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Maximising Stakeholders' Benefits of Work Integrated Learning Programs: Schools of Chemical Engineering

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Abstract

Background

Stakeholders' perceptions are important for the success of Work Integrated Learning (WIL) programs. Operating a WIL program successfully requires close collaborations among three key stakeholders: the institution, the industry, and the student. The strength of these collaborations depends on benefits that subsequently arise. This thesis explores the benefits stakeholders could gain from participating in WIL and investigates their perceptions of WIL's values.

This research aims at:

- Exploring the stakeholders' perceptions of benefits they receive and the effectiveness of WIL;
- Recommending an operational framework for a WIL program; and
- Proposing a structured reflective practice as a tool to help academics improve student learning.

The recommended operational framework suggests strategies that maximises WIL's stakeholders' benefits. These benefits will hopefully lead to more engagements by the stakeholders in pledging recurrent financial support and committing to being permanent placements.

Methods

The University of Wisconsin Extension's logic model was adapted to develop a WIL operational model. This model was used as guidelines to operate and evaluate a WIL program. Three WIL programs in schools of chemical engineering in Australia and Thailand were studied. Based on their roles and responsibilities within WIL, its stakeholders were classified into nine categories, comprising university executives, academics, current students, alumni, industrial mentors (sponsors), employers, alumni and sponsors, alumni and employers, and sponsors and employers.

The data of the stakeholders' perceptions were obtained through three collection methods:

- Student reflection analysis – to investigate learning development and attribute improvement of students,
- Questionnaire – to explore WIL operational models and issues, and

- Interviews – to investigate what benefits the stakeholders gained from participating WIL, how they perceived these benefits, and the problems that occurred.

Results – Stakeholders' perceptions of WIL programs and a WIL operational framework

Research results show that WIL could help students improve their learning and graduate attributes such as ethics through interactions with professionals. The results also reveal important factors that could interfere with student learning at placement: placements' policies, engineers' academic backgrounds and behaviours, academics' experience, and students' learning attitudes and skills.

The questionnaire shows that improving students' experiences and strengthening industry linkages are key factors underpinning the establishment of WIL programs by institutions. While WIL offers an opportunity for students to enhance their learning experience, additional support from the university, such as the management of academics' workload or administrative issues, may be required to consolidate the industry linkage.

As for industry placement, most companies perceive recruiting prospective employees and obtaining project results as valuable benefits from participating in a WIL program. Interview results reveal that a WIL program could be a knowledge source for placement and help its engineers improve their mentoring skills.

Based on results from the investigation, the study recommends a WIL operational framework that maximises these stakeholders' benefits (Figure 1). This recommended framework can be applied to any WIL program that allows students to work in an authentic placement with explicit and well-defined learning outcomes.

Results – Student preparation tool

Figure 1 shows that preparing students for independent learning in placement is an important feature of the framework. This thesis developed a structured reflective practice as a tool to help academics prepare students for placement. The reflective practice comprises three key components: trigger questions, an analysis framework, and feedback frameworks.

