Implementing an Integrated First-Year Engineering Curriculum with Mixed Teaching Approaches

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Abstract

Griffith University offers Engineering programmes over two campuses in South East Queensland, Australia. A large proportion of students are the first in their families to attend university, with many from low socio-economic backgrounds. In 2017, Griffith moved to a trimester system, and the School of Engineering and Built Environment restructured the first-year engineering curriculum to provide an improved engineering experience focusing on key educational outcomes for its diverse student population.

This article describes and evaluates the new integrated first-year curriculum, which includes a mix of traditionally taught, partially experiential, and fully experiential courses. The curriculum structure is discussed, and the outcomes evaluated in terms of student achievement, progression, and satisfaction. Findings of this evaluation indicate that teaching staff have a crucial role in ensuring courses are well received, traditionally taught mathematics courses do not appear to be meeting the needs of the students, and that 'C' is unlikely to be a good choice for a first programming language for engineering students. However, the restructuring shows some preliminary success in terms of increased retention when coupled with proactive outreach. Further research into student perceptions and performance across courses with different teaching approaches is recommended.

Keywords

Engineering first-year curriculum, project-based learning, experiential learning, curriculum evaluation

Introduction

Modern engineering curricula have evolved from their origins in hands-on practice to include solid foundations in science and mathematics, a focus on student outcomes and an emphasis on integration of curriculum content (Froyd & Ohland, 2005; Froyd, Wankat, & Smith, 2012). In particular, the first-year engineering curriculum has been a focus for institutions seeking to capitalise on the educational benefits of curriculum integration. For example, Everett, Imbrie, and Morgan (2000) describe rethinking the structure and delivery of mathematics, science, and engineering through integration noting significant improvements in student satisfaction and progress. Similarly, Pendergrass et al. (2001) report improvements in student performance and retention due to curriculum integration.

Across the literature (Everett et al., 2000; Pendergrass et al., 2001; Parsons et al., 2002; Olds & Miller, 2004; Knight, Carlson, & Sullivan, 2007; McGuire, Li, & Gebali, 2015), there is a general consensus that an integrative curriculum offers the following benefits:

- An increase in motivation and an enhanced learning experience;
- An increase in student engagement - attendance and participation;
- An improvement in the student learning of fundamental concepts;
- An increase in student exposure to connections across the curriculum;
- An increase in exposure to authentic problems and professional practice;
- An improvement in teamwork and communication skills; and
- An improvement in retention rates

In addition to recommendations for curriculum integration, there have been many calls for engineering education to move to using more active approaches shown to improve student learning (Prince & Felder, 2006; Kober, 2015), and improve first-year retention (Braxton, Milem, & Sullivan, 2000; Braxton, Jones, Hirschy, & Hartley, 2008). Accordingly, the intent is to design a first-year curriculum using a "mixed-mode approach" (Mills & Treagust, 2003, p. 13) where students experience a range of increasingly active learning and teaching approaches across their courses each term. This range of approaches aims to cater for the differing learning needs of students (Felder & Silverman, 1988), as well as assisting in developing more flexible learners (Heywood, 2005).

This article describes and evaluates a new common and integrated first-year curriculum for Bachelor of Engineering (B Eng) programmes offered by Griffith University in Queensland, Australia. The curriculum aims to provide a first-year engineering experience focusing on student educational outcomes and including:

- Integration of science and mathematics in the context of engineering practice;
- A focus on experiential learning (with individual and cooperative learning activities);

- An emphasis on sustainability issues (economic, environmental and societal); and
- An increase in focus on professional skills (employability, teamwork and communication).
- Integration of computer (programming) skills into design and problem-solving tasks;

Context: Bachelor of Engineering at Griffith University

Griffith offers a range of Engineering programmes at undergraduate and postgraduate level at both the Gold Coast (GC) and Nathan (NA) campuses, located in South East Queensland, Australia. The campuses are 65 km apart, and the Nathan campus competes with two other major universities in the Brisbane area. Griffith has a social inclusion focus, and a large proportion of the student body are the first in their families to attend university, with many from low socio-economic backgrounds (low SES) (Griffith University, 2017). As shown in Table 1, about half of the students commencing in B Eng programmes in 2017 and 2018 on both campuses are first in family, with a higher proportion of the Nathan student cohort classed as low SES.

