Improving student engagement through content and assessment choice in a common first year

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CONTEXT

Increased student engagement is an important factor in improving performance and retention rates of first year engineering students. Achieving this engagement can be challenging in first year units when dealing with large student numbers and a wide variety in student backgrounds. This issue becomes more difficult when the unit is part of a common first year within an engineering program that includes multiple traditional engineering disciplines. One approach to improve the relevance of studies and student interest is to allow more choice in both unit content and assessment topics while ensuring that the learning outcomes are the same for all students.

PURPOSE OR GOAL

This study examines student perception and performance in two units within a common first year engineering program that have taken different approaches in allowing the students greater choice in what they study. In one of the units students studied common content for most of the unit before choosing from a selection of wholly-online modules to study during the last three weeks. In the second unit assessment was based on a portfolio approach where students worked exclusively on a topic of their choice yet all assessment hurdles were common. In both cases the changes were made under the assumption that allowing students more control over the direction of their studies would improve the relevance of their degree to their future career and to ensure higher levels of engagement.

APPROACH

Student perceptions of the changes in teaching approach were assessed using standard unit feedback questionnaires as well as a survey designed specifically for one of the units. Surveys and questionnaires were given to students that had undertaken the unit both before and after the teaching changes were made, with responses analysed with respect to the students study mode (cloud or campus-based) and their intended discipline of study. Student performance in both units was also examined as a function of intended discipline of study to test the notion that students would perform better in units that more closely aligned to their intended discipline.

ACTUAL OR ANTICIPATED OUTCOMES

While part of an on-going study, initial responses suggest that students strongly preferred the changes for both units, in particular those intending to study a discipline where the traditional content was perceived as being less relevant.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

Early indications support that students appreciate and enjoy doing professional style practice from day one of their engineering education. By giving students the element of choice in their studies a sense of ownership is instilled early on and it is anticipated that this ownership will carry forward throughout subsequent learning.

KEYWORDS

Student engagement; assessment choice, first year engineering

Background

Increased student engagement is an important factor in improving performance and retention rates of first year engineering students. There are many studies and models that have examined contributing factors to student retention, including internal characteristics, such as entry-scores, demographic characteristics, and institutional reasons (Li, Swaminathan and Tang; 2009; Zhang, et.al, 2004; French, Immekus and Oakes, 2005)). While many issues related to individuals are beyond the control of Universities, there are a number of institutional ones, such as student engagement that can be heavily influenced by teaching practices. Kuh et.al. (2008) concluded that student engagement in educationally purposeful activities is positively related to academic outcomes based on first year grades and persistence to a second year of study. Felder, Felder and Dietz (2008) has also suggested that instructional methods can affect retention rates for engineering students.

Achieving this engagement can be challenging in first year units when dealing with large student numbers and a wide variety in student backgrounds; typically including high school leavers, mature age, international and domestic, on-campus and distance, as well as full and part time student combinations. This issue becomes more difficult when the unit is part of a common first year within an engineering program that includes multiple traditional engineering disciplines.

One approach to improve the relevance of studies and student interest is to allow more choice in both unit content and assessment topics while ensuring that the learning outcomes are the same for all students. Rust (2002) suggests that students are more likely to be interested and motivated if they have choice in the assessment tasks. Gibbs (1992) has also suggested that a surface learning approach is characteristic in course with a lack of opportunity to pursue subjects in depth and a lack of choice of subjects, rather than a deeper learning approach.

Purpose

Students in the School of Engineering at Deakin University study eight common first-year units before moving into one of four specific engineering disciplines at the second-year level; civil, electrical, mechanical or mechatronics. Students typically have a wide range of engineering-related interests due to this difference in intended engineering discipline, and may naturally find content in the first-year more or less appealing based on alignment with those interests. There exists an opportunity to vary content (both taught and assessment topics) based on students interests without varying the learning outcomes associated with any of the units or assessment tasks.

This study investigates the response of first-year students to two different approaches used in common first year units that have been designed to allow more student choice into both content and assessment topics. The two approaches have been trialled in different units (‘Engineering Materials’ and ‘Engineering Graphics and CAD’) to determine the student’s reaction to both gaining significantly more control over what they study, as well as the manner that this control is given.

