

Initiating curriculum review: The Chilean experience

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***Abstract:** This paper describes the initiation of a comprehensive engineering curriculum review at the Universidad Tecnológica Metropolitana, in Santiago, Chile. This work is being led by a team from the University of Wollongong through a World Bank contract to assist UTEM in modernising its curriculum and in enhancing the 'employability and general formation' of its graduates. The paper outlines the background to the project, the structured curriculum review process proposed, and the planning and outcomes of an interactive workshop used to initiate the review. It also makes note of the difficulties faced when initiating a major curriculum review through the cultural, political, procedural and professional differences that exist between Australian and Chilean higher education.*

Introduction

Engineers and Universities operate in an International environment and so curriculum designers must take into account changing developments world wide. Individual Universities will also usually be seeking ways of developing features of their degrees which distinguish them from their peers. There is no single right answer or single 'best' solution for all Universities; every one must construct curricula that deliver the 'Graduate Attributes' which best fit their particular aspirations in their particular national and international contexts. In this paper, we detail our recent experiences working on a major curriculum renewal project based on these principles. The work detailed was undertaken with colleagues in engineering at the Universidad Tecnológica Metropolitana (UTEM) and funded by the World Bank. We explain the background to the project, the proposal we put forward to tender, the structured curriculum process around which the project is centred, and the work progress and outcomes to date. We also comment on how the similarities and differences in professional cultures have affected the project.

Background

The project titled *Curricula Innovation of Engineering Programs in the Universidad Tecnológica Metropolitana* is funded by a grant from a program called MECESUP (Programa de Mejoramiento de

la Calidad y Equidad de la Educación Superior; see www.mecesup.cl). MECESUP was set up in 1997 by the Chilean Secretary of Education to improve the quality of higher education in Chile. The total budget of the program (US\$245 million) was supported by the Government of Chile and the World Bank, and these resources were allocated through a competitive process to selected universities and institutions.

The UTEM project (UTM0304) nominated several goals to be addressed through curricular redesign of the undergraduate programs:

- Study plans aimed at the development of competencies and the acquisition of learning outcomes, contrasted with the demands of the employment market;
- Flexible curricula networks, including options for intermediate exit with a first level qualification for the profession;
- Integrated Long Life Learning system through degree specialization and graduate programs;
- Student-centered learning activities emphasizing practical work, laboratory activities and the use of information technology.

In 2006, UTEM called internationally for presentation of proposals to carry out the UTM0304 project. The main activity specified in the call for tenders was technical assistance in curriculum review processes. The tenders were judged by an independent committee and the project was assigned to the University of Wollongong (UOW) to run from March 2007 until March 2008. UTEM specified that at the end of the technical assistance they expect to have an academic team prepared to lead curricular reform at UTEM and knowledgeable in modern techniques of teaching and learning in engineering.

UoW's Proposed Curriculum Review Methodology

The approach to curriculum review proposed in the tender for UTEM was strongly informed by the Wollongong team's experiences of developing and implementing curriculum review processes at UOW. The basis and drivers for the review were strong commitment to mapping, tracking and embedding graduate attributes in UOW's existing undergraduate programs. UOW founded its approach on Walkington's (2002) account of process and a review framework described by Leonard and others (1998), represented below as Figure 1.

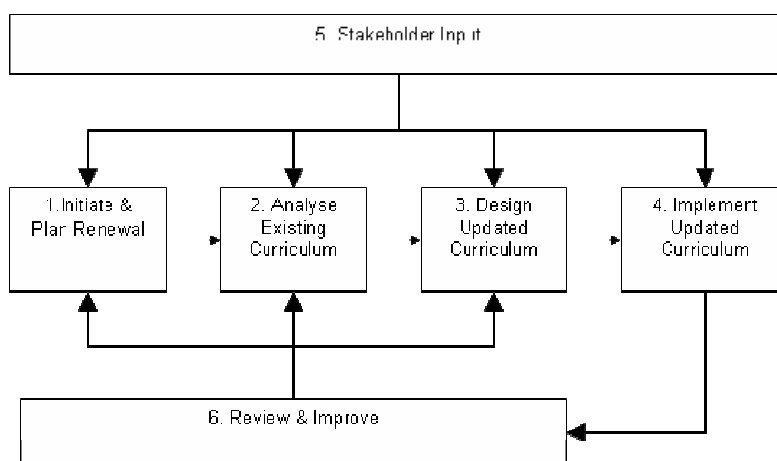


Figure 1 Framework for Curriculum Renewal in Engineering (after Leonard et al. 1998)

