Review of First-year Engineering and Technology Units Based on Student Unit Evaluations

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Abstract
There is recognition that the first-year of university study is a critical phase in the preparation, motivation and retention of science, mathematics, engineering and technology (SMET) students. First-year provides the foundation/generic skills upon which students will base their undergraduate studies and professional practice; first-year is where many poorly prepared/at risk students will drop out and contribute to the poor student retention rate observed in the SMET disciplines; and first-year is when students may lose the motivation to pursue their chosen career direction if they find the studies at the commencement of their undergraduate program appear to bear no relationship to their intended career. In 2003, the Learning Resources Advisory Group of the Deakin University School of Engineering and Technology was requested to undertake a review of first-year units in the School's programs. The information contained in anonymous unit evaluation questionnaires from the years 2000-2002 was used as the basis for analysing student perceptions of first-year units. In unit evaluations, students reported a wide range of issues that impacted negatively on their perception of the content and conduct of first-year units. It was noted that units service taught by other Schools form a significant element of the first-year of all of the Engineering and Technology undergraduate programs – typically 25 to 50 percent of the content. The significant influence of these units on the perceptions of the first-year of the School's commencing students means that the School should exercise some control over the content and delivery of these units.

Introduction

There is recognition that the first-year of university study is a critical phase in the preparation, motivation and retention of science, mathematics and technology students generally[1], and for engineering students in particular[2,3]. First-year provides the foundation/generic skills upon which students will base their undergraduate studies and professional practice[2,4]; first-year is where many poorly prepared/at risk students will drop out and contribute to the poor student retention rate observed in the science, mathematics, engineering and technology (SMET) disciplines[2,5,6]; and first-year is when students may lose the motivation to pursue their chosen career direction if they find the studies at the commencement of their undergraduate program appear to bear no relationship to their intended career[7-10]. This paper presents a review of first-year engineering units (subjects/classes) at Deakin University based on student unit evaluations conducted in the years 2000-2002. This review aimed to better understand student perceptions of first-year units, and to provide guidance to academic staff with the responsibility for the development and delivery of these units on how they might enhance the students' first-year experience.

Engineering Programs at Deakin University

The Deakin University School of Engineering and Technology offers four-year Bachelor of Engineering (BE), Masters and Doctoral engineering programs. In the period under study, the undergraduate programs included the engineering disciplines of mechanical, manufacturing,

mechatronics, electronics, robotics, computer systems and environmental. The undergraduate programs are delivered in both on-campus and off-campus modes[11]. Off-campus students receive printed study notes that form the basis for the course, and these study notes are also available to on-campus students via campus bookshops and the Library. A student studying full time would normally be enrolled in four units of study per semester. Conventional (secondary school) entry students would normally undertake these programs on-campus, full-time. Mature age students may study the programs on-campus, full-time, but most elect to study off-campus and/or part-time because of employment, family or other commitments.

The School programs include the following units in first-year:
SEB121 – Fundamentals of Technology Management
SED102 – Introduction to Engineering Design and CAD
SEE103 – Electronics
SEM111 – Materials 1
SEP101 – Physics 1A
SEP102 – Physics 1B
SEP115 – Physics for Technologists
SEP122 – Physics for the Life Sciences
SEV131 – Coastal and Marine Environments 1 (not offered after 2002)
Additionally, other Schools within the Faculty of Science and Technology provide the following first-year units into the School's programs:
SBC111 – Chemistry A
SCC104 – Introduction to Software Development
SCC105 – Basic Programming Concepts
SCM124 – Introduction to Mathematical Modelling
SCM165 – Introduction to Calculus

Many of these first-year units are common to all (or most) of the School's programs, hence they typically have large enrolment numbers and the attendant problems that come with large class sizes. For many students, their encounter with these units will be their first experience with study at university; hence, their experiences in these units are likely to be influential on the rest of their university studies. Many of these units are 'foundation' units upon which later engineering applications will be based, but, of themselves, may contain little that is directly related to engineering[3]. Students coming to university to study 'engineering' may find such units confusing or lacking relevance, no matter how much the importance of these foundation studies are explained.

In all engineering programs, three out of the eight first-year units are provided by Schools other than Engineering and Technology, except for the first-year of the environmental course, where this figure is four out of eight. No direct evaluation information about units 'service taught' by other Schools is available; however, there has been anecdotal evidence in the past of problems where units and delivery have not been responsive to Engineering and Technology student needs. These service taught units are important foundation subjects (including mathematics, computing, etc), but are not directly connected to 'engineering'[12]. This 'distance' from engineering is exacerbated by the fact that they are taught by staff from other Schools, use administration procedures from other Schools, use on-line support systems from other Schools, and may not be presented in an engineering context.

