Flipped Learning not Flopped Learning

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SESSION C1: Integration of theory and practice in the learning and teaching process

Context Introducing Flipped Learning across the University of Technology Sydney (UTS) was trialled through the Faculty of Engineering and IT (FEIT). It raised concerns on how to implement such a teaching program in skill-based subjects that had strong elements of core competencies centred on communication, understanding and critical analysis. Rather than revert to conventional teaching when half a class fails to prepare, an alternative approach for motivating students to read and study the material was needed. We had to demonstrate to students an advantage in preparing for class if active engagement was to take place. This may include peer assessing of each other's work, presentations by expert staff on alternative perspectives, or application of the content being taught beyond the assessable items

Purpose In order to encourage intrinsic motivation in study we wish to allow students to manage their own study and engage with material in their own time. This experience will increase their confidence to approach problems themselves if they receive timely feedback. One of the aspects of Flipped Learning that academics consider the most difficult is to enforce preparation for class work. We describe here some more conducive approaches to encourage students to engage with preparation material, including pre-submitting work for sharing in the tutorial. We provide some case studies of strategies, from those doing face-to-face courses ,to engage their students. We wish to show that there are a variety of ways to provide this added benefit for students,

Approach The paper provides case studies from approaches that have been shared amongst staff during staff development workshops run by Teaching and Learning in FEIT at the UTS. Some strategies to engage students who have prepared for a class, and hence provide intrinsic motivation for preparation, are:

1. Provide immediate feedback as they go through the preparation material; e.g. a quiz designed to cement concepts learnt in the lectures provided before the class.
2. Provide practical examples for the student to undertake and upload online a report. Students use this material to peer assess each other using an assessment rubric also online. This process allows them to engage with the rubric to learn how it applies to such a submission as well as engage in group discussion with their peer about their work.
3. Present material from a different perspective that is not part of the course, but bonus work, such as stories of the use of the skill in the workplace, an alternative use of the theory in another sector not related to course, and so on.
4. Develop a narrative approach where the experience of the lecturer in industry is used to make the material more engaging, and where the industry in this case can be cross cultural experience such as Aboriginal community infrastructure and appropriate technology.

Results In the first and second example, the changes to the preparation strategy has achieved a nearly 20% increase in success rate on a significant assessment, the writing of a resume to fit industry standards and ensure students achieve an internship job. The third examples has provided mixed students feedback partially due to different student learning expectations.

Keywords: Flipped learning, Student activities, Student engagement

Introduction

From a teaching perspective, flipped learning provides the time and space within the conventional university class format to allow active learning. It is supported by research that indicates students can experience significant learning gains compared to passive lectures (Freeman et al., 2014; Biggs, 1999; Pathen & Schunn, 2015). However, functional implementation for staff is often challenging particularly when it comes to encouraging student preparation for, and participation in, class. We describe, through examples, conducive approaches trialled to encourage student engagement with preparation material, including pre-submitting work for sharing in the class.

The first course examined here is preparing students for their work internship, a process the university guides them through with various modules. It is highly vocationally oriented to reflect practical engagement with industry and will therefore change as the nature of the internships available changes, reflecting changes in industry. Changes to the preparation strategy have achieved an increase in success rate on a significant assessment: the writing of a resume to fit industry standards and ensure students achieve an internship job.

The second course is a Transmission Systems subject recently taken over by Canning. This is a postgraduate course for International Masters students the majority of whose primary motivations are to access Australian residency and employment. The third example is a series of modules being developed to integrate into different subjects and provide a new perspective on the course content.

There are a variety of ways to engage students with the material that provides added benefit for them and engage the lecturer or students in more in-depth explanations to avoid forced learning. Some are more intensive to implement than others and an assessment of their value is necessary. This paper looks at the four strategies listed above and some results supporting these changes are provided. However, the model chosen by lectures will often match their preferred teaching strategies, hence a range of options with their motivations is discussed.

