Introduction

The purpose of this paper is to explore the strategies and approaches currently being implemented in a redesigned Engineering program of study at Macquarie University. Our approach is a balanced Engineering program aimed to develop holistic graduate Engineers who are equipped with the fundamental and advanced technical skills, interdisciplinary judgement and well developed transferable skills that are expected of modern university graduands. However, to covers such a range of technical knowledge in-depth while simultaneously developing professional skills and thinking processes in the 4-year time-frame, typical of an undergraduate program with Honours, poses some challenges. (The use of the term 'professional skills set' is interchangeable with other terms such as 'soft skills', 'transferable skills' within this communication) Such a mammoth task is also complicated by myriad challenges currently being faced by contemporary university education, particularly:

1. Increasing casualisation of teaching staff and the need to ensure teaching quality is maintained.(Percy & Beaumont, 2008; Richardson, 2011)
2. Changing of student demographics that renders the need to adopt suitable pedagogical approaches.
3. Misguided expectations and reasons for students undertaking university education and the values it offers.
4. Densification of courses, that is, the need to teach both technical knowledge and skill development of transferable skillsets in a shorter period.

Therefore, most traditional Engineering curricula have emphasised the delivery of technical knowledge over professional skills and thinking processes. (Mills & Treagust, 2003) Although a large majority of the Engineering discipline is comprised of technical knowledge, it is those transferable skills sets that render a graduate employable. These professional skills are complementary to the technical skills that are the essential characteristics of a holistic professional Engineer.(Grasso & Helble, 2010) Such transferable skills, which are commonly referred to as 'soft-skills' are widely accepted as encompassing, teamwork, communications, resources management, self-management and learning, ethics, and problem-solving skills.(Laskey & Hetzel, 2010; McNamara, 2009; Mohan, Merle, Jackson, Lannin, & Nair, 2010) The conventional method of developing such key skills has been very hands-off and is not well scaffolded in the curriculum. Students may undertake a program of study without being properly facilitated to develop these key skills. To address these issues and prevent the risk of students not developing these skills to a competent level upon completing the program of study, an alternative pedagogy must be used for these process oriented skill development. Unlike technical units, the development of these skills cannot be taught via the conventional behaviourist perspective.

Conventional behaviourist teaching perspective is one in which understanding is achieved by practicing activities repeatedly which induces memory association. Conventional teaching and evaluation such as examination is not an effective feedback tool for the development of these skills. Students need constant feedback and scaffolding to direct the learner's behaviour toward a targeted outcome. Such active pedagogical approaches where mentors are engaged in an active dialogue with the student are better strategies for achieving the learning outcome of skills development. These active teaching approaches are better received by the modern day student cohort. With the shift in student demographics, the traditional behaviourist perspective and approaches are no longer applicable and effective to today's cohort of students. This younger generation often classified as 'Generation Y', 'Gen Y', 'dot-coms' and 'millennials', has a very different approach to learning and thus suggests the need for alternative pedagogies to bridge the conventional teaching method and their ability to learn.(Connor, Shaw, Shaw, & Fairhurst, 2008) It is broadly anecdotal that the newer and younger generation are not interested in knowledge accumulation and are pressured into tertiary education by social norm or they are under the false sense of increased chance of employability after university.(Krause, Hartley, James, & McInnis, 2005) Such a misaligned view of university education is orthogonal to a conventional understanding of university education that focus on passing units rather than striving for greater knowledge. Such disparity in understanding between the teaching staff and the student cohort must be addressed. Without an alignment of these values, students may not be appreciative of the subjects being taught and thus will not understand the subject matter and may even be disheartened in their university education.