Figure 1 represents curriculum renewal as a closed loop cycle. Stage 1 of the cycle is initiation and planning during which those who will drive and champion the process negotiate and consult with their colleagues and others on the objectives for the review. Here, tentative agreement is reached on how the process will be undertaken and the timeline and resources/commitment required. Stage 2 is the analysis of the existing curriculum and the authors suggest that the process of analysis begins with broad visioning at curriculum level and general agreement on the overall goals of the program ie the development of 'program level objectives'. Initial focus on program level objectives is recommended as a means of reaching consensus before individual academics' teaching practices and content come under scrutiny and, potentially, under a perceived 'threat' of change. During stage 3, adjustments are

negotiated on existing program structures and these suggest ways that individual subjects might need to be adjusted. Stage 4 is implementation and this encompasses both the formal checking and approval processes that might be needed for minor and major program or subject changes (ie. approval by a faculty or university education committee) as well as the first run at changing teaching, learning and assessment methods for the amended curriculum. The two processes that Leonard and others (1998) suggested to close the quality loop are stage 5 (stakeholder input) and stage 6 (review and improve). The stakeholder consultation is intended to ensure that course revision takes into account the views of all those with a stake in the process or product (ie. students, university administrators and managers, industry employer groups, professional bodies). Stage 6 refers to the need for systematic collection of evidence on what is working and what needs to be further improved or adjusted in the new curriculum (eg. teacher or subject surveys, cross-institutional benchmarking, academic workload impacts of changed teaching practices).

During stage 2 of the curriculum review process at UOW, some unique approaches to understanding, auditing and representing the curriculum as a whole were developed. The tools were intentionally visual and straightforward, and apparently appealed to the committee judging the tender.

- Curriculum maps – one-page depictions showing all of the subjects in a degree program and how they are linked through pre- and co-requisite requirements and assumed prior knowledge.
- Learning paths – one-page depictions of the main concepts (ideas, theories), analytic techniques and applications for a sub-discipline area (ie. mechanics; Hadi and Carew, submitted).
- Mastery skills lists – an extensive syllabus listing all the bits of knowledge, skill, experience and attitude that students in the program must be exposed to and master in order to graduate (eg. NCEES, 2007)
- Program Level Objectives – statements that briefly and clearly define what a graduate from a particular program can do on graduation.
- Assessment Inventory – spreadsheets that list selected mastery skills and prompt academics to specify how much, and how, they teach and assess each skill.
- Graduate attribute continuum – a matrix of statements describing what a graduate would need to do to prove competence on specified graduate attributes.

An important emphasis in the proposed methodology was that the UOW team had the intention of sharing these tools and experiences of using them with our Chilean colleagues. We explicitly wanted to support the team at UTEM in trying the tools and processes, and adapting them to the unique needs of their own institution. Our tender included a work plan recommending a number of activities, including a four day Workshop held in July, 2007 to be supported by a team from the Faculty of Engineering at UOW (Prof. Chris Cook, Dean; A/Prof. Paul Cooper, Mechanical Engineering Discipline Advisor; Prof. Tim McCarthy, Civil Engineering Discipline Advisor; Dr. Anna Carew, Engineering Educational Specialist; A/Prof. Sharon Nightingale, Acting Materials Engineering Discipline Advisor; and Mr. Thomas Goldfinch, Project Officer and Mechanical Engineer).

Initial interactions with UTEM

Initial progress of the project was slow, and it became clear that the academics at UTEM had very similar time, resource and funding pressures that exist in many Australian Universities. The first two months of the project were focused on obtaining as much information as possible about the UTEM curricula, such as structure, content, teaching and assessment practices and policy. This proved to be a non-trivial task due to a number of factors such as the language barrier, time difference (an Australian day is a Chilean night) and the time needed to understand the inevitable and significant differences in academic governance systems between different University systems.