Background

There are various issues to deal with when teaching Engineering and IT. We are dealing with a cohort of students from many countries, sometimes mature age with experience in industry, often working full time and those who grew up with online learning. At UTS, these learning issues have influenced the implementation of flipped learning, and the approaches taken in different courses.

With flipping, classroom lecturers are often simply providing a static method of knowledge transmission via videos that have to be updated regularly and cannot be tailored to the individuals. However, we have added to this process other tools such as peer review prior to classes and it is in the classroom that we can provide active learning and motivate a diversity of students. This diversity can create challenges.

Motivation of International Cohort

To undertake the courses, the students often pay significant fees and sometimes work more than 20 hours per week. It is evident that many are struggling with the workload with one student falling asleep during laboratory work raising sifnificant OHS concerns. The strong connection with political and economic migration make Australian international students prone to the vagaries of immigration policy. Other reasons that enhance challenges include sometimes lower standards of preparation from their home institution, lack of support to transition from face-to-face teaching to online learning (Kember, 2000), including a feeling of

isolation, low communication skills in English, a lack of genuine independence of learning strategies, and a focus almost exclusively on employment outcomes.

The success of future teaching will rely more on tailored and customized adaption of courses to students, particularly moving towards individualised and active learning becomes more popular. This will need to focus on the difference in motivation towards competition or achieving as an important dimension for Australian students, and an equally potent motivating factor for Asian students of social approval and intrinsic factors (Niles, 1995). To cater for group differences we need to rely on providing a variety of activities and assessment.

It is worth noting that the motivation for overseas students have been researched and can be quite unlike the stereotypes, as for Hong Kong students:

> "Courses which provide good career preparation are a source of motivation but it is not an extrinsic form of motivation which depresses intrinsic motivation. There are high levels of achieving motive, but it frequently has a collective nature rather than being individual and competitive" (p. 99 Kember, 2000)

Learning Strategies across Cultures

What we need to consider is the instructional and environmental preferences of students and what are the range of styles we need to cater for in course design. Rather than try and classify our students each session, we would benefit more from catering for the expected range of learning strategies we might have in the class, and encourage students to broaden their strategies. While Hofstede's (1986) work has been criticised for over-simplifying, to provide some idea of the options for cultural variation around teaching and learning, we can use his dimensions to look at activities that suit students from different cultures:

- the effectiveness of group learning and how to structure these (collectivism);
- forms of questioning in instructional groups (uncertainty avoidance);
- the expected authority, knowledge and role of the instructor (power distance);
- the use of academic or plain and emotive language by the instructor (femininity); and
- the use of praise by the instructor (indulgence).

By varying these we can provide activities that suit different student's learning approaches. We give examples of subject themes under these topics under strategies below.

Flipped for Engineering and IT

Concern over the practise of flipping the classroom has often arisen from the approach of transferring the lectures to videos to view at home as a substitute for a live teacher's instruction, which is not considered useful (Bernard, 2015). However, there are advantages in this approach in overcoming imbalances arising within traditional teaching. Students at the back of the lecture theatre will not be as active or engaged as students at the front and different personalities interact more (Freeman et al., 2014; Stumm & Furnham, 2012). This imbalance results in approaches to learning that directly correlate with the undergraduate students performance at graduation (Chamorro-Premuzic & Furnham, 2009). Further, videos provide the option of repeated watching to overcome the short time span focus of most students in lectures.

Flipped learning ultimately has to also deal with competing online courses. A motivated student can possibly learn a university level course outside of the university system. Notably, the emphasis on continuing education for life is increasingly adopted by professional employees as a way to stay ahead of technological change. Flipped learning buys into the online aspect of such learning and needs to provide added incentives and engagements for students to ensure they benefit from the online material and learn to motivate themselves.

