

Evaluation of Engineering Work Experience Programs (I): Principles

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***Abstract:** Currently, most Australian universities offering engineering degrees have developed work experience programs as advocated by Engineers Australia. It is of great importance that academics and the engineering industry continue to evaluate these programs. However, a review of existing literature in Australia and overseas reveals a shortage of evaluative research on engineering work experience programs (EWEP).*

This paper is the first part of a three-part report on the “Evaluation of Work Experience Programs” project carried out at the Faculty of Engineering, The University of Sydney since 2007. It highlights the need for and the basic theories pertaining to the evaluation of EWEP. A brief literature review on existing evaluative studies is also presented. A program outcome model is then derived for EWEP to guide future evaluative research in the area.

Introduction

Engineers Australia in its program accreditation guideline states (Engineers Australia, 2006, 2008):

It is considered that there is no real substitute for first-hand experience in an engineering practice environment outside the educational institution. Engineers Australia strongly advocates that all engineering schools include a minimum of 12 weeks of such experience (or a satisfactory alternative) as a requirement for the granting of qualifications.

In response to this recommendation, most Australian universities offering engineering degrees have incorporated a form of Engineering Work Experience Programs (EWEP) in their degree programs. However, despite the prevalence and the importance placed upon EWEP, there is not yet a well accepted method for their evaluation and evaluating EWEP is not standard practice in most institutions.

This is a concern, because it is only through evaluation that stakeholders can ascertain the effectiveness of a program. It is also through evaluation, that program administrators can obtain useful information which may assist them in improving the design and implementation of the program. As Martin noted there is considerable variation in the effectiveness of practice in work placement programs (Martin, 1996):

Although there are many studies indicating that work-based education is effective in developing competent and professional graduates, it is unclear how much and what aspects of these programs contribute effectively to this end. ... there is still no set of clear guidelines on how to maximise the effectiveness and efficiency of these programs.

Evaluating the outcomes of EWEP is all the more important considering the current higher education climate that focuses heavily on learning outcomes. Presently, many accreditation processes require universities to define and measure learning outcomes and revise programs based on the results (Linn et al. 2004). As universities strive to evaluate learning outcomes of their academic units, it is imperative that universities also evaluate the learning outcomes of its EWEP and the extent to which EWEP add value to the overall learning outcomes of the degree program.

EWEP evaluation is also beneficial for the industry as a whole. It is through evaluation that employers can justify the resources invested into EWEP (Cameron-Jones and O’Hara, 1992). Furthermore, a recent study by the Australian Department of Education, Employment and Workplace Relations (DEEWR) found that students’ experience in their work placements influences their decisions to

pursue a career in engineering (DEEWR, 2008). Therefore, the quality of EWEP is as much an issue for the engineering industry as it is for the educational institutions.

In 2007 the academic author of this study commenced a project “Evaluation of Work Experience Programs”. The preliminary results of this study are now reported in three consequent papers: Evaluation of Engineering Work Experience Programs: (I) Principles, (II) Implementation, and (III) Current Practice in Australian universities.

Research in Work Experience Programs

There is extensive evaluative research in certain forms of work placement programs, most notably co-operative education (Linn et al., 2004), however, there is considerably less research in shorter-duration, non-recurrent work experience programs – a form that is more commonly adopted by engineering faculties in Australia. While the differences between different forms of work placements may be significant, studies in other forms of work placement programs offers an insight into how EWEP can be evaluated. A brief overview of relevant studies in the area is provided here. A more extensive study may be found in Yusman (2008).

Areas of Evaluation and Methodologies

Current evaluative research in the area has investigated and documented numerous benefits from incorporating work placement programs. The benefits for students range from higher starting salary and increased probability of receiving an offer prior to graduation (Schuurman et al., 2008), improved generic skills (Crebert et al., 2004; Martin, 1996; Freestone et al., 2007) to intellectual development (Keen, 2001).

Benefits have also been identified for the employing organization and the academic institution involved. Braunstein and Stull (2001) found benefits for the host organization include the hiring of people with special skills, the bringing of new knowledge into an organization and the fulfillment of social responsibilities. Examples of benefits for the academic institution are student recruitment and curriculum development (Weisz & Chapman, 2004).

