



Invited Paper - Curriculum Development to meet Accreditation Requirements

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Dr Prue Howard has a Bachelors Degree in Mechanical Engineering, A Masters Degree in Engineering, and a Professional Doctorate in Transdisciplinary Studies. She came to academia after four years as an engineer and designer in industry.

Her initial research/consulting area was in dynamics and failure analysis, but the opportunity to become involved in Engineering Education research quickly changed her direction. An early grant from what was then known as CAUT showed how integration of content, and a context based approach to teaching could motivate and enthuse students. The outcome was the opportunity to redesign the engineering program at CQU, and develop the PBL program. The program was introduced in 1998.

Since then she has been involved in research in the area of Safe Design and the transdisciplinary teaching of safe design. The research has involved colleagues in Occupational Health and Safety and the Victorian State Coroner.

Awards have included receiving the Vice Chancellors Award for Excellence twice and the Australasian Association for Engineering Education award for Excellence in Curriculum Development.

She has recently finalised an ALTC funded project as lead investigator to develop a model for assessing students as individuals who do their learning in team based environments, and is currently an investigator on another ALTC grant investing the development of final year engineering projects.

She is currently the Editor for the Australasian Journal of Engineering Education.

Prof. Duncan Andrew Campbell, Queensland University of Technology

Professor Duncan Campbell is the Director of the Australian Research Centre for Aerospace Automation (ARCAA) and is a Professor with the School of Electrical Engineering and Computer Science at the Queensland University of Technology, Brisbane, Australia. He was President of the Australasian Association for Engineering Education in 2011 and is the CDIO Chair of Australian and New Zealand regional group of the global CDIO collaboration in engineering education. Duncan has led many projects around engineering curriculum reform and has particular interests in internationalisation and student mobility, the first year experience, integrated curriculum, and a systems approach to curriculum design and aligning program level learning outcomes with national and international frameworks. He recently co-delivered a series of national workshops in Australia on top-down curriculum design to satisfy program and accreditation requirements.

Curriculum Development to meet Accreditation Requirements

Introduction

Engineering programs in Australia are accredited by the professional body, Engineers Australia. Graduate engineers cannot become a member of Engineers Australia unless they graduate from an accredited program. Additionally the ability to practice as an engineer in many other countries is governed by accreditation of the national professional body by international agreements such as the “Washington Accord”. Therefore accreditation by Engineers Australia is a critical aspect of any engineering program within Australia.

Engineers Australia has been proactive in encouraging engineering faculties to develop programs that meet the needs of employers and the profession. Developments from the 1996 review of engineering education¹ changed the accreditation process from an input (content-based) approach to program development to an outcomes-based approach. This change allowed and encouraged a diversity of approaches to education, while attempting to ensure the same quality of outcome. Since that time, engineering programs throughout Australia have been attempting to implement the new requirements, which have required the use of constructive alignment of learning outcomes, learning and teaching activities and assessment. The recent ALTC-supported project “Engineers for the Future”² supported this requirement.

Although some institutions have implemented the changed curriculum in response to these developments, there has been little development of the learning and teaching knowledge and skills of academic staff. The concentration of across institution training and development in the area of outcomes based teaching within engineering has been with the Associate Deans and program Leaders. It has been assumed that these are the roles that need to understand the place of outcomes based education within the accreditation framework. These roles however are primarily management roles rather than leadership roles. The high workload of these roles in coordinating internal and external requirements for engineering programs, coupled with the latest trend of “mega faculties”, where the Associate Dean may not even be an engineer, has meant that the leadership for learning and teaching does not truly reside with those roles.

Workshops for Outcomes based Education

Outcomes based education is a pedagogical approach that targets the development of specific learning outcomes in students, within individual units as well as across all units in a particular course of study³. The Australian Engineering Accreditation Centre (AEAC) requires tertiary engineering programs to be able to demonstrate that they are delivering an outcomes based educational program in order to be formally accredited. Formal accreditation gives recognition of the professional status of graduates within Australia, but also within the international Washington Accord agreement. While this requirement for outcomes based education has been in place for

more than a decade, staff are still struggling to implement outcomes based education in curriculum design and unit delivery.

