

## WIL-fully flipping online: A novel pedagogical approach in STEM

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Work integrated learning (WIL) is becoming an important focus in tertiary education as we attempt to prepare students with graduate attributes that are fit for the real world outside academia. Developing students' employability skills during their course of study is the focus of new purpose-created WIL programs. These may be delivered in face-to-face, blended or fully online modes. When online options are chosen as the mode of teaching, and as an alternative to instructivist approaches where material is provided in passive ways, how can the learning engage the students and provide active and connected learning opportunities? The pedagogical approaches, the chosen learning design and associated assessment tasks, all play a key role. This paper reports on the transformation of twin online WIL units at an Australian university through the adoption of a novel fully online flipped learning approach through a Science, Technology, Engineering and Mathematics (STEM) lens.

Keywords: flipped learning; online learning; work integrated learning (WIL); Science, Technology, Engineering and Mathematics (STEM)

### Introduction

In the realm of Science, Technology, Engineering and Mathematics (STEM) in higher education, there is a call to develop industry oriented learning activities within a student's course of study (Office of Chief Scientist, 2015; The Australian Industry Group, 2015). This is the realm of work integrated learning (WIL). Patrick et al. (2014, p.1) note that in the Australian context, WIL "is a response to demonstrable and increasing demands for the tertiary education sector to provide graduates with improved employability skills through an industry relevant curriculum". To this end, WIL approaches are commonly being utilised in higher education to provide students with opportunities to develop their employability.

At the same time, institutions are adopting ways to foster student work readiness into their strategic plans. Deakin University is no exception. For example, as part of the 'Live the Future 2020' strategic plan, Deakin University aims to "empower learners for the jobs and skills of the future" (2015, p.20). The related strategic direction at Deakin University sees an enhancement of courses whereby students undertake authentic tasks and professional skills proximal to industry to enhance employability (Oliver, 2015). Typically, units which are high in authenticity and proximity are 'work placement units'. At Deakin University, these work placement units are promoted to students as an opportunity to gain exposure to industry, as a valuable way for preparing for graduate employment, and thus increasing graduate employability. To this end, these units are aimed to help students in a variety of ways, including the opportunity to apply and consolidate knowledge gained from their course of study; to help them gain discipline specific and non-discipline industry exposure; to explore career options relevant to the student's discipline; and to help them develop a professional network (Deakin University, 2016a). As such, WIL units aim to prepare students for their unknown careers of the future.

Early and scaffolded engagement of students in multiple and varied WIL opportunities during their course of study is the focus of new purpose-created programs. These may be delivered in face-to-face, blended or fully online modes. For the purposes of scalability, online options tend to be chosen as a viable alternative to face-to-face modes. However, the online mode of learning can tend to rely on instructivist approaches, where content is uploaded and thus provided to students in passive ways. This paper reports on the transformation of twin online units at Deakin University through the adoption of a novel fully online flipped learning approach, driven by the question, how can the learning engage the students, foster connectivity and collaborative learning opportunities, and provide innovative active learning opportunities?

## Flipped learning; fully online

Around the globe, the traditional chalk and talk, content-driven lecture style remains the norm in the field of STEM, and while staff and students might be familiar with this approach, it is not the best approach for every student, or for every context (Love et al., 2014). At the same time, teaching and learning in higher education is changing with advancements in educational technology. In the 2016 Horizon report, an identified mid-term trend in teaching and learning in the context of Higher Education as the result of technological change is the 'Redesigning of Learning Spaces'. This redesign involves "new forms of teaching and learning [which] necessitate [the facilitation of] emerging pedagogies and strategies" (Johnson et al., 2016, p. 12).

One emergent pedagogical strategy noted making a difference both in the literature within Higher Education is flipped learning (cf. Johnson et al., 2016). Flipped learning is also showing promise in STEM fields for increasing student interest and improving student learning (Love, Hodge, Grandgenett & Swift (2014). So what is flipped learning? It is not simply a way of teaching or a modality of learning as some would suggest. The term flipped learning, and the often associated term of flipped classroom, are most often associated with a mixed mode or blended learning approach. This is evident from definitions such as that from Strayer (2012, p. 171) who defines flipped learning as "a specific type of blended learning design that uses technology to move lectures outside the classroom and uses learning activities to move practice with concepts inside the classroom". In contrast to the traditional lecture format of academia, technology-mediated, cloud-based opportunities are utilised for the pre-class and post-class activities, and campus-based, face-to-face opportunities used for during the in-class session. Under this model of flipped learning, students participate actively during the in-class session, completing applied activities in lieu of the place of what would be the lecture in the traditional format. In this face-to-face opportunity, the students participate actively, applying the material they have learnt in the pre-class time. Finally, the learning is reinforced in post-class activities (Abeysekera & Dawson, 2015), before the cycle continues again. There are an increasing number of exemplars found in the literature of the adoption of flipped learning in the blended learning environment of tertiary education (Strayer, 2012; Johnson et al., 2016).

