A retrospective on work integrated learning by engineers

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Structured abstract

BACKGROUND
The UNSW Co-op Scholarship Program, which has graduated 968 engineers in 25 years, involves a partnership between university and industry. Engineering students (amongst others) complete up to 68 weeks of industry-based education integrated with their formal BE studies, while being financially supported by the companies providing the training experience.
The value of integrating industry-based education with university study is widely recognised. Having students use their learning reinforces and accelerates understanding. Research into the learning experience, though, has concentrated on students' immediate outcomes and on measures of graduate employability. The longer term benefits are less well documented, but these matter when it comes to allocating resources to support student learning.

PURPOSE
This project sought to examine the perspectives on the long-term value of industry-based education held by those graduates who had completed their industrial training several years ago, and compare this with that of both the newly graduated engineers and teaching academics.

DESIGN/METHOD
For a longer term view, we surveyed the Program's Alumni to learn what they now considered to have been the key value of their work placements, and how their thoughts about this may, or may not, have changed since graduation. We used both Likert-scale and open-ended questions. The Likert-scale items included aspects of personal, career, work-skills and academic development. For quality assurance purposes, the Program has collected an extensive database of perspectives provided by students through exit surveys at the end of their studies and these were available for comparative purposes. We compared the views of Engineering graduates with their Business counterparts and their former academic mentors.

RESULTS
The important benefits of the WIL are those associated with personal development and the student's increasing sense of professional identity. This is agreed by their mentors and also the Business Alumni.

CONCLUSIONS
Successful work-integrated learning needs good workplace mentors (not just good supervisors) to help students develop their sense of professional identity. Since these cannot be guaranteed, to ensure maximum benefits come from the industry-linked training, part of the program needs to include structured learning opportunities specifically designed to help a student develop this.

KEYWORDS
Industry-based education, work placements, work integrated learning.

Introduction

The UNSW Co-op Scholarship Program, which involves students completing segments of structured industry-based training (IT), is celebrating its 25th year in 2013 and this, being a natural time to look both forward and backward, provided an opportunity to assess various perceptions about the educational merit of its IT component, a form of work-integrated learning (WIL). The structure of the program, described more fully in the next section, involves cycles of experiential learning in which students, who are sponsored by industry, 'study' in an academic context and then 'apply' in a workplace, before returning to the academic context. The formalised descriptions of such experiential learning and their associated pedagogical value have long been discussed (e.g. Kolb, 1984). WIL is ***not*** simply learning by experience. The latter is unstructured and random and lacks assurance of successful outcomes. The benefits (learning outcomes) of WIL are many and varied, some intended and some entirely accidental. Educators should be controlling the process, to enhance the former and ensure that, when the latter occur, they do not obstruct learning. This Co-op Program provides structured support to students to do this. Investigation of the success of IT is part of the quality assurance needed to successfully design education.

Engineering itself has a very long tradition of work-integrated education. Some of the modern disciplines arose from an apprenticeship system, prior to their adoption into tertiary education institutions, and there has always been a debate about how practical, on-the-job training should be included in an engineer's education. More generally, the value of WIL is widely supported. The notion of reinforcing academic learning by its application in a real context has intrinsic pedagogical merit. That graduates of such education are better prepared for employment is believed, but how, precisely, are they better prepared? What are the benefits of an industry-linked training? This is explored below, as the main theme of this paper.

Graduates of WIL programs such as the Co-op Program are expected to demonstrate a number of specific beneficial learning outcomes, which have been much studied. We used the description proposed by Fletcher (1989 & 1991; Eames & Cates 2011) to group the benefits (outcomes) into the following broad categories.

- (A) Academic development: attributes that lead to improved academic performance, eg motivation. Such development is not expected to be valued as highly once someone has finished formally assessed learning.
- (D) Personal development: the inter-personal skills that support teamwork, leadership and organisational activities, as well as accepting responsibilities.
- (W) Work skills: the day-to-day skills needed by everyone to negotiate the workplace, e.g. taking instructions.
- (I) Career development: about the student becoming comfortable in the chosen career. We prefer the term "professional identity (self-awareness)" as it is really about developing a sense of identity as a professional, in our case as an engineer.
- (C) Career progression benefits.

