

A systematic approach to teaching and learning development in engineering

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Context

Over the last three years, as academic course designers in the Learning Support Team, we have supported academic staff in the School of Engineering at Deakin University, to develop and implement courses and units using the Project-Oriented Design Based Learning (PODBL) approach. During this time, Deakin University also embarked on Course Enhancement, which was a major curriculum renewal process. Together, these strategic objectives aimed to improve student experiences and learning outcomes, thereby preparing them for the jobs and skills of the future. The school's initiative combined with the University's intervention, provided us the opportunity to work closely with academics. Our aim was to build academic capacity for developing teaching, learning and assessment activities, that enable our students to evidence learning outcome achievement.

Purpose

Drawing from examples around teamwork skill assessment, this paper describes the systematic approach taken to support pedagogical change in academic practice, from a teacher-centred approach to a student-centred approach. We emphasise the need to support academics from the design stage through to delivery of teaching, learning and assessment of their units.

Approach

Shifting the academic's thinking about their pedagogical approach, required review and revision of teaching, learning and assessment practices in many units. We interviewed academics and then workshopped ideas for teaching and assessing specific unit and graduate learning outcomes. Following the interview, volunteering academic staff members were recruited to implement changes to their units, in alignment with the course-level thinking. These academic staff were provided with personal one-on-one support to integrate graduate learning outcomes into their unit and assessment design. Our support then continued beyond the initial design phase to include practical advice during the teaching and assessing delivery phases, and ended with unit performance reflection and consolidation.

Results and Conclusion

Shifting to learner-centred teaching and learning activities was quite confronting and challenging for most. A recurring theme was the reference to "soft skills", with the implication that these skills were not as important as the "hard skills" of discipline-specific knowledge. Additional concerns included lack of time, and the stress associated with teaching and assessing skills outside their 'comfort zone'. By taking this systematic approach, we were able to foster positive and trusted relationships with early adopter academic staff. This resulted in measureable growth and development in their teaching and learning skills. These academics in turn became role models for change within their course teams.

Keywords

Curriculum change, pedagogical change, teaching and learning support.

Introduction

In recent years, there has been an increasing national focus on higher education institutions to assure graduate capabilities. This is done through ensuring the validity, reliability and comparability of learning outcomes in a degree course, and student achievement of those learning outcomes at an appropriate standard (Oliver, 2015). In Australia, universities have implemented an agreed set of Graduate Learning Outcomes, irrespective of the discipline or level of study, which are translated into course-level, unit-level and assessment-level outcomes. During their degree course, and through a number of assessment opportunities, students develop evidence and demonstrate success towards achievement of graduate capabilities at an appropriate standard in order to obtain their degree.

For engineering, graduate capability (competency) standards are set and monitored by Engineers Australia. King (2008) in his review of engineering education, identified six key recommendations that boldly called for changing the status quo of engineering education for the 21st century.

1. Raise the public perception of engineering.
2. Refine definition statements of engineering occupations to develop, promote and support all members of the engineering professional team, in order to enable collaborative work in the sector.
3. Develop best-practice engineering education, promote student learning and deliver intended graduate outcomes.
4. Enhance staff capacity and material resources to enable the delivery of an aligned and integrated engineering curriculum.
5. Improve the authenticity of engineering education by engaging in partnerships with the industry to enhance graduate employability skills.
6. Address shortages in the engineering workforce by increasing diversity in the workplace and by offering a range of engineering education programs matched with industry trends.

At the same time, engineering education must also deal with other pressures that have brought many universities to rethink their educational strategies. These pressures include, but are not limited to:

- Rapid increase in competition from universities within Australia and beyond, for example through open courses.
- A significant decrease in funding from the federal government.
- Greater scrutiny on change and its effectiveness through performance measures.
- Maintaining student satisfaction with their educational experiences.

Deakin University's School of Engineering responded to these challenges through the development of the Project Orientated Design Based Learning (PODBL) methodology for training future engineers. The PODB method uses Design Based Learning (DBL) as its core. DBL integrates problem solving and collaborative teamwork with hands-on activities and creative design techniques that requires students to make logical connections, identify cause and effect, draw analogies, and think critically at the highest level. The change idea associated with the implementation of PODB was to shift from the current content-driven approach to a learner-centred approach to teaching and learning (Agouridas, 2007; Chandrasekaran, Stojcevski, Littlefair, & Joordens, 2013).

Around the same time, Deakin University embarked on an intervention called "Course Enhancement". This project was underpinned by Deakin's promise to students, and was designed to improve teaching and learning at an institutional level. A key outcome of this

project was the design and delivery of courses that supported student development and achievement of transferable skills referred as Deakin Graduate Learning Outcomes (GLO). Table 1 below illustrates Deakin GLOs. Students develop these outcomes throughout their degree course in the context of a discipline, for application either in the discipline or outside of the discipline in jobs and skills of the future (Deakin University's Strategic Plan).

