embraced the challenges of technology and focused on the needs of their differing student cohorts; further, reflected on their practice and shared the experiences with the extended academic community in the University.

Preparation of students for these innovative learning modes was identified as a crucial step in flipped classroom strategies. The lecturers were explicit about the learning out comes and the activities expected of the students, which supported the successful implementation of flipped classrooms. Student perceptions and attitudes towards the flippedmodel of learning changed with improved engagement in learning activities.

Keywords: Flipped Classroom; Tertiary Education; Student Experience; Pedagogy; The Role Of The Lecturer; Technology; Innovation.

Introduction

Flipping the classroom or flipped learning is a concept that has, in recent times, captured the imagination of educators in higher education [1-10]. Flipped learning approaches are not necessarily 'new' despite the hype associated with them in the last five years [4, 11]. The concept was first introduced by Professor Eric Mazur of Harvard University in 1997, and since the early 2000s blended classroom strategies and flipped classroom techniques are used synonymously, to engage face to face and distant learners, to deliver courses on campus and online platforms [4,8,12].

This paper presents the experiences of five academics who embraced the concept of blended learning activities, especially the flipped classroom concept in their courses, to accommodate large cohorts of online students along with their on-campus students. The flipped classroom concept was an impetus in this small regional Australian university to engage a large and diverse online student cohort, to form and inspire a community of practice in the Science, Technology, Engineering and Mathematics (STEM) faculty. Referred

to as the 'iScholar group', five academics (2x Nursing; 2x Information Technology; and 1x Sports Science) explored various innovative educational approaches by applying the concept of flipped classroom to their pedagogical practices. This involved developing resources to meet the learning needs of their student cohorts and preparing case studies to fulfil their disciplinary requisites. Interrogating the concept of flipped classroom for an online platform using one set of learning materials for both on –campus and off -campus students, these academics took the concept further than the simple model being promulgated by Bergmann and Sam [13,14] of video lectures before class and written exercises in class.

The key questions underpinning the design of the flipped approach were:

- How to create equitable learning experiences for both on-campus and off-campus students?
- How does the role of the lecturer change with the implementation of flipping in blended learning environments?
- What activities would work for large online/face to face classes that didn't require excessive preparation and facilitation time for the academic?
- How could incentives be used for students to increase engagement with flipped activities?

Background

Over the last two decades, there have been rapid advancements in the field of technology which transformed the pedagogical strategies in higher education, along with the student needs to deliver more flexible courses [9,10]. Emphasis on flexible learning modes, especially, online education lead to improved cost-effectiveness in higher education which inadvertently led to mounting pressure on educators to develop innovative, student-centred instructional methods. The advancement of blended learning strategies, especially the evolution of flipped classrooms in the recent decade,must be examined in the changing higher education platforms around the globe. Flipped classroom models with the latest technological advancements provide a splendid ground to support learner-centred pedagogy [2-5] [1,6,7,9,10,15]. Flipped classroom models thus became a palatable pedagogical strategy amongst the new world universitiesincluding this Australian University.

The theoretical and conceptual clarity of flipped classrooms has been an active discussion among educators because of its popularity in recent times, with the caution of its effectiveness being under-researched and under-evaluated [2,4,5,10], [16-18]. Bishop & Verleger [6] explored the flipped classroom literature to formulate a theoretical frame work, to explain student -centred learning, and used the major learning theories of Jean Piaget and Lev Vygotsky to support their inferences. Moreover, they explained student-centred learning activities in light of other significant theories and models such as David Kolb's experiential learning, Carl Jung's psychological types and learning, collaborative learning and active learning models. Waldrop et al. [19] supported Bishop and Verleger's arguments about the theoretical soundness of the flipped classrooms, and the student's need to be engaged and accountable for their learning. The active learning concept was emphasised for students to take charge of their learning and thus learn more static knowledge components. Waldrop et al. [19] also theoretically explained flipped classroom methods using Kolb's experiential learning, according to Kolb; the most valid learning experience is learning by doing. Therefore, the active involvement of students in flipped classrooms could improve the learning outcomes [19].