The modular nature of the School's units that provides flexibility to reconfigure programs and to offer single units into other programs, also leads to a lack of integration across programs[13]. Generally, units are developed and re-developed with nominal consideration of how they integrate with other units. Units tend to be designed to be 'stand-alone', so that they do not disadvantage students studying part-time or students taking the unit as part of another course.

The reality of the situation for the School is that Faculty policy compels it to accept service-taught units from other Schools in the Faculty into its programs where suitable units exist (the School is not permitted to offer units that 'compete' with other Schools), and, that its student body includes many individuals who will study part-time and/or in a sequence that departs from the ideal model course plan.

Method

In 2003, the Learning Resources Advisory Group (LRAG) of the Deakin University School of Engineering and Technology was requested to 'undertake a review of first-year units in the School's programs'. Having very limited resources (five members and 72 hours of collective time allocated to conduct its annual business) LRAG was not in the position of being able to conduct extensive new data collection, or to consider the entire 'first-year experience' of the students beyond their direct interface with the School. Until 2003, the School undertook its own end-of-semester evaluation of all units (the University has now centralised evaluation). The evaluation takes the form of an anonymous questionnaire delivered to all students that seeks information about the respondent's level of agreement with a number statements relating to both the content and the delivery of the unit. Additionally, the questionnaire invites respondents to add any comments they wish about the unit. The information contained in these written comments from the years 2000-2002 was used as the basis for analysing student perceptions of first-year units. Over the period 2000-2002 the total student enrolment in the identified first-year units was 2330, from which 908 completed end-of-semester unit evaluations were received, corresponding to a response rate of 39.0 percent.

The purpose of the investigation was not to identify concerns with particular units and/or academic staff, rather, to provide a general overview of students' perceptions and issues in their first-year studies in the School. The analysis of student perceptions was based on the written responses provided on the end of semester unit evaluations. As such, there were a number of limitations to the analysis that should be noted. It was not a representative sample of all enrolled students – only the responses from those students that made a written comment out of the group that completed the evaluation were included. It is possible that dissatisfied students would be more motivated to make a specific written comment than students that were generally satisfied with the unit, so written responses may be skewed toward being critical of the unit. The unit evaluation process did not collect any information outside the context of content and delivery of the individual unit – general information about the student's experience of their first-year of university life was not collected. The results presented are not quantitative – the report seeks only to identify the various issues raised by students, not their frequency of occurrence, correlation with a particular unit, or any other parametric statistic.

Results and Recommendations

With the limitations noted above in mind, the reported student comments were reviewed and collected into common themes. Based on an analysis of the reported student evaluation comments, recommendations regarding first-year units were made to the School Executive. The following section presents the students comments (in italics) and the corresponding recommendations.

1 – Relevance / context

Unit reported as boring/irrelevant.
Examples used in the unit were too abstract and not realistic/practical.
Tools/techniques used were outdated – no longer used in industry.
Objectives of the unit not explained.

More case studies and applications would help clarify concepts.
Some models or examples of items discussed would help students understand.
Outdated DOS-based software does not operate correctly on Windows computers.
Felt the unit presented formulae rather than explained concepts.
Need models to explain concepts.

First-year students, who may have a limited understanding of engineering practice, may find it difficult to appreciate the relevance of the content of a particular study unit. The objectives, context and relevance of all units should be explained explicitly as possible up front. The relevance of a unit could also be made more apparent by the inclusion of real examples/case studies of how the content relates to engineering practice at relevant points in the unit. Examples that are too abstract may hinder rather than help. Unit content, software and other associated resources need to be reviewed from time to time to ensure currency, accuracy, correct operation and relevance. The use of physical models may assist some students to visualize/ comprehend certain ideas/principles.

2 – Assessment criteria / feedback

Criteria against which assignments were marked were not clear before submission.
Assignments were not returned before the next one was due, so students were not able to incorporate feedback to improve the submissions.
Couldn't read handwritten comments on returned assignments.
Incorrect marking of assignments.
Extremely slow return of marked assignments.
Feedback on assignments was extremely critical and not very useful in understanding how to improve.
Assignment aims not clearly spelled out.
No feedback at all on some assignments.
Assignment requirements not given in enough detail / tasks not explained
Assignments were marked down on criteria that are not relevant to the real world.
Found it hard to relate the assignment questions to the study notes.
Felt assignments were marked too harshly.
Student felt that their subsequent treatment was harsh/unfair after disagreeing with lecturer in class.
Assignment submission instructions were ambiguous – unit guide said hardcopy submission, but on-line was really required.

