Level 0 - The Hidden Differences between the daily experience of engineering first years and high school

Students entering their first year at university know that tertiary education is different to secondary education, but these differences are not clearly articulated. This paper describes these differences for first year engineering students. Strategies implemented to address these differences are discussed.

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Introduction

Just as every new appliance comes with an instruction manual, every commencing university student receives their university's 'instruction manual' or 'orientation book' before starting classes. These orientation materials include general university information, faculty specific information as well as information from the student guild or student support teams. Just like an appliance's instruction manual, the orientation book is filled with rules, more rules, exemptions, waivers, relevant policy details, what to do when things go wrong and the contact details of relevant people, often written in a way that seems to be a poor translation of another language. And to a first time 'user' of the university 'appliance', this information is just as bewildering.

I have found that with new university students, part of the reason for the bewilderment is what I call the 'level' of the orientation information. This standard 'level 1' orientation information makes sense once one is aware of the 'level 0' assumptions that underpin them. When the 'level 0' information is made explicit, especially when contrasted against their previous educational experiences, new university students more quickly grasp and work the new teaching and learning culture. This paper describes the 'level 0' assumptions that impact a typical first year engineering university student.

Level 0 - Assumptions and Key Distinctions

The table below summarises the 'level 0' assumptions for a new student in engineering at a typical university, contrasted against a typical secondary school culture.

Secondary Education	**Tertiary Education**
The teacher teaches the person	The teacher teaches the subject
The curriculum is designed to develop	The curriculum is designed to develop

the whole person	certain skills and content.
The aim of the curriculum is to deliver the student to university.	The aim of the curriculum is to deliver the student to the workplace.
Curriculum differentiation is available.	Everyone is presented with the same curriculum.
Throughout the day, the student spends time learning and studying in the domains of Arts, Languages, Science, Humanities, Drama, Physical Education.	Throughout the day, the student spends time learning and studying in the domain of Science.
Co curricular activities are structured to genuinely complement the curriculum.	Any activities that might complement the curriculum are ad hoc, inconsistent and usually planned by student groups, not the Faculty.
The teacher identifies and arranges for interventions.	The student needs to reflect on his/her work, identify and arrange for interventions.
Team building activities are built into the daily experience.	Team building activities are incidental to the curriculum, and are usually planned by student groups, not the Faculty.

Table 1: Level 0 assumptions compared against high school practice.

The Level 0 assumptions all cluster around teaching and learning culture, and impacts the students two ways: the student's experience of the formal teaching and learning activities, and the student's experience of his/her whole day as a university student.

1. Student's Experience of Formal Teaching and Learning Activities

The teacher teaches the person / the teacher teaches the subject / Interventions

This distinction underlies the most noticeable difference the new student first experiences. Secondary school teachers are qualified educators, and those who base their teaching on the theories of Maria Montessori and William Glasser, for example, are aware of the need to create a safe, supportive, collaborative and challenging learning environment (Gordon, Arthur and Butterfield, 1996). So secondary school teachers start the annual educational journey by remembering the name of every student they teach as quickly as possible, determining their status by administering a series of diagnostic quizzes, monitoring each student's progress, identifying each student's challenges and determining appropriate

interventions. This individual attention is foundational to a successful learning journey.

The tertiary educator, in comparison, teaches the subject – and it is expected that the students drive their own learning. This does not mean students are on their own – and it is important for staff that are in contact with first years to make explicit that the teaching and learning system at university is based on a team approach, rather than an individual approach: difficulties with any aspect of teaching and learning are outsourced to a university 'student support service', tutors support the lecture material, medical certificates for assessment absences are submitted to the Associate Dean (Students). Students may be expecting a more personal approach to their studies (Song-Turner, 2008), and it is important that this new teaching and learning framework be explicitly described to new students.