Any evaluation of IT needs to consider how successfully the training provides positive outcomes in all these categories. Some of the benefits would seem to be more valuable before graduation, e.g. greater motivation to study, but some would seem to have enduring post-graduation benefit. In this paper, we seek to investigate whether there is evidence to support this separation.

While the pre-graduation benefits can be assessed by improved academic outcomes in formal study, the post-graduation benefits can only be measured by career progression and self-reflection by graduates of a program. Educational institutions tend to respond to the immediate benefits identified for students, but they should not forget the importance of the longer term benefits in order to provide a complete education. For that reason we have involved the Program's Alumni in our research. Experiential learning in general (Kolb, 1984)

has a focus on the process, not the outcomes which are harder to identify and may not appear for years. This contrasts with traditional university emphasis on assessing outcomes as soon as possible. This, too, means Alumni, not only students, are needed to properly evaluate the success of the Program's IT.

It was outside the scope of this work to explore what the sponsoring partners thought about the importance of IT and its various benefits. Previous work has revealed what employers see the most important benefits to be (Commonwealth of Australia, 2007; Braunstein et al, 2011). Sponsors tend to give the same answers as industry more generally about what is important: immediately useful employment skills top the list. An early internal survey (Nawar, 1996) showed 75% of sponsors rated general workplace awareness as the most important benefit of IT, a higher ranking even than the oft cited appreciation of improved communication skills. Also, there has been a very high turnover of the Program's key contacts within the industry partners so a retrospective survey corresponding to that asked of Alumni was not feasible.

There are several reports (eg as surveyed by Dressler & Keeling, 2011) about what both enrolled students and new graduates thought of their IT experiences. There are far less reports, though, exploring a longer term perspective to identify the enduring, long-term value of such education. This paper touches on the experience and perceptions of new graduates, but concentrates more on the perceptions of the program's Alumni about what they gained from their IT. This longer term perspective is important to the design of the educational system supporting WIL. Given educational resources are not infinite, choices about allocating them need to be guided by delivering important benefits, not superficial ones. Specifically, we found that the long term benefits were seen in the sense of professional identity and personal skills that the students developed. This paper points to the need for good workplace mentoring to enhance the students' sense of identity as engineers. We suggest formal support is essential in case of its absence in the workplace.

In the next section, we briefly review the scholarship program itself, including its aim. Thereafter, we describe what we learnt about the benefits of the WIL component. Conclusions on the 25 year retrospective form the final section.

The industry-linked Scholarship Program

The UNSW Co-op Scholarship Program (UNSW, 2011) has been operating since 1988, when it was established in response to an identified need and supported by Australian Government funding. Of the 2566 Alumni, 968 are engineering graduates of various sorts. Most of the remainder come from a variety of business-related disciplines. The Program not only integrates traditional academic study with WIL, but also systematically develops the so-called soft skills of students through structured and supported activities such as workshops and camps.

Scholarship-holders are selected for both academic ability and leadership potential, i.e. the Program wants not only technical excellence but also the engineering executive ability. Scholars are selected from recent school-leavers on the basis of (i) a written application, (ii) an interview conducted by a panel of academics and representatives of sponsoring companies, and (iii) school results. There is a minimum academic requirement, corresponding to the Australian school-leaving ATAR of 96. Because of these selection criteria, there is less diversity within the cohort of Co-op scholarship holders than the student population as a whole. This means that there is an element of control over many of the confounding variables often involved in studies of WIL: a limited set of high schools, all ATARs over 96, excellent interpersonal and communication skills. Different types of learners produce different outcomes in any given situation. Selection to participate in the Co-op Program means a narrowing of this variability, too, e.g. most, if not all, will be comfortable learning in a group context rather than alone. Each student in the Program has a nominated academic mentor.

