Masters of 'Decision Making' – Online Delivery

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CONTEXT

The three core-engineering units of Southern Cross University's (SCU) Masters of Engineering Management (MEM) deal with complex, uncertain and rapidly developing bodies of knowledge, placing a priority on preparing students to make better decisions (manage) in this context. Previous experience (Heldt & Black, 1997) presenting (conventional) courses that require a strong understanding of context, associated uncertainty, synthesis of ideas and non-numeric decision making illustrated the value of:

1. Engagement of students in simulated situations;
2. Framework/reference material describing key concepts;
3. An interactive collegiate learning environment including reflective learning of both individual and class learning outcomes.

PURPOSE

This paper outlines how the approaches described by Heldt & Black (1997) have been applied to the inaugural MEM units in its first offering in 2016. The paper is aimed at providing insight on how this method of on-line teaching is able to impart knowledge and understanding of these core units to the students, providing them with the skills and confidence to make decisions in practice.

APPROACH

An approach similar to that used previously was adopted for these units, however the on-line environment provided both challenges and opportunities in presenting the unit. This method of teaching was designed to provide students with a practical understanding of the unit body of knowledge and exposure to decision making tools and processes, such that they are well equipped and confident to engage in decision making in the respective units.

The paper explores how the unit incorporated engagement of students in simulated situations with framework material describing key concepts and an interactive collegiate learning environment including reflective learning and development of supporting online tools and techniques.
With more than 50% of the same student cohort being completing the asset management unit following on to take subsequent units, there was an opportunity to examine how students have adapted to this method of learning.

RESULTS

The experience has shown that this mode of delivery has enabled an effective learning experience for the students while enabling greater access for students who have very busy careers. As a result this access for a diversity of students has enabled a richness of peer discussion that would be hard to achieve in a face to face mode.

CONCLUSIONS

This mode of delivery effectively engages students in an online environment, enabling students that are very busy and not otherwise able to engage in postgraduate learning to enrich their knowledge in a learning environment that is inclusive of rich peer discussion. This is enabling the student with skills needed to communicate within their professions, apply techniques and make decisions in areas that are at the forefront of engineering management thinking today.

KEYWORDS

On-line delivery, role play, reflective learning, decision making.

Introduction

Southern Cross University (SCU) has introduced a Masters of Engineering Management (MEM) online degree programme combining both business and engineering specific subjects. Content for the engineering subjects was relatively well defined in the course design, however there was a desire to make these subjects as relevant and challenging as possible (and therefore attractive) to students, most of whom are practising professionals.

As the first MEM units to be developed, a methodology had to be designed to deliver the course objectives. This paper discusses:

1. Background considerations for delivery methodology;
2. An overview of the units to be delivered;
3. The delivery methodology including underlying pedagogy;
4. The results achieved in inaugural unit delivery;
5. Learning's and improvements for future implementation

Background

SCU's MEM on line degree programme, is based on the following inaugural engineering units:

- Strategic Infrastructure Asset Management;
- Engineering for a Sustainable Future;
- Stakeholder Engagement.

All three units deal with complex, context specific, rapidly developing bodies of knowledge with inherent uncertainty. The SCU course places a priority on preparing students to make better decisions (manage) rather than simply gain an awareness of the body of knowledge.

Previous experience (Heldt & Black, 1997) presenting (face to face) courses that require a strong understanding of context, associated uncertainty, synthesis of ideas and non-numeric decision making illustrated the value of:

- Engagement of students in simulated situations;
- Framework material describing key concepts;
- An interactive collegiate learning environment including reflective learning of both individual and class learning outcomes.

The context for this previous work was the final year design subject for a civil engineering degree. In that case, the objective was to educate students about the design process, beginning with pre-concept (political) stakeholder directions, through to detailed design of components, with practical illustration of how the application of design principles (focusing on decision making) varies depending on the level of design maturity. The delivery strategy was to place small student groups in a range of contexts throughout a realistic (design) context, and have students:

1. Make their own (small group) decisions;
2. Critique the decisions of the class cohort (posed with the same questions);
3. Reflect on their own decisions and decision making processes, considering reference/framework documents on design processes and decision making;
4. Reflect (with the benefit of hind sight) on their earlier decisions, with a focus on the most important decision drivers;
5. Come to an understanding that multiple valid solutions can exist in response to a design question, and that underlying stakeholder requirements substantially determine the most appropriate solution.