Table 1: Characteristics of 2017-2018 Commencing Engineering Cohorts by Campus

Year/Term	Campus	Commencing Students	First in Family	Low SES
2017, Tri 1	NA	117	48.7%	17.1%
	GC	291	50.2%	7.9%
2018, Tri 1	NA	109	45.9%	22.9%
	GC	274	46.0%	6.2%

These cohort characteristics impact on the likelihood of students successfully transitioning to university, engaging in their studies, and continuing until graduation (Braxton et al., 2000; Tinto, 2006). Surveys of Australian university students have previously shown that low SES students are less likely to feel prepared for university, and are also more likely to have financial issues which can lead to difficulties balancing work and study (Baik, Naylor, & Arkoudis, 2015; Cherastidtham, Norton, & Mackey, 2018).

Redeveloping the First-Year Curriculum for 2017

The development process for the first-year of the B Eng programme follows the multi-dimensional framework presented by Al-Holou et al. (1999). The five dimensions considered are:

- Course Structure
- Time-sharing
- Learning environment
- Topical span, which refers to integration across a combination of courses
- Topical coordination, which refers to the approaches taken to assist students to connect the different topics encountered across courses

For the purposes of this paper, topical span and topical coordination will be combined.

Course Structure

In 2017, Griffith moved to a trimester system, with three 12-week terms in the academic year. This change provided an opportunity to redesign the B Eng programme for improved student outcomes and to differentiate the programme from other universities in the same region. As shown in Table 2, the first year consists of eight separate courses, normally taken over two terms. The set of first-year courses is common to both campuses, and is divided into six compulsory core courses, with the remaining two discipline-specific foundation and computing courses changing depending on the student's major. Students on the Gold Coast can choose from Civil, Electrical & Electronic, and Mechanical Engineering. Nathan campus offers Civil, Electronic, Environmental, and Software Engineering.

The majority of courses in the B Eng are offered in trimester one (T1) and trimester two (T2), with a range of key first-year courses available in trimester three (T3). The addition of T3 allows students to commence the B Eng in either T1 or T2, and provides an opportunity for students to repeat courses in T3 if necessary.

Table 2: Overview of First Year Structure

Term	Courses	Offered	Notes
T1	1010ENG Engineering Mathematics 1	T1, T2	Core
T1	1018ENG Engineering Science	T1, T2	Core
T1	1017ENG Engineering Materials	T1, T3	Core
T1	1701ENG Creative Engineering	T1, T3	Core
T2	1020ENG Engineering Mathematics 2	T2, T3	Core
T2	1022ENG Engineering Design Practice	T2	Core
T2	1501ENG Engineering Mechanics	T2, T3	Foundation: Civil, Environmental, Mechanical
T2	1301ENG Electric Circuits	T2, T3	Foundation: Electrical, Electronic, Software
T2	1305ENG Engineering Programming	T2	Computing: Mechanical, Electrical, Electronic, Software
T2	1105ENG Numerical & Computing Skills	T2	Computing: Civil, Environmental

Time Sharing

The courses are offered as per the concept of "static time allocations" with a fixed timetable with a set amount of time scheduled for each course, each week (Al-Holou et al., 1999). This structure is preferred to the concept of "course blocks" or "course pairs/triads", for example: mathematics, physics and programming in MATLAB (Liron & Steinhauer, 2015). While course blocks, pairs/triads can help provide explicit integration of curriculum content, the need to undertake a number of courses simultaneously can reduce the opportunities for enrolment flexibility, particularly for part-time students.

Learning Environment

Of the four courses normally taken each term, one course is designated to be "fully-experiential" (Full), where the majority of the assessment is project-based, without a final exam. This allows for individual and cooperative learning opportunities, and aims to take advantage of the many student benefits for project-based courses (Thomas, 2000; Frank, Lavy, & Elata, 2003; Mills & Treagust, 2003; Helle, Tynjälä, & Olkinuora, 2006). Two courses are designated as "partially-experiential" (Part), and contain a considerable experiential component integrating the theoretical concepts through small embedded practical activities or projects (for example: Woodfield, Hall, and Tansley (2015)), with some form of final exam permitted. The remaining course each term, the mathematics course, is taught in a traditional (Trad) manner and is primarily assessed by quizzes and a final exam. The courses and their approaches are shown in Table 3.