Design/Methodology

Outline of unit changes – Engineering Materials

The approach in the first year materials unit was to reduce the content traditionally taught by three weeks. Thus a strong focus was put onto the material properties and types of materials

that were considered vital for all engineers to understand. The extra three weeks were then replaced with several specialist modules based on research-active material topics that were each considered to be of highly interest or appeal. In addition, the breadth of topics were selected to ensure that there was at least some relevance to each of the four engineering disciplines at Deakin. Students were allowed to enrol into the specialist module of their choice based after being given access to introductory videos of what they were about, and then studied the module wholly online (i.e. no face to face classes).

Within each module, students are also given a choice of assignment topics. The specific learning outcome associated with the assessment task was *"communicate the outcomes of research into the use of engineering materials in specific applications"* in addition to the overarching learning outcome *"explain how the structure of materials determine their mechanical and functional properties"*. Video lectures, readings and website links were used to point students to the content they needed to understand the fundamental concepts relevant to the elective module, with an understanding of that content necessary to be demonstrated in their assignments. Online tutorials were run within each module every week to allow the students the opportunity to discuss the provided content. The learning outcomes and assignment requirements were identical for each module and assignment topic. The elective modules available were:

- Biomaterials
- Functional materials (emphasis on materials for energy storage)
- Sustainable and green materials (recycling and the use of recycled materials)
- Alternative materials (the use of biomimicry in developing materials)

Table 1 shows a summary of the changes made to the unit. It should be noted that there were also several other changes to the unit as well as the introduction of these modules. These changes included the unit approach in terms of unit delivery and assessment task being adjusted from science-first to design-based.

Table 1 – Outline of changes for the Engineering Materials unit

	Old unit version	**New unit version**
Course outline	This unit includes the following topics: the basic structure of solids; crystal structures and imperfections; testing and application of materials; overview of metals and polymers, basic engineering properties of materials.	This unit covers the main classes of materials, their basic structure and the way in which the structure determines their mechanical and functional properties. Case-studies will be used to highlight the basis for selecting a material and how the structure can be manipulated to improve performance in specific applications. The unit will also introduce students to research processes through independent learning activities associated with engineering materials.
Contact hours	• 3 x 1 hour lectures • 1 x 1 hour tutorial per week, • 3 x 3 hour practicals per trimester	Weeks 1 to 8 and 12: • 3 x 1 hr per week (lecture/demonstration class) • 1 x 1 hr tutorial per week Weeks 9 to 11: on-line elective module
Assessment	• examination 60% • two problem-based assignments (10% each) • practical exercises 20%	• design-based assignment 25% • literature research assignment 25% • examination 50%

Outline of unit changes - Engineering Graphics and CAD

The first-year Engineering graphics and CAD (computer aided design) unit was also restructured to cater for the range of student interests and intended engineering disciplines, as well as for the contrasting CAD software requirements at later year levels by the different disciplines within the School. Students were required to choose something to design that was either of interest to them or relevant to their intended discipline of study (ideally both). The focus of the unit also changed from teaching engineering graphics, CAD tools and drawing standards and conventions, to teaching design philosophies and strategies. Thus students were required to use CAD software, standards, etc. in their assessment tasks without them being explicitly taught with the unit. Students were able to develop the CAD model for their design using any software package available to them, with assistance provided in using the software by tutors during tutorial/workshop contact hours. The specific learning out comes that the assessment was based on are *"Articulate the exchange of graphical and digital information"* and *"Apply modelling techniques via the use of computer programs and applications to build virtual designs".* A comparison between the new and old version on how the learning outcomes were achieve can be found in Table 2.