This approach deliberately de-emphasised "design training", as this was considered a barrier to the design education process.

The most important education tools were:

- Interactions between students, either in small groups as they developed their team solutions, or as they debated the merits of various solutions between groups;
- Reflection on the merits of various options, and the decision processes used to develop them – without having to "rework" the solution calculations.

Face-to-face engagement between students and staff was an essential component of the education process in this previous work.

The objective of the new MEM units was similar to the previous work, however there were a number of significant differences (challenges/opportunities), in particular:

- With an on-line delivery mode, there was no opportunity for face to engagement between students and staff;
- Being a post graduate course, the student body contains even more valuable resources than an undergraduate course – particularly since different industry sectors (commercial, resources, energy, local government) are naturally represented;
- The body of knowledge for the various topics is less well established (and rapidly developing) than engineering design processes and is (arguably) more context sensitive than the engineering design process.

Overview of MEM Units

The content for presentation in the SCU MEM programme is important to place the pedagogy in context.

'Strategic Infrastructure Asset Management', together with two subsequent units of 'Engineering for a Sustainable Future' and 'Stakeholder Engagement' are delivering 'body of knowledge' content areas which are both very new and still developing within the industry.

Strategic Infrastructure Asset Management

The scope of the unit is on strategic asset management issues and current application of key principles in various industry sectors. Focus is placed on the interfaces between the key discipline areas which effective asset management must integrate, including:

- Planning;
- Accounting and finance;
- Capital projects;
- Operations;
- Maintenance;

A suite of international standards (ISO 55000 series) have been published covering asset management, forming an underpinning framework (specification) for the discipline (and this unit). However they are not (on their own) readily used as a framework for implementing the principles in a typical organisation.

The Institute of Public Works Engineers Australia (IPWEA) has developed an asset management manual and associated support materials over a number of years. Most recently, this has been published as the International Infrastructure Management Manual (IIMM). This document is aligned and consistent with the ISO standards, but forms a much more usable framework for application to organisations. The IPWEA have also published a companion Australian Infrastructure Financial Management Manual (AIFMM) dealing with financial management. Together these two documents form a comprehensive readily applied body of knowledge directly applicable to local government, and they also provide a usable framework for the unit based on AS ISO standards.

Since Asset Management is also context (industry sector and specific organisation) dependent, students must also become broadly familiar with the factors influencing how the above principles are applied in different contexts.

Engineering for a Sustainable Future

The objective of the unit is to challenge students to engage in a wide range of emerging social, environmental and economic aspects for sustainable futures in engineering management. A key learning is that engineered systems do not exist in a vacuum. They instead exist in a physical place, and use physical and financial resources. This has a multitude of effects which can be positive or negative. By occupying a physical space, engineered systems can both interfere with ecological systems and affect communities in or near that space becoming entangled with stakeholder values. Innovations in sustainable technologies are introduced in addition to decision making strategies and case studies across various industry sectors.

Stakeholder Engagement

Different contexts for stakeholder engagement are explored, putting the student into the various roles through a scenario exercise as the unit progresses. This has included the publics and other external stakeholders through to the vertical and horizontal relationships necessary amongst stakeholders internal to the project continues into a fourth context which can cut across all of the contexts explored in earlier weeks. Stakeholder engagement in the virtual delivery team is a new and growing reality for all projects and operation of engineering systems in today's world.

Pedagogy

Pedagogy for the unit was based on:

1. The ability for student to identify and make good decisions in a complex conflicting (subject specific) context being the key desirable outcome;
2. Achieving (1) requires access to best practice framework and or knowledge base;
3. Decision making education can be effective achieved by;
    a. posing questions to the student body (specific context), and requiring them to respond in accordance with a specified role (in context);
    b. having students engage with (2) to prepare and present decisions;
    c. providing feedback on decision validity;
    d. providing an understanding of alternative decisions under the same circumstances, and their relative merits (approaches taken by others to the same scenario);
    e. requiring individual student reflection on (a) to (d);
4. Ensuring that a range of questions are posed to students for them to gain an understanding of breadth and relative importance of key issues.