Table 3: Overview of Courses and Learning and Teaching Approach

Term	Courses	Type	Approach
T1	1010ENG Engineering Mathematics 1	Core	Trad
T1	1017ENG Engineering Materials	Core	Part
T1	1018ENG Engineering Science	Core	Part
T1	1701ENG Creative Engineering	Core	Full
T2	1020ENG Engineering Mathematics 2	Core	Trad
T2	1022ENG Engineering Design Practice	Core	Full
T2	1501ENG Engineering Mechanics	Discipline Specific	Part
T2	1301ENG Electric Circuits	Discipline Specific	Part
T2	1305ENG Engineering Programming	Computing	Part
T2	1105ENG Numerical & Computing Skills	Computing	Part

Topical Span & Coordination

Foundation Science and Mathematics

The foundation science and mathematics courses dominate the first-year curriculum with four out of the eight courses. These courses are taught by staff from outside the School of Engineering and Built Environment, and are taken by a diverse range of students enrolled in different programmes. This approach is time and cost-efficient, but can make it more difficult for engineering students to see the connections between the course content and engineering practice (Holmegaard, Madsen, & Ulriksen, 2016). To address the disconnect, it was planned that engineering students in the mathematics courses would have separate tutorials where they work with engineering-relevant examples, but still attend the common lecture series. The courses were renamed "Engineering Mathematics 1" and "Engineering Mathematics 2". Similarly, the foundation physics course was renamed "Engineering Science" with a common lecture series, but separate engineering-centric laboratory projects and tutorials.

Engineering Materials and Engineering Science were also redesigned to be delivered as partially-experiential courses. Engineering Materials now includes a more practical "investigative" emphasis with physical laboratory activities that use a more enquiry-based learning model (Prince & Felder, 2006). For example, the first introductory laboratory activity requires students to categorise a variety of "unknown" materials through conducting simple mechanical and/or electrical experiments, analyse and interpret their own experimental results, and then apply their results to a real-world situation. Similarly, Engineering Science was redesigned to include hands-on project laboratories where students work to solve engineering physics problems.

Design Stream Courses

The first-year design stream highlights the important role of design and open-ended projects in engineering practice (Mills & Treagust, 2003; Dym, Agogino, Eris, Frey, & Leifer, 2005; Froyd & Ohland, 2005; Sheppard, Macatangay, Colby, & Sullivan, 2008; Crawley, Malmqvist, Östlund, Brodeur, & Edström, 2014), and consists of two fully-experiential courses, 1701ENG Creative Engineering, and 1022ENG Engineering Design Practice. Both courses aim to provide deeper opportunities for students to connect and apply concepts from their other courses and focus on the importance of designing sustainable engineering solutions for real people. As Sheppard et al. (2008, p. 9) put it, students need to understand "that social and ethical connections are as important, if not more so, as electrical and mechanical ones". The Design Stream courses also form the basis of an integrated professional practice and employability skills stream embedded into the programme (see Howell, Tansley, Jenkins, and Hall (2018)).

Creative Engineering focuses on developing creative approaches to problem solving, and requires students to explicitly nominate which UN Sustainable Development Goal (UN General Assembly, 2015) they wish to address in their design solutions. Similarly, Engineering Design Practice revolves around the Engineers Without Borders

(EWB) challenge widely used in Australian Universities (Cutler, Borrego, & Loden, 2010). The EWB challenge requires students to design sustainable solutions for specific communities in the developing world, and the course is also an opportunity for the students to develop Computer Aided Design skills needed to document their designs.

Computing Skills

The partially-experiential computing and programming course is currently split by discipline, with Civil and Environmental Engineering students taking 1105ENG Numerical and Computing Skills ("Matlab"), and all other students taking 1305ENG Engineering Programming ("C"). Both courses have broadly similar learning outcomes, where students use programming tools to solve problems by applying concepts from foundation science and mathematics courses.