To mark the formal launch of the new Engineers Australia Stage 1 Competency Standards, a series of national workshops sponsored by the Australian Council of Engineering Deans was conducted between July 2011 and February 2012 to examine the basis of the Standards and their role as a generic foundation for a systematic, outcomes-based approach to engineering education in the Australian context. While the AEAC had run workshops in previous years to inform faculties about the accreditation process, the outcomes for this series were to be different.

Previous workshops had been attended by Associate Deans and Program Leaders. These were typically the staff responsible for developing the accreditation documentation for their faculty. However, at the accreditation visits over a series of years, it had been noted that academic staff had found it difficult to fully participate, as they were unaware of the accreditation process, and quite often of the program details at their particular institution. Staff were very involved in their own subject areas, but lacked overall understanding of the entire degree program.

A major issue identified in previous accreditation visits was the lack of understanding of staff of outcomes based education and the curriculum design process. Evidence of how outcomes are developed is critical within the accreditation process, and staff need to be able to discuss how their individual courses contribute to the development of the stage 1 competencies.

The AEAC recognised that the workshops had to attract a different audience. The academic staff who were involved in developing and delivering curriculum needed to know about the accreditation process and aims, and to become aware of how their curriculum development could achieve the accreditation aims. To this end they approached the Australasian Association for Engineering Education for assistance in developing and running the new series of workshops across Australia.

Key staff from the AEAC, in conjunction with leading Australian engineering educators nominated by the Australasian Association for Engineering Education, discussed the requirements and decided on a back to basics approach. As the theoretical basis for outcomes-based curriculum is Bigg's model of Constructive Alignment⁴, the workshop curriculum development activities were developed to introduce constructive alignment. The workshops covered the following topics:

- Outcomes and implications of the recent review of the Stage 1 Competency Standards;
- Addressing the competencies through curriculum design and mapping (processes, examples and outcomes); and
- The Engineers Australia accreditation requirements and process.

The primary focus of the workshops was to build an appreciation and commitment to holistic and systematic educational development and delivery. The workshops were used as a space to support faculty development in the area of curriculum development. An invitation to attend one of the workshops was offered to all members of academic and professional staff primarily focussed on engineering programs or involved in the accreditation process at all universities in Australia This included:

- Members of teaching teams;
- Unit (subject) coordinators;
- Program Leaders;
- Associate Deans (Learning and Teaching);
- Staff involved in upcoming Engineers Australia accreditation visits;

The Workshops

Entitled, “Addressing the Standards through the Curriculum”, the workshop had an objective of “building an appreciation and commitment to holistic and systematic educational development and delivery”. The topics covered were:

- Outcomes and implications of the recent review of the Stage 1 Competency Standards;
- Addressing the competencies through curriculum design and mapping (processes, examples and outcomes); and
- The Engineers Australia accreditation requirements and process.
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The curriculum design and mapping activities were introduced over a 3 hour session, and included:

- Top–down curriculum design, constructive alignment and addressing the competencies
- Exemplars and competency mapping activities
- Group work themed by institution/program
- Closing the loop - Reporting back and reflections

The workshop introduced outcomes based education by considering some of the common responses to the topic:

- But I teach teamwork in 1st year, why do it again?
- But I already have too much content in my subject [to fit professional competencies]
- But students need to know it [the content I am expert in]

The activities focused around 3 key concepts

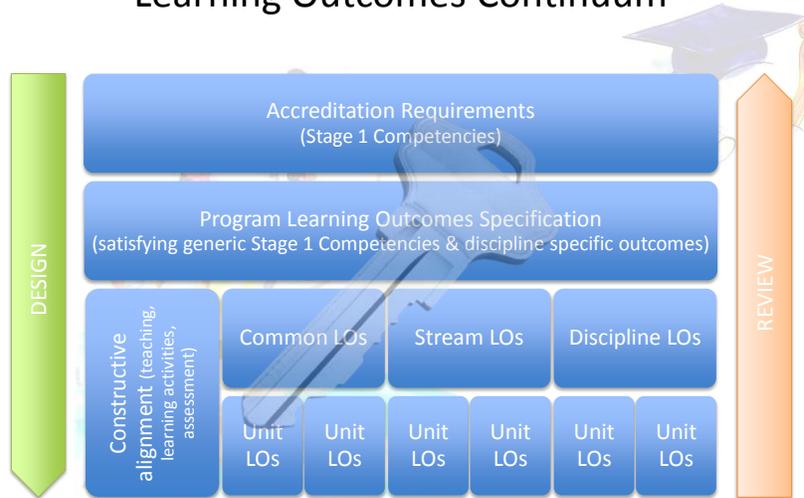
1. Learning Outcomes
2. Developmental levels (or levels of attainment)
3. Constructive alignment