Methodology

The first unit to be developed was Strategic Infrastructure Asset Management, and this unit was presented in early 2016. Development of the unit delivery methodology was an iterative collaboration between SCU and Keypath staff, and involved:

1. A proposed methodology (including underlying pedagogy);
2. Review of this methodology in the light of on-line tool capability;
3. Exploration of how on-line tools could provide additional opportunities in delivery;
4. Identification of methodology "challenges" based on current on-line practice;
5. Propose an adjusted methodology and return to (1).

Three iterations were required to converge on the actual delivery concept, with only minor variations were required during subsequent implemented. The underlying pedagogy did not substantially change during this development process.

The unit presentation is relatively concentrated, with students expected to complete a single unit in 7 weeks (with no other units being studied). This type of delivery provides a strong focus for the unit, but little opportunity for "recovery" should a student miss key concepts. The actual delivery methodology is summarised in Table 1, with key elements being (shaded green):

1. The underlying framework introduced to students in week 1 providing structured content to facilitate understanding of the topics covered in unit activities and includes;
    a. AS ISO Standards;
    b. Infrastructure management;
    c. Financial management;
2. Role play via a scenario – where students are required to make weekly decisions in a simulated context. One week represents one year in the scenario, and the scenario context changes each week – introducing new challenges that are dependent on the original student choices (nominal student solution strategies diverge over time);
3. A number of key challenges for profession are introduced to students, with students required to develop their own solutions to these challenges in the context of specific roles.

<table>
<tr><td></td><td>Week 1</td><td>Week 2</td><td>Week 3</td><td>Week 4</td><td>Week 5</td><td>Week 6</td><td>Week 7</td></tr>
<tr><td>Content</td><td colspan="6">Web based content providing a weekly focus on specific material</td><td rowspan="8">Final assessment, particularly scenario conclusion and reflection, and final class challenge</td></tr>
<tr><td>References</td><td colspan="2">AS ISO Standards</td><td colspan="2">Infrastructure Management</td><td colspan="2">Financial Management</td></tr>
<tr><td>Scenario</td><td colspan="6">Context modified each week, with each representing 1 year
Decisions required each week
Decision output reviewed each week</td></tr>
<tr><td>Class Challenge</td><td>CC1 posed</td><td>CC2 posed</td><td>CC3 posed</td><td></td><td></td><td></td></tr>
<tr><td>Webinar</td><td colspan="6">Weekly presentation/discussion on pertinent issues, opportunity for debate and questioning, and presentation by industry practitioners</td></tr>
<tr><td>Discussion board</td><td colspan="6">Communal on-line debates about key issues and questions</td></tr>
<tr><td>Assessment</td><td></td><td>Quiz 1</td><td></td><td>Quiz 2</td><td>CC1&2 submit</td><td>Quiz 3</td></tr>
</table>

Table 1. Summary delivery methodology for strategic infrastructure asset management

The content (white in **Table 1**) provides a "navigating narrative" to link concepts and activities. The core information (shaded green in **Table 1**) provides the primary material that students must interact with. Student community support is provided for this interaction (shaded grey in **Table 1**), while student output is shaded yellow. Combined, this approach provides:

- State of the art (industry) content underpinning basis of learning;
- Exposure of students to specific (changing) context in which they must make decisions with limited information;
- An understanding of key current questions that the industry is addressing.

The result is a challenging, multi-faceted learning environment that simulates (to some extent) the challenges faced by practitioners in the field.

Tools provided to support students in their learning, include:

1. Weekly focussed content that students work through in their own time providing additional focus on key questions such as
    a. Why assets?
    b. Why systems & tools?
    c. Key issues and enablers;
    d. Resourcing aspirations;
    e. Asset management in different contexts;
2. Weekly webinar that begins with interactive discussion aligned with (1), but also includes perspectives from a number of industry practitioners operating in different contexts, and provides students with the opportunity to ask questions and debate specific issues and concerns;
3. Discussion boards (web based) that allow students to debate questions and pose solutions with their peers. This also provides an opportunity for students to share their own experiences and perspectives, maximising the use of this valuable resource.