The traditional concept of flipping is an instructional model with two parts, a pre-class activity designed as an external instructional method followed by an interactive group learning activity in the classroom [6,20,21]. The educators claim that by providing learning material early as recorded lectures and working on the same material in the flipped classroom as quizzes and problem-solving exercises elicited more student engagement than didactic lectures [3,17,22] [21,23]. Removing much of the transmission of static knowledge component from the classroom improved student engagement and allowed educators to bring about more active instructional methods in the classroom [6,20,21,24,25].

Traditional methods of teaching strategies had been compared to flipped methods [21,23,24], and the educators delivered the same material to different cohorts of students during the same enrolment period and found significant differences in exam outcomes. Students were reported to be more engaged through pre-recorded materials, and the in-class quizzes and exercises concluded that the flipped classroom models are a greater success than the traditional models [23,24]. However, more research is required of adult learning in the flipped classroom model, particularly when the students are required to utilisecritical reflection more intensely in a flipped classroom environment to link content to action/ activities to apply the above findings extensively.

Another important point in the flipped classroom model was the formation of supportive student communities with learning groups which demonstrated better student outcomes. Wilson [25] and McCubbinset al. [26] used the concept of learning groups by incorporating pre-class preparation in the form of group activities. Along with the formation of learning communities, Wilson [25] and McCubbins et al. [26] linked these pre-class activities to assessments. The combination of the team-based learning and linking pre-class activity to the assessments resulted in increased student performance both as individuals and teams. The notion of rewarding for pre-class activities was successfully applied by Tune, Sturek and Basile [20] and Enfield [27] in their flipped classrooms. The key tactics used in these flipped experiences consisted of creating a learning community, use of incentives for activities, and linking flipped activities with assessment tasks which collaboratively led to successful flipped models. Within these examples, one could infer that incentivizing pre-class activities both engaged and encouraged students to attend learning activities leads to better learning outcomes.

There are some cautionary tales about the success of flipped classroom models. Butt (2014) designed a research project which explored the perceptions of students within the traditional lecture/ tutorial style of delivery as opposed to the flipped classroom model. The traditional lecture was replaced with a class which had structured activities for students to complete in groups, with the lecturer providing group assistance. Even though the students predominantly enjoyed and benefited from the flipped model, it was noted that they appreciated the expertise provided by the traditional lecture and they felt this could not be replaced by using pre-class readings of lecture notes [28]. Similarly, Bishop and Verleger [6] reviewed 24 studies related to flipped classrooms and identified that it is important to be explicit about the achievement of learning outcomes to students. Poor teamwork and lack of critical thinking skills of students to do the class activities challenged the successful implementation of flipped classrooms.

In the following flipped classroom examples within the iScholargroup, flipping the classroomstook multidimensional, creative angles as the lecturers focused on their teaching philosophy, their disciplinary requirements and own innovative interpretations of flipped mode.

The Flipped Classroom Examples

The following synopsis of flipped classrooms outline how the iScholar group differed in their concepts of flipping the classroom, and the approaches taken by the lecturers to embrace the flipped model in the STEM disciplines.

Research -Nursing Lecturer1

The health research unit had 202 off-campus students and the flipped activity aimed to achieve three learning outcomes for the unit, by preparing the students to evaluate health research critically. The activity in the health research unitwas designed along a major assessment activity of the unit, and the lecturer used the Community of Inquiry Framework by Garrison, Anderson and Archer [29] to design the flipped activity. The complete iteration of the task using the framework can be accessed from the latest article by the first author, Panicker [30]. There were four sections to the flipped task: a pre-class reading and responding to that reading, followed by a critical discussion in the synchronous and asynchronous online classrooms, and a post-class activity to reflect the experience. The task of reading and reacting to a health research article and posting the findings via Padlet (interactive online whiteboard)was providedas pre-class activities. The open online forum to respond to the pre-class activities created a learning community. Moreover, the ownership of the learning and the engagement in these activities were enhanced by using incentives in the form of marks towards students' final grade. The use of flipped classroom, to prepare students for the main an assessment activity, produced a better-quality assessment, increased the engagement of students in the task and eventually reflected in higher academic performance in the research unit.