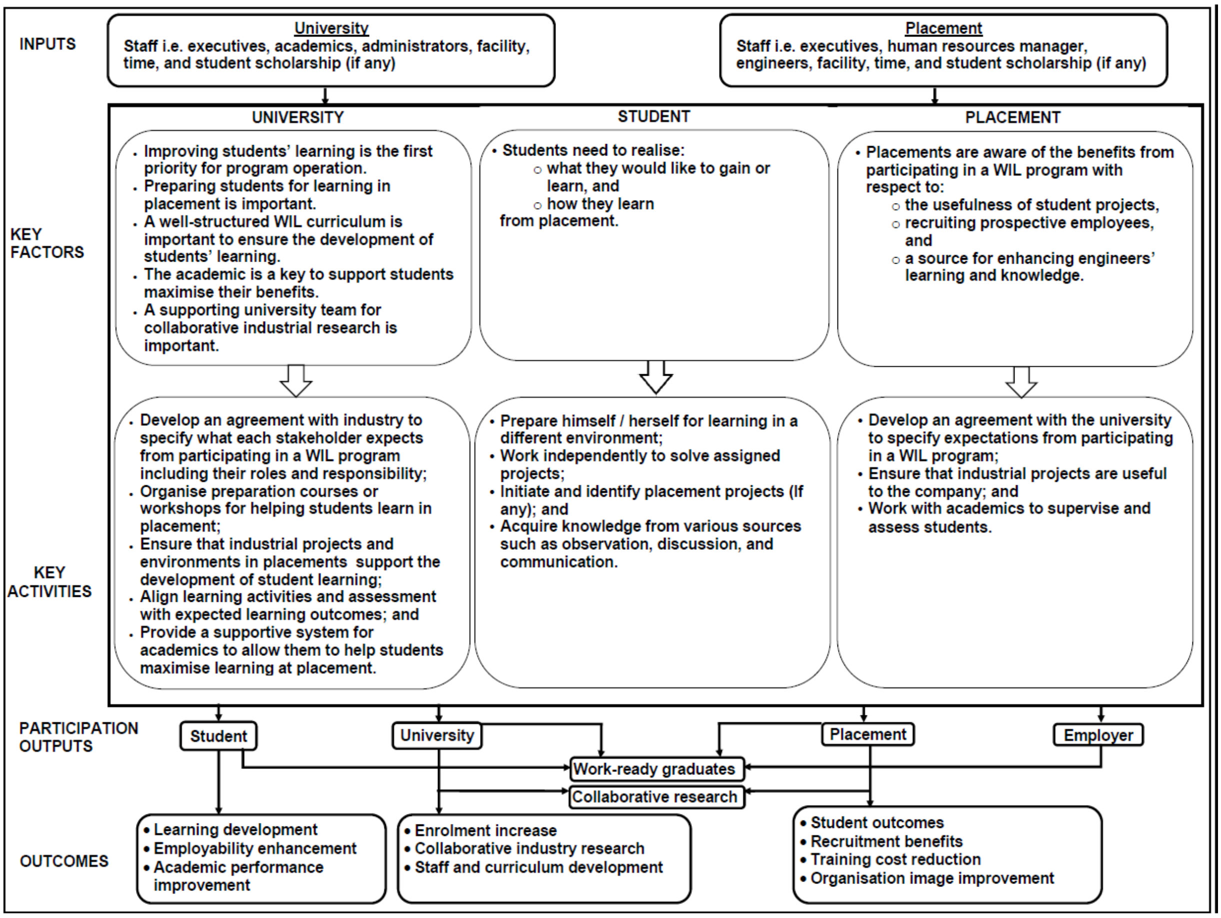

Figure 1: A WIL operation framework for maximising stakeholders' benefits

The trigger questions, adapted from Doel (2009)[1], are aimed at framing students' thoughts and structuring their writing. The questions comprise a series of inquiries about certain events that took place during students' academic life and their subsequent responses and learning outcomes.

The framework for reflective practice was developed from a combination of the work of Knowles, Holton and Swanson (2005)[2] and Boud, Keogh and Walker (1985b)[3] who investigated if students' reflection showed evidence of learning development. The investigation classified students' reflections into five categories: observation, realisation, action, evaluation, and change.

Two feedback frameworks for student reflections were developed. The first framework without actions aimed at provoking students' critical thinking and encouraging students to implement their ideas (Figure 2), while the second framework with actions aimed at

[1]Doel, S. (2009). Fostering student reflection during engineering internships. *Asia-Pacific Journal of Cooperative Education, 10*(3), 163-176.
[2]Knowles, M. S., Holton, E. F., & Swanson, R. A. (2005). *The adult learner: The definitive classic in adult education and human resource development* (6th ed.). Amsterdam: Elsevier/Butterworth Heinemann.
[3]Boud, D., Keogh, R., & Walker, D. (1985b). What is reflection in learning? In D. Boud, R. Keogh & D. Walker (Eds.), *Reflection: Turning experience into learning* (pp. 7). New York Nichols Pub.

encouraging students to enhance their learning (Figure 3).