An underlying principle of this methodology is that students must have time to explore solution and debate ideas before preparing their final submissions. Subsequently, they also have the opportunity to critique the solutions of fellow students and reflect on the learning's that result from their own and other student experiences.

Assessment of the unit is closely aligned with the delivery methodology and consists of:

1. Multiple choice quizzes (with limited grade value) that foster detailed familiarity with the framework/reference material;
2. Written solutions to some of the key questions confronting practitioners;
3. Simulated decision making in changing context with written reflection and critique of the results.

While the asset management discipline is still undergoing significant development, completing students will be "current" with the existing body of professional knowledge and more comfortable to lead strategic asset management decision making in the context of an organisation. The subsequent units, of Engineering for a Sustainable Future and Stakeholder Engagement, do not have the benefit of somewhat developed and homogenised practice body of knowledge (e.g. Standards and IPWEA manual), so the above methodology had to be adjusted.

Engineering for a Sustainable Future adjustments

The approach to frameworks and methodologies in this unit differs from that used in Strategic Infrastructure Asset Management unit, a key difference being to expose the student to the wide range and emerging nature of these and making the student aware that there is less clarity at this point in time on a standard approach. In the first two weeks, the student is encouraged to familiarise themselves with the high level sustainability approaches and make choices on which to apply, reflect on why they have selected that approach and apply it to specific challenge exercises that stretch their thinking. The student is then taken on a journey from early preconcept strategic thinking in week 1, progressively focusing down the life cycle stage of engineering systems and the considerations that are important at each stage in the journey.

As for the Strategic Infrastructure Asset Management unit, a scenario activity is used, to provide students the opportunity to make a series of decisions at differing points in this unit being at different points in the life cycle of an engineering system. The initial objective of this scenario is to allow students to identify the real life stakeholders and explore the application

of different frameworks. As the unit progresses the student role changes from a role of advisor to the minister to that of the strategic planning manager for the system and then later to that of the engineering manager overseeing design and delivery. Similarly, each week the students receive a change in the scenario parameters and in this case need to respond according to the role, making decisions that they believe are the best for the sustainability outcomes.

Stakeholder Engagement adjustments

The approach taken with this unit was to firstly expose the students to the challenges an engineering manager may face, by viewing a controversial project and engagement example, getting the student to think about what if I were in that position, what would I do. Students were then taken through a journey over following weeks that provided a range of strategies and tools for engagement on the four perspectives ranging from community to internal project team engagement. In each case the facilitators used their own wide practical industry knowledge to develop the students understanding and application. The scenario remained a crucial part of the approach along with a number of class challenges.

Results

Early results from all three units have been very positive. The feedback results for each of the three units' first offerings are summarised in Figure1, 2 & 3 relative to the university average.

Figure 1. Strategic infrastructure asset management (student feedback)

Figure 2. Engineering for a sustainable future (student feedback)