Table 2 – Outline of changes for the Engineering Graphics and CAD unit

	Old unit version	**New unit version**
Course outline	Topics covered: • Intro to Engineering Design • Planar and pictorial views • Multi, Auxillary and Section Views • Drafting conventions and standards • GD&T • CAD Theory	Topics covered: • Design Concepts • User Centred Design • Design for X • FMEA • Drawing conventions and standards / GD&T • Design and communication strategies •
Contact hours	Every week • 1 x 1 hour lectures • 1 x 1 hour tutorial • 1 x 3 hour practicals	Every week • 1 x 1 hour Lecture • 1 x 1 hour formative feedback session • 1 x 3 hour workshop
Assessment	4 X 25% assignments • Ass 1 – AutoCAD 2D drawing • Ass 2 – Engineering Drawing • Ass 3 – Solidworks basic modelling • Ass 4 – Multi-choice Quiz on drawing/modelling conventions	100% portfolio assessment incorporating eight major tasks • Idea/Concept Sketch • Mind Map • Information Sketches • 2D Engineering Drawings • 3D CAD models • Info-Graphic • Product Story Board • Rendered CAD models

Student assessment of changes

Deakin University has a standard student feedback questionnaire and rating system (SETU) that is used to evaluate all units that are taught in the University. Students are asked to rate the unit based on ten different questions (see Appendix) using a 5

to 1 rating (strongly agree, agree, neutral, disagree, strongly disagree). The questionnaire also asks them to identify the best aspect of the unit, and the worst aspect on the unit. The best/worst aspect comments were used to identify any trends in responses that related directly to the unit changes associated with allowing them more choice. While interpretation of the rating scores from evaluation tools such as this can be extremely difficult (as there is no opportunity to establish the reasons behind the scores given by the students, which can vary significantly), they do provide a rudimentary measure of student satisfaction with the unit.

A survey, partially shown in Table 3, was also developed to assist in gauging the perception of students as to how interesting and relevant the content in Engineering Materials was to them. Surveys were given to two groups of students; one group that completed the unit during the third trimester using the previous unit structure (without the elective modules), and a second group that completed the unit the following year during the second trimester using the new unit structure (with the elective modules).

Table 3 – Survey questions for the Engineering Materials unit

Quantitative questions	**Qualitative questions**
How high would you rate the relevance to your intended engineering discipline (very high, high, moderate, low)	What was the most interesting aspect of Engineering Materials?
How interesting would you rate the content in this unit? (very high, high, moderate, low)	Please list any advantages and disadvantages of the elective module*

* This question was only relevant to the students that undertook the new version of the unit.

Results

Engineering Materials

SETU data shown in Figure 1 for Engineering materials show a significant increase in the average score for the unit after the changes had been implemented. The average number of responses for each offering were approximately 50 to 60. Scores were significantly higher for all of the individual ten questions in the new offering of the unit relative to the previous offerings. In addition, the score for the new offering was higher than the University average.

SETU scores only give an indication of student satisfaction, and despite the individual questions asked, they are not necessarily easily attributable to specific aspects of the unit. There were a number of changes made to the unit in addition to the introduction of the elective modules, hence no conclusions can be made that the improvement in feedback scores is related directly to the elective modules and hence the introduction of choice. These other changes included the unit teaching team, approach (design-based rather than science-first), learning outcomes and assessment type.