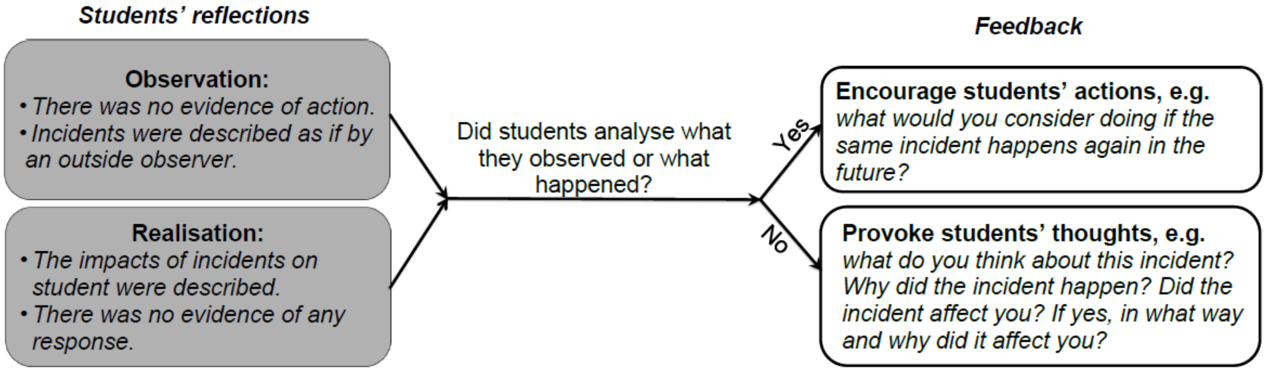

Figure 2: The feedback framework for student reflections without action

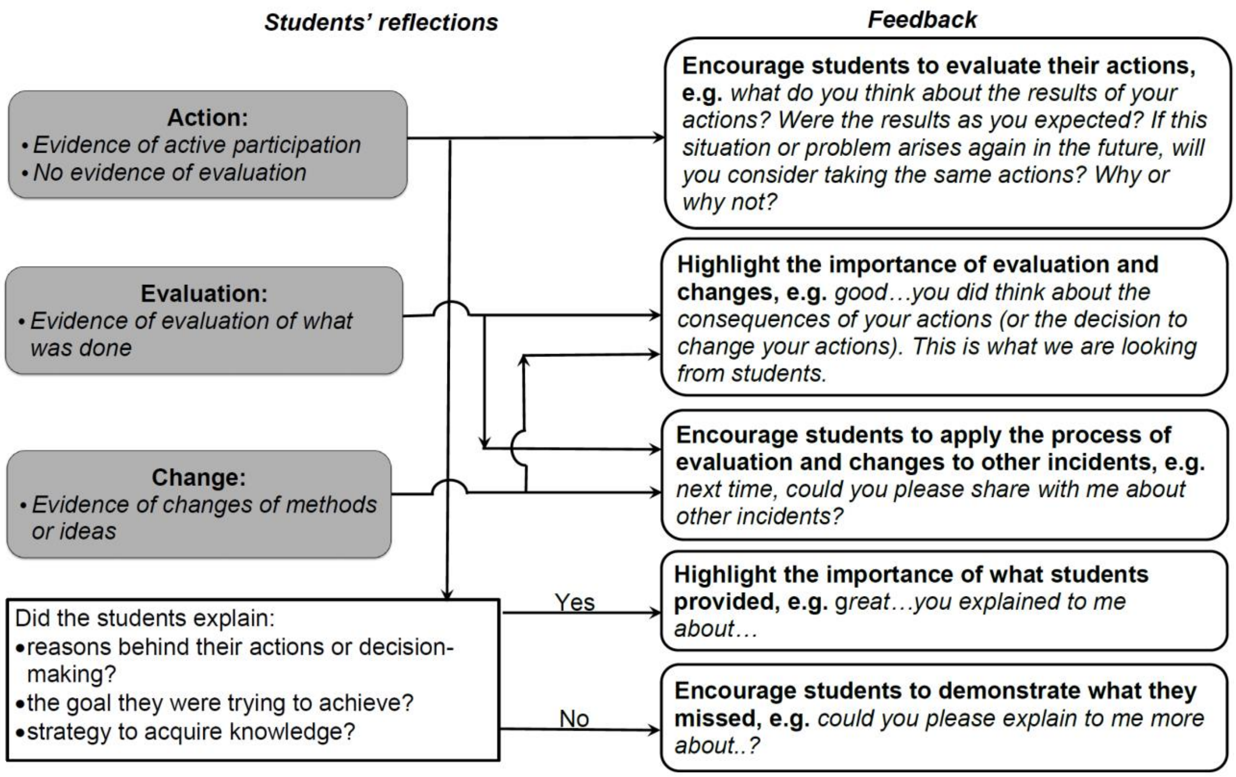

Figure 3: The feedback framework for student reflections with action

Conclusions and recommendations

Investigating stakeholders' perceptions of a WIL program through reflection analysis, a questionnaire, and interviews can be a good approach for evaluating the effectiveness of the program. The evaluation results can also be used to recommend an operational framework that maximises the stakeholders' benefits. Implementation of the recommended framework is suggested to investigate the effectiveness and limitations of the framework.

The study shows that structured reflective practice could help academics prepare students for learning in placement by providing feedback and identifying students who might have difficulty with independent learning. Moreover, the feedback framework could assist the academics in providing constructive critiques. It is recommended that this reflective practice be used over a period of time, such as one semester, to allow students to develop the ability to learn independently. Finally, the importance of reflections should be highlighted to ensure that students stay attentive during placements and reap maximum benefits from the feedback.

Declaration by author

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in my thesis.

I have clearly stated the contribution of others to my thesis as a whole, including statistical assistance, survey design, data analysis, significant technical procedures, professional editorial advice, and any other original research work used or reported in my thesis. The content of my thesis is the result of work I have carried out since the commencement of my research higher degree candidature and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution. I have clearly stated which parts of my thesis, if any, have been submitted to qualify for another award.

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Publications during candidature

Conference papers

1. Thonglek, S., Ku, H., Kavanagh, L., & Howes, T. (2013). "*Stakeholders' perspectives of a work integrated learning program: The chemical engineering practice school".* Paper presented at the 24th Annual Conference of the Australasian Association for Engineering Education, Gold Coast, QLD.