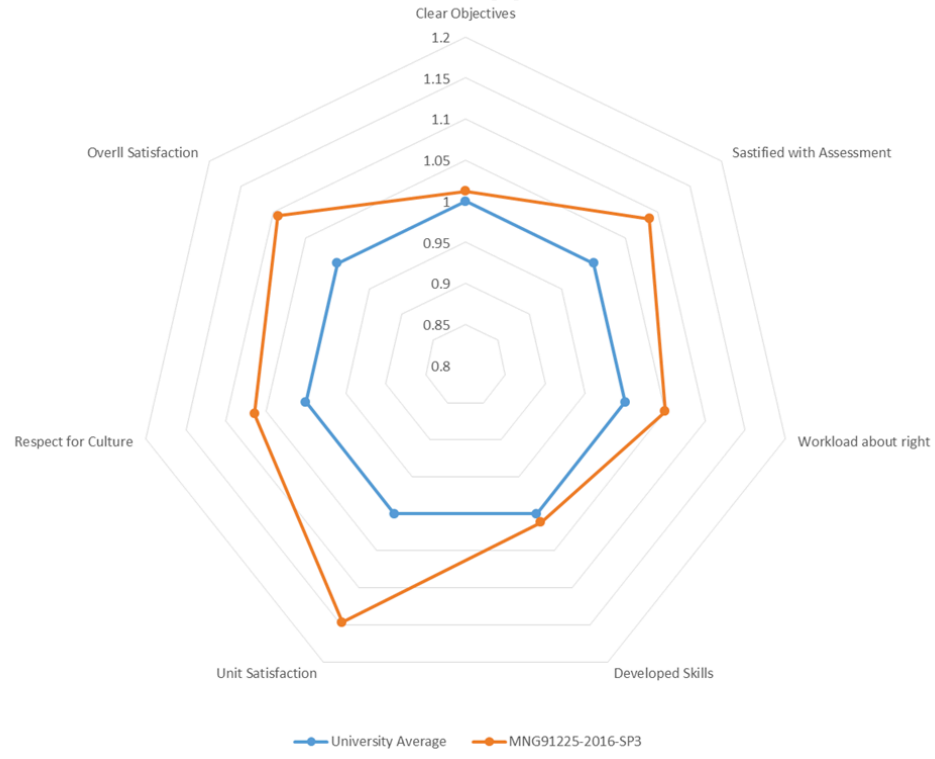

Figure 3. Stakeholder engagement (student feedback)

The student feedback sample size in each of these charts represents in the order of 20% to 30% of students in the units. It can be observed from the charts that the unit with the clearest objectives is Strategic Asset Management. This is not unexpected and may reflect the greater clarity in framework and methodology compared to the emerging variety of frameworks in the other two units. Engineering for a Sustainable Future has a lesser satisfaction with assessment, which upon reflection was due to confusion on assessments that included overlapping with the one case study.

The perception of a too high a workload, appears to reflect the intensity of the compressed units which only run for 7 weeks in combination with assessments which are stretching students out of their comfort zones. However, students in all three units have indicated their satisfaction with the units is higher than the university average. In the words of one student: "I think this course is going to challenge the way in which I have become accustomed to thinking, which cannot be a bad thing."

A common success factor in all the units was the importance of peer discussion in formal discussion boards, discussion points throughout the narrative and the weekly Q&A webinar. As the units progressed the teaching team become aware of the need to reinforce with students that the success of their learning experience depended on them engaging effectively with each other and with the teaching team on a peer to peer level, willingness to make decisions based on a considered assessment of the frameworks, methodologies and contexts in an environment where they may not be any one correct approach, and be able to explain the reasons for their decisions. Furthermore, as the depth of their understanding grows along the journey and contexts change, they needed to be able to be reflective and make changes to their earlier decisions if needed.

The experience of these three units has shown that this mode of delivery has enabled an effective learning experience for the students while enabling greater access for students who have very busy careers. As a result this access for a diversity of students has enabled a richness of peer discussion that would be hard to achieve in a face to face mode.

For the teaching team, management of each unit has been enhanced by the development of a number of tools by Keypath to help with the operational challenges in a compressed 7 week time frame. The emphasis on and importance of peer to peer discussions in the online environment has generated a need for tools to enable the teaching team to efficiently keep on top of the discussion and to help in facilitation of discussions each week. The tools below were progressively developed and deployed over the course of this first year. The tool shown in Figure 4 enables the teaching team to filter post content by unit, week, and drill down to specific discussion points and even students to see the list of discussion posts of interest. While this does not replace viewing the discussion in the context of the learning platform, it has helped greatly in assessment or in specific queries we need to answer during the management of the unit.