In skill-based courses knowledge content does need to be presented before the class in such lectures. However, a flipped classroom requires a strategy to integrate collaborative group

activities and meaningful, online individual instruction (Zappe *et al.*, 2009). Some lecturers provide assigned readings before class and offer incentives (e.g. quizzes with bonus points) to encourage student to complete pre-work (Bates & Galloway, 2012). The difficulty is that, as Love *et al.* (2014) concluded, "There is no single model for implementing the flipped classroom approach, … and our review of the literature indicates that the approach is still in a stage of innovation" (p. 319). The most dramatic impact of online teaching that reflects this niche class approach is the swelling of preparation times required to continually adapt and monitor these flipped courses.

Strategies

The aim of this paper is to provide clear examples of strategies used at FEIT in the UTS across various Engineering programs with some outcomes in terms of students' results or feedback. These examples highlight particular challenges and can assist those teachers who wish to innovate in their subjects. It is an attempt to put into a greater context the notion of flipped learning. We look at providing: feedback to students working on pre-class material; encouraging student verbal interaction through peer review; providing alternative applications of the skill in class to extend the pre-work; posing questions for post-work that encourage non-verbal students to engage more; and narrative teaching to help students develop a cultural context for their learning

Assessing the Flipped – the role of quiz

Providing online content before class means many students work alone whilst a small cohort may work together. There are limited options for synchronous feedback to address this, so self-assessment through quizzes highlight the significant concepts covered in the lecture. Students begin thinking about the material as well as receive feedback on understanding concepts but there are concerns that this process is isolating and unsettling for many students. It can be partly addressed through group activities. For Transmission Systems, group quizzes and peer assessment follow individual quizzes.

Quizzes can begin the lengthy process of teaching personal responsibility, offering a gauge for students and their peers to monitor against. Working with others teaches team work and communication, in turn demanding responsibility from all group members. A group variant of traditional paper quizzes is now being done for students online.

In class peer review

Research (Patchan and Schunn, 2015) shows peer review of other's submitted work has been fundamental to growth, taking assessment out of the hands of (often casual) teachers and putting it back in the hands of the students. Peer review has the advantage of generating student interactions, and providing an opportunity to quantify and teach teamwork. Learning grows from relative assessment against one's peers,

The context of peer review learning was described previously (Figueroa *et al.*, 2014). The subject focuses on preparation for industrial work through learning about transferrable skills such as communication, ethics, OH&S, industrial relations and dive. Students attend tutorials of up to 20 students to discuss and compare their work. A repeated theme of each tutorial is students learning through reflection.

Rust et al. (2005) describe the process of peer review which can be used to enable students to construct their own understanding of the assessment criteria, helping to understand what they and the instructor is aiming to achieve in their reports. The activities in the tutorial help develop a common understanding of the rubric enabling the students to develop their own professional and relative assessment of their work. The tutorial process involves:
1. Introducing the concept of professional self-assessment and the exercises enabling this,
2. Have them pre-submit the work and in the tutorial those who have not done so sit out,
3. Provide the rubric and set up groups of pairs to assess each other's work,

4. Mark the students' work that is submitted after rework based on peer feedback to provide further reinforcement of the rubric approach.

In the results section, we will discuss the benchmarking exercise and its results in assessing improvements in the students' learning.

Tutors need to be strongly engaged in this process so that they are sufficiently prepared on the material to use it without reverting to repeat-teaching it in class. To manage the course, the mostly casual tutors are trained in a similar manner to students. After marking some samples, the subject coordinator meets with tutors to discuss the marks and/or sections that differ greatly. The rubric is reworded to match what the tutors and course coordinator understanding of the words until a near-shared meaning is achieved. This results in the spread in marks on each test assignment across an acceptable level, clearly an exhaustive process if it is to be successful.

A second example was carried out in Transmission Systems. This subject allows students to engage with the rubric to learn how it applies to a submission as well as engage in group discussion with their peers about their work, developing a shared understanding of the task.