What is not found as frequently in the literature are attempts to construct a flipped learning environment into fully online environments, where there is no opportunity of face-to-face learning, and where there is the absence of physical staff presence due to resource allocations and challenges of scalability. While flipping learning online might sound like an oxymoron or simply a synonym for asynchronous learning, Honeycutt and Glover (2014, n.p.) have defended this question. They argue that:

In our work, we continue to push the conversations toward more comprehensive definitions of the flip. At its core, the flip means shifting the focus from the instructor to the students. You can do this by inverting the design of the course so students engage in activities, apply concepts, and focus on higher-level learning outcomes... Using this definition, the flip moves away from being defined as only something that happens in class [versus] out of class. Instead, we focus on what students are doing to construct knowledge, connect with others, and engage in higher levels of critical thinking and analysis... The real flip is not about where activities take place—it's about flipping the focus from you to your students. (ibid)

Flipped learning is, therefore, a broad pedagogical approach in which there is increasing student self-regulation. To emphasise this, Toivola and Silfverberg (2014) note that flipped learning flips not only teachers' and students' actions, but also their pedagogical assumptions about teaching and learning". As such it is about pedagogy, not simply about presentation of content.

It is difficult to find a definition of flipped learning that is not related directly to the mode of learning. Fortunately, the organisation Flipped Learning Network (FLN) defines flipped learning as:

a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter. (FLN, 2014, p.1)

As such, flipped learning is a pedagogical approach to teaching and learning and is not about the mode of learning. Rather, flipped learning involves the key concepts of student engagement with their peers in the learning environment, connectivity, the application of concepts learnt in practical ways, and higher level learning outcomes, all to be addressed in the learning design.

## Case study

### Background

WIL programs offered within the Faculty of Science, Engineering and Built Environment (SEBE) at Deakin University are actively responding to both the call for STEM educators to transform traditional pedagogies (Office of Chief Scientist, 2014), along with Deakin University's 'Live the Future 2020' strategic plan (Deakin University, 2015). The primary means for enabling an increasing number of students' access to work integrated learning, is via work placements. These work placements, referred to variously as internships, professional practice and industry based learning, are core and elective credit point units within a student's degree. Through these, it is hoped to transform education by producing relevant, contemporary learning experiences to prepare students for careers and life more broadly in a rapidly changing world (Deakin University, 2015).

However, a missing element in these offerings was a preparatory and connective phase for students going on work placements. Recognising this deficit, a dual undergraduate and postgraduate Introductory WIL placement unit was created in the Faculty in 2013. These units – STP010 and STP710 (Introduction to Work Placements) – function as a core pre-requisite unit to any WIL placement and industry project unit within the Faculty. As of 2017, all undergraduate students must successfully complete the compulsory zero credit point unit. Deakin University runs on a Trimester system, and at present, these fully online prerequisite units run each trimester, as well as in a new 'start anytime, finish anytime' mode. The unit has approximately 1600 enrolments per year at present (Trimester 2, 2016).