At Macquarie University the Department of Engineering has taken these challenges into consideration and has developed units wherein these practices are incorporated to reduce the impact of the challenges has on our enrolled students.(Kehm & Teichler, 2007). The new approach to the design of the Engineering curriculum from a holistic point of view and revised pedagogical approach is intended to bridge the gap between the teaching staff and the Gen Y students cohort. Many of these approaches and strategies are well represented in our course Introduction to Engineering (ENGG100) that is presented as a mandatory prerequisite for all incoming Engineering students. Our approach in mitigating the aforementioned challenges is broken up in to four major areas, which are:

1. **Aligning expectation:** the alignment of student expectations of the purpose of a university degree in the contemporary sense.
2. **Modularisation of learning outcomes:** an articulation of learning outcomes and the use of threshold concept theory.
3. **Appropriate pedagogies and teaching activities:** a learning framework that is fractal in nature and aims to facilitate the accumulation and assimilation of experiences as a mean to learning.
4. **Tutor support programs:** to provide support and upskills for our increasing sessional teaching facilitators.

Each of these areas is currently integrated into this introductory course (ENGG100) and is reflected throughout the Engineering program of study. Each of the areas will be discussed in sections of this paper. In particular, we consider how these practices potentially ameliorate and mitigate some of the challenges faced by modern university and the contemporary audience of the Generation Y.

Approaches and rationale

1. Aligning expectation

The purpose of university education has changed over time and there is a significant difference in the views of university education between the Gen Y cohort and their predecessors. These changes are reflected in their learning styles as well as their expectation of the value university can add for them. There has been in-depth studies in the differences of learning styles and expectation of university education between the two generations of students, these include the various forms of teaching pedagogies Gen Y are responsive to, their perception of values of education and their readiness to self-motived learning.(Cleyle, Partridge, & Hallam, 2006; Howe & Strauss, 2009) To address such differences a different teaching strategy and pedagogy is needed. In the past, students are receptive to the behaviourist perspective of learning and practices. Techniques included the use of repetitive exercises and memorisation, as well as the single authoritative-teacher figure that defined the content layout of the subject, who is also regarded as the ‘sage on the stage’. This approach however no long applies, partly due to our improve understanding of learning theories as well as changing student demographics. These pedagogical issues will be commented further in a subsequent section.

Indeed, there have been changes to the emphases of university education; this has been partly due to changes in social expectations. University education it no longer a place for just pure academic endeavour but have become an increasingly required minimum level educational level and qualification of employers and society in general. This norm and expectation mean most intake cohorts will not continue to pursue a research academic career. The expectation of these students is to complete their Bachelors degree and find positions in the job market. Despite this social reality, the consequence is that we must address these changes appropriately without becoming technical trainers. Practically, this implies we must also consider the students employability in addition to the conferral of their Bachelors degree.

Attributes that render graduates to be attractive in workplaces are typically professional and transferable skills.(Laskey & Hetzel, 2010; Mohan et al., 2010; Nguyen, 1998; Pulko & Parikh, 2003) These skills, widely accepted as Graduate Attributes, are defined as teamwork, commination skills, critical and problem-solving skills, ethical judgement, time management skills, and most importantly ability to self-motivate and learn. To effectively develop these skills to a competent level within an already constrained Engineering program is the a challenge. Fortunately, Engineering programs are professional programs that have to adhere to professional Accreditation guidelines, and Engineers Australia (EngAust) has clearly defined these attributes to be part of their Stage 1 Competencies and therefore revision of the Engineering program of study to include the development of these skills are supported.(Bradley, 2008; Nguyen, 1998; Passow, 2012) These skills are traditionally developed via a form of osmotic learning processes, where students are to pick them up during their involvement in team based projects and thesis research projects. Such a delivery method however is not pedagogically appropriate for all student types.(Laskey & Hetzel, 2010) (Pulko & Parikh, 2003) Students who are self-efficient will perform well with such an learning approach, however most student will not be reciprocate well with this approach. A more robust method of knowledge transfer for these skills is therefore needed.

In 2013, our first year Engineering introductory unit, ENGG100, was restructured to better integrate the unit within our program of study. ENGG100 is the first unit in a series of ‘spine units’ that are designed to encourage students to practice and hence retain the skill development that are the objective of the degree program. In ENGG100, the main emphasis, or ‘threshold concept’ is ‘Transition into University’. This central theme entails a list of subsidary learning outcomes, that includes the above-mentioned graduate attributes, and self-driven learning. Acquiring these graduate skills will greatly faciliate the student’s ability to adapt to university education. Self-driven learning and other professional skills compound the student’s effort in their learning within university.