Some particular difficulties also arose from the significant differences in terminology between UOW and UTEM. For example; many of the degrees at UTEM (and in most universities in Chile) are termed Civil Engineering, such as Construction Civil Engineering and Computational Civil Engineering. In Chile, the Civil denotes a particular level of engineering degree, rather than a particular discipline of engineering as it does in Australia. A useful glossary of terms was developed to ensure that definitions

of many individual words like course, subject, degree program, examination, assessment, and so on were all well defined and agreed.

To maintain progress in the project, and to clarify issues such as those mentioned above, regular *Skype* meetings were held between the Vice-rector at UTEM, Prof. Patricio Olivares, the UOW Engineering Dean, Prof. Chris Cook, and the UOW project officer, Mr. Thomas Goldfinch. These meetings allowed us to obtain new information, build our working relationship and confirm our assumptions about various aspects of the curricula. We also gathered information and strengthened ties through brief visits to UTEM by key UOW staff (A/Prof. Paul Cooper and Prof Ernest Baafi from the Engineering Faculty and Ms Maureen Bell from the Academic Development unit).

Much of the initial evaluation of the UTEM curricula relied on a 'bits and pieces' approach to obtaining information. Detailed documentation on curricula, and teaching and assessment practices was not readily available from UTEM. As would be expected, the documentation and education committee processes at UTEM are not the same as at UOW, and so another aspect of any such collaboration involves the necessity of understanding the different lines of command, approval and committee processes and the differences between documentation and data which are 'easy' to obtain in comparison with those which are 'difficult'. One instance of this was the difficulty in finding a definitive collection of current assessment procedures, for example. As a result, much of the early work in the project relied on inferences pieced together from the UTEM documentation available, discussions with UTEM's Vice-rector, Prof. Patricio Olivares, and publicly available information on Chile's higher education system (eg. NOOSR, 1999). These problems would be typical of any international collaboration and so need to be factored into the times and costs of any such work.

The findings of this first stage of the project were summarised in a 'Phase 1 report'. This report was focused on the aspects of the UTEM curricula that the UOW team felt would benefit from revision and improvement, and what needed to be done by the UTEM academics to prepare for the workshops planned for July. The delivery of this report corresponded with the advanced stages of a program accreditation review, completely separate from this contract, at UTEM, which had tied up the majority of the UTEM engineering academic staff and so the workshop preparation tasks which were outlined in the Phase 1 report could not receive significant attention from the busy UTEM academic staff, resulting in several 11th hour revisions to the objectives and activities planned for the July workshop. These sorts of time pressures are clearly common across both Chilean and Australian tertiary sectors!

It became clear that the four day workshop planned for July, 2007 would need to provide an introduction to the processes and tools proposed for the curriculum review at UTEM. The workshop would also need to effectively kick start the curriculum review by encouraging discussion and consultation, and empower motivated UTEM colleagues to initiate a structured approach to analyzing the current curricula.

Curriculum review workshop

The objectives of the four day curriculum review workshop run in July 2007 at UTEM were to:

- identify strengths and weaknesses of existing UTEM Engineering programs
- nominate priorities for change (hard and soft skills)
- clarify Engineering program objectives
- obtain feedback on strength, weaknesses and priorities for change from industry, alumni and other invited stakeholders
- commence curriculum mapping for each Engineering program
- commence audit of teaching and assessment
- reconcile Engineering program stakeholder priorities with UTEM priorities
- emphasise the need for comprehensive consultation with all stakeholders.

Support Materials

To support the workshop, a number of resources were developed. A detailed running order which included activities, objectives, and time constraints ensured that the workshop was kept on track, and important tasks were not neglected. The running order was complemented by a complete set of slides

containing presentations, stimulus material, and instructions to guide activities, as well as several forms to assist with note taking during discussions and aid the collection of data for review later on.

All of these materials were translated into Spanish and compiled in a booklet which was distributed to all workshop participants. Several documents from the University of Wollongong's Engineering faculty curriculum review were also translated and used as stimulus material during group discussions.