All assessment should be against objective criteria. These criteria should be explicitly communicated to students as part of the requirements for the assessment activity. It should be clear to students how assessment tasks relate to the unit content. Assignments should have a formative (feedback/improvement) aspect, as well as a summative (grade-bearing) aspect. If the formative component is to be of any value to students, some feedback needs to be provided, and it needs to be returned to students in time so that it may be taken into account in their following assignment submissions. Where handwritten feedback is given to students it should be clearly legible. Where students' efforts are criticized, this should be done in a constructive and positive manner that provides information on how the student can improve their submission next time. Providing a clear explanation of any shortcomings will help avoid student perceptions that they are being dealt with harshly/unjustly.

3 – Textbook

Couldn't see the use/relevance of the textbook.
Inconsistency between the textbook, the course notes and the lectures.
References in notes to textbook were wrong.

Study guides did not match well with the textbook.
Textbook seems poorly organized.
Textbook too simple in contrast to difficult material presented in class.
Textbook was very poor, a discouragement to study.
Textbook was expensive, and only used in the last few weeks of class.
Study guides and textbook used different nomenclature causing confusion.
Textbook is very expensive.

The selected textbook is a crucial aspect of a unit. Textbooks are expensive for students, and it is important that where it is compulsory for students to purchase a textbook, that the textbook chosen offers good 'value'. Textbook value includes the cover price, readability, currency, integration with the other printed and classroom aspects of the unit, and what proportion of the semester the textbook is used for. If there is inconsistency (nomenclature, directions, facts, etc) between the textbook and the printed study notes and/or what is presented in lectures, then students are likely to be confused. The level of the textbook should be appropriate for a first-year unit and contain appropriate problems and worked solutions.

4 – Classroom teaching

Difficulty reading handwritten lecture notes.
Lectures always started 10 minutes late.
Course material was not all covered by the end of semester.
Difficultly hearing lecturer in class.
The classroom used was terrible.
Overheads were used, but not enough time was given for students to copy them down.
Explanations of material were not clear.
No opportunity to reflect on unit material.
Overheads were small and hard to read.
Material was covered too fast.
Tutorial groups were too large to be useful.
Couldn't understand the lecturer's accent.

Conduct of classroom teaching is crucial to student perceptions. If students are required to take notes from material written by hand in class, then the lecturer's handwriting needs to be clearly legible, and written notes or overheads need to be displayed for long enough for students to take down notes. If overheads are used, text and images on them need to be large enough to be read at the back of the classroom. Classes should start promptly on the hour; otherwise students feel they are wasting their time. Persistent late starts may lead to rushed presentation of material at the end of the semester and/or students arriving late to compensate for the tardiness of the lecturer. Students may experience difficulty hearing what is spoken by the lecturer in a large auditorium. Most large lecture rooms at Deakin have room amplification systems. Radio microphones for these rooms are available from the campus audiovisual services department.

5 – Lesson planning

Lecturer tended to get off the track.
Presentation of material in class didn't match the notes and was confusing.
Lecturer did not appear prepared for classes.
Much information repeated in both lecture and tutorials, duplication a waste of student time.
Tutorials just involved answering problems from the textbook, there was no extra help or material provided.

Anecdotes may be effectively used to illustrate key issues, but tangentially deviating from the class or unit objectives can be viewed by students as getting off the track or being ill-

prepared. Reviewing lecture objectives and key points prior to class can help the presentation appear more coherent and prepared. Presenting substantially the same information in lectures and tutorials may mean that students question the value in attending one or the other. While tutorials are a useful forum for trialling problems from the textbook or elsewhere, they should provide more to students than just practice of problem sets. Tutorial groups that are too large will defeat the intention of small group work.

6 – Timing / availability of materials

Class used a lot of overheads of material not in the study guides, and that students had no subsequent access to.
Late receipt of materials.
Class posted out extra materials for assignment that were not mentioned in the unit guide, causing confusion for students.
More support for off-campus students required – perhaps posting solutions to on-campus tutorial problems.
Some supplementary information required for assignments was provided too late to be of use.
Required supplementary material was posted on the website too late to use.
Off-campus students should be provided with model solutions to assignments.