The development of these skills cannot simply be learnt, unlike technical knowledge; it requires time for development via repeated practices. Therefore, the formal scaffolding for the development of this skill are often not possible due the way university courses are setup. Only through repeated application of learnt theory, would they become habit. In addition to creating a culture and expectation within the student cohort, metacognitive strategies are introduced at this level. The practice of this skill becomes very rewarding to the progress of learning for the student as they continue to develop self-sufficiency in learning. As students progress through the Engineering program, they will practice and develop the attributes of self-learning and continual lifelong learning. These attributes should not be underestimated, as they are highly valued by employers. They allow student to adapt to new environments such as different workplaces effectively. In order to completely oversee and evaluate the development of these skills, multiple units and assessment need to be in place throughout the degree program to evaluate students' performance in acquiring the graduate attributes. However as previously mentioned, part of the challenge of modern day Engineering degrees is the lack of time available for the transfer of the required knowledge to produce competent Engineers by the end of the 4 year program. This imposes a time constraint and therefore all assessment must be unique and should not be repeated. The ~~proposed~~ ENGG100 unit along with the other spine units offers a potential avenue to streamline the development of the required knowledge within the time constrain.

Another objective of ENGG100 is that it establishes standards and expectations that are to be enforced with all other units within the program. Such standardisation of expectations between the units provides students with a uniform learning environment, encourages them to carry over their learning, and repeat practices in other units following ENGG100. The formalism of the expectations from the Department creates a professional culture within the student cohort and, just as importantly, amongst the Departmental staff. This would be similar to the working culture of professional cooperation which allows students to simulate the behaviours expected in a professional culture and allow students to model off one another. This approach follows the social and situational learning theory, which encourages students to develop the needed graduate attributes more readily by the end of their degree education. Self driveng learning is an attribute that is arguably more valuable than all other attributes and technical knowledge.(Bolhuis, 2003; Parkinson, 1999) There are anecdotal evidence that engineering companies of various sizes value this attribute, along with communication and teamwork skill over the technical knowledge. Most of the interviewed companies' executives agree that discipline specific skills would require continual update and renewal.

2. Modularisation of learning outcomes.

As mentioned, creating a balanced and holistic Engineering program of study within the prescribed 4 year program is a challenge. In order to achieve this, we believe that the learning outcomes should be well defined and articulated. Traditional Engineering courses use a behaviourist teaching perspective and associated pedagogy often over emphasised the knowledge being taught but not the knowledge being learnt.(Mills & Treagust, 2003) The result is that students being able to temporary retain the information long enough to pass the required assessment task. Knowledge retention however is short lived. As a result, the program of study becomes ineffective, as the taught knowledge has to be reiterated at a later stage. In order to circumvent such a problem, assessment emphases should be placed on the knowledge learnt and not on knowledge that that has been taught. Strategies for doing so involved restructuring information content and the method of assessment. The latter attribute will be discussed in more details in a subsequent section of this communcation. One approach to effectively dissecting the large body of knowledge and offers a more organised and effective learning framework for engineering students is to use threshold concepts.(J. Meyer & Land, 2013) A threshold concept is transformative in nature and acts as knowledge gateways or portals, upon understanding the threshold concept new method of thinking or viewing of subject matter is attended.(Carstensen & Bernhard, 2008; J. H. Meyer, 2008)

By evaluating subject matter from the perspective of threshold concepts, a framework for assessments and competency development are created. Associated learning outcomes are derived from these threshold concepts.(A. Parker & McGill, 2009) The understanding and perspective of the subject matter are vastly different between students who have understood the threshold concept and those who have not. The successful students' view of the subject matter is more comprehensive and a multitude of related topics may be seen as blended into a single body of knowledge.(J. H. Meyer & Land, 2005) Therefore an effective method in managing the large body of knowledge that are involved with the engineering discipline is to fragment the field into individual threshold concepts.(T. Parker & McGill, 2014) Each unit of study is defined with one threshold concept. For example in the aforementioned ENGG100 introductory class for all engineering, the threshold concept would be 'transition to university'. Such a simple statement encompasses a range of sub-concepts that are important for students to develop and transition into university.(Brinkworth, McCann, Matthews, & Nordström, 2009) This includes self-learning, understanding of expectations and university regulations and practices of professional and transferable skills. Students who have learnt the threshold concept would have developed a certain level of self-sufficiency for learning and proficiency. Each unit have multiple associative learning outcomes that act to facilitate the development towards a single threshold concept within a unit.