Activities

The workshop provided a mix of activities including: semi-formal presentations where UTEM participants mostly listened but had the opportunity to ask questions (eg. Description of the curriculum review framework; importance of setting up appropriate administrative/approval structures for the review; stakeholder consultation processes; examples of good teaching practice; etc.); small group work where participants worked together to begin the process of analysing the existing curriculum at UTEM; reporting back on group work to ensure consensus summaries, groups staying on task and cross-fertilisation between groups; facilitating consultation where invited stakeholders offered their perspective on graduate attributes; 'large group' formal lectures with more limited interaction; and open forum and informal time for general sharing and discussion. The workshop design blended several theories and approaches to Academic Development in response to the perceived purpose and needs of the context. This design followed an approach to Academic Development that has elsewhere been termed 'Elastic Practice' (Carew, submitted).

The workshop was designed to give UTEM academics authentic, supported experience using the curriculum review processes that had already been used successfully in the Faculty of Engineering at the University of Wollongong. The activities were designed to work across a language divide (English – Spanish) and were supported by instructions and examples that had been translated into Spanish. They were also intended to further familiarise the UOW team with the professional culture and current curricula at UTEM.

Most of the activities were undertaken in small groups of around six UTEM academics with one of the UTEM participants acting as interpreter and a UOW team member present to guide discussion, and ask and answer questions. Groups were discipline-based and effort was focussed on establishing some consensus about priorities for change in the three disciplines selected for the project: Construction Civil Engineering, Electronic Engineering (both from the Faculty of Engineering), and Computational Civil Engineering (from the Faculty of Informatics). In the next section, we describe four of the workshop sessions in more detail and provide specific details of how each ran, the supporting resources used, and the outcomes that resulted.

Session 1 – Career-prompted Defining of Graduate Attributes

This session was run as an introductory visioning exercise to ascertain what the UTEM teams priorities are for graduate attributes, which were then to be compared with the priorities of a wider group of stakeholders. Discipline-based groups were asked to identify the three main career destinations for students from their program and nominate the most important hard and soft skills for each career. An example of career-prompted mapping of subjects from UOW Materials Engineering was used to guide the process. Hard and soft skills were collated and prioritised to indicate the graduate attributes for each discipline. This session ran well with enthusiastic participation from the UTEM academics. The activity highlighted differences of opinion present in even a small group, thus demonstrating the need for consultation with a wide group of stakeholders.

The graduate attributes defined by the three disciplines for graduates of each discipline were typical of the graduate attributes being defined by universities around the world. In terms of soft skills, teamwork and language skills proved common to all three disciplines, while the technical skills were, as expected, more varied.



Figure 2 (left) UTEM colleague reporting priority hard and soft skills for Computational Civil Engineering



Figure 3 (right) Invited stakeholders discussing strengths and weaknesses of the existing Construction Civil Engineering program

Session 2 – Stakeholder Consultation

During this session, several people from Industry, combined with some UTEM staff, several of whom are UTEM graduates and/or part-time academics with positions in Industry, worked with facilitators (Prof Cook, Dr Carew and UTEM staff) to discuss and define the strengths and weaknesses of current UTEM Graduates. Participants were divided into discipline groups, each working independently and then reporting back to the entire group. Discussion then moved on to defining the ‘ideal’ graduate attributes, both technical and non-technical (‘hard’ and ‘soft’). This activity was adapted from one used in the UOW Science Faculty.

This information was collated and formed an important part of the documentation defining feedback from key UTEM’s stakeholders. There was considerable unanimity about what constituted the most desirable ‘soft’ skills, most of which were common across discipline groups. This has considerable implications which could be used to guide UTEM in choosing appropriate teaching and assessment methods. It was generally understood that, whilst this section of the workshop was a good start, a wider selection of stakeholders would later need to be consulted for more comprehensive and valuable feedback.

Session 3 – Stakeholder Consultation Review

On the third day of the workshop, the UTEM academics were asked to compare the Graduate Attributes defined by them in session 1 with the Graduate Attributes defined in consultation with stakeholders in session 2. The participants noticed that many of the attributes defined by the UTEM academics were similar to those defined by stakeholders; however, prioritisation of these attributes differed greatly.