2. Thonglek, S., Howes, T., & Kavanagh, L. (2011). "*Work integrated learning: A realistic evaluation of KMUTT 's chemical engineering practice school"*. Paper presented at the 22nd Annual Conference for the Australasian Association for Engineering Education (AAEE), Fremantle, WA, Australia.

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Book chapter

1. Ku, H., & Thonglek, S. (2011). Running a successful practice school: Challenges and lessons learned. In P. Keleher, A. Patil & Harreveld, R. E. (Eds.), *Work-integrated learning in engineering, built environment and technology : Diversity of practice in practice* Hershey, PA: Information Science Reference.

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Contributor	Statement of contribution
Saranya Thonglek (Candidate)	Designed experiments (100%) Analysed and interpreted data (90%) Wrote the paper (75%)
Lydia Kavanagh	Analysed and interpreted data (5%) Wrote the paper (10%)
Tony Howes	Analysed and interpreted data (5%) Wrote the paper (5%)
Hong-ming Ku	Wrote the paper (10%)

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Lydia Kavanagh	Analysed and interpreted data (5%) Wrote the paper (10%)
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Saranya Thonglek (Candidate)	Designed experiments (100%) Analysed and interpreted data (90%) Wrote the paper (80%)
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Keywords

work integrated learning, operational framework, structured reflective practice

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CHAPTER I:
INTRODUCTION

1.1 Work Integrated learning (WIL)

Work Integrated learning (WIL) is a mechanism that provides an opportunity for students to work with professionals in an authentic environment (Patrick, Peach & Pocknee 2009). Such opportunities allow students to develop work skills that are vital to students' future careers but are difficult to obtain through lecture-based teaching (Jonassen, Strobel & Lee 2006). WIL is introduced to an educational curriculum to complement students' learning and enhance the development of technical knowledge and working skills that may be missing from the conventional curricula (Cooper, Orrell & Bowden 2003). The following are the benefits that students can gain from WIL.