Presentation of material across the semester that does not match the printed study notes may cause confusion. There is a need to consider how off-campus students will get access to any new information that is presented only in class. If on- and off-campus students study substantially different information, then the unit assessment must account for this. If on-campus students get access to worked solutions in tutorials, these worked solutions could also be made available to off-campus students via the unit web page. If supplementary information is to be mailed to off-campus students, then care must be taken to ensure it arrives in time to be useful, particularly for assignments.

7 – Practical work

Off-campus laboratory session was very rushed, leaving little time to comprehend the experiments.
Conflicting information for required report format in laboratory manual, notes given out in laboratory and information provided on the web page.
Laboratory work required material that had not yet been covered in class.
Poor explanation of the laboratory requirements made it difficult to get a good mark.
Too many students in laboratory classes/groups.
It was not possible to complete the practical sessions in the time allowed.
All laboratory work was done in one session, with a subsequent enormous write-up required in one go.
Material for laboratory sessions should be available beforehand, so students can be prepared and actually complete the laboratory work in the allotted time.

Practical sessions should allow enough time for students to complete the required work – this may include preparation, conducting the experiment and writing up. Consider allowing students to do the preparation and/or writing up in their own time. Rushed sessions will leave students little time to reflect on, and comprehend, what they are doing and learning. Off-campus practical sessions may be extremely rushed if students have to complete a number of laboratory activities in one day/session. Documentation and requirements for practical sessions contained in laboratory manuals, report guidelines, etc should be clear, and consistent between sources. Successful completion of practical sessions should not be contingent on unit material not yet covered in class. Practical class groups that are too large may make it difficult for individual students to actively participate and benefit. While it may

be efficient from a delivery perspective to complete all required practical work in one session, this leaves students with a large write-up task in one hit.

8 – Assessment weighting

Small weekly assignments (as given in maths units) were preferred to large assignments.
Allocation of marks for various assessment activities did not seem to correlate with the amount of work required for those activities.
Many assignments for different classes due at the same time.
Assignments were too hard and not explained well enough.
Not enough time between assignments.
Some areas of the unit were not covered in the assignments – only tested on the exam.

The apportioning of marks to assessment activities should correlate both with the size of the various assessment tasks and with the weighting given to the associated course content during the semester. Assignments that take a large amount of work to complete but carry little weighting of marks will be viewed as unfair. The timing of assessment tasks should be considered – a small number of large assignments may lead to a crisis-mode approach where students 'cram' just prior to due dates, and, at the other extreme, too many assignments may not leave enough time to adequately complete assignment tasks. Consider where unit content will be assessed – assessing parts of the syllabus only in the exam gives students limited opportunities to demonstrate their mastery of that topic.

9 – Study materials

No answers were available for the review questions.
No consistency between different course modules written by different authors.
Obvious mistakes in both the unit notes and the unit guide.
Lack of worked examples on both textbook and course notes.
First-year students are not professors – they need explanation at an appropriate level.
No answers given for questions in the study guides.
Too much prerequisite knowledge assumed.
Course notes were good, but did not explain the basics/fundamentals.

Where unit study notes have been developed over time by different authors, it is important to ensure some degree of consistency between the presentation styles used in the various study modules that comprise a unit. Unit study notes should be cautious in assuming the level of prior knowledge of students – it is important to ensure adequate coverage of fundamental concepts and provide explanations of formulae presented. Unit study notes should provide review questions to test students' knowledge of course material. Where the study notes do not contain answers to review questions, consider making these available via the unit web page. Students like to be reassured that they are getting the right answers to review questions. Suitable examples of typical problems with complete worked solutions should be included in unit study notes (and in class). Where feasible, students should be provided with access to model solutions to assignment questions.

10 – Off-campus sessions

An on-campus session for off-campus students would be of assistance.
An on-campus laboratory session would be better than software simulations.
Need laboratory classes.
Explanation of required laboratory work for off-campus students was poor.
Laboratory sessions available for off-campus students during the week are no help – they need to be on the weekend.

Many units in others areas of the University offer a weekend unit seminar session for off-

campus students. Many students reported that they would attend such a session and would prefer on-campus practical work, rather than software simulations. Such a session would not be suitable/feasible for all students, but may be possible for some units. Where off-campus students are required to perform practical work at their home location, the instructions provided should be clear and unambiguous.

11 – Communication with academic staff

Difficult to contact academic staff.
Long delays in getting a reply to messages left for academic staff.