Public Health-Nursing Lecturer 2

The public health unit previously consisted of self-directed reading, was assessment focused, with little evidence of relevance for application to health. Tutorials had been run as lectures, with poor student attendance, and littleevidence of active student learning leading to poor success rate. In this flipped classroom model, a traditional flipping concept of providing pre-class information and working on that information in the active class was attempted; the flipped sessions were also incorporated into online activities for off-campus students. The lecturer took a facilitator role by giving students the opportunity to critically think, analyse and apply concepts introduced both in the class and with online activities. Hence, there were active online discussions between on-campus and off-campus students. Student engagement was enhanced using incentives to participate in the discussion and created an online community of learning supported by formative feedback.

Human-ComputerInteraction -IT Lecturer1

Within the Human-Computer Interaction unit, the IT Lecturer flipped learning by providing a variety of pre-class tasks (some of which required video review) for both online, and on-campus students; this helped students to engage actively during class workshops or to complete structured online tasks. Using Design Thinking by Kelly and Kelly [31], concepts to teach foundational elements in Human-Computer Interaction, students in this unit worked in groups to ultimately build a mobile application prototype. Group work required students to individually create a range of artefacts and develop the final product. A learner-centred, activity-based approach had always been used in the unit which used a workshop approach for on-campus students: i.e. there were no separate lectures and tutorials as these were integrated into two or three-hour workshop sessions. The effective time spent on the pre-class tasks and the class activity helped students to achieve a range of human centred design processes applied in the specific context of use. Interestingly, no incentives were offered to students for the pre-class tasks to find out whether students would do flipped tasks without rewards; there was significant student engagement in the flipped learning activities.

Biomechanics - Sports Science Lecturer

Thisflipped model used prerecorded videos to engage the distant learners and on-campus students. The learning materials for this unit were designed focusing on off-campus students and then modified for on-campus students, rather than the traditional practice of designing for on-campus students and modifying for off-campus students. With the vast majority of students in the unit being enrolledoff-campus (typically between 85-90%), the focus on online delivery appeared logical. In the design and presentation of videos, conversational type recording was used to avoid a monotonous single voice. The video delivery was in a conversational format, typically having a colleague or a student as the co-presenter. The visual information and the practical sessions were live streamed for all students and then recorded practical sessions with internal students were made available for future reference. Student results showed significant academic improvement with the redevelopment of learning material and the new mode of delivery. However, it was noted that high-quality audio-visual equipment with the ability to record in the laboratory area was a basic requirement for this type of innovative teaching method.

Programming -IT Lecturer 2

The learning of Programming in IT had always faced challenges, and the unit used in this flipped model had its own unique skill sets to achieve. The flipped model was designed to address the following objectives. Firstly, the students should have mastery of the unit's assumed knowledge (both conceptual and applied) as this formed the basis upon which the unit learning content rested. Secondly, programming students needed to develop the ability to self-educate as this is crucial to long-term success in the IT workplace. The lecturer engaged with students in the orientation week by linking their existing knowledge to the current unit learning outcomes, giving them an opportunity to fill in any gaps in their prerequisite knowledge before the start of the semester. A storyline was created for the unit, a theme which ran throughout every week's learning, explicitly connecting the weekly learning topics. The strategies used to nurture student engagement were the provision of early feedback, building on existing knowledge and rewarding good work.

Role of the lecturer

The role of the lecturer in the blended learning activitiesis still evolving with varying responsibilities towards the changing student cohorts and the essential pedagogical soundness. Challenges arise with emerging generations of students, presenting with more diverse educational expectations, and with the rapid introduction of technology in higher education for the lecturers to contend with [32]. Concerning the concept of flipping the classrooms, there are many additional factors that both influence and shape the role of the lecturer such as a focus on promoting better student outcomes and producing more engaging learning materials. The following six themes emerged from the iScholar case studies about the evolving role of the lecturer, and each theme is discussed in detail.

1. New explorations of pedagogy inclusive of blended learning, mixed mode, synchronous and asynchronous teaching and learning have been successfully used with flipping the classroom; in many cases extended the boundaries of the traditional flipped mode adding post class activitiesto assess effectiveness.
2. Advancements and utilisation of technology in pedagogy has been embraced by lecturers choosing to flip their classrooms.
3. Lecturers using flipped methods present as established reflective practitioners in their fields.
4. An increased workload for the lecturer related to using the flipped model was evident; however, this was considered ancillary to improved student outcomes.
5. Lecturers using a flipped model of teaching had a sound focus on their student cohorts concentrating on improved and quality student experiences.
6. Addressing equity of access to learning for on-campus and off-campus students was the core focus of activities and course design.