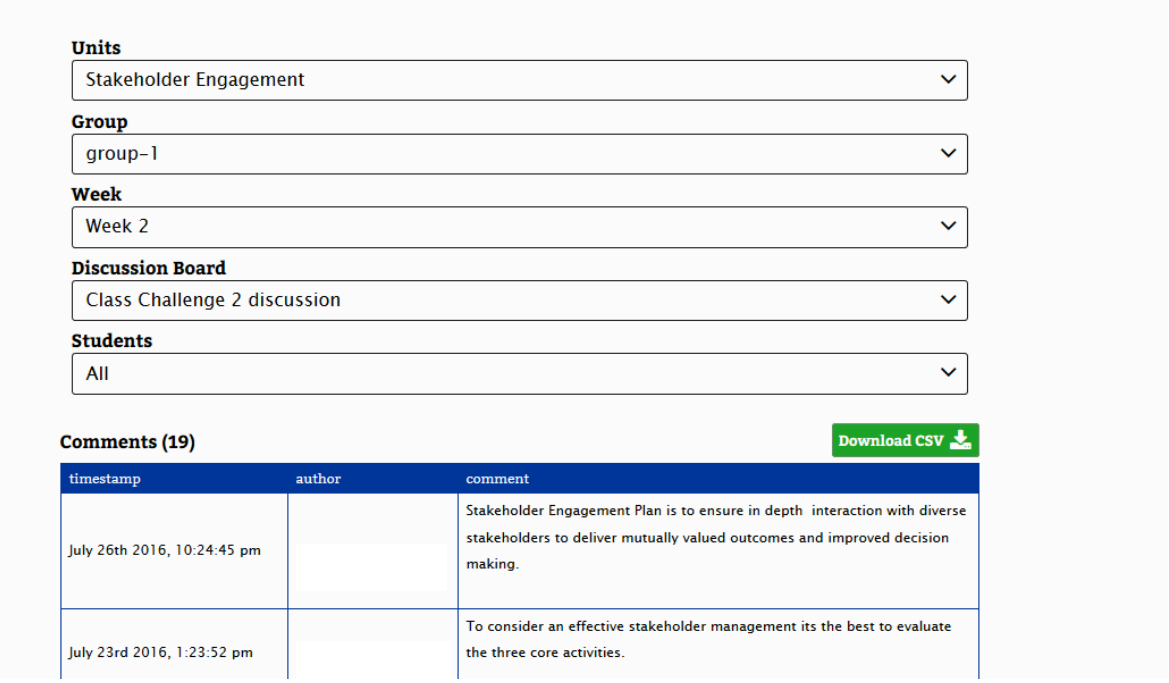

Figure 4. Admin post content filtering tool

An additional support tool developed recently, shown in Figure 5, is a complementary tool to the post content filtering tool, it enables a visual comparison of student posting and comment activity, to track the number and time of posts and comments each student makes. This can be filtered to specifically look at a particular student activity, or simultaneously display a range of students to see general trends or compare student engagement patterns. The quantity, timing and quality of posts by each student can be easily tracked by using the two tools in combination.

The teaching team is also discussing the further development of functionality in the learning platform to enable both the facilitators and the students to be alerted when and where new posts are made, giving even greater opportunity for interactive peer discussion. The teaching team is also experimenting with the use of word mapping to reflect back to both the facilitators and the students, the key learning concepts that are being discussed by the students.