Discipline-Specific Foundation Courses

Both discipline-specific foundation courses are partially-experiential courses, and build on Foundation Science and Mathematics courses to assist students in developing a basic understanding of key concepts in their chosen major. Electric Circuits was redesigned for 2017 and includes two projects, leading to a hands-on laboratory-based exam in which students demonstrate their skills in the design and analysis of circuits, and answer questions related to theoretical concepts. Similarly, Engineering Mechanics was redesigned to include guided enquiry-based workshops, with projects on beams and trusses.

Methodology

To explore the student experience of the new curriculum, this paper draws its conclusions from three data sources over a two-year period from 2017 to 2018: Student evaluation of course (SEC) results, course failure results, and first year retention data. Approval to use these data sources was received from the Griffith University Human Research Ethics Committee, and is discussed in more detail in the following sections.

Results

Student Satisfaction Scores

Students can provide feedback on their courses through an online student experience of courses survey. These surveys run each trimester and close shortly before the start of the exam period. The SEC survey asks students to respond to a series of statements on Likert scale ranked from Strongly Agree (5) to Strongly Disagree (1). Although there are normally six statements on the SEC survey, Griffith uses the mean response to the survey item, "Overall, I am satisfied with the quality of this course", as a key metric for courses. Therefore, this result is used in this paper. Table 4 shows the SEC scores for courses across campuses in 2017 and 2018, with an identifier from A1 to A21 representing the course staff responsible for convening the course on each campus.

Table 4: Course SEC Summary 2017-2018

Term	Type	Course Name	2017 SEC (Staff)		2018 SEC (Staff)	
			GC	NA	GC	NA
T1	Full	1701ENG Creative Engineering	2.6 (A1)	3.5 (A1)	4.2 (A9)	2.6 (A1)
T1	Part	1017ENG Engineering Materials	4.2 (A3)	2.4 (A2)	4.5 (A3)	3.1 (A2)
T1	Part	1018ENG Engineering Science	4.4 (A5)	3.9 (A6)	3.8 (A6)	4.4 (A5)
T1	Trad	1010ENG Engineering Maths 1	3.9 (A7)	4.2 (A8)	3.9 (A7)	4.3 (A8)
T2	Full	1022ENG Engineering Design Practice	3.4 (A9)	3.0 (A10)	4.3 (A9)	4.4 (A10)
T2	Part	1305ENG Engineering Programming	4.2 (A11)	4.3 (A12)	3.7 (A11)	3.6 (A12)
T2	Part	1501ENG Engineering Mechanics	4.3 (A13)	4.3 (A14)	4.4 (A13)	4.7 (A14)
T2	Part	1301ENG Electric Circuits	4.1 (A15)	4.4 (A16)	3.8 (A17)	4.3 (A16)
T2	Part	1105ENG Numerical & Computing	3.8 (A21)	4.1 (A20)	3.5 (A21)	4.3 (A20)
T2	Trad	1020ENG Engineering Maths 2	4.1 (A19)	2.6 (A18)	3.9 (A19)	3.8 (A18)
Average SEC (T1)			3.8	3.5	4.1	3.6
Average SEC (T2)			4.0	3.8	3.9	4.2
Average SEC (Year)			3.9	3.7	4.0	4.0

T1 Courses

In 2017, the Gold Coast students were most satisfied with partially-experiential courses, with both courses scoring over 4.0. The fully-experiential course, Creative Engineering, performed poorly with a low score of 2.6. At Nathan, the traditionally taught course, Engineering Maths 1, was the only course scoring over 4.0.

For 2018, Engineering Materials, a partially-experiential course, was the highest rated (4.5) on GC, with Creative Engineering (Full, 4.2) improving greatly from a poor result of 2.6 in 2017. Conversely for Nathan, the fully-experiential course, Creative Engineering, performed poorly (2.6), with the most successful courses being Engineering Maths 1 (Trad, 4.3) and Engineering Science (Part, 4.3).

T2 Courses

In 2017, Engineering Design Practice (Full) was the only course scoring under 3.5 on GC, and also scored poorly at NA (3.0). Engineering Mathematics 2 (Trad) had high variation between campuses (GC: 4.1, NA: 2.6), with the remaining partially-experiential courses all scoring above 4.0.