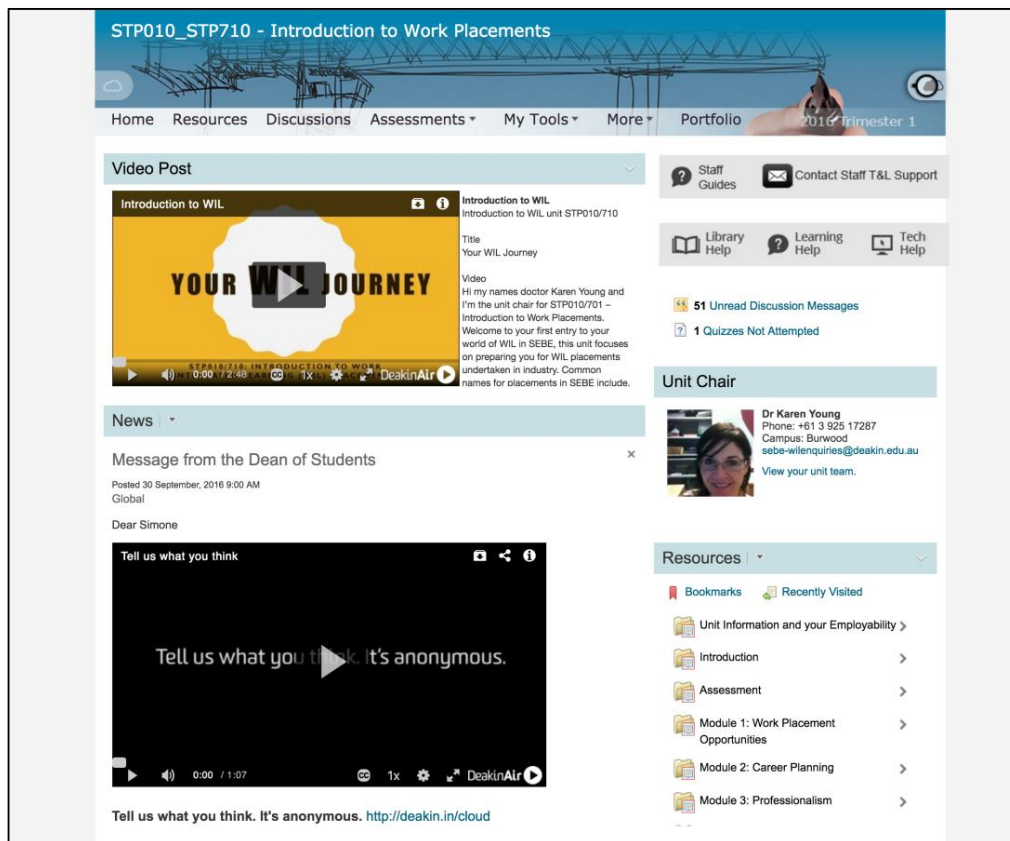
### Unit review

As with any good teaching practice, cyclical reviews of unit offerings are necessary for good practice through the process of unit reviews (Deakin University, 2016b). The online units STP010 and STP710 (Introduction to Work Placements) are no exception. Informal student feedback, along with feedback from staff, had indicated that unit reinvention was required. To give some background, the pre-existing structure of the twin units will be outlined.

At the time of the review, STP010 and STP710 were static and transmissive in the learning design. When students entered the learning management system (LMS) – Brightspace (Desire2Learn) – they were informed that the purpose of the units was to prepare them for a work placement, and in a broader sense, improve their employability. The unit content was structured around four key modules plus both an introduction and revision module. The existing four modules were: Work Placement Opportunities; Career Planning; Professionalism; and Searching for a Placement.

Material in each module was delivered as text-based webpages with supporting information such as videos and PDF text-based documents for students to read and work their way through. The LMS also had a discussion forum designed for intra-cohort and cohort-to-unit chair communication. Once students completed their reading and viewing of the unit content, they then had to complete and upload to the LMS three pieces of hurdle assessment. The first was a personal résumé. The second was a personal career plan. The third was either a Strengths, Weakness, Opportunity, Threats (SWOT) analysis or, alternatively, a 'Me in a Minute' script ready for the creation of a future video recording. Me in a Minute is an innovative initiative for students at Deakin University (Deakin University, 2016c) wherein they are encouraged to create a one-minute video presentation about themselves for the purposes of prospective employers. This free service results in a video-clip which students can then use to actively promote themselves in the employment market. Thus, the writing of the Me in a Minute script as part of the assessment task was to prepare students for the preparation of this personal marketing tool.

These assessment items were intended to encapsulate their capabilities for potential employability. Finally, students were required to undertake a short automated quiz with a required pass rate of 70% or above to verify that they had successfully met the unit learning outcome requirements (see Figure 1).



**Figure 1: Screenshot of existing unit site Trimester 1 2016 before unit reinvigorization**

During a recent formal internal curriculum review of the twin units, six major concerns and accompanying strategies for overcoming the shortfalls emerged. These are as follows.

First, and as noted, the unit was instructivist in its pedagogy. The passive nature of the learning environment has led to the perceived need to make way for active learning approaches in the online learning environment (Figure 2). Passive learning, “where students passively receive instruction from the instructor”, is often considered the antithesis of active learning which encourages “are student activity and engagement in the learning process” (Prince, 2004, p.223). As active learning, both in located and Cloud-based learning environment, is a priority for Deakin University, the unit team raised concerns that the unit was under-delivering in the Deakin promise to provide engagement for deep learning.