All engineering scholars are financially supported through the four years of study required to complete the BE and also through three or four periods of IT which total from 36 to 68 weeks, depending upon engineering discipline. Thus, scholars complete 4 to 5 years, with most being on the Program for 5 years. The Program's academic support of WIL focuses on formalising the acquisition of the associated soft-skills, to ensure all students benefit from their IT placements. Students agree on nominated professional development outcomes before commencing and complete a formal workplace appraisal at the end. They are encouraged to have regular reviews during their IT. Alas, in Engineering placements, the emphasis is more often on project deliverables and technical skills than on imparting professional attributes and identity.

To date, there have been 1139 engineering scholarships (some not yet completed) corresponding to over $61 million invested by sponsoring organisations, mostly Australian companies although, in recent years, the global nature of the photovoltaics industry has been shown by sponsorship by some off-shore companies. Also, some Australian-based companies have assigned scholars to placements in their off-shore operations. Although support for business scholarships was affected by the GFC, it seems to be recovering. Not so with Engineering. There was a peak of 50-60 engineering scholarships annually but, over the past decade, this has dropped to about 30 each year and continues to decline.

After 25 years of success, then, it was time not only to celebrate, but also to conduct some research into why industry support was declining and assess whether the existing scholarship model remains relevant. Part of this involved a detailed study of the benefits and outcomes of the IT component and part of that research involved examination of perceptions about the true value of the industry-linked portion of the scholars' education, as reported in the next section.

Evaluation of benefits of industry-linked training

To evaluate the benefits of the IT component, we surveyed various stakeholder groups: the Alumni, those who have just graduated, and the university's academic staff who mentor the scholars.

First, respondents were asked to rank the relative importance of various features of the scholarship program. Alumni and graduating students were requested, "Rate how important you feel each of the outcomes of IT ... actually was to you." This used a 4 point Likert-scale. The surveyed outcomes included 14 items which were derived from topics that had been previously specifically nominated as "the most important thing" by students completing their respective industrial training periods. Another three items about employment were added. Together, these questions covered all five of the categories described above. The survey also included scope for open-ended comments.

In terms of the total number of replies examined, a more rigorously validated survey exists: the PLACE instrument (Parks et al, 2001) which measures benefits of WIL by respondents' (graduates or students) self-reporting answers to 34 questions. These, too, involve all the above categories, and are based on the outcomes listed in the ABET documentation. Many correspond to explicit items in the Engineers Australia accreditation documentation, too. We did not use this longer instrument, in part to keep the survey as short as possible, given that the Co-op Scholarship Office was simultaneously asking after other topics, and in part to ensure focussed local relevance.

We used the UNSW Co-op Scholarship Alumni database to email the survey asking (amongst other topics) what the graduates thought about their respective IT experiences, and specifically its value to them.

Results

There were 86 usable replies to the survey from Engineering Alumni, including graduates from all years from 1992 to 2012.

Table 1 gives the outcome of the Alumni's ranking of the relative importance of various features of the scholarship program. This is as the average ranking points, out of a maximum possible of 7. They clearly considered the most important item to be the IT placements, with 5.1 points. This is not surprising since IT is central to the identity of the scholarship. The lowest importance is afforded to academic mentoring (2.3), which may be a consequence of the selection criteria ensuring that the scholars are high achievers anyway (an interpretation less damaging to our egos than the obvious one). Standard deviations on these average rankings varied from 1.8 to 2.6, so this was far from a uniform choice. Interestingly, the open-ended comments showed that they had the most difficulty with ranking the relative importance of the scholarship income. This comment highlighted that puzzlement well (quoted verbatim):

> *As a student I think that the payments hold more importance but after employment, with hindsight, the other factors hold more importance.*

Table 1: Relative importance of aspects of the UNSW Co-op Scholarship Program
Given by average ranking points: theoretical maximum 7, minimum 0.