Outcomes based education requires the developer to be conscious of all three of these issues. A big step for many academics is the understanding of learning outcomes as opposed to content knowledge. The first 2 points are inextricably linked. It had also been observed through accreditation visits that many of the issues with outcome based education development were based in individual academics focusing on their subject matter in isolation. So in the workshops

the curriculum design process was introduced with the concept of a Learning Outcomes Continuum (fig 1 below)



Learning Outcomes Continuum



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Fig 1. – Learning Outcomes Continuum

- The developmental levels were further discussed starting with a range of possibilities such as Bloom’s educational objectives, and the CDIO proficiencies (fig 2 below). The interesting element of this discussion for participants was when they were asked – “In consideration of the Stage 1 Competencies, consider how many you consider yourself to be a leader or innovator (read expert)?”.

Outcome Developmental Levels

- All competencies develop as a continuum

BLOOM'S EDUCATIONAL OBJECTIVES	CDIO PROFICIENCY
Knowledge	1 To have experienced or been exposed to ...
	2 To be able to participate in and contribute to ...
Comprehension	3 To be able to understand and explain ...
Application	4 To be skilled in the practice or implementation of ...
Analysis	
Synthesis	5 To be able to lead or innovate.
Evaluation	

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Fig 2. Outcome Developmental Levels

Participants were then asked to consider one of the subjects that they teach into, and identify the learning outcomes, establish how they do (or could) achieve constructive alignment for that course. They were then asked to map that one subject to the engineers Australia competency standards.

Outcomes

Many participants struggled with differentiating learning outcomes from tasks. Many staff were still content focused rather than outcome focused. While the workshop had introduced them to the concepts of outcomes based learning, it was going to take some time for them to be able to assimilate it into their practice.

It was observed through several other projects, the Australian Learning and Teaching Council (ALTC) project "Assessing individuals who learn in a team environment"⁵, and the ALTC project "Curriculum renewal in engineering through theory-driven evaluation"⁶, that there is a lack of awareness of, or application of, the educational concepts by engineering educators to produce outcomes based education in alignment with EA accreditation guidelines. This was evident even amongst some academics with a genuine interest in engineering education. These educational concepts include the constructive alignment of learning outcomes, teaching and learning activities, and outcomes based assessment. This is a necessary starting point for the development and delivery of an outcomes based education.

The overarching observation from the three projects, is that the lack of awareness or application of outcomes based teaching and learning can be found across a range of academic levels, and across a range of institutions and regions. It was further observed that staff struggled to articulate

their understanding of the learning outcomes from their own units and programs to their peers and to their students.

Conclusions

The Australian Engineering Accreditation Centre (AEAC) requires engineering programs to be able to demonstrate that they are delivering an outcomes based educational program. While this requirement has been in place for more than a decade, staff are still struggling to implement outcomes based education in curriculum design and unit delivery.

The experience of both AAEE and EA has been that formal managers rather than internal leaders have been given responsibility for the development of outcomes based teaching within such programs. The professional development activities that have been offered by both EA have been supported only by those who are responsible for developing the formal accreditation documentation. The impetus for outcomes based teaching and learning must come from within the ranks, rather than being imposed by the management structure. Experience has shown that when change is imposed by management, rather than adopted by the coal face, success is limited.

In the face of these challenges, Australia's leading engineering education organisations, including EA, AAEE, and the Australian Council for Engineering Deans (ACED) have concluded that coordinated efforts are necessary across the engineering education sector to build leadership capacity at multiple organisational levels in support of more authentically embedding outcomes-based education principles in curriculum design efforts and teaching practice.

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