It is evident that the lecturers who embraced the flipped classroom model were incorporating inclusive pedagogical strategies and using innovative forms of blended learning in their teaching. Forseyet al. [33] made the point "*Shall we mourn the passing of the university lecture",* and in the true sense of flipping, this should be celebrated as we replace didactic lecture styles with more innovative and engaging forms of pedagogy. Additionally, our contemporary higher education, with the technological progress and social evolution, require to keep up with technology and appreciate the benefits that are offered with online student activity and enhanced student engagement with the learning materials [24]. The lecturers in these examples designed multi-modal, blended learning experiences for students extending beyond the traditional instructional methods.

Advancements and utilization of technology in the instructional methods were important attributes of these flipped classrooms. The use of innovative online education resources by lecturers in flipped models of teaching provide diverse challenges; however, it should be recognised that technologybrings in options with course material delivery [19]. The iScholargroup used many different technological applications in the delivery of learning materials and class activities. This ranged from online interactive platforms, discussion forums and development of videos as described by the Sports Science lecturer who had to self-reflect on the video style used and modify the techniques for better recordings and student outcomes. The Nursing Lecturer[1] incorporated 'Padlet', an interactive online platform to create an active learning community which engaged off-campus students with the flexibility of synchronous and asynchronous access to student contributions on the platform. This technological design resulted in better student interaction and equity in accessing the resources as per the student pace. A common theme in these examples is that the lecturers, some of them, even without strong digitalliteracies, utilised the technical support in the University and advancedthe teaching outside the traditional pedagogical strategies.

Reflecting on teaching and learning as a group (iScholar) and improving teaching practices from those reflections were ascertained as a characteristic demonstrated by the lecturers in these flipped classroom examples. Wilson [25] evaluated methods of flipping for STEM students and found students' positive attitudes towards the lecturer improved as a result of the flipped model of teaching. This result was obtained by the lecturer acknowledging and reflecting on the anxieties of students in challenging subjects and how these perceptions can be changed to achieve positive student outcomes. Reflective practice is necessary for improving practice and progressing to positive changes [34], and within the iScholarteam, the reflective practice was deemed vital for self-assessment of teaching and learning processes. The reflection on pedagogical practices was developed as structured sessions, and advanced into a community of practice within the iScholar group where lecturers shared ideas, challenges and experiences of innovations in flipping the classroom.

An increased workload for the lecturer related to using the flipped model was evident, butit was difficult to quantify the workload and was not necessarily viewed as a negative factor. The Nursing Lecturer[2] aimed for better student outcomes and

encouraged higher levels of interaction with the learning materials by innovatively developing online resources for both on-campus and off-campus student cohorts and incentivized student activities. The process was time-consuming, however, follow-up unit evaluation demonstrated improved student grades and positive student feedback. Enfield [27] explored the different challenges faced by the lecturers in higher education and identified the following: increased time to develop learning resources, technical issues faced by students, completing tasks set by lecturers and then the subsequent additional student support required. Within the iScholar team, developing high-quality learning resources was paramount, and the context of increased workload related to this did not attract much focus because of the success and effectiveness of student learning.

The lecturers in these flipped classrooms demonstrated motivation and inspiration in the use of innovative pedagogical strategies in tertiary education which accommodated different learning needs of students and emerged as more satisfying educational experiences for all involved. IScholar lecturers exhibited technological excellence with enthusiasm for creative session preparations and delivery, moving away from the traditional lecture method. There was an underpinning dedication of valuing good teaching and getting to know the student cohort beyond student numbers. Ultimately, there is optimism, a refreshing sense of pride and dedication in the new modes of flipping the classroom and the roles undertaken by these lecturers.

A common focus for the role of the lecturer incorporating the flipped model was an active evaluation of the student cohort and their experience. This focus ultimately led to an understanding of what would improve student outcomes and make the learning experience more relevant and beneficial for students. It is evident in the flipped classroom examples that student learning can benefit from creative session planning with technology, and providing stimulating environments where they can engage and achieve deeper learning. The flipped classrooms presented opportunities to enhance student learning and demonstrated that even simple innovations such as the use of incentives and in-class quizzes could improve student engagement. Getting students motivated and invested in pre-class activities had been a core focus of flipped classes and one of the biggest challenges faced by the lecturers. Linking the assessment activities with flipping enhanced the probability of student interaction and gaining insight from the learning experience.