Feature of scholarship program	Engineering	Business
Industry placements	5.1	5.1
Employment opportunities	4.2	4.4
Payments	4.1	3.0
Sponsor networks	3.5	3.5
Soft skills training	3.2	4.1
Leadership opportunities	3.2	2.9
Network of friends	2.7	3.4
Mentoring & academic guidance	2.3	2.2

For comparison, Table 1 also gives the rankings returned by the Business Alumni. They had the same 2 highest and same lowest choices, but shuffled the aspects between these limits. Perhaps most surprising is how differently the payments were placed.

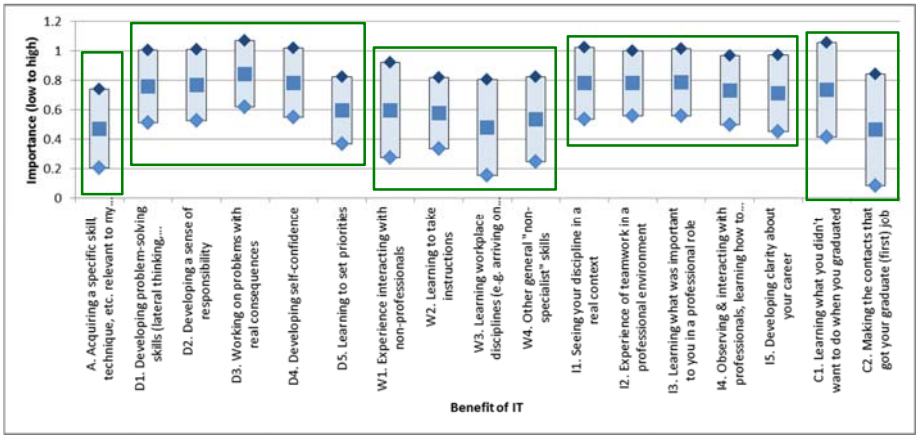

Figure 1: Importance of the outcomes of IT
Bars extend one standard deviation either side of the mean. Boxes group items by benefit category.

Given that the IT involves WIL, rather than this overall importance within the Program of IT itself, it is more interesting to discover what they think are IT's more important benefits, particularly as they perceive them now, in some cases 21 years after graduation. Results are seen in Figure 1, where the Likert-scale is normalised from 0 to 1. The grouping of responses is quite revealing. Those items related to either personal development category (D) or professional identity category (I) scored highly; items related to the generic workplace skills category (W) and academic development category (A) rated lower. To make this clearer, the average ratings for the respective categories of IT benefits are given in Table 2. From this longer term, post-graduation perspective, personal development (D) and professional identity (I) are considered far more important benefits of the WIL. Employers of graduates, though, value workplace skills (W) as the most important IT benefit.

Table 2: Normalised ratings for IT benefit categories.
Importance: critically important 1, unimportant 0. Change in importance: maximum increase +1, maximum decrease -1. This is ***not*** a change to the importance rating shown, as it derives from answering different questions.

item	Engineering		Business		Mentors
	importance	change	importance	change	importance
academic development (A)	0.47	-0.13	0.70	-0.03	0.59
personal development (D)	0.75	0.52	0.80	0.43	0.74
work skills (W)	0.55	-0.04	0.54	-0.15	0.49
professional identity (I)	0.76	0.26	0.81	0.20	0.72
career progression (C)	0.60	-0.13	0.73	-0.06	0.55
sample size	86		95		9

Again, in Table 2 we include comparison with the survey of Business Alumni who considered each of the benefit categories as more important than did Engineers. Although the same two categories were on top, the distinction between categories was not statistically significant. Past and present academic mentors were also invited to give their perspectives on the important benefits of the IT. The averages from this very small sample are remarkably close to the Alumni's assessment!