A plethora of methodologies have also been employed in the evaluation of these benefits. Comparative studies between placement and non-placement students tend to use quantitative methods such as a five-point Likert scale questionnaire and regression analysis (Martin, 1996; Parks et al., 2001), while qualitative methods such as attitudinal surveys (Eakins and Christopherson, 2000), interviews (Eames, 2004) and student reports (Tener, 2004) is the preferred choice for studies focusing on the in-depth recovery of student and employers’ perceptions.

Design, Outcome and Implementation

An alternative way of looking at current research in the area is to categorise them based on which facets of a program are evaluated by the studies. According to Rossi and Freeman (1985) there are three foci of evaluations: conceptualisation and program design, monitoring of program implementation and assessment of programs outcomes. In other words, there are three aspects of a work experience program that can be evaluated: (1) the design of a program, (2) its implementation and (3) the outcomes of the program.

The majority of research in work experience programs tends to focus on the (3) outcomes and (2) operational aspects. Lipsey (1993) argued that by merely focusing on the output and input of the program, evaluators tend to take a ‘black-box’ approach to evaluation and overlook the causal process. This prevents evaluators from assessing whether the program is ‘designed’ in conformity with the intended goals and whether there is a coherent rationale underlying the program.

More recent works have made progress into the area by attempting to study students’ learning processes during their work placements (see Tener, 2004; Eames, 2004). In doing so, they are providing useful input to program coordinators in the design of their work experience programs.

Gaps in Current Research

While there is extensive evaluative research in work experience programs, majority of the examples cited above refer to co-operative education programs. There is unquestionably a lack of research in short-duration, non-recurrent EWEP commonly adopted by Australian universities.

Moreover, while there is a growing body of literature that attempts to link implementation issues with the learning outcomes (see for example Freestone et al., 2007; Martin, 1996), there is a lack of investigation into the relationship between students' learning processes and outcomes. It has also been noted that studies in work experience programs tend to have little or no theoretical underpinnings (Linn et al., 2004):

The field of cooperative education and internships has not made consistent and systematic efforts to surface questions and then seek answers, as have other fields of study. Furthermore, the existing body of research in co-op and internships has fallen short of scientific inquiry to illuminate relationships, predict effects, and explain findings in light of existing theory.

The above observations indicate significant gaps and great potential in this research area. In 2008, in answer to the enquiry by the Australian Government Department of Education, Employment and Workplace Relations 20.5% engineering graduates stated that their work experience did not meet their expectations (DEEWR, 2008). There is no doubt that this research area needs much more attention by researchers and all stakeholders of these programs.

Defining Evaluation of EWEP

Unlike an engineering or science academic unit, work experience programs involve a large variety of learning environments. Students work in companies of different sizes, organizational structures and disciplines, undertaking different projects and tasks over varying durations of time. The learning processes and outcomes of each individual student will be unique and establishing common criteria for measuring success is challenging.

Consequently, EWEP is a social program rather than a scientific one and the evaluation of a social program will require a different approach than one used in a scientific or engineering inquiry. While scientific research typically aims to generate a theory or test a hypothesis, the purpose of evaluation is to examine the effectiveness of a program or intervention. Evaluation research aims to inform stakeholders and assist them in their decision making (Rossi et al., 2004):

Program evaluation is the use of social research methods to systematically investigate the effectiveness of social intervention programs in way that are adapted to their political and organizational environments and designed to inform social action to improve social conditions.

Rossi et al. (2004) also identified that the central tasks of evaluation are assessing the design, the implementation and the outcomes of a program. Therefore, for the purpose of this study, it is possible to draw from Rossi et al. (2004)'s broader definition of program evaluation, a more specific definition pertaining to EWEP evaluation:

Evaluation of engineering work experience programs is the use of social research methods to systematically assess the design, implementation and outcomes of engineering work experience programs to enhance the educational effectiveness of these programs.

It is also possible to extract from these definitions, qualities which an evaluation method should possess:

- The method should yield useful information for stakeholders that can be utilised to improve the implementation and management of the program.
- The method should be reliable and valid according to the theories of social research.
- The method should be practicable.