For 2018, Engineering Design Practice (Full) improved at GC to 4.3, and was also the highest scoring course on the NA campus (4.7). Again, the majority of partially-experiential courses scored above 4.0, with the exception of Engineering Programming (GC: 3.7, NA: 3.6).

SEC Averages

The SEC averages for the year for both campuses improved to 4.0 in 2018 from 3.9 (2017, GC) and 3.7 (2018, NA). The term with the consistently lowest average SEC is T1 at Nathan campus, scoring 3.5 (2017) and 3.6 (2018), with the highest NA average in T2, 2018 (4.2).

Staffing

The recorded SEC scores appear to follow staff when they move campuses, with course convenors A1 (2017, Creative Engineering, GC: 2.6; 2018, Creative Engineering, NA: 2.6), A5 (2017, Engineering Science, GC: 4.4; 2018, Engineering Science, NA: 4.4), and A6 (2017, Engineering Science, NA: 3.9; 2018, Engineering Science, GC: 3.8) receiving the same or very similar scores for their courses in T1, 2017 and 2018 regardless of campus.

Failure Rates

Table 5 shows the 2017-2018 failure rates by campus and total cohort size for first-year courses. Nathan has a higher average fail rate than Gold Coast (2017, NA: 30.7%, GC: 21.6%; 2018, NA: 32.2%, GC: 21.1%). The average fail rates at GC dropped by 0.5% from 2017 to 2018 but increased by 2.5% at NA. T2 at Nathan has the highest average fail rate at 33.2% in 2017, and 39.4% in 2018.

T1 Courses

Engineering Science in 2017 had very high fail rates on both campuses (GC: 39.6%, NA: 43.7%), although this improved for 2018 (GC: 11.8%, change -27.9%; NA: 19.8%, change -23.9%). Engineering Mathematics 1 also had high fail rates in T1, 2017 (GC: 30.8%, NA: 27.0%). In 2018, the fail rate decreased for GC, but increased for NA (GC: 25.8%, change -5.0%; NA: 38.1%, change +11.1%). In the same year, the fail rate in the NA offering of Creative Engineering increased to 26.7%, a marked change from 9.0% at GC, and from both campuses in 2017 (GC: 5.8%, NA: 11.9%).

Table 5: Course Failure Rate Summary 2017-2018

Term	Type	Course Name	2017 Fail Rates (Cohort Size)		2018 Fail Rates (Cohort Size)	
			GC	NA	GC	NA
T1	Full	1701ENG Creative Engineering	5.8% (189)	11.9% (93)	9.0% (177)	26.7% (82)
T1	Part	1017ENG Engineering Materials	19.5% (245)	25.1% (84)	8.3% (193)	10.8% (94)
T1	Part	1018ENG Engineering Science	39.6% (190)	43.7% (87)	11.8% (186)	19.8% (106)
T1	Trad	1010ENG Engineering Maths 1	30.8% (250)	27.0% (100)	25.8% (248)	38.1% (97)
T2	Full	1022ENG Engineering Design Practice	5.8% (223)	10.9% (93)	3.5% (197)	14.4% (90)
T2	Part	1305ENG Engineering Programming	24.6% (154)	52.4% (84)	42.7% (143)	61.5% (83)
T2	Part	1501ENG Engineering Mechanics	22.5% (151)	35.0% (40)	25.4% (126)	32.3% (31)
T2	Part	1301ENG Electric Circuits	22.6% (53)	22.2% (27)	28.3% (45)	50.1% (38)
T2	Part	1105ENG Numerical & Computing	6.5% (78)	16.7% (36)	11.2% (63)	23.3% (30)
T2	Trad	1020ENG Engineering Maths 2	37.9% (169)	61.7% (73)	45.2% (213)	55.0% (69)
Average Fail Rate (T1)			23.9%	26.9%	13.7%	23.9%
Average Fail Rate (T2)			20.0%	33.2%	26.1%	39.4%
Average Fail Rate (Year)			21.6%	30.7%	21.1%	33.2%