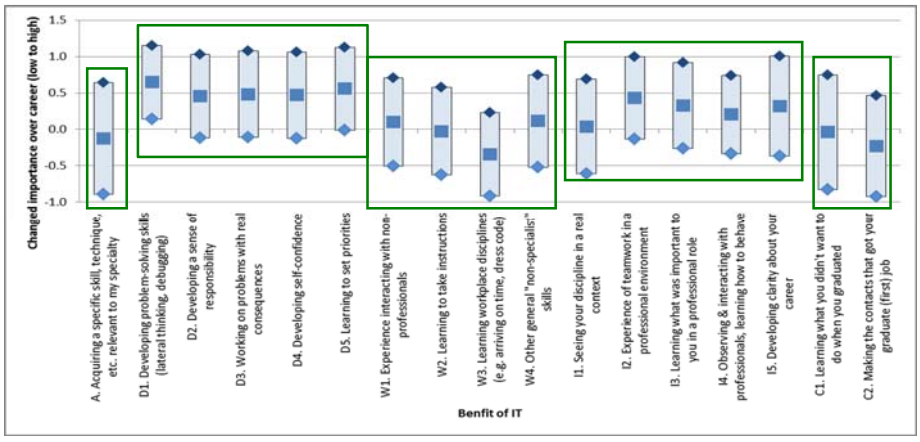

Figure 2: Changed perception of importance of benefits of IT
Bars extend one standard deviation either side of the mean. Boxes group items by benefit category.

It is also interesting to see how perspectives on the importance of the benefits have changed over time. Alumni were asked whether the respective "issues had become more or less important." The resulting averages are given in Table 2, and can be seen item-by-item in Figure 2. The 4-point Likert scale has been renormalised from -1 to 1, so that positive values are increases in importance, negative values decreases. The importance of three categories has reduced – academic skills (A), workplace skills (W), and career progression – has dropped and the importance of personal development (D) and professional identity (I) has increased over time. Considering the number of years elapsed since graduating from the UNSW allows a more detailed analysis of how an issue's perceived importance changes with time. Given the relatively small numbers, three 7-year clusters were formed. The average changes for the IT outcome categories with time are plotted in Figure 3. Those items specifically related to academic development (A), workplace skills (W) and career progression (C) have become progressively less and less important (negative values) with time after graduating, entirely consistent with expectations. Other benefits are consistently seen as more important now (positive values) and this increase in importance was realised almost immediately after graduation. The Business Alumni, too, gave increased and reduced importance to the same benefit categories, but they assessed workplace skills as that which had reduced most. The argument is that the benefits of WIL that are actually important are the benefits which experience has shown to be important to the Alumni. Before this experience, importance is influenced more by expectations.

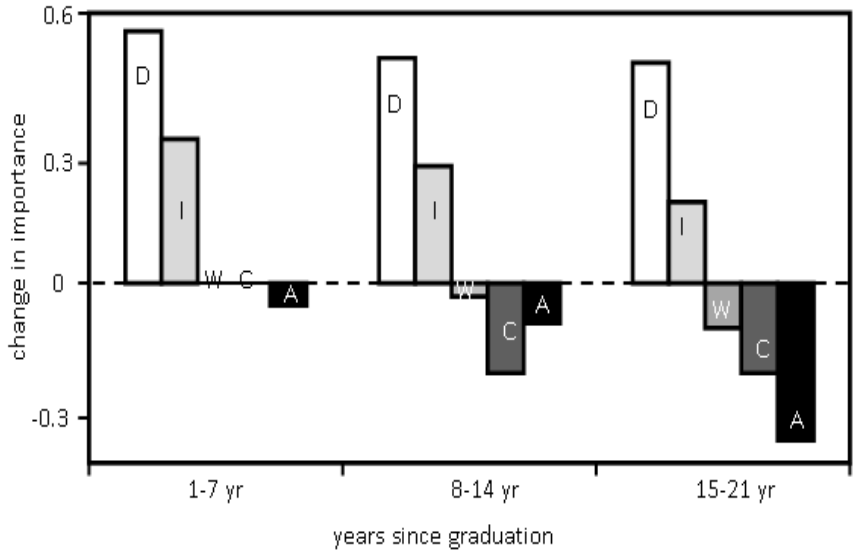

Figure 3: Variation of perceived importance of the IT benefit categories over time.
Note that both W and C did not change in the first year cluster.