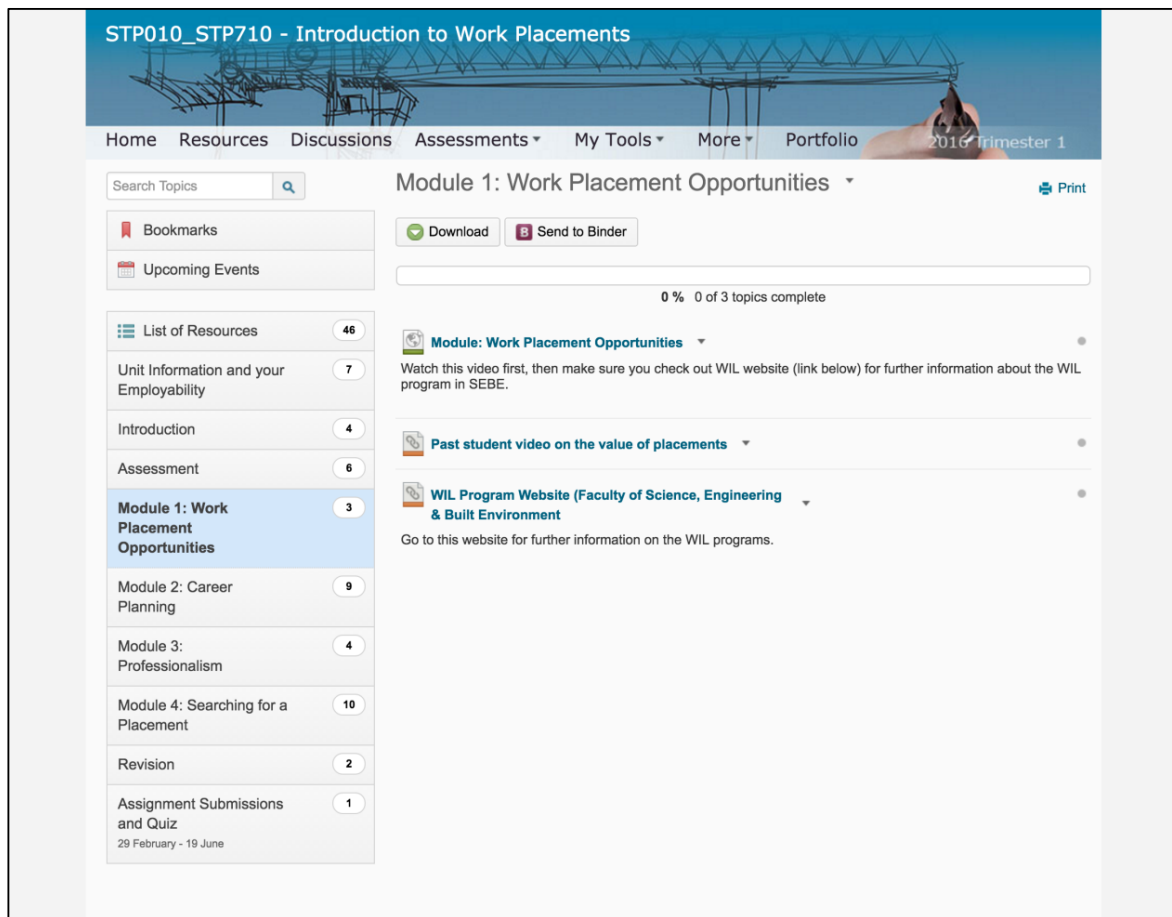
Second, and leading on from this, strategies for optimal ways for delivering the fully online units were required. These needed the creation of learning environments which were active, connected and social. This is a challenge for any online unit, let alone one that has a zero credit point outcome.

Third, the discussion forum was typically being used by students as a means for communicating directly with the unit chair, rather than as a means for collaboration or communication online with peers. Strategies for increasing purposeful traffic for peer-based communication were needed to alleviate perceptions of isolation for the online student cohort.

Fourth, content in the modules was not directly and logically linked to the assessment, but instead loosely to the concepts and ideas around preparing students for a work placement through the development of career transition tools. Rigorous curriculum alignment was needed in order to improve clear satisfaction of the unit learning outcome.

Fifth, the allocated workload model for the zero credit point unit inhibited robust academic feedback on the 4000+ assessment submissions. Technologically driven initiatives for meeting the high assessment demand of the unit was needed in order to meet Deakin assessment guidelines.

Sixth, the online unit was required to remain fully automated due to increasing scalability concerns and workload pressures, impacted by the directive that there was to be a minimal physical staff time allocation to the ‘teach’ the unit. Countering this thought was necessary to consider how one might still reflect an active teacher presence within the unit.