In ENGG100, students are encouraged to be aware of the learning outcomes of the unit and the associated activities. These assessment activities are mapped to the learning outcomes and thus the evaluation and feedback of students' performance are based on their understanding of the specific learning outcomes. Through achieving these outcomes within the semester, students may develop their understanding of the threshold concept at their own pace. Assessments may also be mapped to multiple learning outcomes within the unit and are aimed to be developmental in nature.

3. Appropriate pedagogies and teaching activities

Gen Y learns very differently from to their predecessors and some of these differences include the increased tendency for group-based studies; low numeric and literacy skills; and the innate dependency to technologies.(Black, 2010; Sweeney, 2006) Traditional Engineering courses however employ conventional pedagogies to deliver the broad subject matters.(Mills & Treagust, 2003) A classic example of such pedagogies is the authoritative instructor that stands in front of the room, the 'sage on the stage'. This approach is monologic and students are expected to passively sit and listen. Students are frowned upon if they display behaviours that deviate from this norm. Such passive and single-sided communications are not effective with the current Gen Y cohort.(Barnes, Marateo, & Ferris, 2007; Black, 2010) The increasing shift in student demographics magnifies the need to change such method of delivery for the engineering discipline.

Research have shown that Gen Y are receptive to hands-on approaches to learning, and generally, the approaches associated with social Constructivism.(Mills & Treagust, 2003) Constructivist learning builds upon existing knowledge and enables the learners to discover and construct an understanding for themselves. This approach allows students to take ownership of their learning experience. More importantly, the learning methods would be individually tailored to the different student; a more appropriate strategy that resonates with the individualism of Gen Y students. Some activities that promote such a learning style and behaviours are project based learning (PBL) and group based activities. Using these delivery methods, students are exposed to the knowledge needed to achieve the learning objective of the classes, which in turn, facilitates their achieving an insight into the threshold concepts designated to the unit.(Black, 2010)

In our ENGG100 unit, we use a range of project and group based activities to delivery our desired learning outcomes. The use of simulated role-playing and simulated situation allows the student to be formally introduced to the professional and transferrable skill development that are part of the unit's learning outcome. To further reinforce these skill development, we run simulated engineering projects, which are evaluated based on the processes and not the results. In the standard 13 weeks of semester, two 4-week long projects were undertaken. The marking requirement increases in difficulties and weighing, thereby encouraging the students to practice and hone the learnt graduate skills in order to receive the marks. Such structure acknowledge the time required for these skills to be developed as well as the fact that students are highly motivated by marks awarded. The two engineering projects do not required high level of technical knowledges and therefore are suitable to all incoming engineering students. As observed before, in order for students to be awarded the marks, they must participate in the projects to their peers' satisfaction. In addition to such peer evaluation, tutors are also required to grade the students' effort by their weekly attendance and commitment to the group project. At the end of each group project, students are required to self-evaluate their effort as defined by themselves at the beginning of the project. Such self-critique is similar to key performance evaluation or other metrics that are routinely used in cooperated environment. This teaching approach encourages to undergo reflective learning processes and take ownership of the learning process. Additionally, the simulated projects will allows students to begin to accustom to the requirement and standards that are expected in other engineering work places. Such a method of introduction of professional standards should better prepare the students for employability.