Table 1: Deakin University's Graduate Learning Outcomes

GLO1	Discipline knowledge and capabilities:	appropriate to the level of study related to a discipline or profession
GLO2	Communication:	using oral, written and interpersonal communication to inform, motivate and effect change
GLO3	Digital literacy:	using technologies to find, use and disseminate information
GLO4	Critical thinking:	evaluating information using critical and analytical thinking and judgment
GLO5	Problem solving:	creating solutions to authentic (real world and ill-defined) problems
GLO6	Self-management:	working and learning independently, and taking responsibility for personal actions
GLO7	Teamwork:	working and learning with others from different disciplines and backgrounds
GLO8	Global citizenship:	engaging ethically and productively in the professional context and with diverse communities and cultures in a global context

Change ideas, such as these, are intended to cause significant broad scale disruption for improving current practice. Scott, Coates and Anderson (2008) quoted Fullan's (1982) seminal work on effective change management in higher education.

"Good ideas with no ideas on how to implement them are wasted ideas" and "Change doesn't just happen but must be led, and deftly".

He implied that it is vital that leaders, at all levels strategically plan for implementing change. In this paper, we present a systematic approach to supporting teaching and learning development in the School of Engineering at Deakin University. While our support involved many areas of curriculum design and development, here we focus on our plan and the strategies we used to advance the capacity of academics to integrate teaching, learning and assessment of teamwork skills.

Learning and Teaching Support

Learning and teaching support at Deakin University is both centralised and distributed. It follows the hub and spokes model (Gosling, 2009), where staff members employed by Learning Futures, provide planned support for teaching and learning development in collaboration with Faculty teaching support staff who provide day-to-day operational support. Within the Faculty of Science, Engineering and Built Environment, learning and teaching support staff operate as the Learning Support Team. This team consists of academic and professional staff members that support various functions from course and unit design, to learning resource production, and evaluation of teaching and learning performance.

Our job, as academic staff in the Learning Support Team, is to influence academic action through the provision of resources, tools and professional development, to enrich student learning and experience. This way, the academics become our learners, and our role as change agents is to support and facilitate their scholarship in Teaching and Learning. We

provide personalised support for academics at their point of need to cater for considerable diversity in their pedagogical knowledge and preparedness to teach in higher education. Our approach presented here, is extracted from both the support we provided for Course Enhancement project activities, as well as the School's initiative to redesign engineering courses and units for delivery using the PODBL approach.

Facilitating Self-review and Problem Identification

In the PODBL approach, while learning activities in many PODBL units required students to complete tasks as part of a team, we found that strategies for teaching and assessment of teamwork skills were not identified or agreed upon for implementation across the course. We informally interviewed the Course Directors and Unit Chairs to understand the reasons for this gap.

A recurring theme was the reference to teamwork as a 'soft skill', with the implication that it was not as important as the 'hard skills' related to a specific discipline. Several academics also identified that they were not in the best position to assess teamwork, as the meetings and development stages of projects, often occurred external to the classroom. Some assumed that students spontaneously develop teamwork skills when provided the opportunity to work together in groups. Many academics believed that group work and teamwork were one and the same, and used the terms interchangeably.

Our analysis of the assessment tasks revealed that student marks associated with the completion of a team task, was based on the product (design, prototype, model) and not the team process. Academic staff mentioned that they were often questioned by students regarding the equal distribution of marks for production of a product. Some academics responded to that by requiring students to complete a short questionnaire to measure individual contribution and thereby adjusting a student's final result. These academics observed that this self- and peer-assessment process was often done in hard copy, was difficult and time consuming.

Formulating Responsive Support

To address the issues identified during the self-review, we devised an action plan to:

1. change the academic mind-set of teamwork as a 'soft skill' to a vital 'transferable skill' that employers seek in university graduates.
2. enable academics to easily and confidently teach and assess teamwork skills using an online tool.
3. build the pedagogical confidence of our academics in the teaching and assessing of teamwork through professional development.

Changing academic mind-set

During our work with academics in enabling their redesign of the engineering curriculum, it became clear that there was a need to promote graduate learning outcomes through teaching, learning and assessment practice. We used a consistent language and encouraged academics to use the same language with students to enable their understanding of graduate learning outcomes. When reviewing assessment and learning design, we challenged academics' reference to soft (non-discipline) and hard (discipline) skills, in order to improve the integration of transferable skills into the curriculum. We provided key reference material, such as purpose made bookmarks, to develop their vocabulary and definition of these learning outcomes and their alignment with employability skills.