**Figure 2. Transmissive nature of the modules (Trimester 1 2016)**

Added to these was the need of these units, following their reinvigoration, to become a showcase for fully online learning to the rest of the Faculty, supporting the broader call for innovation in STEM education (Office of Chief Scientist, 2013). A critical factor for consideration during the review process was whether the unit adhered to the mandated policy at Deakin University that premium cloud-based (online) learning needs to be accessible, media-rich, interactive and relevant educational experiences designed for excellent learning outcomes and optimum employability (Deakin University, 2015, p.7). This is important as 25% of Deakin University’s students are fully online students, and the remainder will have some component of blended learning. As Atkinson, Rizzetti and Smith (2005, p. 44) note, “The analysis that precedes any design of online resources examines student and curricular needs, but it also must consider the teaching context in which the resources are to be used”.

Subsequently, the aims of unit renewal project were to address the six concerns noted in the existing offerings through an exploration of possible strategies and the implementation of novel approaches to improve the online unit. STP010 and STP710. The way that we approached the redesign of the units, factoring in each of the identified six concerns will be discussed in the following section.

### **Unit reinvigoration – WIL-fully flipping online**

We adopted a fully online flip to reinvigorate the twin Introductory to WIL units STP010 and STP710. In this environment, while all content and practical application was completed online, the focus was not on transmission and dissemination of information, or the mode of delivery, rather the pedagogical underpinning and scaffolding. We achieved this on a two-dimensional tripartite grid structure with a vertical plane and a horizontal plane. Three figures have been added to the following section as exemplars of the changes to the learning design in the unit that were made, should colleagues be interested in exploring how to consider adopting the flipped learning approach in general, and in the online context in particular.

On the horizontal plane, as students moved through the unit, they progressed through three modules, aimed to also deepen student awareness of the role of WIL during their studies. Module One was a ‘retrospective of self’, looking back at what they had already achieved in their past. Module Two examined the student’s current self – what they were currently doing to prepare themselves for future work opportunities. Finally, Module Three was a future-focussed, professional-self module.

In these modules, students were encouraged to reflect on their past, current (present) and future employment opportunities, as well as their transferable skill acquisition experiences. On a practical level, this structure also assisted students in understanding how and why to create three professional career transition tools that were to become the new hurdle assessment pieces: a résumé (‘Past’), a ‘Me in a Minute’ script for the creation of a future short video recording (‘Present’), and a Capacity Building Plan (‘Future’). A Capacity Building Plan (CBP) is a career development tool, rather like a Career Plan, but instead shifts the focus to capacities for multiple careers and connects the student’s current identifiable capabilities (skills, knowledge and values) with their short- and long-term career goals, and in relation to self-awareness and opportunity awareness. The CBP utilises Specific, Measurable, Assignable, Realistic and Time-related (SMART) goals to enhance student employability and enable a successful transition to a fulfilling working life.