Firstly, the WIL mechanism helps students develop the ability to construct knowledge. As stated by Kolb (1984a), students construct knowledge through four learning steps:

- Experiencing - students experience applications of knowledge in an environment that stimulates their curiosity to learn,
- Observing and reflecting - students observe and reflect upon this experience,
- Constructing - students construct knowledge and/or develop new ideas from these reflections, and
- Testing - students test the developed ideas and knowledge under different scenarios. Knowledge is further developed through evaluations of test results and explanations of the reasons behind the results.

In an authentic environment such as that provided by WIL, there are many occasions in which students experience circumstances that provoke their thoughts and engage them in learning, thus allowing them to develop new ideas and deepen their knowledge.

Secondly, WIL allows students to better understand theories that they have been taught in classroom. According to Dewey's (1916) work on educational reform which focused on how knowledge could be transferred from teachers to students:

> *'…Gardening, for example, needs not be taught for the sake of preparing future gardeners, or as an agreeable way of passing time. It affords an avenue of approach to knowledge of the place farming and horticulture have had in the history of the race and which they occupy in present social organisation'* (Dewey, 1916, p.200.)

Similar to gardening, knowledge possessed by academics may not be so easily transferred to students but can be readily done so through 'learning by doing'. At placement, students are required to use knowledge or theories they study to solve real-life problems. Solving these real problems allows students to understand ways to apply theoretical knowledge and limitations of the knowledge application. This understanding is increased through learning by doing and not by studying from lectures or textbooks. So WIL offers an opportunity for students to enhance their understanding of what they learn in classroom or from textbooks.

Thirdly, WIL allows students to understand the differences between what they study in classroom and what happens in the real world. For example, a given problem in real life often has more than one solution, depending upon the scope of work and the underlying assumptions, whereas there is usually an exact solution to a textbook problem (Jonassen, Strobel & Lee 2006). In addition, solving a problem in the workplace generally requires multidisciplinary knowledge and collaboration amongst experts from each field. However, at university, students mostly use specific disciplinary knowledge to solve problems, and they rarely have a chance to collaborate with students from other disciplines. As a result, through WIL, students have a chance to experience ‘reality’ which differs significantly from ‘academic settings’.

Finally, WIL offers students a chance to work with professionals and learn ways in which these professionals tackle industrial problems. To solve a real problem, professionals often use rules-of-thumb or tacit knowledge (Glen 1995). Tacit knowledge is personal ‘know-how’ that has been accumulated experientially in the workplace by each professional, so it is difficult for students to learn this type of knowledge from academics. Furthermore, tacit knowledge cannot be easily transferred verbally from professionals to students. Instead, students need to work with professionals and observe how these professional work in order to develop this tacit knowledge. Consequently, WIL allows students to reflect and discuss their observations and thus, through Kolb’s learning cycle, construct tacit knowledge.

1.2 Context and importance of the study

There are a number of ways to integrate WIL concepts into educational programs (Calway & Murphy 2006). Some WIL models aim at providing an opportunity for students to obtain a glimpse of the workplace atmosphere with no requirement for them to be actively involved in learning at placement, while others require students to actively participate in placement for a period of time to increase their learning ability and develop their working skills.

For instance, the School of Chemical and Biomolecular Engineering at the University of Sydney, Australia, has been running a WIL program, called The Major Industrial Project Placement Scholarship (MIPPS) scheme (The School of Chemical Engineering 2014; Re & Bartram 2011). This program has been operating since 2000 to allow final year undergraduates and postgraduates to be exposed real-life experiences in workplace for six months. The workplace is located across Australia and overseas. Students are required to work full-time on projects that are of interest to them. The MIPPS scheme allows placement companies to gain direct benefits from earlier employee recruitment and students’ project outcomes. In addition, these companies can use this scheme to strengthen their relationships with the school, faculty, and the university.