T2 Courses

In 2017, Engineering Mathematics 2 (Trad), had the highest fail rate on both campuses (GC: 37.9%, NA: 61.7%). For 2018, Engineering Mathematics 2 (GC: 45.2%, NA: 55.0%) still had the highest fail rates of the GC courses, but Engineering Programming (Part, GC: 42.7%, NA: 61.5%) moved to being the course with the highest fail rate at NA, and the second-highest fail rate at GC. Trimester 2 at Nathan in 2018 was particularly challenging, with two additional courses with fail rates of above 30%: Engineering Mechanics (Part, GC: 28.3%, NA: 32.3%) and Electric Circuits (Part, GC: 28.3%, NA: 50.1%). In total, four out of the six T2 courses at Nathan had fail rates of above 30%, compared to two courses on the Gold Coast campus.

Engineering Programming

Engineering Programming ("C") consistently had fail rates three to four times higher than Numerical & Computing Skills ("Matlab"). The 2018 fail rates for Engineering Programming (GC: 42.7%, NA: 61.5%) were much higher than Numerical & Computing Skills (GC: 11.2%, NA: 23.3%). The 2018 T2 fail rate for Engineering

Programming on the Gold Coast increased sharply from 24.6% in 2017.

Commencing Student Retention

Figure 1 displays retention for students commencing in the B Eng on GC and NA from 2012 to 2017. A student is defined as being retained if they are enrolled in any program at Griffith University at census date the year following commencement. In the 2012 to 2017 period, the percentage of students retained on GC campus peaked at 86.4% in 2012, and remained stable at 82.3% subsequently (2014-2017). Conversely, NA has lower retention rates, averaging at 64.6% over the six-year period, peaking at 73.6% in 2017. The peak coincides with the introduction of the common first-year B Eng structure, and the move to a trimester system.

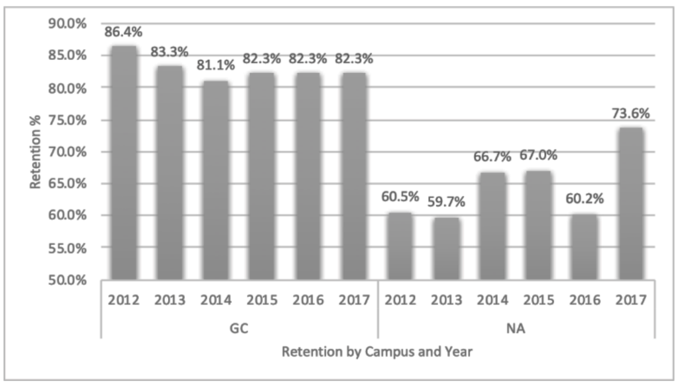

Figure 1. 2012-2017 Commencing Student Retention by Campus.

Repeating Courses in Trimester 3 and Retention

A number of courses are available in T3, providing students with the opportunity to repeat failed courses, and get back on track for the following T1. Table 6 shows T3, 2017 enrolment and T1, 2018 status for students commencing in 2017 that failed 1020ENG Engineering Mathematics 2, 1301ENG Electric Circuits, or 1501ENG Engineering Mechanics. On both campuses, similar percentages of students who failed (GC, 11 students, 22.4%; NA, 9 students, 25.7%) chose to repeat 1020ENG Engineering Mathematics 2 in T3. At NA, 100% of the T3-repeating students were retained in T1, compared to 53.8% for those students who chose not to repeat. At GC, the retention rate was higher for non-repeating students for 1020ENG in T3 (73.7%) compared to those who did repeat in T3 (63.6%). These students then need to repeat the failed course at a later date.

Table 7 displays T3, 2018 enrolment, and preliminary T1, 2019 enrolment data for students who failed courses in T2, 2018. 1020ENG Engineering Maths 2 has the largest number of T3-enrolled students, but this varies between campuses. On GC, 20 students (50%) who failed the course in T2 compared to only three students (15%) at NA. T3 Electric Circuits and Engineering Mechanics show higher T3 enrolment at GC than in 2017 (3 students, 60% and 5 students, 26.3% respectively). No NA students chose to re-enrol in either course. T3 re-enrolment at NA is generally lower than GC, for example, 11.8% of those who failed Engineering Mathematics 2 re-enrolled for T1, 2019, compared to 50% of the GC cohort Table 7.