4. Tutor support programs

The final aspect of our integrated approach to Engineering for Gen Y is our tutor support system. As mentioned before, the student demographic has changed and has to be reflected by adapt to new teaching styles that are more reciprocated by the new student cohort. The content inclusion in professional degrees such as engineering also needs revising to include professional skill development in addition to the technical contents. The program must be holistic in its curriculum design for it to be appealing and connected to the need of the modern Gen Y cohort. Additionally, educational challenges such as diminishing stable university employment opportunities needs to be considered. The increasing causalisation of educational staff is a continuing trend in modern day university.(Harvey PhD, 2013; Kimber, 2003; Percy & Beaumont, 2008) This has been suggested to a challenge in maintaining the quality and standard of course being taught in university, as in some case up to 80% of the course are taught by such category of staff. Therefore, preventative measures and quality assurance should be considered and systematic processes should be used to mitigate any negative effects of such trend of staff causalisation. We have formalised these systematic processes through our tutor induction program (TIP).

TIP is a tutor training and support activity and incorporates an induction program that is designed to bridge the pedagogical gap that young teaching academics may lack to be successful and effective in their teaching practice. Junior academics are typically high achieving postgraduate students or postdoctoral fellows who may not have had any formal training in tertiary education or pedagogy. These postgraduate students may have the technical skills needed for the subject, however effective and appropriate teaching techniques may not have be made aware to them in the past. This may result in poor communication between the teacher and the student. Problems like this are addressed by the mandatory tutor induction program (TIP), which aims to educate the tutors and junior academics of the pedagogical toolkit that are available for them to be effective in their teaching. Such a program is similar to the conventional diploma or certificate in tertiary education; however, it is much more focused and is contextualised specifically for the Engineering discipline. Within the TIP program fundamental pedagogical topics that are covered. These include the definitions of pedagogical approaches and practical advices. New tutors, who may not have any prior teaching experience find this workshop invaluable as experienced tutors would contribute and share their views, experiences, strategies and comments to assist the new tutors. In addition, the workshop empowers the tutors by formalising our Departmental standards and expectation for both the level and quality of teaching and processes. The standardisation of tutors enables a consistent of expectation to be enforced within all units running in the Engineering department.

Furthermore, our flagship unit, ENGG100, as previously discussed, requires the tutors to participate in the development of the transferable skills and graduate attributes that the students are trying to develop. In addition, the use of the Constructivist approach within ENGG100 requires tutors to be able to relate and apply different teaching strategies to best engage the students. both the student and the teaching staff would rely heavily on their past experiences to construct new understanding. This requires the tutors to understand such a fundamental differences from the traditional teacher-student relationship. Such a teaching strategy may not be intuitive to tutors without the formal introduction within the TIP workshop. No longer can tutors to simply recite from the prescribed text, they are expected to facilitate the learning experiences of their students. Tutors need to understand the students' different learning styles as well as their own teaching perspective and to moderate their interaction accordingly amongst the students. The Tutor Induction Program (TIP) properly inductstutors to of the basic learning theories and techniques to facilitate PBL and other group activities in our engineering curriculum.

Conclusion

We are currently restructuring our Enginerring program of study at at Macquarie University to recongise the changes Gen Y students demand of university education. In doing so, we have employed strategies that are believed to be effective in mitigating some of the challenges that the university education sector is facing. These changes include the increasing casualisation of teaching staff, changing student demographics, changes in the expectation of the value university education offers and the modernisation of pedagogical approaches for the tridtional engineering dicipline. Furthermore, there is the increase expectation of an all-rounded engineering graduate who are competent in both technical training and professional skills. To address these challenges we have aimed to devise a holistic and integrated Engineering program starting with the ENGG100 unit, that is mandatory for all Engineering students. Within this unit, we establish and present the Departmental expectation we have of the students. This process aligns the different expectations students might have had of university and the requirement for commitment. In addition, we use PBL and other group- based learning activities as a method of develop the metacognitive skills and other professional skills the students need to excel in the engineering program of study. Our postgraduate student cohorts, all of whom are professionally trained by our tutor induction program, primarily perform these activities. Within the TIP activity, tutors and other teaching facilitators are educated on the techniques and teaching practices that are designed for the Gen Y student cohort. Ultimately, this establishes consistency with in the casual academic to ensure a high level of teaching is achieved. Further work will be presented on the effectiveness of these approaches.

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