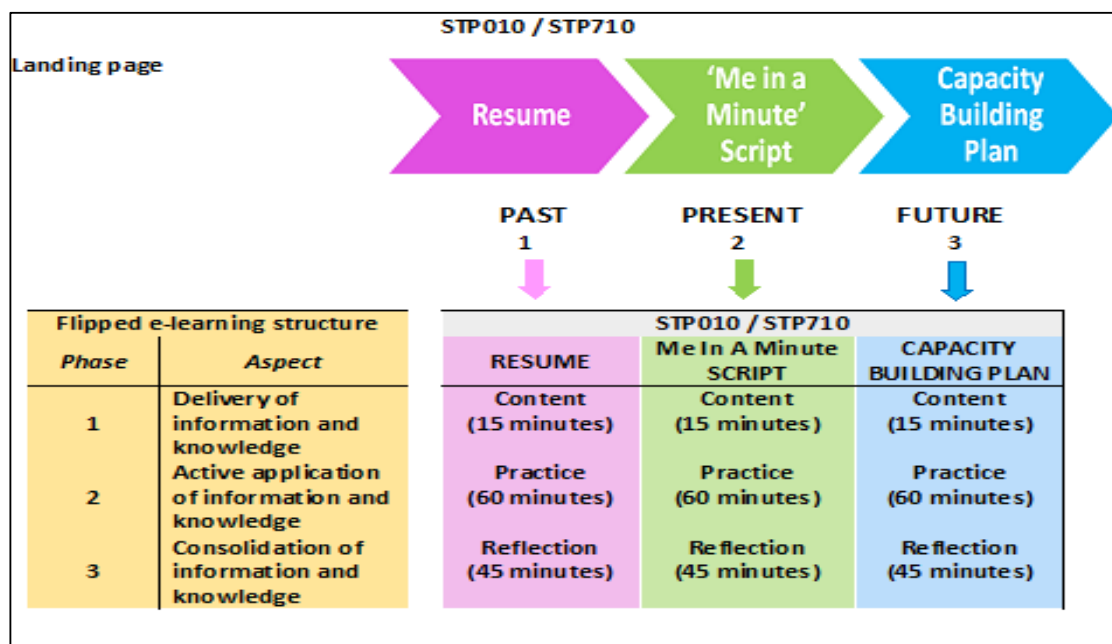
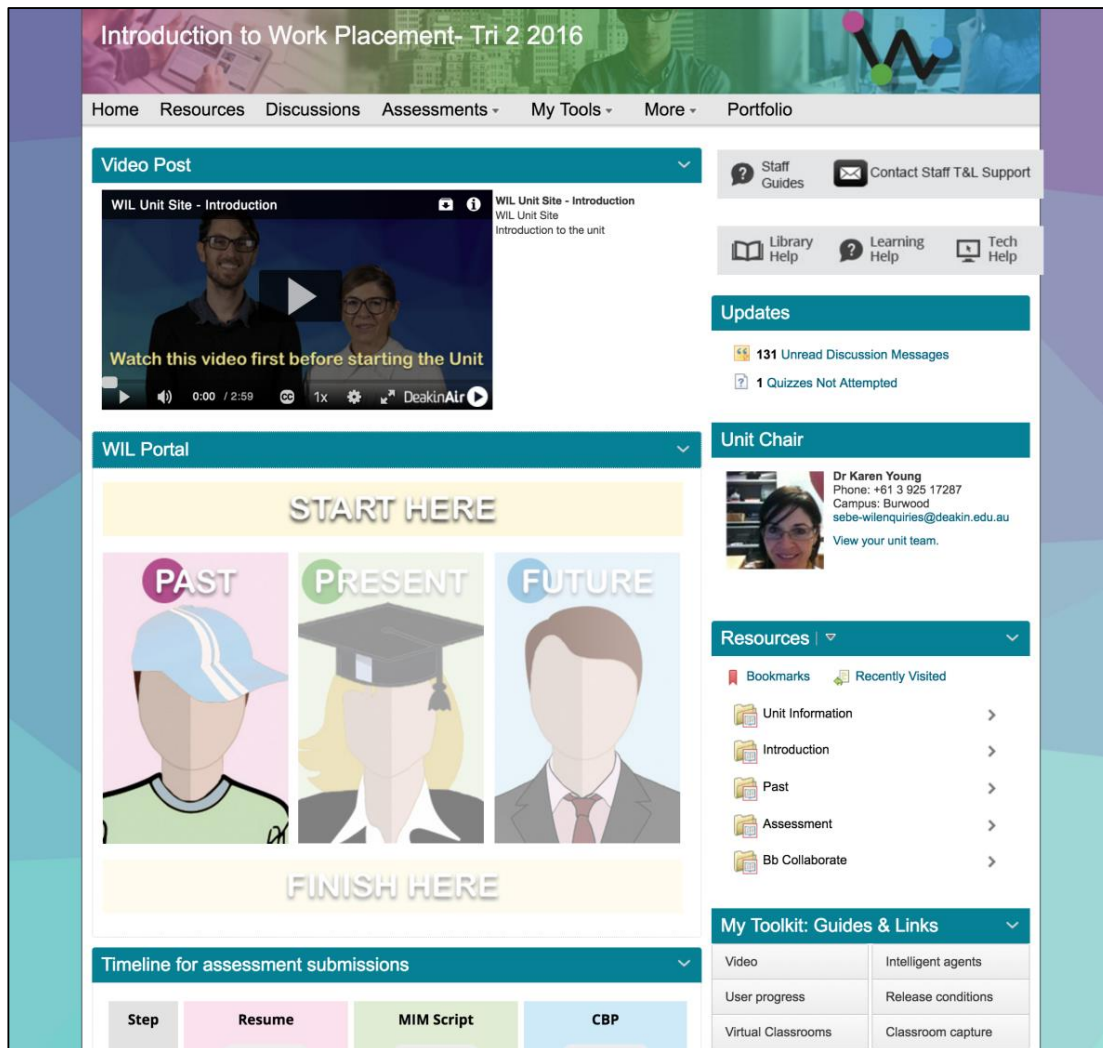


Figure 3. Storyboard for the flipped learning pedagogy showing horizontal and vertical structure