AT RMIT University, there is the WIL program called The RMIT International Industry Experience and Research Program (RIIERP) (RMIT University 2014; Abanteriba, Parkinson & Reid 2014). The program has been operating for students across all RMIT disciplines to undertake either work experience or research in Europe, North America, and Asia. To serve different students’ needs, the

RIIERP program offers six different models of embedding students in an authentic working environment. Of the six models, three of these focus on enhancing work experience: Work Experience, Bachelor Thesis Project, and Graduate Traineeship. Regarding the Work Experience model, this model is designed for undergraduate students who are in their second year or their third year, depending on their disciplines. These students are required to work as part of multinational teams for 6 to 12 months to enhance their knowledge that is relevant to professional development, especially in the area of work ethics in different cultural settings.

The Bachelor Thesis Project model provides an opportunity for undergraduates who are in their final year to undertake their thesis projects overseas for 6 to 10 months under the supervision of industry experts. Such an opportunity allows students to enhance their understanding in professional skills, particularly cultural differences, and gain benefits from early job offers. With respect to the Graduate Traineeship model, graduates are required to work in a reputable international company for 6 to 12 months. Working experience allows these graduates to hone the skills that are vital to their future careers.

Another WIL program in Australia is Professional Engineering Placement Scholarship (PEPS) at The University of Queensland (Doel 2009; Doel 2011; Doel, Smith & Tibbetts 2009). The PEPS program has operated across many disciplines of engineering, including Chemical Engineering, Mechanical Engineering, Electrical Engineering and Software Engineering, for undergraduate students. Placements under this scheme are generally committed full-time for up to 6 months. Similar to other WIL programs, PEPS aims at providing an opportunity for students to work with people in their future professions in an authentic environment to enhance their professional knowledge and working skills.

In Thailand, the WIL model employed across many schools of engineering is called **Co-operative education** (Sirijeerachai et al. 2014; Chinintorn 2011). This model is designed for undergraduate and graduate students who are required to work as full-time temporary employees. Prior to placement, students are required to take a preparation course to ensure that they are ready for work in placement. These WIL students need to work at placement for at least four months to use the knowledge they learn in the classroom to solve real-life problems, and at the same time they are expected to develop necessary working skills. Before graduation, it is a requirement for these students to submit a report pertaining to the experiences they have gained from the training. In addition, the students' performance is evaluated by supervisors from institution and industry. Generally, it is optional for engineering students in Thailand to undertake this WIL program, except those from the Suranaree University of Technology (SUT) which requires all of its students to undergo co-operative education.

Another WIL model in Thailand is the Science and Engineering Practice School (SEPS) at King Mongkut's University of Technology Thonburi (KMUTT) (Ku et al. 2005; Ku et al. 2007). In contrast to the co-operative education, the SEPS model is designed as a compulsory component for graduate students. SEPS is a two-year international program. In the first year, Masters students in SEPS are required to study coursework at the university campus. In the second year, the students need to spend one semester at placement working on industrial projects and the other semester to carry out individual research on campus. So far, the SEPS program comprises students from three schools: chemical engineering, food engineering, and bio-resources and technology.

To ensure the development of students' learning, two important features of WIL models in several professional programs including engineering must be present, namely identifying expected learning outcomes and requiring students to work at placement for at least one semester (Cooper, Orrell & Bowden 2010). Therefore, this thesis will focus on WIL models that are well-structured, i.e. expected learning outcomes are clearly specified, students are required to intern for at least one semester in an authentic environment, and students must be given the opportunity to apply theories to real-world work.