Students, particularly off-campus students were frustrated by not being able to contact academic staff, and, when long delays were experienced in getting a reply to messages left for staff. Student expectations of staff availability and response times need to be managed. The unit web page can be used to provide details of when staff will be available for consultation and/or the expected turn-around time on messages. Where staff know they will be absent or otherwise unable to respond to student requests, they should make arrangement for someone else to handle student questions/requests.

12 – Tutors

Tutor didn't seem to be familiar with the course material.
Tutor did not turn up very often.
Tutor didn't know how to answer some questions.
Tutor gave wrong answer to some questions.
Tutor has poor communication skills.
Tutor was disorganized and couldn't keep to the topic/questions.

Where tutors are used to support academic staff in unit delivery, it is important that the tutor is appropriately qualified and experienced; is familiar with the course material; is familiar with the solution of the unit problems; is reliable in attending class; and knows how to conduct a class. Deakin now offers a paid professional development workshop for new sessional academic staff.

13 – Non-engineering students

Had difficulty with the mathematics required for the unit.
Aimed/pitched too high for non-engineering students
Could use supplementary resources for those students who don't have a background in the topic.
Unit was difficult for people without a chemistry background, even though chemistry is not a prerequisite.
Non-engineering students had difficulty with content of a unit service taught by the School.
Students experienced difficultly because they had no prior studies in the unit area.
Difficult to understand for someone without a physics background.
Non-engineering student couldn't see the relevance of the unit to their course.

Where units are taken by a number of (or predominantly) non-engineering students, then their backgrounds need to be considered in both the unit content and delivery. The aims of the unit need to be clearly identified, and this may necessitate content of a different style than normal. Teaching may require an explanation of the relevance of the unit and/or the presentation of fundamental concepts normally assumed to be known by engineering students. Supplemental resources could be supplied to allow students to do the ir own 'bridging' study.

14 – Computing and IT

Requirement for computer skills caused problems.

Software provided caused problems.
Problems caused by failure of on-line system.
Had trouble with off-campus Internet access.
Required software only available in engineering computer lab, and it is always booked out and/or busy.
As the use of computer-based resources and information technology move from being an optional element to a core requirement of courses, issues such as Internet access, network availability, software compatibility, software licensing, software distribution, and increasing student competition for access to limited computer laboratories will become crucial.

Discussion

It was noted that students also made many positive comments about the teaching and delivery in these units. This evaluation focused on concerns and problems noted by students, but this in no way devalues the reports of satisfaction and good teaching reported by students. In some circumstances, a wide diversity of student responses were found in the same unit evaluation, ranging from strongly positive to strongly negative. This perhaps reflects not only the subjective and individual nature of the student experience of study, but also the wide diversity of the first-year student population in terms of age, maturity, approach to study, independence and academic preparation[14]. However, if the School sets the entry requirements to its courses and then accepts a student into a course, then, within the bounds of the parameters that the School can control, it becomes incumbent upon the School to offer programs that cater for the subsequent variation in student backgrounds that are observed.

Some students made observations relating to issues beyond the control of an individual unit, such as problems with off-campus Internet access, sub-standard classrooms and the failure of Deakin's electronic communications systems. Also in this category were comments relating to the preparation of the students for study, including not having the required mathematics, physics or computing skills required, as well as student comments suggesting that units were duplicating material they had previously studied at secondary school. There were also issues raised that, while outside of the scope of individual units, relate to coordination between units in the School's programs, including apparent duplication of content between units and assignments for two or more units falling due at the same time.

Conclusions

In unit evaluations, Deakin University School of Engineering and Technology students reported a wide range of issues that impacted negatively on their perception of the content and conduct of first-year units. The wide variety of comments about content and delivery in the evaluations reflect the diverse student population, and, inherently, this diversity means that it will not be possible to satisfy all students all of the time. Based on the issues reported, a range of recommendations for the content and delivery of first-year units were made. It was noted that units service taught by other Schools form a significant element of the first-year of all of the Engineering and Technology undergraduate programs – typically 25 to 50 percent of the content. The significant influence of these units on the perceptions of the first-year of the School's commencing students means that the School should exercise some control over the content and delivery of these units.

It can be seen from the diversity of issues noted by students that many of them are not inherently related to first-year teaching, and it would be expected that many of the same issues are likely to apply to units in all years. There are many issues which impact on students during their first-year of study beyond the content and delivery of level one units. A

more wide-ranging and holistic review of the 'first-year experience' of Engineering and Technology students would need to consider inter-unit issues (such as timetabling, assignment due dates, and other scheduling issues), the impacts of other areas of the University on student life, and the changing personal circumstances of students, including the growing proportion of students that now undertake some form employment concurrent with their university study.

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