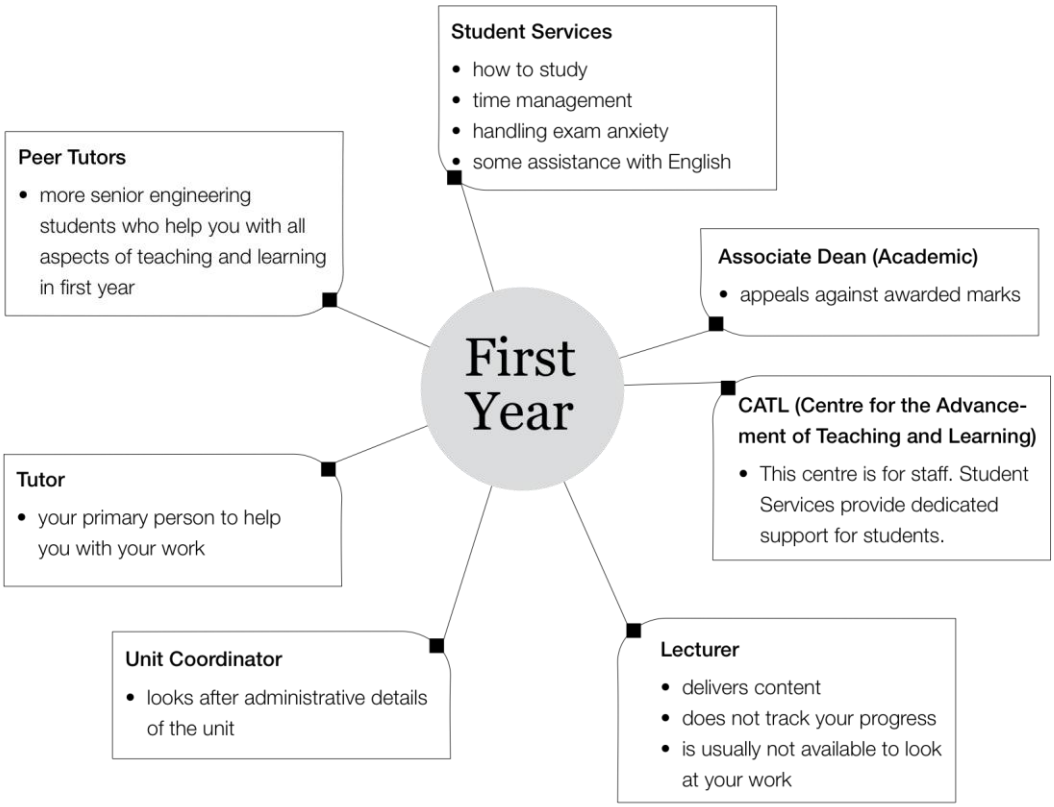

Diagram 1: Example of a teaching and learning team at University (Szymakowski, 2009)

Curriculum for the whole person / Curriculum for skills and content Differentiation

Secondary Schools are guided in the formation of their curriculum by the government's designated body responsible for determining curriculum directions and providing direction for the development, accreditation and assessment of senior secondary school courses. In Western Australia, this body

is the Curriculum Council of Western Australia, and their key curriculum document is the "Curriculum Framework". This document typically provides an overview of the body of knowledge of each subject area K - 12, each subject's learning area outcomes, links with other learning areas, learning, teaching and assessment outcomes, as well as describing values, and the student's phases of development. (Curriculum Council, 1998). Religion-based secondary schools will also add religious education into the curriculum design. Development of the whole person is built into the curriculum.

Engineers Australia is the body that accredits most engineering degree programmes in Australia, and the basis of their curriculum design has, naturally enough, a different focus.

> In accordance with the Accreditation Policy, a four-year professional engineering program would be expected to include the following elements, the percentages denoting indicative proportions of the total learning experience:
>
> - mathematics, science, engineering principles, skills and tools appropriate to the discipline of study (not less than 40%),
> - engineering design and projects (approximately 20%),
> - an engineering discipline specialisation (approximately 20%),
> - integrated exposure to professional engineering practice, including management and professional ethics (approximately 10%),
> - more of any of the above elements, or other elective studies (approximately 10%).
>
> (Bradley, 2006)

Additional detail is provided in another Engineers Australia document 'Stage 1 Competency Standards'. The document lists the competencies that apply to someone freshly completing an engineering degree. The competencies are worded as outcome statements e.g.,

> **PE2.3 Ability to utilise a systems approach to complex problems and to design and operational performance**
>
> a. Ability to engage with ill-defined situations and problems involving uncertainty, imprecise information, and wide-ranging and conflicting technical and non-technical factors
>
> (Engineers Australia, 2007).

At secondary school, the teacher leads students on a strongly student focussed carefully constructed learning journey. "Rather than being prescriptive about what must be taught, the Curriculum Framework will be used by schools to develop and implement their teaching and learning programs according to the needs and characteristics of their students. " (Curriculum Council, 1998). In contrast, an engineering degree learning journey aims to build the engineering principles, skills, tools, design skills, project skills and practice in the student. There is no requirement to address the whole person. However, thoughtful engineering lecturers do slip in personal anecdotes and stories with lessons or insight about the human person into their classes, recognising that students respond favourably to them.

The Curriculum Framework's student focus also implies that curriculum differentiation can be expected, especially for special needs (struggling as well as gifted) students. In most first year engineering units, the same content is

presented to the entire cohort, undifferentiated. This causes stress and disappointment for our gifted and talented first years.