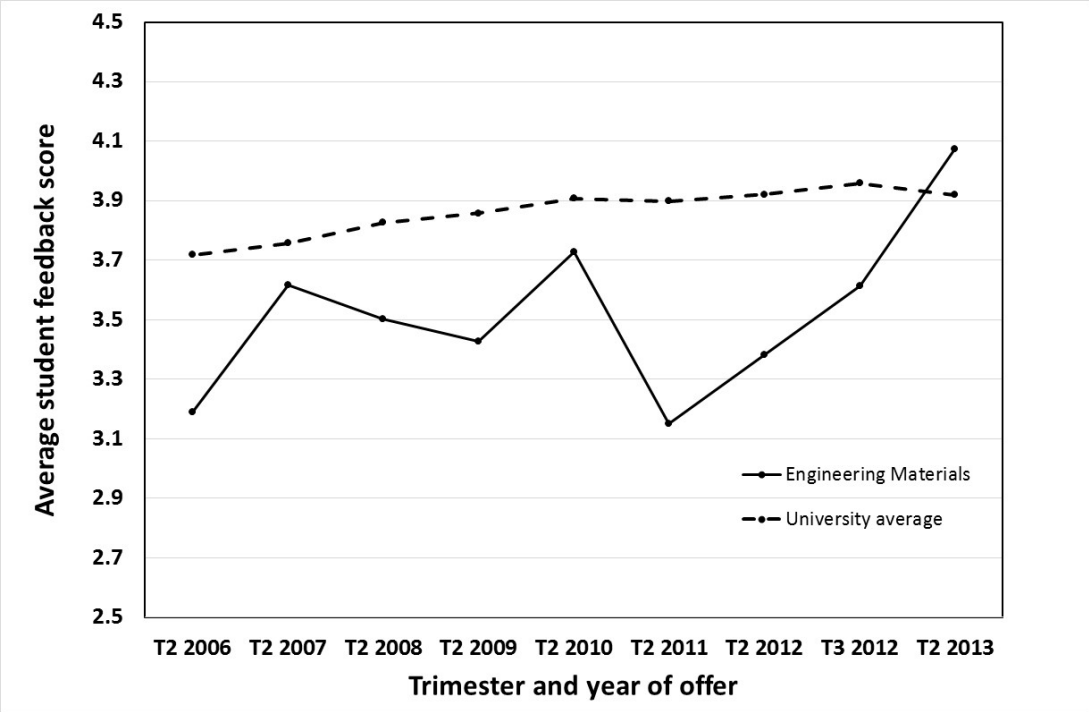

Figure 1 – Average score for the ten standard student feedback questions for each offering of the Engineering materials unit since 2006

Another form of feedback collected were the questions of the best/worst aspect of each unit. While these questions didn't specifically ask students regarding their opinion of the elements of choice added to the unit, the presence of comments specifically related to the changes can indicate their perception.

There were 20 respondents to each question relating to 'best aspect' and the 'worst aspect' of the unit for the new offering of the unit (that contained the elective modules), with three direct comments that stated the elective modules were the best aspect. While this proportion seems rather low, it does not indicate that the students did not appreciate the elective modules, only that they weren't the 'best' aspect. There were also three direct comments that the elective modules were the worst aspect of the unit. One of these comments was due to large amount of content in the elective module, while the other two were specifically to do with how the content was organised in one of the modules. The three comments regarding the elective modules as the 'worst' aspect of the unit was not unanticipated, as there were some difficulties in completing the video content for one of the elective modules in time for the offering of the unit.

Survey data for the two student groups that completed the unit immediately before and after the changes to the unit were implemented show several interesting results. 19 students responded for the new offering (with the elective modules), while 9 students responded for the previous offering. A similar percentage of respondents in each offering suggested that the course content had a 'very high' relevance (~20 %) to their intended discipline of study, while a higher percentage responded that the unit had a 'high' relevance for the new offering compared to the previous offering (60% versus 40%). Thus 80% of respondents from the new offering had a 'very high' or 'high' perception of relevance compared to 60% for the previous offering. For the question regarding how interesting students found the content, similarly 20% in both offerings found the content to be 'very high', while for the new offering

50% responded ‘high’ compared to 20% from the previous offering (thus the total ‘very high’ and ‘high’ was 70% for the new offering compared to 40%).

In response to the survey question regarding the most interesting aspect of the unit, 6 of the 19 students for the new offering responded that their elective module was, while a further 5 had a more generic answer regarding understanding how to control material properties that is relevant to both the core content and the elective modules.

The advantages and disadvantages listed by the students regarding the elective modules show several interesting results:

- 6 students specifically responded that the freedom to choose was an advantage
- 8 students responded that either the accessibility or flexibility in the modules being wholly online was an advantage
- 7 students responded that the lack of formal classes or no face-to-face with the lecturers was a disadvantage

The results of the standard university feedback system and specific survey suggested that the elective modules have contributed to both a higher student perception of how interesting and relevant the content is, and a higher overall satisfaction with the unit. However, it also appears that while online tutorials were run during the 3 weeks of the elective module, these is significant opportunity to better engage the students during that period as well improving the quality, organisation and quantity of online content within each module.