Perhaps the words of the Alumni themselves convey their thinking most clearly. The following are indicative comments (verbatim).

> *In retrospect the program was a lot more valuable than I (and I suspect many others) recognised at the time and making best use of the opportunity is to everyone's advantage.*
>
> *The IT experiences were the most influential factor in preparing me for the workforce. I grew so much as a person and as an employee during those period. I valve the lessons I learnt and they set me up to win when I did enter the workforce on a permanent basis. The friendships I made will last a lifetime.*
>
> *With hindsight, I see that I wasn't supervised properly, and didn't get appropriate projects or the guidance or feedback required to develop and learn.*

It was relevant then to building professional skills, experience, behaviour, and I would consider is still the same now.

Considering survey responses by discipline, 30 came from electrical engineering in its widest sense, 26 from chemical engineering/industrial chemistry, and 30 from others. We identified no significant differences between these smaller sub-sets. For example, for almost all questions, the standard deviation for each sub-sets did not vary by more than 0.05 from the overall standard deviation of all replies for the relevant category. The largest range of the three sub-set means was for category A, with 0.18, which is less than a quarter of a standard deviation for category A and the smallest spread of means was 0.03, for category P. In terms of rankings the Program's attributes, the "other" Engineers were slightly more definite in their scoring, but again differences were small in terms of standard deviations.

Each year an exit survey of the new graduates is conducted. This is basic quality assurance. Specifically, scholars are asked about employment-related matters and how they found the program more generally. Most refer to two things: there are the employment benefits (sponsor networking, etc.), which is not surprising given the large number who find employment with sponsoring companies (fluctuates, but over 75% is long term average) and there are fond, immediate memories of the close friendship network they developed, particularly amongst the students who shared their IT experiences. Though these nominations are understandable, the Alumni survey suggests they are not be the true educational benefits of the WIL.

Discussion

From the perspective of learning, the most valuable benefits of the IT seem to be those associated with personal skills and professional self-awareness, as evidenced by the importance given to these items in the survey, rather than to the others. Furthermore, the importance of these benefits appears to be appreciated more with time. It is often quoted that "Education is what is left after all that has been learnt is forgotten." Specific skills can be forgotten or become obsolete; a sense of personal identity need not.

The Program's WIL is having a profound effect on the scholars' developing a sense of identity: Who they are? What kind of engineering professional they will be (not in the sense of technical specialisation)? This is consistent with what is happening more generally in the students' lives at that age, a time of developing a sense of independent identity. It would seem that the IT accelerates the engineering-related part of this developing self-awareness. This emphasises the importance of providing students with high quality workplace mentoring to enhance the long-term value of their IT. The Alumni's open-ended comments tell how they, too, recognise the program would be strengthened by better mentoring and monitoring of the IT. Here is a very insightful suggestion:

Consider assigning each student an industry mentor to work with them throughout the course of their degree. The mentor would not be there to help them with their studies but with transitioning to becoming an effective professional.

In our experience, though, mentoring is not an engineering sponsor's priority, despite the literature arguing that employers also benefit from the development of a student's sense of professional identity (Braunstein et al, 2011). Not all industry placements are good learning experiences. Workplace learning outcomes are highly influenced by the engineering project undertaken and the supervision given. If the workplace does not provide the necessary mentor, no matter how good the supervision or role model may be, then the student needs to receive suitable support from elsewhere. Then the academic partner in the WIL program needs to structure formal learning opportunities, not just for soft-skill development, but also to replace the missing professional mentoring. This is something that the industry partner may find surprising, if not disconcerting. UNSW is currently formalising support of the Business scholars' WIL by integrating specific learning activities, e.g. reflections, to ensure that personal development and professional identity, as well as practical work skills, are enhanced from the each IT placement.

In summary, successful work-integrated learning needs good workplace mentors (not just good supervisors). Since these cannot be guaranteed, to ensure maximum benefits come from the industry-linked training, part of the program needs to include structured learning opportunities specifically designed to help a student develop a sense of professional identity.

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