Outcome Model for EWEP

The concept of evaluation itself entails a description of the performance of the program being evaluated, as well as the development of criteria for judging the performance. Thus, a well defined outcome model is crucial when determining which outcomes should be considered for evaluation (Rossi et al., 2004):

An impact theory expresses the outcome of social programs as part of a logic model that connects the program's activities to proximal (immediate) outcomes that, in turn, are expected to lead to other, more distal outcomes. ... It is thus especially important for evaluator to draw on this portion of program theory when identifying these outcomes that should be considered for measurement.

In developing an outcome model for EWEP, the authors looked to the numerous proximal and distal outcomes covered by studies in industrial placements. Examples of these proximal benefits include academic progress (Van Gyn and Ricks, 1997), career enhancement (Schuurman et al., 2008), development of generic skills (Crebert et al., 2004; Martin, 1996) and knowledge augmentation (Williams et al., 1993). The authors hypothesise that these proximal benefits affect students' readiness for the labour market or their 'employability' (Abadeer, 2007) and in the long term, provide the skills necessary to lead a successful and sustained career in engineering. Based on the above, the outcome model for EWEP has been developed as shown in Fig. 1.

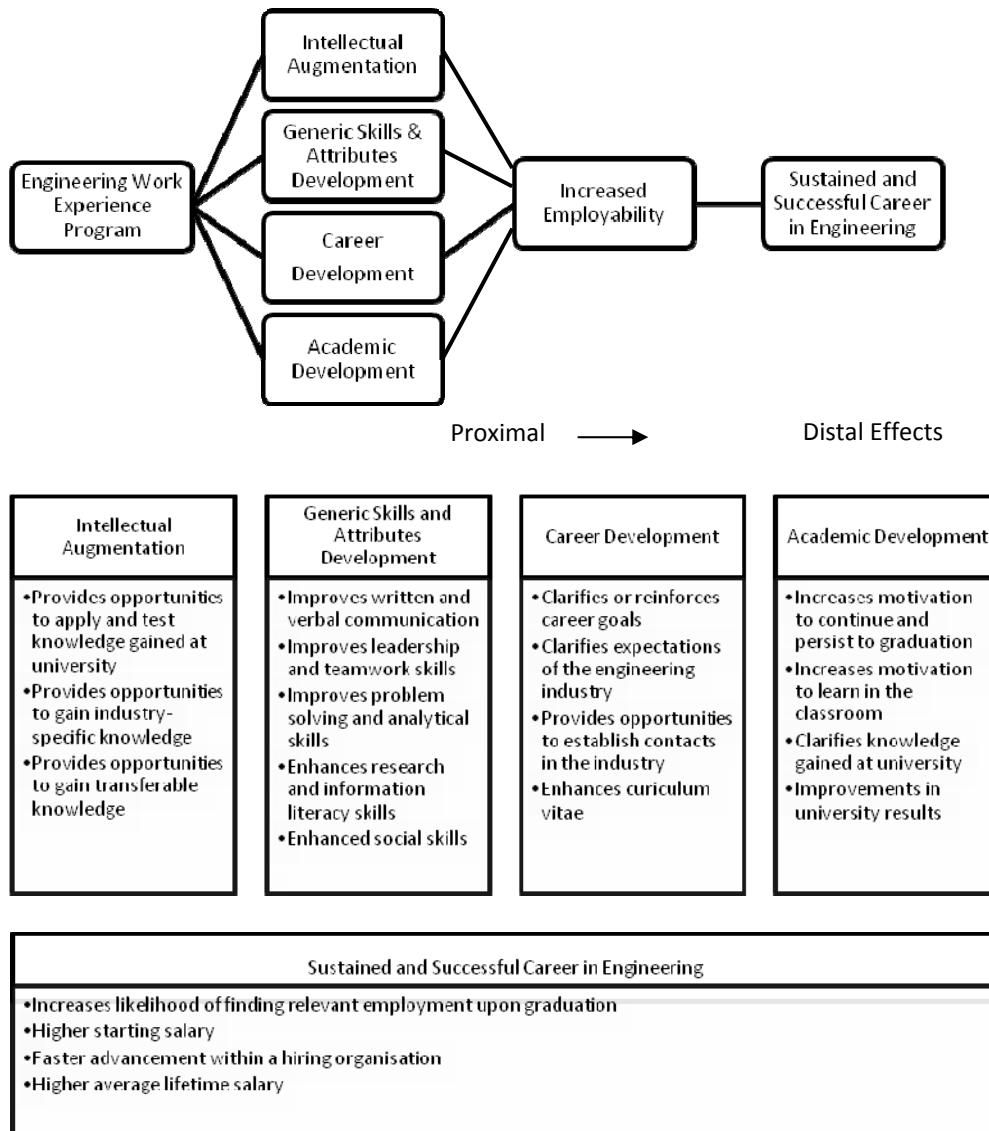


Figure 1: EWEP Outcome Model

One of the reviewers has raised an interesting comment on if it is a result of all the other effects rather than being an 'effect' in itself? The authors would leave this to all others rather than trying to answer it by themselves in a limit time and space.

Developing Research Questions

According to Rossi et al. (2004), a good evaluation question must 'address issues that are meaningful in relation to the nature of the program and also of concern to key stakeholders'. In the last decade, one of the key areas of concern in higher education has been the development of students' generic skills. Reports commissioned by higher education stakeholders (Business Higher Education Round Table, 1991; Institution of Engineers Australia, 1996) recognised the importance of generic skills. It is

no longer sufficient for engineers to have technical expertise. In addition to science and engineering fundamentals, engineering graduates need to possess social, teamwork, communication and learning skills (Institution of Engineers Australia, 1996).

In response to this, many universities have addressed and evaluated the development of generic skills in their academic units. Effort has been made to target generic skills development in classroom teaching and assessments. At the University of Sydney, the mandatory Unit of Study Evaluation questionnaires ask students to rate the extent to which academic course develops valuable generic skills. The development of generic skills in the EWEP however, has never been formally addressed or evaluated.