To operate a WIL program successfully requires collaborations from its stakeholders: universities, industries, and students; therefore, the benefits these stakeholders gain from participating in the program are crucial. Universities use WIL as a mechanism to produce students who possess the attributes that industry requires, and as a channel to develop or strengthen linkage with industry. On the other hand, industry can reap direct benefits from the outputs of students' projects and use WIL as a channel to explore prospective employees. Finally, through WIL, students can improve independent learning which is important to their future professional development. At the same time, the working experiences gained during students' internships help boost their confidence during job interviews.

On the other hand, although WIL programs can offer significant benefits to their stakeholders, three major issues associated with students' learning and program operation are well recognised. Firstly, students may not develop learning at placement as expected. Sim, Zadnik and Radloff (2003) found that students who merely followed protocol at placement or who worked on routine tasks that offered them little motivation to learn might not fully develop their learning. Students' learning can also be hindered if they are assigned projects for which companies expected unrealistic results. Thonglek, Howes and Kavanagh (2011) found that unrealistic expectations from placement companies could put students under stress, and this stress had the potential to interfere with their learning development.

Secondly, there are recurring issues that concern academics and industry when they agree to participate in a WIL program. Thonglek et al. (2013) found that some academics involved in WIL programs had misgivings about coping with unfamiliar tasks such as dealing with industry, managing administrative issues, and advising students about non-technical issues. In addition, McCurd and Zegwaard (2009) showed that most academics perceived the workload of participating in WIL as under-valued and under-appreciated. From an industry perspective, poorly defined roles in being a student's mentor and ambiguous responsibilities in supervising students are the main issues (Cooper, Orrell & Bowden 2010). As a result, academics and industry generally have reservations about being involved in WIL programs.

Finally, how each stakeholder contributes financially to WIL programs is still being debated. The issue stems from the tendency for WIL programs to run into large budget deficits. Weisz and Chapman (2004) estimated the cost of running a WIL program in Australian business schools and found that there was a funding shortfall of approximately AU$ 1,300 per student per year. To tackle this financial problem, there have been attempts to solicit money from other sources such as the private sector and alumni (Ku & Thonglek 2011; Weisz 2001). Weisz (2001) asserted that in more than 95% of placements it was agreed that WIL students did provide significant added values to sponsoring companies and that industry could therefore be expected to close the funding gap. Ku and Thonglek (2010) claimed that in order to convince companies to fully understand these values and the importance of funding WIL programs, the estimation of cost savings or profit increases achieved through student placement should always be reported.

To address the above operational issues and ensure that WIL stakeholders can maximise their benefits from being involved in the programs, an operational framework for a WIL program is recommended. This recommended operational framework is suitable for the WIL programs in many professions, such as nursing, medicine, law, and teacher education, in which student learning outcomes are clearly identified, students are required to work in industry, for at least one semester, and students are allowed to apply theories to solve real-life problems. In addition, these WIL programs should aim at engaging stakeholders in terms of their pledging long-term financial support and committing to being permanent placement.

1.3 Research questions

The research questions stem from the issues addressed in Section 1.2.

1. What are the best practices for WIL programs that maximise stakeholders' benefits while supporting student learning at the same time? (The importance of stakeholders' perception on WIL operation and sustainability will be detailed in Section 4.2). The practices must address issues related to students' learning outcomes, program operation, and program sustainability.
2. Can reflective practice be used as a tool to help academics prepare students for placements, thus ensuring that students maximise their learning? 'If so, how?'

   This question was developed based on analyses of stakeholders' interview data which revealed that students' attitudes towards learning and students' ability to learn independently played an important role in the effectiveness of their learning at placement. If students' attitudes and learning abilities can be identified before they enter placement, placement benefits could potentially be maximised. Referring to Kolb (1984a), reflection is an important part of student learning, and reflective practice is generally used as a tool to disclose what and how students learn at placement. Reflection could also be employed to reveal students' attitudes and their abilities to learn independently prior to placement.

1.4 Research contribution

As mentioned previously, how stakeholders perceive the value of a WIL program and its effectiveness is vital to its long-term sustainability. This thesis contributes to research in the field of Work-Integrated Learning by developing a WIL operational framework that will allow stakeholders to maximise their benefits from participating in the program. Hopefully, the new framework will prompt the stakeholders to engage more in WIL programs by pledging long-term financial support and committing to being permanent placements.