Providing tools for teaching and assessment practice

Working with the central Learning Futures staff, we made an online tool (SparkPlus) available for trial (Willey & Gardner, 2009). Through self- and peer-assessment of student contribution and performance, this tool allowed the calibration of an individual mark from a team task much easier than extrapolating that from hard copy questionnaires. However, during the trial, it became clear that providing a tool and a set of 'how to' instructions was not enough to encourage participation. The lack of 'buy-in' from academic staff to use the SparkPlus tool raised significant questions regarding how to best support teamwork skill assessment.

Although academics wanted to use the tool, they lacked the time to learn about the tool and lacked the confidence to implement the tool on their own. They were also unsure about setting expectations for the level at which teamwork skills should be demonstrated within a unit, and how to teach and assess teamwork skills rather than assessing group work. The change we expected from academics was beyond their preparedness and therefore beyond their comfort zone. This oversight provided the impetus for the development of a strategy to provide professional development.

Professional development

Our academics have significant expertise in their respective engineering disciplines, and knew how to teach those disciplines. However, enabling student development of transferable skills essentially adds to the academic's required subject matter knowledge. We had assumed that academics had the ability to teach and assess a range of transferable skills as core curriculum. As their struggle to integrate transferable skills as learning outcomes became apparent in the interviews, we provided personalised professional development to extend their pedagogical knowledge.

Implementing Systematic Support

Initially, our work was focussed on supporting the academic staff to construct learning outcomes at course level. This was then translated to unit level and assessment level in alignment with the body of knowledge embedded within the unit and the assessment task. This required academics to articulate the intent of the unit that they are responsible for, in relation to other units in the course (Biggs & Tang, 2011).

Our experience in supporting the School of Engineering through this major pedagogical change, confirmed our understanding that all academics aspire to be successful teachers. However, we observed qualitative differences in terms of their experience and developmental needs. Åkerlind (2003, p. 380) categorised growth and development in terms of:

- Teacher's comfort with teaching, in terms of feeling more confident as a teacher or teaching becoming less effortful;
- The teacher's knowledge and skills, in terms of expanding content knowledge and teaching materials, and/or expanding repertoire of teaching strategies;
- Learning outcomes for students, in terms of improving students' learning and development.

Although this research explored structural differences between categories, it stopped short of exploring teacher's comfort with extending learning outcomes beyond the discipline, to integrate transferable skills within the core curriculum. By exploring the ways in which the teacher's understanding and comfort combines with their skills and confidence, we found it necessary to provide dedicated support for teaching and assessing specific transferable skills, for example teamwork skills.

By targeting ten 'early adopters', we were able to focus our limited resources to support those academics who were willing to change (Wilson & Stacey, 2004). Our position has been to be supportive rather than punitive. A consequence of this approach is that the change implementation can take time. However, the benefits of this approach, from our perspective, outweighs the stress that rapid and unplanned change can cause.

Our plan has been to utilise the skills of the early adopters for peer-coaching and mentoring, which not only celebrates their work, but also promotes scholarship of teaching and learning (Harris, Farrell, Bell, Devlin, & James, 2008). During the process of change implementation, we were able to influence the formation of trusted collegial relationships within and beyond the disciplinary boundaries. The ten early adopters, essentially promoted the value of the support that we provided to other academics in the School. Validation from the School for unit and assessment redesign work, together with the visible growth of early adopters in teaching and assessing teamwork skills, encouraged other academics to approach us for support.

Based on the premise that we are all learners in a changing environment, building the pedagogical confidence of academics was vital to enable change implementation. As our teaching academics were required to apply the change at the student level, support for each individual at their point of need was a priority. In this change situation, we applied a systematic approach to ensure clarity about the change and were strategic in the use of resourcing pedagogical support for implementation of the change through the support we provided.

Simply put, our identification of three significant challenges, as we formulated a responsive support, helped prioritise support strategies for facilitating and managing the implementation of curriculum change to teach and assess teamwork skills. We commenced this process by providing clarity around what change was needed and why, and what it takes to implement that change. Equally important was to set priorities for ourselves within the Learning Support Team. A summary of our implementation strategy for teaching, learning and assessment of teamwork skills integrated through the core engineering curriculum is illustrated in Table 2.