Design unit

Student feedback and evaluation data for the design and CAD unit were only tracked for the past two offerings as significant changes had been made to the content before that. There was no noticeable change in relation to the average SETU score, with both units obtaining just over 3.6. It should be noted, however, that two of the questions showed a significant decline in the new offering. The two questions with lower SETU scores were related to whether the ‘technologies performed satisfactorily’ and the ‘online teaching resources enhanced the learning experience’. It is believed that both of these declines were related to technology issues for distance students; firstly the poor performance of the remote server set up to run the various CAD software, and secondly, the online tutorial rooms proved unable to run the tutorial/workshops in the manner designed by the teaching team. For all other questions there was a slight improvement in SETU score.

The output (portfolio) of the students showed a significant increase in their capabilities using the software relative to the previous offering. This can be put down to several aspects, firstly students selected their own product to design, and there was an emotional investment in the outcome. Also in previous iterations of this subject all students learnt both AutoCAD and Solidworks, thus results only in limited time in each suite. In the current iteration students used only one CAD suite for the unit, thus became more familiar with its capabilities. Students were also asked to present technical information in various forms such as powerpoint, illustrator etc thus augmenting digital information and communicating on different levels and for different audiences and expanding on one of the learning outcomes.

From the student evaluations comments in the new offering, 11 of 46 comments directly spoke about the ability to choose and develop their own design in the “best aspects” of the unit. Only two of 56 comments from “worst aspects” did not like the freedom of choice; the vast majority of the “worst aspect” comments was due to IT issues. In the new offering a “virtual desktop” and expanded “virtual classroom” was introduced to allow all students to use any software (AutoCAD or Solidworks) on any OS platform (Windows, Android, Linux

and Mac). Unfortunately there was issue as the student uptake was larger and servers systems were not able to handle the load.

Conclusions

While more data is currently being collected in relation to this investigation into whether student choice in first year units improves their interest levels and their perception of the unit's relevance to their intended discipline of study, preliminary student feedback and survey data collected in this study suggests that;

- The changes related to content and assessment topic choice in the first year materials unit have likely contributed to an increased student satisfaction and interest in the unit content, as well as in increasing their perception of the relevance of the content to their intended engineering discipline
- The changes in the Engineering graphics and CAD unit have led to improved student outcomes in relation to command of the software and communication techniques in an engineering environment, as well as anecdotally a greater satisfaction and engagement within the unit.

References

Felder, R.M., Felder, G.N., & Dietz, E.J. (1998). A Longitudinal Study of Engineering Student Performance and Retention. *Journal of Engineering Education*, 87(4), 469-480.

French, B.F., Immekus, J.C., & Oakes, W.C. (2005). An Examination of Indicators of Engineering Students Success and Persistence. *Journal of Engineering Education*, 94(4), 419-425.

Gibbs, G. (1992). *Improving the Quality of Student Learning*. Bristol: Technical and Educational Services

Kuh, G.D., Cruce, T.M., Shoup, R., Kinzie, J., & Gonyea, R.M. (2008) Unmasking the Effects of Student Engagement on First-Year College Grades and Persistence. *The Journal of Higher Education*. 79(5), 540-563

Li, Q., Swaminathan, H., & Tang, J. (2009). Development of a Classification System for Engineering Students Characteristics Affecting College Enrolment and Retention. *Journal of Engineering Education*, 98(4), 361-376.

Rust, C. (2002). The impact of assessment on Student Learning. *Active Learning in Higher Education*, *3*(2), 145-158.

Zhang, G., Anderson, T.J., Ohland, M.W., & Thorndyke, B.R. (2004). Identifying Factors Influencing Engineering Student Graduation: A Longitudinal and Cross-Institutional Study. *Journal of Engineering Education*, 93(4), 313-320.

Appendix – Standard student evaluation questions (SETU)

1. This unit was well taught
2. The course materials in this unit were of high quality
3. The workload in this unit was manageable
4. Requirements for completing the assessment tasks in this unit were clear
5. The teaching staff gave me helpful feedback
6. The library resources met my needs for this unit
7. I would recommend this unit to other students
8. The technologies used to deliver the online content in this unit performed satisfactorily
9. The on-line teaching and resources in this unit enhanced my learning experience
10. This unit challenged me to learn