Discussion

The two fully-experiential courses, Creative Engineering and Engineering Design Practice, received low SECs across both campuses in 2017. This improved in 2018 where the courses were among the group with high SECs, with the exception of Creative Engineering at Nathan. After reviewing the data, the SEC response appears to follow the staff member rather than the course.

Table 6: T3 Re-enrolment and 2018 Retention Status for students who commenced in 2017 and failed a T2 course

Campus	Course	Students Failing T2 Course	Students Repeating Course in T3 (% Failing Cohort)	Students who Repeated Course in T3, and were retained in T1, 2018	Students Failing T2 course but did not repeat Course in T3	Students who did not repeat Course in T3, but were retained in T1, 2018
GC	1020ENG Eng Maths 2	49	11 (22.4%)	7 (63.6%)	38 (77.6%)	28 (73.7%)
GC	1301ENG Electric Circuits	6	0 (0%)	0 (0%)	6 (100%)	3 (50%)
GC	1501ENG Eng Mechanics	22	1 (4.5%)	1 (100%)	21 (95.5%)	14 (66.7%)
NA	1020ENG Eng Maths 2	35	9 (25.7%)	9 (100%)	26 (74.3%)	14 (53.8%)
NA	1301ENG Electric Circuits	6	0 (0%)	0 (0%)	6 (100%)	4 (66.7%)
NA	1501ENG Eng Mechanics	10	1 (10%)	1 (100%)	9 (90%)	5 (55.6%)

Table 7: T3 Re-enrolment and 2019 Enrolment Status for students who commenced in 2018 and failed a T2 course

Campus	Course	Students Failing Course in T2	Students Repeating Course in T3 (% Failing Cohort)	Students who Repeated Course in T3, and re-enrolled in T1, 2019	Students Failing T2 course but did not repeat Course in T3	Students who did not repeat Course in T3, but re-enrolled in T1, 2019
GC	1020ENG Eng Maths 2	40	20 (50%)	17 (85%)	20 (50%)	10 (50%)
	1301ENG Electric Circuits	5	3 (60%)	2 (66.7%)	2 (40%)	2 (100%)
	1501ENG Eng Mechanics	19	5 (26.3%)	5 (100%)	14 (73.7%)	6 (42.9%)
NA	1020ENG Eng Maths 2	20	3 (15%)	2 (66.7%)	17 (85%)	2 (11.8%)
	1301ENG Electric Circuits	11	0 (0%)	0 (0%)	11 (100%)	2 (18.2%)
	1501ENG Eng Mechanics	6	0 (0%)	0 (0%)	6 (100%)	0 (0%)

For example, one staff member for Creative Engineering received the same low score in both years despite teaching on different campuses. This may indicate that students are rating the staff member rather than the course, and aligns with research noting that students are strongly influenced by the lecturer's personality (Patrick, 2011) or charisma (Shevlin, Banyard, Davies, & Griffiths, 2000) when rating courses. Similarly, Engineering Materials, a partially experiential course, is one of the highest rated courses on the Gold Coast, but consistently receives low scores at Nathan when taught by different academic staff.

Overall, it seems that partially-experiential courses receive slightly better satisfaction scores on average when compared to the other teaching approaches. As students bring their own perceptions and expectations of how they will be taught when they enrol (Prosser & Trigwell, 1999; Ramsden, 2003), it is important to assist students to adjust to learning approaches that may not match their own learning preferences and expectations (Dart et al., 2000). This includes "designing learning environments that make students somewhat uncomfortable, while providing enough support to allow new strategies to be developed without undue anxiety" (Entwistle & Peterson, 2004, p. 425). Accordingly, the variation in SEC results for fully-experiential courses suggests that staff for such courses need to be chosen carefully, and supported with appropriate training (Mills & Treagust, 2003). It is also worth noting that some staff indicated their dissatisfaction with the designated teaching approach for their allocated course. Unsurprisingly, this can lead to poorer learning outcomes for students when the teaching staff's beliefs about appropriate teaching approaches do not align with the way a course is to be taught (Trigwell, Prosser, & Waterhouse, 1999).