Table 2: Summary of our systematic support strategy

Strategy	Description
Define the change	The PODBL curriculum is underpinned by teamwork, and students are required learn and achieve project outcomes collaboratively, while demonstrating their own success towards intended learning outcomes. Upon graduation, students should demonstrate teamwork skills in professional situations. Academic practice needed to change in order to integrate teaching, learning and assessment of teamwork skills in the core curriculum.
Justify the change	Teamwork skills are highly valued by employers of engineering graduates. Our initial review of engineering courses identified limited teaching and assessment of teamwork skills. For students to be successful learners in PODBL, teamwork skills needed to be taught, practiced and assessed explicitly.
Establish the timeline	Curriculum change for teaching and assessment of teamwork skills needed to coincide with the progressive implementation of PODBL methodology, as well as other timelines set by the University for handbook publications for the following year.
Identify stakeholders and their responsibilities	As members of the Learning Support team, we took directions from the Faculty into order to support the requirements of the following stakeholders, while respecting their responsibilities and expertise.

	<p>Unit chairs were required to redesign the unit and assessment tasks, ensure alignment of unit learning outcomes with GLOs, and communicate to students how and why teamwork skills were taught and assessed.</p> <p>Course Directors were required to facilitate discussions that identified specific units for scaffolding teamwork skills, and negotiate with unit chairs the timeline for implementation.</p> <p>The School was required to quality assure that alignment statements were articulated using a student-centred language within unit and assessment information documents.</p> <p>The Faculty was required to provide operational support strategies to help the Faculty and the School to satisfy the University's overall goals and vision.</p> <p>Deakin Learning Futures was required to facilitate the assessment of teamwork skills in all courses.</p> <p>The University was required to fulfil their learning promise to students "to provide a brilliant education that empowers them for the jobs and skills of the future".</p>
Identify challenges and potential solutions	<p>Valuing teamwork skills – Building academic confidence in teaching, learning and assessment of teamwork skills.</p> <p>Meeting deadlines for curriculum change – Supporting timely redesign of units and assessment for University publications.</p> <p>Continuing students – Collaborating with the Faculty to ensure that curriculum change does not adversely impact student progress.</p> <p>Using appropriate assessment tools – Identifying and providing an effective online tool that facilitates assessment of teamwork skills.</p> <p>Student guidelines and resources – Generating essential resources for students that support their teamwork skill development.</p> <p>Marking and grading – Supporting academic staff to use the assessment tool effectively to analyse and apply student results and calibrate an individual's mark in teamwork.</p> <p>Academic workload – Providing just-in-time and personalised support to academic staff taking into account their work pressures and time.</p> <p>Integrating POBBL implementation – Alongside implantation of GLOs, there was a requirement for redesigning engineering curriculum using design based projects.</p>
Target and support 'early adopters'.	<p>Ten early adopters were chosen based on their interest and the School's planned offering of these units in the implementation of POBBL curriculum.</p> <p>Needs analysis - During the design phase we established the needs of these early adopters and prioritised our work to ensure the provision of targeted support.</p> <p>Professional development – Provided personalised support to</p>

	<p>redesign assessment, teaching and learning activities, to develop resources for student engagement, to use the assessment tool for engaging students in self- and peer-assessment, to analyse and finalise student results.</p> <p>Practical support – In class support that models teaching and learning practice for academics to support student engagement in teamwork tasks.</p> <p>Review and reflection – facilitating academic review, and improvements to practice through reflection on student evaluation, self-evaluation, and peer-evaluation.</p>
Celebrate achievements	<p>Communicating outcomes – Making academic work public in various forums for reporting back to University Senior Executives.</p> <p>Encouraging Scholarship of Teaching and Learning – Collaborating with early adopters to present their work at the University Teaching and Learning Conference.</p> <p>School celebrations – Working with the school to organize internal celebrations for acknowledging the early adopters, promoting their success and encouraging others to participate.</p>
Evaluate the impact of our support	<p>Self-review - Collecting evidence to measure our success in supporting the academics to integrate teamwork skills in teaching, learning and assessment. This includes, developing academic experience reports, student feedback on the use and usefulness of the tool for self- and peer-assessment of teamwork skills, and development of a plan for continuing support for progressive implementation.</p>

Conclusion

There are many ways to improve teaching and learning performance. An academic's plan for growth provides the need and the context for supporting teaching and learning development (Southwell & Morgan, 2010). We consider that the summary table of our systematic support approach can be utilised in other contexts for managing change. Preparing for change, identifying challenges, targeting and then providing practical support to willing participants, were the fundamental components of our support strategy. Investing quality time in 'early adopters' in the initial stages of the change process, provided the evidence and impetus for shifting the School's culture from a teacher-centred to a learner-centred pedagogical approach. These early adopters willingly engaged with the process to further support change implementation and became the catalyst for change as they shared their positive experience with others, through conversation and presentation. Further work is needed to implement a whole of course approach, scaffolded through clear outcomes and standards at each year level. From our experience, developing a trusted collegial relationship and providing practical support is vital in bringing about change leadership in teaching, learning and assessment practice.

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