On the vertical plane the three modules adopted an identical tripartite structure as an alternative to the usual ‘pre-class’, ‘in-class’ and ‘post-class’ structure of flipped learning. It was initially decided for this redesign project that we would use the terms ‘pre-practicum’, ‘practicum’, and ‘post-practicum’ to delineate the new structure. Subsequently, we have since relabelled these as ‘Content’, ‘Practice’ and ‘Reflection’ (CPR) to better reflect to the student the alternate pedagogy in their online journey through each of the three modules. Phase One was labelled Content as it was the section for the delivery of information and knowledge in each module. Phase Two was labelled Practice as this was the phase for the active application of information and knowledge. Phase Three was labelled Reflection, and in this section, activities were designed for the consolidation of information and knowledge. In this redesign, there was also an intended play on words: the new structure for learning was intended to signal to the student that they were about to breathe new life into their learning through the inclusion of CPR. Figure 3 (above) is the storyboard for the rebuild of the unit site in the learning management system, breaking down the CPR activities showing both the horizontal and vertical structure. Figure 4 (below) is the landing page of the reinvigorated unit in the LMS. Figure 5 is part of the new Trimester 2 2016 unit rollout, showcasing part of both the flipped online learning structure with its associated CPR structure in Module 1 (Past).

A combination of video and written instructions (‘Content’) for each of the three modules and for the unit introduction and conclusion were created to clearly articulate the process which students need to follow in order to do the Practice and complete the unit. Before submitting the work that was undertaken during the Practice stage of each module, students were directed to Reflect on the content and their interactive activities in the practice section to actively reinforce key learnings. In addition, a suggested timeline to complete the unit was also added. Figure 4 is part of the new Trimester 2 2016 unit rollout, showcasing the CPR process.

Another innovation used in the reinvigoration includes the implementation of personalised feedback mechanisms in the dual units. This was necessitated as they have zero hours of instructor time allocated to the provision of feedback. A work around was through the implementation of intelligent agents. Intelligent agents (IA) are defined by Tran and Tran (n.d., n.p.) as “software that assists people and act on their behalf. Intelligent agents work by allowing people to delegate work that they could have done, to the agent software”. Intelligent agents were integrated into the units via the functionality of Brightspace (Desire2Learn). Brightspace (2016, n.p.) states that IA can assist those involved in the LMS by “providing an automated notification when defined activity occurs in a course or when there is a lack of login or course entry.” This enables opportunities to engage, motivate and retain students through the release of a timed personalised email when a student does, or does not do, a certain action. For example, an email can be set to send if a student has not logged into a site for a number of days. Intelligent agents and interactive automated feedback innovations were adopted in the gamification of the new structure.



**Figure 4: Reinvigorated unit site reflecting the flipped learning approach (launched Trimester 2 2016)**

For feedback on the résumé assessment, the co-opting of a pre-existing but separate university service was used. As part of ‘Preparing students for jobs and careers of the future’, Deakin University’s Graduate Employment Division offers the guidance of job application essentials to all students. This unit was co-opted to provide their expert feedback to students on their submitted résumés, doing so directly through the unit’s LMS. Figure 5 (below) captures part of this student WIL learning journey.

Guided peer assessment was also employed for the 'Me in a Minute' script, providing an alternate form of feedback to students. Students were required to post their script to the LMS's inbuilt discussion forum to receive peer feedback and to provide feedback on at least one of their peers scripts. A rubric was provided to students to help them determine whether the different components of the script deserved a 'Fail', 'Weak', 'Satisfactory' and 'Excellent' mark. They were also encouraged to leave direct text based feedback explaining what could be improved about the script. Students had to both submit their script and provide feedback for one other script before they were given access to the next component of the course. This was only possible because the peer feedback system was implemented through the LMS's inbuilt discussion forum which provided the option of requiring students to participate in this activity before continuing.

**STEP 2: PRACTICE**

**2.1. Pick 'n' Pack Game**

The Pick 'n' Pack game is designed to help you identify what past experiences you have that will be beneficial for you to highlight in your resume.

Take 5-10 minutes to immerse yourself into the game and figure out what experiences you have and others that you will need to think about gaining.

Remember it is not enough to just have an experience, you must also be able to explain why and/or how it developed your employability skills.

[Play Pick 'n' Pack Game](#)

**2.2. Resume Rubric**

Review the rubric and make notes on what you need to include in your resume. A good tip is to just look at what is required to achieve 'Exceeds Standard'.

[View Resume Rubric](#)

**2.3. Example Resumes**

When creating your resume it can be helpful to see how it's done. Here are three examples of professional student resumes for students studying within the Faculty of Science, Engineering and Built Environment. Review, reflect on and make notes about what you might include from these examples.