Redo the content in a new format or context

Much of the aim of this teaching method is to inspire students to use critical thinking to see beyond economic drivers to the wonders of science, engineering and technology. This aspect of what is essentially research intensive thinking is becoming fundamentally essential in the workplace and needs to be reinstated as a primary objective of any teaching. The Transmission Systems subject is particularly amenable because transmission systems hardware and signal processing are underpinning societal change in the way communications is viewed and in the way the community will function. For example in one tutorial, we highlighted the internet of things (IoT), where a consumer fridge could have many sensors monitored online. This emphasised how much we rely on core transmission systems as well as highlighted how end-user directions will shape the next generation technologies.

Although purely introductory and not put into the online lectures, the aim was to point out that the course lectures are a comprehensive backbone that remains essentially relevant in the new language of IoT, where many graduates will be expected to be participating in, not simply in traditional telecommunications jobs. This opens up the student to a new landscape in employment opportunities. We feel this opportunity to contemporize the course in the tutorials without sacrificing the solid online foundations is a critical step to motivating students and to demonstrate that the future may not be the simple economic one they began with.

We introduce scholarly pursuit to students as driving deeper technological solutions, more so than economic factors. Examples are:
•   When discussing noise in transmission, the online content was about the reduction of noise in signals. The face-to-face discussion was opened with instead sensing noise: noise external to the fibre is registered as distortion in the signal reflection as the features of the fibre material changes. Hence, noise analysis from the fibre can be used to extract voice and other signals from the area around the fibre, a potential cyber security concern.
•   To demonstrate the expansive nature of the IoT, several novel examples were provided. One example was an experiment Canning was involved in, where in-line optical fibre filters (known as fibre Bragg gratings) were used to monitor strain in the hooves of a competitive Brazilian Creole horse and through an optical fibre cable the data uploaded as the horse was put under standard training with a professional trainer. The training rope was replaced with an industrial optical fibre cable collecting the data from the sensors onto computer and online in the farm (Martelli *et al*. 2017). What was found was that the horse trotting was synchronised with the heart rate of the horse. The compressible hooves were acting as a distributed heart for the horse effectively giving the horse a five heart organ and any misalignment of synchronisation can trigger arrhythmia. From the transmitted data an equivalent cardiogram was possible to extract.

- The growing dominance of photonics in transmission systems and the massive problem of latency, driven initially by gaming and other interactive activities and identified as looming challenge for ubiquitous sensing with the IoT. Given the speed of light is finite and ultimately sets an upper limit classical mitigation of latency, what will solve the coming latency roadblock as sensors are scaled through the internet? The students were asked to think about this problem based on what they have been studying, and when reaching an impasse, later the idea of quantum communications was introduced as the only viable solution at present.

Re-present knowledge with existential angst

The final example was developed at a previous university appointment by Kutay. The classes were activities around team formation, team building and scenarios not directly relating to, but supporting, the assessable work. The aim of the course was to provide a situation where the students are dealing with the required knowledge in a totally different cultural context,

The lecturer comes from a background of Appropriate Technology development in Aboriginal communities around Australia and has been involved in technical projects in urban, rural and remote areas. This has enabled them to understand how Aboriginal people relate to technology and engineering concepts, which makes for some interesting narratives for teaching and some confronting scenarios on the cultural bias in technology. The main aim of the course is to understand how culture and society effect an engineering design.

The series of topics can be considered in light of the first four Hofstede dimensions above as providing examples of cultural variation:
- Team development using an analogy with Aboriginal Kinship system of relationships
- Tacit knowledge sharing using story telling rather than the Socratic style
- Organisational governance and flat management where the learners are encouraged to manage the classroom
- Sustainability and scientific expression of concepts from an observational perspective

Some of the class time involves a lecturing format, but much of the time is student discussion of concepts relating to their experience so that students have an opportunity to unravel their own assumptions. We are expanding this work to modules that include assessment by video story telling and reflective journals.