Aim of the curriculum – university / Aim of the curriculum - workplace / Co-curricular

The students who choose to undertake post-compulsory secondary education do so in order to secure a place in tertiary education. These students approach their studies strategically, tending to choose subjects to minimise their effort and maximise their university entrance score. Although there are some who choose subjects 'for the love of it', most play 'the game' in their final years and become very skilful in working out the system (maximising effort on assessment, appeals, exam techniques, subject choices). This has been described as a surface or strategic learning approach rather than a deep learning approach (e.g., Houghton, 2004).

When they first arrive at university, these students then try to use these well-developed skills as the basis of their approach to being successful in their engineering studies. These students very quickly encounter resistance from teaching staff who emphasise that what is primarily being developed in an engineering degree are engineering skills, not the skills of passing exams or being able to find out what questions are in an exam. These student's exam skills will not be valuable to them in the workplace, whether it is as a professional engineer in industry, or as an engineering academic. These skills will not even help them secure that job.

For a student adopting a strategic approach to their learning, their focus is what is in the curriculum. Little value is placed on events that are co-curricular or extra-curricular, whether planned by the Faculty or student groups. Encouraging first year students to attend a presentation by a visiting Nobel Prize Laureate, going on a site visit to industry, meeting industry at a Faculty organised networking event, attending a presentation by the careers centre about planning your resume, attending a presentation on equity or diversity – these activities are not assessable parts of the first year engineering curriculum, even though the Faculty sees these activities as worthwhile for the students, genuinely enriching the first year engineering experience.

2. Student's Experience of His/Her Whole Day / Team Building

A secondary school student's day contains classes in Mathematics, Sciences, English, Languages, Arts, Drama, Music, Physical Education, study skills, possibly religious education, assemblies, 'home rooms', and co-curricular and extra-curricular activities, all planned by the school as part of developing the whole person. This is a good mix of left-brain and right-brain activities.

The daily experience of an engineering first year is different. All classes are Mathematics and Science based. This means for 6 – 8 hours a day, the classes are based dominantly in the left-brain. Add to that homework and revision, and the

first year engineering student is expected to spend 10 – 12 hours a day predominately in his or her left-brain. This is a major change to the educational experience of the engineering first year, who may not be consciously aware of this left-brain focus. Many first years start off with good intentions, doing the hours, grit their teeth, and get on with it, only to run out of steam after a few weeks.

The student groups around university become very attractive at this point. Social needs can by met through the Faculty and Student Guild student groups, religion based groups meet other needs, one can practice a language learnt during secondary education through the French, Italian, German, etc clubs, and drama, music, tai chi, medieval, dance, etc, clubs help provide right brain balance to the overall educational experience.

Some first year engineering students also address this balance in the curriculum by choosing to study a combined degree. Students have remarked that the non-engineering part of their studies is 'relaxing' and helps them cope better with the engineering side.

Possibilities for communicating Level 0 assumptions

The challenge of a person in the role of supporting first years is to encourage the first year university student to see their education as more than just the formal curriculum, the content delivered in the scheduled classes or what is being assessed. These 'formal' offerings are only part of the student's educational journey. The university's offered co-curricular activities and extra-curricular activities are a way of achieving a left-brain / right-brain balance, and unlike secondary school, where this balance is built into the curriculum, it is now up to the first year student to choose and schedule these activities into his or her day.

Level 0 assumptions about the tertiary teaching and learning environment are communicated to students and their parents in a number of ways. Orientation booklets can be reworked so that the 'teaching and learning team' approach is explicitly stated. New students in a professional degree can be challenged to reframe their approach to their studies so that they are now seen as leading to a workplace – for engineering, the challenge could be for the new first years to not see themselves as students studying engineering, but to see themselves as engineers – in – training, professionals - in – training, thus raising the value of co-curricular and extra-curricular events.

Some universities also hold orientation activities for parents of first years. At these 'Parent Welcome's, parents are keen to know how to support their sons and daughters. For engineering, one way is to highlight to the parents the extremely left-brain nature of the engineering student's daily experience, and to encourage their son and daughter to persist with typically right-brain activities to provide balance. If their son or daughter previously played a musical instrument, sang in a choir, played sport, danced, painted, suggest to the parents that they support them in continuing to do these activities, even when it gets

tough and their son or daughter is tempted into a tunnel vision focus on their engineering studies.

Concluding Comments

I have found our first year engineering students to be very bright, capable and determined to succeed. They have just signed on to this strange 'appliance' called a four or five year university engineering degree. With a little attention to the 'Level 0' distinctions at the start of their 'instruction manual', not only will the rest of the manual make sense, but they may even feel more empowered to succeed, feel they can belong sooner, and feel they can be more effective sooner.

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