Low SECs may also indicate student disengagement with the course, and this can be seen in the relatively high fail rate of 26.7% for Creative Engineering at Nathan campus in T1, 2018, compared to the generally lower fail rates of the fully-experiential design courses. This pattern can also be seen in the T2, 2017 offering of Engineering Mathematics 2 which has the highest fail rate of all courses during 2017 and 2018, with a low SEC of 2.6. High fail rates, however, do not always link with low SECs as can be seen in the Nathan offering of Engineering Mathematics 1. In 2017, this was the only course scoring over 4.0, perhaps because it was a teaching style the students were most used to that term. The course again received high SECs in T1, 2018, yet had the highest fail rate of Nathan courses that term. It should be noted that SEC survey period closes before the students sit their final exams.

The mathematics courses had the highest failure rates in three of four terms on the Gold Coast, and two out of the four terms at Nathan. In the three terms where the mathematics course did not have the highest failure rate, it had the second highest failure rate. Although Griffith Engineering programs have a Mathematics B prerequisite, there has long been wide variation in mathematics knowledge amongst students entering Australian engineering programs (Cuthbert & MacGillivray, 2003; Jourdan, Cretchley, & Passmore, 2007; Broadbridge & Henderson, 2008). Given the current high failure rates, the mathematics courses taught in the traditional manner are not meeting the student's needs. The courses therefore need to be reviewed to consider how different teaching approaches could be used to help students connect mathematics with engineering practice, and improve learning (Flegg, Mallet, & Lupton, 2012; Harris et al., 2015).

With regards to the computing courses, fail rates for Engineering Programming ("C") are far higher than for Numerical & Computing Skills ("Matlab"). The sharp increase in GC fail rates in Engineering Programming from 2017 to 2018 is because a group of second-year electrical engineering students who had previously completed Matlab were enrolled in the course in 2017 due to their programme requirements. The higher fail rates for a "C" course align with suggestions that Matlab or Python would be more appropriate choices for a first programming language for Engineering students (Fangohr, 2004; Wang, Hill, & Foley, 2017).

The introduction of the new first-year curriculum, coupled with the ability for students to use T3 as an opportunity to repeat courses they have failed, appears to have improved retention rates at Nathan in 2017. Students who failed key courses in T2, 2017 were sent text messages direct to their mobile phones, and emailed information on using T3 to repeat courses to get back on track. This is in line with recommendations to monitor student progress to improve student success (Coates, 2009). Due to an oversight in T2, 2018, only GC students were contacted in the T3 text message re-enrolment campaign. As there are major differences in T3, 2018 enrolment rates, and very low numbers of NA students who have failed courses re-enrolling for T1, 2019, this indicates that targeted re-enrolment support campaigns are crucial, and impact on retention. It is therefore likely that NA retention for 2018 will drop from the 2017 peak.

Conclusion

This evaluation of the new first-year B Eng structure and move to a trimester model shows some promising outcomes as well as areas needing improvements and further research. Future program improvements will include moving to a common computing skills course, most likely with Python instead of C. The teaching approach and course structure of the mathematics courses will also be reviewed to improve student performance and learning. Pleasingly, the move to a trimester-based first-year structure can lead to improvements in retention, when coupled with proactive and targeted student outreach.

Student satisfaction scores also provide some insight into the success, or otherwise, of the mixed-mode approach to teaching styles, with student enjoyment of a course being a product of both course and educator. Whilst fully-experiential courses have been shown to have numerous benefits to student learning, the educator needs to have the capability to actively support students, and believe in the teaching approach. A partially-experiential approach appears to be a "safer" option for course delivery for a large/multi-campus department with staff of varying teaching method preferences, experience, and support skills.

The link between student satisfaction and student achievement is not completely clear. Whilst some courses seem to show a link between poor SEC and disengagement or poor outcomes, other courses score highly despite high failure rates. This is particularly in the traditionally-taught courses which have a major end-of-trimester exam taken after the SEC survey period has closed. It could be proposed that fully and partially-experiential courses allow the students to measure their own success sooner, which may lead to disengagement for some students. Future research could investigate this further, and also identify if the experiential courses lead to increased independent study in more dedicated students.

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