Results

The aim of the paper is to provide some strategies for providing active learning for students, through flipping the classroom. However, the aim is also to verify the success of each strategy before recommending the approach to other lectures. The approach is to encourage critical thinking and analysis supported by enthusiasm and genuine interest, yet this is hard to assess. We can only assess changes in content learning outcomes within these new environments, or students expressed motivation.

Peer Reviews and Quizes

The work done on flipping the workplace preparation course involved flipping the lectures, running quizzes on these and providing in class peer review of student's work. After reviewing the lecture material at home, the students were involved in peer discussion over their activities and used the analytical rubric themselves to assess others work. This ensures not only that the students read the rubric, but engage in active learning of the rubric concepts, enabling them to not only assess their own work before submission but consider why specific aspects are valued and what is being sought in the assessment. (Jackson & Larkin 2002).

The outcome of the new mode of learning, compared to the previous session's subject (which was not flipped) was an 23% improvement in the initial assessment based on pre-

study and quiz; and an 18% improvement based on learning from peer-review, with a satisfactory mark set at 11/20 for Resume 2. The rest of the cohort had to resubmit.

Table 1 Results for the Resume assessments across the two formats

	Pre-flipping		Post Flipping	
	Resume 1	Resume 2	Resume 1 after quiz	Resume 2
Total mark	/5	/20	/5	/20
No Students	218	222	124	122
Average	2.28	11.23	2.59	12
Std	0.91	3.63	1.05	3
Min	0	0	0	4
Max	5	19	5	17
No Satisfactory	84	135	77	96
% Satisfactory	39%	61%	62%	79%

Redo the content in a new format or context

The student open response to the feedback survey (SFS) results for the Transmission Systems subject are shown in Table 2. Reflecting the disparate variation in expectations for the flipped postgraduate course, are comments 7-6 and 7-8. These appear often and are probably unavoidable. They reflect the earlier discussion around the background of the students, many of whom were inadequately prepared for post-graduate study. It was for many their first exposure to online learning of this nature. Rather than simply being diametrically opposed, both comments clearly reflect a different level of maturity around learning responsibility. This tends to reflect that some aspects discussed in this paper did achieve some of the critical elements we aspire to in presenting such courses.

After a session of lectures where students were exposed to new topics and research in the area being discussed, we were delighted to see that in general the student feedback surveys were positive. The first comment 7-1 recognises the effort that was put in. We believe this is a fundamental re-evaluation of motivation and inspiration needed in all teaching.

Table 2: Results on Student Feedback Survey for Transmission Systems

7	What did you particularly like in this subject?	8	Open question	17.78

7-1	Most of the topics covered could be related to the real world applications. Professor helped us to think of what we study and how to apply innovative ideas to the existing technology. This is very important to me. Transforming what we have to something new would be great.
7-2	The content.
7-3	Overall good..however it may be better if subject focus on less content more deeply rather than more contents.
7-4	All the subject content is best and understandable videos make it simpler.
7-5	interest showed by the instructor during the tutorial sessions
7-6	I like the structure of the subject. The lecture videos is also great. There are very clear and not boring.
7-7	i liked the level of details in each chapter.
7-8	I don't like learning this subject just by watching the video.

Re-present knowledge with existential angst

The cross-cultural material was presented as part of larger subjects, to take a fresh perspective on relevant topics, and often the knowledge provided in class was not the assessable material, but simply a way to engage students more in the process or critique the approach proposed by the course content. The move to include Indigenous knowledge into the assessment across Engineering subjects will enable the class to engage more fully in cross cultural material relevant to their employment and engagement in Australian technological development.

Conclusion

A range of customising approaches to enhance student engagement in flipped classrooms has been analysed. Their applicability and success may depend on the lecturer or specific

aspects of the student cohort, but the examples provide some evidence for the application of various novel approaches in teaching. These are examples where flipping the classroom gives the lecturer and the students much greater scope for learning concepts of knowledge creation, analysis, problem solving and cross-cultural understanding.

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