In light of this, the authors chose to focus this evaluation project on the development of generic skills in work experience programs. It is also recognised however, that simply evaluating generic skills outcome alone is not sufficient. Stakeholders need to also understand which aspects of the work experience program contribute to the effectiveness of the program in developing students' generic skills. Hence, the following questions were proposed:

- What general transferable work skills and attributes are developed in work experience?
- What aspects of the workplace and the program support the development of these skills and attributes?
- What learning experiences and processes in the workplace lead to the development of these skills and attributes?

Conclusion

Paper (I) of this study lays some theoretical foundations for the project of 'Evaluation of Work Experience Programs'. Its definition, the gap in current research, the program impact model and the research questions are outlined. This serves as a prelude to the Paper (II), which describe the implementation of an evaluation method in the University of Sydney. It will be followed by an examination of EWEP current practices in Australian universities in Paper (III) with recommendations.

It is not the authors' intention to fill all the gaps in current research. It is neither possible given the limited time and resources. It is, however, their intention that by addressing the subject matter, they are able to draw the attention of the engineering education research community to an important topic in contemporary engineering education.

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References

- ABADEER, O. (2007) Evaluation of the work experience program. *School of Electrical and Information Engineering, Faculty of Engineering*. Sydney: The University of Sydney.
- Braunstein, L.A. & Stull, W.A. (2001). Employer benefits of, and attitudes towards post secondary cooperative education. *Journal of Cooperative Education*, 36(1), 7-17.
- BUSINESS/HIGHER EDUCATION ROUND TABLE (1991). *Aiming Higher: Business/Higher Education Round Table 1991 Education Survey. Commissioned Report No. 1*. Melbourne, Business/Higher Education Round Table.
- CAMERON-JONES, M. & O'HARA, P. (1992). Making placement more successful. *Management Education and Development*, 23, 46-53.
- CREBERT, G., BATES, M., BELL, B., PATRICK, C.-J. & CRAGNOLINI, V. (2004). Developing generic skills at university, during work placement and in employment: Graduates' perceptions. *Higher Education Research and Development*, 23, 147-165.
- DEEWR (2008). Views of Engineering Student: Report of a survey of final year university engineering students in Australia. *Surveys and Workforce Analysis Section, Skills Analysis and Quality Systems Branch, Strategic Analysis and Evaluation Group, Department of Education, Employment and Workplace Relations*. The Government of Australia.