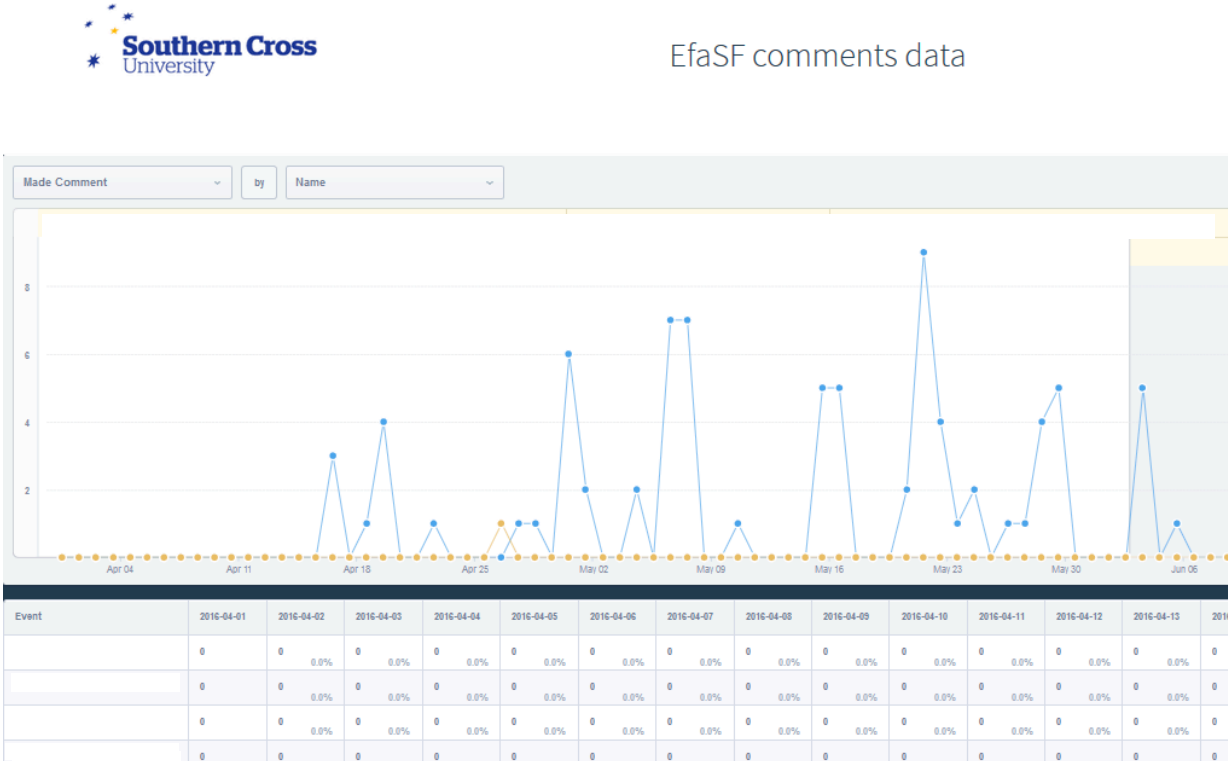

Figure 5. Admin post pattern tool

Further Development

While the student feedback was positive, review of assessments items submitted indicated that many students were unclear about how to approach this type of learning environment. In addition, it was evident that students undertaking subsequent units were better aligned with the learning environment (and were more successful), than those being exposed to the environment for the first time.

Subsequently more detailed guidelines for the unit have been prepared, in particular addressing:

1. The need for strong generic skills such as;
    a. Active listening
    b. Strategic reading
    c. Professional writing
2. The importance of playing the prescribed role;
3. Answering the specific questions framed, rather than providing free form general discussion around the topics
4. Making clear decisions;
5. Reflecting on own and class decisions.

The combination of this guidance and a student body more broadly familiar with the learning environment has significantly improved the quality of responses, and the quality of learning.

It is evident that members of the student body that have managerial roles in their work environment adapt more quickly, and possibly gain more from the learning environment than those with more technically focussed roles. As a general observation, it also appears that some students with non-English speaking backgrounds have more issues becoming

comfortable with the learning environment. Further development of tools to support these students is planned.

Conclusions

The SCU Masters of Engineering Management units provided by the engineering team require a strong understanding of context, associated uncertainty, synthesis of ideas and non-numeric decision-making. The approach utilised by Heldt & Black (1997) for undergraduate engineering design has been extended to the on-line MEM units presented by SCU. While early student feedback has been good, further development of tools to assist students to rapidly become familiar with this simulated practice environment are planned.

The approach is highly suited to topic areas with a strong practice focus. The experience at SCU, is that the mode of delivery and pedagogy is an effective mode for engaging students in an online environment, enabling students that are very busy and not otherwise able to engage in postgraduate learning to enrich their knowledge in a learning environment that is inclusive of rich peer discussion. This is enabling the student to effectively gain skills needed to communicate within their professions, apply techniques and make decisions in areas that are at the forefront of engineering management thinking today.

REFERENCES

Heldt T. J and Black R., (1997). *Allowing students to learn design.* Paper presented at the Ninth Annual Conference of the Australasian Association for Engineering Education, University of Ballarat, Ballarat, Victoria.

Acknowledgements

This paper is dedicated to the memory of the late Robin Black – gentleman, scholar, and exemplary engineering educator.