[Environmental Science Resume](#)  
[Engineering Resume](#)  
[Information Technology](#)

**2.4. Career Guru: Create your resume**

Career Guru is a tool that will help you create a professional resume. Now that you know what should be in your resume use Career Guru to create it.

Note: If you need more information about creating a professional resume please think about attending one of [Owens resume workshops](#).

[Create Your Resume Here](#)

**2.5. How is my resume looking? A self-assessment exercise (MUST DO TO ACCESS DROP BOX)**

You need to do a self-assessment check on your completed resume to make sure you have included all of the important parts. Do this by following the link below to the resume self-assessment exercises. You must get a score of 80% for this exercise before you can submit your resume and resume confirmation email.

Complete the exercises and make sure to record what you have to include or improve.

[Complete Resume Self-assessment](#)

**STEP 3: REFLECTION**

**3.1. Bringing it all together.**

Reflection helps with deep learning, so please begin to reflect on what you discovered about yourself in this module.

1. What was this module mainly about?
2. So what do I know now that I didn't before?
3. Now what do I need to make note of, to do or learn more about...

**STEP 4: ASSESSMENT SUBMISSION**

To complete this section the submission process occurs in two parts:

Figure 5. Part of the Content, Practice, Reflection (CPR) structure in the revised unit rollout, Trimester 2 2016 (Module One – Past)



The CBP also included advanced coding to give each student tailored but still automated feedback. The CBP diagnostic interactive tool invites students to judge and rank three different quality plans using specified criteria and then provides video tips and feedback on how to create a high quality plan. Firstly, students rank each plan section by selecting a drop down menu choice of ‘good, better or best’ and then submit their answers for feedback. Each CBP section has a predetermined ranking in the advanced code of ‘good, better or best’ and students must match all three correctly before proceeding to the next section. The feedback students receive is either ‘Great! You correctly ranked this plan as [GOOD]’ if they have correctly ranked the selection, or ‘Hrm, not quite. You ranked this plan [BETTER]- why not try again?’, if they got the order incorrect on their first selection. If students receive the second type of feedback, they are then asked to have a second go at ranking the sections. Regardless of students getting either all the choices correct or incorrect the second time, the tool forces students to a feedback screen where each of the CBP sections are then teased apart and each of the important CBP elements that students need to have are colour coded to demonstrate why each of the CBP sections are ranked in the order that they are. Once students have finished with the initial feedback screen, they proceed to a video reiterating the feedback in the previous screen. This sequence of events happens two more times until all of the sections of the CBP are successfully completed.

## Future Research Directions

There were a number of deliverables to this project. In addition to the revitalisation of the units themselves, the evaluation and reporting on the success of these changes was also a high priority for the team. Love et al. (2014, p. 317) note that in researching the integration of flipped learning in STEM in higher education, that to date the evidence of success tends to be anecdotal rather than data driven, stating that “very little research has been undertaken to rigorously assess the potential effects on student learning that can result from the flipped...environment”. By placing research in and around the reinvigoration process, we hope to assess the impact of the structure of the unit on the students.

As a consequence, ethics has been gained to further explore the impact of the changes in the redesign of this unit on student learning. Our purpose is to collect both quantitative and qualitative data from a variety of means to ascertain the success of the changes from the students’ perspective. Several research avenues have been put in place behind the new learning design. These include the collection of unit analytics, formal student responses, and student focus groups, all backed by ethics permissions. In this way, our research will add to the scholarship of the field.

The units have also attracted funding to ensure the meeting of their inclusion requirements for students, so this aspect too will need careful monitoring. In addition, while the units remain fully online, they will become increasingly automated and self-sustaining. Whereas the twin online units are currently being run every Trimester, an adaptation to ‘start anytime; end anytime’ units is to be trialled. This too will have further implications for research and development.

## Conclusion

The literature suggests that the pedagogical model of the flipped learning is promising for improving STEM learning and increasing student interest in STEM fields (Love et al., 2014). However, as noted previously, the usual flipped learning model involves a blended learning approach. Little, if any, material exists on adopting this process in a fully online environment. Brought about by a process of review, this paper has explored the novel approach in delivering introductory WIL units in STEM through a flipped learning pedagogy to actively engage students. Our adaptation of the pedagogical approach of the flipped learning model to the online environment is through our structure of ‘Content’, ‘Practice’ and ‘Reflection’.

With the first round of reinvigoration of the compulsory fully online units STP010 and STP7010 launched, the research is underway, through collection a variety of quantitative and qualitative indicators. The results of the data will inform the refinements of the ensuing version of the units. The research continues.

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