- EAKINS, P. & CHRISTOPHERSON, G. (2000). The importance of context in work placements. *Journal of Cooperative Education*, 35, 61-67.
- EAMES, C. (2004). Researching in cooperative education: How a practitioner met the challenge. In LINN, P. L., MILLER, E. & HOWARD, A. (Eds.) *Handbook for research in cooperative education and internships*. Mahwah, NJ: Lawrence Earlbaum.
- ENGINEERS AUSTRALIA (2006, 2008). *G02 Accreditation Criteria and Guidelines. Accreditation Management System for Programs at the level of professional*. Accessed at http://www.engineersaustralia.org.au/shadomx/apps/fms/fmsdownload.cfm?file_uuid=0B19D0FF-0BC5-BAC1-DB36-6FB8599DDE67&siteName=ieaust on 30 June 2009.
- FREESTONE, R., WILLIAMS, P., THOMPSON, S. & TREMBATH, K. (2007). A quantitative approach to assessment of work-based learning outcomes: An urban planning application. *Higher Education Research and Development*, 26(4), 347-361.
- INSTITUTION OF ENGINEERS AUSTRALIA (1996). *Changing the culture: Engineering education into the future*. Barton, Canberra.
- KEEN, C. (2001). A study of changes in intellectual development from freshman to senior year at cooperative education college. *Journal of Cooperative Education*, 36, 37.
- LIPSEY, M. W. (1993). Theory as method: Small theories of treatments. In SECHREST, L. B. & SCOTT, A. G. (Eds.) *Understanding Causes and Generalizing about Them: New directions for program evaluation No 57*. SF: Josey-Bass.
- LINN, P. L., MILLER, E. & HOWARD, A. (Eds.) (2004). *Handbook for research in cooperative education and internships*. Mahwah, NJ: Lawrence Erlbaum.
- MARTIN, E. (1996). The effectiveness of different models of work based university education (Report No. 19). *Australian Government Publishing Service, Evaluations and Investigations Program, Department of Employment, Education, Training and Youth Affairs (DEETYA)*.
- PARKS, D. K., ONWUEGBUZIE, A. J. & CASH, S. H. (2001). Development of a measure for predicting learning advancement through cooperative education: Reliability and validity of the PLACE scale. *Journal of Cooperative Education*, 36, 23-31.
- ROSSI, P. H. & FREEMAN, H. E. (1985). *Evaluation: A systematic approach*. Beverly Hills, California: Sage Publications Ltd.
- ROSSI, P. H. Lipsey, M. W. & FREEMAN, H. E. (2004). *Evaluation: A systematic approach. Seventh Edition*. Beverly Hills, California: Sage Publications Ltd.
- SCHUURMAN, M. K., PANGBORN, R. N. & MCCLINTIC, R. D. (2008). Assessing the impact of engineering undergraduate work experience: Factoring in pre-work academic performance. *Journal of Engineering Education*, 97, 207-212.
- TENER, R. K. (2004). Using theory in research 1: Understanding the learning experience in structured internships in construction engineering. In LINN, P. L., MILLER, E. & HOWARD, A. (Eds.) *Handbook for research in cooperative education and internships*. Mahwah, NJ: Lawrence Earlbaum.
- VAN GYN, G. & RICKS, F. (1997). Proteges perception of the characteristics of the mentoring relationship and its impact. *Journal of Cooperative Education*, 27, 215-221.
- Weisz, M. & Chapman, R. (2004). Benefits of cooperative education for educational institutions. In Coll, R. K. & Eames (Eds.), *International handbook for cooperative education: An international perspective of the theory, research and practice of work-integrated learning*, pp. 247–258. Boston: World Association for Cooperative Education.
- WILLIAMS, W. M., STERNBERG, R., RASHOTTE, C. A. & WAGNER, R. K. (1993). Assessing the value of cooperative education. *Journal of Cooperative Education*, 28, 32-55.
- YUSMAN, C. (2008). Evaluation of the work experience programs. *School of Electrical and Information Engineering, Faculty of Engineering*. Sydney: The University of Sydney.

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