It is apparent that (as in Australia) there is disagreement over responsibilities in university education. The industry stakeholders held that some skills should be taught thoroughly at university, while the UTEM academics believe that a proportion of this teaching was the responsibility of industry. This issue emphasised the need for both consultation and negotiation with stakeholders.

The intention of this activity was to show how graduate attributes can be arrived at and to demonstrate the need for a comprehensive consultative process for defining attributes, and in subsequent stages of the curriculum review. Taking into account the points of disagreement and the positive and spirited discussion observed between UTEM academics and stakeholders, the UOW team believes this was achieved.

Session 4 – Curriculum Mapping

This session included a presentation of some examples of curricula maps from UOW degree courses to demonstrate how the learning pathway for students in Mechanical Engineering and in Civil Engineering degree programs have been developed and can be depicted. These maps showed three different aspects of the curriculum: a) learning paths: b) pre-requisite structures: and c) map of sub-disciplines responsible for subject groups. The UTEM academics attending this session were then

asked to begin identifying these features in their own curricula. The session then moved on to auditing and mapping for graduate attributes. Participants identified subjects they teach and, using a simple Graduate Attribute Audit form that was developed for this activity, mapped the level of content in the subject to nine graduate attributes. The audit form was a modified version of one developed and used during the UOW Engineering Faculty review. Subsequently the UTEM participants also evaluated how student attainment of the graduate attributes were assessed within each subject. Figure 5 shows a partially completed audit form.



Figure 4 (left to right standing) A/Prof Cooper and Prof McCarthy demonstrating curriculum mapping and auditing techniques for UTEM

(por favor indicar el nivel de atención que se le da al desarrollo de tales atributos en una escala del 1-5, donde 1 = No se Considera, 5 = Objetivo Clave del curso)

Cursos que ha enseñado (Enero 2005 - presente)	Peso del Examen Final como % de la evaluación total.	Graduate Attributes									Examinaciones técnicas		
		Comunicación oral	Comunicación escrita	Trabajo en equipo	Ética	Administración de recursos humanos	Administración de operaciones	Resolución de Problemas	Creatividad	Conocimientos Técnicos	Otros	Examinaciones técnicas (escritas)	Presentaciones orales individuales
1 FIA - Kinesiólogos	40	4	4	3	3	1	1	1	1	3	3	4	4
5 FIA - Análisis	40	4	5	2	4	1	1	1	1	3	3	4	4
8 FIA - Circuitos	40	3	5	4	3	1	1	1	1	3	3	4	4
3 FIA - C. Matemática	40	3	5	2	3	1	1	1	1	2	2	4	4
2 FIA - R. Matemática	40	3	5	2	3	1	1	1	1	3	3	4	4
4 FIA - S. Diferenciales	40	3	5	2	3	1	1	1	1	3	3	4	4
3 FIA - Laboratorio	40	5	5	4	4	1	1	1	1	5	5	4	4
4 Y - Automatismos	40	3	5	4	3	1	1	1	1	3	3	4	4
4 Y - Sist. Control	40	3	5	4	3	1	1	1	1	3	3	4	4
4 Y - Análisis de Señal	40	3	5	3	3	1	1	1	1	3	3	4	4
7 Y - Circuitos	40	3	5	3	3	1	1	1	1	3	3	4	4
5 Y - Conversión de Energía	40	3	5	4	4	1	1	1	1	3	3	4	4

Figure 5 Example graduate attribute audit form

This session demonstrated the links between curriculum auditing and mapping and emphasized the importance of establishing sub-discipline groups to develop the curriculum maps and to analyse the subjects against the development of graduate attributes.

Overall Workshop Outcomes

The success of these activities was enhanced by the enthusiastic group of academics at UTEM, who were vigorous and constructive in discussions. The UOW team believe these activities successfully provided the UTEM team with a useful introduction to the curriculum review process that has been implemented at UOW. It is believed that the UTEM team are now in a good position to implement this process at UTEM, having demonstrated considerable enthusiasm through the workshop activities.

There were several important outcomes of this workshop:

- Successful introduction to several key tools for curriculum review.
- Demonstrated ability of the UTEM team to apply curriculum review tools.
- Improvement of the UOW team’s knowledge of the professional culture at UTEM.
- Improvement of the UOW team’s knowledge of the UTEM curricula.