It is also apparent that pedagogical designs need to be contextualised with student needs and the learning outcomes in its application. The IT lecturer[1] reflected on what worked for herself as a learner and implemented these principles in flipping the classroom for the group of tertiary IT students. Thus, by preparing learning materials as viewed from the student perspective, the lecturer gaineda better interpretation of what strategies could help students to succeed. This also demonstrated a more holistic and reciprocal consideration of the provision of tertiary education and extended the boundaries of flipping models.

In a similar example, IT Lecturer[2] recognized that the students found the IT unit difficult and therefore aimed to assist students in recognising their ability and limitations in the unit as early as possible. It was evident that this resulted in more work for the lecturer, particularly in restructuring learning materials according to the student strengths; however, in the long term this reduced workload in other areas such as student enquiries and feedback.

In addressing equity of access to the flipped learning mode for on- campus and off- campus students, the iScholar examples demonstrate some innovative and effective methods of achieving this. Recognition of the needs between these different cohorts has not been widely addressed in the current literature, despite most universities now hosting mixed modes of unit deliveries. Being aware of the diverse needs of off-campus students is a challenge for lecturers and often resulted in the need for incorporation of high levels of technology [35]. Within the iScholargroup, it was seen that being creative with technology was the most effective way to present an equal access platform, such as the Padlet platform developed by the Nursing Lecturer1, the conversational style videos by the Sports science lecturer and online activities with incentives attached by the Nursing Lecturer[2] and the IT Lecturer[1]. An additional point made by the Sports Science Lecturer was to design the materials to meet the needs of the off-campus student cohort and then adapt those for the on-campus class. This ensured a quality online experience for both cohorts and helped to dissipate the associated disadvantage of being off-campus and not attending classes.

Recommendations

Identifying and acknowledging the role of the lecturer in designing multimodal contexts is central to successful student engagement. Student perceptions tend to vary with flipped tasks, with some being resistive early; however, improved engagement is shown throughout teaching sessions. Incentivizing student engagement and attaching the flipped learning to assessment activities came out as a successful step to keep student interest in flipped classrooms.

Preparing students towards these innovative teaching modes could be another factor which needs to be considered to improve student learning outcomes. Incorporating flipped methods such as pre-recorded lectures and online quizzes can be effective, however from a student's perspective they can also be considered boring and there is a risk that the students may not be willing to take on the additional responsibilities of preparing for class [36]. Some students may resent the lack of interaction with the lecturer who they see as the expert in a specific field and who should be more actively imparting their knowledge with the class [28]. It would, therefore, be imperative to ensure lecturer presence in the whole exercise, and pre-class preparation is relevant and contextualized for students.

Although the flipped classroom method is widely used in higher education, there has been limited research evidence about its effectiveness in student learning. Hence, experimental and quasi-experimental studies to investigate the achievement of learning outcomes in this method are desirable. The flipped classroom strategies used in these shared examples were success stories; however, these are still not generalisable results. Another significant point to ponder is the long-term effects of these types of blended learning strategies in learning, which cannot be

assessed via summative assessments.

Conclusion

The continual changing prospects of higher education teaching and learning have presented both opportunities and challenges for educator's today. Thispaper shared experiences of a group of academics in flipping their classes. The role of the lecturer was explored, and demonstrated the views of this scholarly community on practice, with an aim to implement innovative flipped learning models in higher education. Regarding improved student outcomes and engagement, this became apparent that the evolving role of the lecturer and the lecturer's relationship with the student cohort is paramount. Another observable theme wasthe lecturers' digital literacy was not a significant factor in these flipped examples; they managed the flipped activities with the generic technical support of the University. Reflecting on one's practice, creating a community of scholars and supporting each other with a foundational focus on differing student cohorts were the apparent indicators of successful teaching. Each of these areas provides the potential for further research about the specific role of the lecturer and how the changing scope of teaching can be supported by a scholarly and supportive community of practice.

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