Where to Now?

Following the success of this workshop in initiating the discussion required to commence a major curriculum review, it was necessary to provide a detailed list of tasks and deadlines to maintain the momentum and emphasise that consultation is the key to success. Table 1 is the summarised version of the task list and reporting dates laid out by the UOW team. A table similar to this one has been sent to UTEM at the time of writing, and we hope to be able to support the UTEM team in achieving these goals on their way to a successful curriculum review.

Table 1 Reporting dates for tasks outlined in section 4.

Date	Tasks to Report (Progress)	Tasks to Complete and Report
31 st Aug 2007 (reporting date 1)	Progress of Graduate Attribute Audit form	Name curriculum review committee Name sub-discipline groups
14 th Sept 2007 (reporting date 2)	Mapping of current curriculum Graduate attributes statements Program objectives	Graduate Attribute audit form, first revision – Current state of curricula
24 th Sept 2007	1 st revision of Graduate Attribute audit form	

(Paul Cooper to visit UTEM) (reporting date 3)	Mapping of current curriculum Curriculum review committee and sub-discipline groups	
19 th Oct 2007 (reporting date 4)		Graduate Attribute audit form, second revision – Target state of curricula Final curriculum maps (existing curriculum)
2 nd Nov 2007 (reporting date 5)	Graduate attributes statements Program objectives Curriculum review objectives Mastery skills lists Effectiveness of curriculum review committee and sub-discipline groups.	Preliminary proposal for changes to the curriculum (content, assessments, teaching practices etc.)
16 th Nov 2007 (2 UOW staff to visit UTEM)	Ideas for teaching and assessment innovation at UTEM Curriculum renewal plan	Select subjects to develop
30 th Nov 2007	Curriculum renewal plan Curriculum maps (new curriculum)	
21 st Dec 2007	Curriculum maps (new curriculum) Policy drafts	Final curriculum renewal plan (objectives, goals, timelines)

Conclusion

The project to date has proved an enlightening experience for all involved. The importance of understanding all of the factors influencing a curriculum, and the cultural and political issues associated with curriculum review has been emphasised. Articulation and implementation of a clear curriculum review framework/process that is understood by all concerned has also been demonstrated to be of great value. Our conclusion is that it is crucial to adopt an approach to curriculum review that takes these factors into account and offers a clear path to completion.

The interactive workshop proved to be an effective educational and motivational tool for establishing the groundwork for the structured curriculum review. The communication made possible by the face-to-face visits and formal workshop provided the necessary influence to get the ball rolling. It also enabled direct and immediate addressing of the concerns and queries regarding a major curriculum review, inspiring confidence in the process. We would recommend a workshop such as this as a valuable first step in any curriculum review. UTEM now has the tools and people needed to initiate the updating of their curricula and compete in an increasingly competitive and internationalised Chilean higher education system.

The overall experience highlights how tertiary engineering education is being subjected to similar high demands internationally, and how similar are the time and resource demands on academics involved in engineering education. The benefits of such collaborations are immense. Both UTEM and UOW academics have learnt a lot about how to synthesise best practices from two different tertiary systems to improve the quality of engineering graduates, and prepare them for an increasingly internationalised profession.

References

- Carew, A.L. (submitted). Elastic practice. *Submitted*.
- Hadi, M., Carew, A.L. (submitted). A learning path for Civil Engineering students. *Submitted*.
- Leonard, M.S., Beasley, D.E., Scales, K.E., Elzinga, J.D. (1998). Planning for curriculum renewal and accreditation under ABET engineering criteria 2000. *Proceedings of the 1998 American Society of Engineering Education Annual Conference* (session 3257). Seattle, WA: ASEE.
- NCEES (2007). *Fundamentals in Engineering (FE) examination specifications*. Accessed at http://www.ncees.org/exams/fundamentals/fe_exam_specs.pdf on 20th August 2007.
- NOOSR, (1999). *Country education profiles: Chile, a comparative study*. Canberra; J.S. McMillan.
- Walkington, J. (2002). A process for curriculum change in engineering education. *European Journal of Engineering Education*, 27(2), 133-148.