This new framework is suitable for WIL programs that require students to spend at least one semester in an authentic environment which allows them to apply theories and developing their learning. In addition, these WIL programs need to be well-structured to ensure that students can improve learning outcomes as expected.

In the workplace, the development of students' learning depends on cultures, attitudes, and values within the organisation as well as students' activities and learning ability. So an investigation into the student's learning ability prior to placement can help WIL students with their learning development. However, it appears that the exploration of such an ability is missing from the stage of preparing students for placement in most WIL programs (Cooper, Orrell & Bowden 2003). Subsequently, another contribution of this thesis to the field of engineering education is the development of a tool to help academics prepare students for placement. A structured reflective practice, including frameworks of reflection analysis and student feedback, is detailed. The developed tool will assist academics in monitoring students' ability to construct new knowledge and provide them with constructive feedback to help them improve their learning. In addition, the tool will help identify students who may face learning difficulties at placement. It is hoped that this tool will prepare students for learning independently in placement so that they can maximise their benefits from participating in a WIL program.

1.5 Structure of thesis

Chapter 2 provides the reader with an overview of WIL. The chapter firstly explains the importance of WIL with respect to learning development and industry requirements. Next, WIL operational models are investigated. Finally, learning assessment methods are described.

Chapter 3 provides the reader with an overview of three WIL programs in schools of chemical engineering in Thailand and Australia, namely Chemical Engineering Practice School (ChEPS) program, Professional Engineering Placement Scholarship (PEPS) program, and EQUIP program, which were used as case studies in this thesis. ChEPS is located in Thailand, while the other two programs are located in Australia. The details of these three programs with respect to curriculum structure, student preparation for placement, placement operation, and program admission and enrolment are described.

Chapter 4 investigates stakeholders' perceptions of participating in ChEPS, PEPS, and EQUIP programs. Firstly, an overview of stakeholders' perceptions of WIL programs is described. Then, data collection methods are explained, and finally study results are presented.

Based on the analysis of results from **Chapter 4**, **Chapter 5** recommends an operational framework that can maximise stakeholders' benefits.

Referring to the operational framework that is recommended in **Chapter 5**, preparing students for independent learning at placements is a key element to program success. To this end, **Chapter 6** develops a tool to help academics monitor students' learning and provide students with constructive feedback that assists them in developing their learning skills.

Chapter 7 provides conclusions that address the research questions and describes the implication of research results and recommends further studies which will be useful in the field of engineering education and WIL programs.

During this work, two conference papers and one published journal were generated. In the two conferences, part of the interview results on how ChEPS stakeholders perceived the value of the program and its operational effectiveness were presented. The details of the two conference papers are attached in Appendix A and B. As for the published journal, a developed tool that could help academics prepare students is described, and this journal paper is presented as part of Chapter 6.

CHAPTER II:
WORK INTEGRATED LEARNING

2.1 Introduction

This chapter provides the reader with an overview of Work Integrated Learning (WIL) and all the definitions used in the thesis. The overview starts with an explanation of how WIL helps students develop learning and assists institutions in producing graduates who are well prepared for industry. In addition, broad operational models of WIL programs are presented and the WIL operational model used in the thesis is explained. Since the development of student learning underpins any WIL operation, methods to assess are described at the end

2.2 Operational definitions for WIL used in this thesis

For the purpose of this thesis, the following definitions are used.

- **Work Integrated Learning (WIL) program.** WIL, in a broad context, is the concept that allows students to be exposed to real-life experience prior to graduation. The intensity of exposure can vary, from occasional site visits to semester-long internships, depending on learning objectives and program operations (Calway & Murphy 2006).

- In this thesis, a WIL program refers to one that provides an opportunity for students to work in an authentic work environment through collaboration between an institution where students are studying and a sponsoring company called placement (Boud & Solomon 2001). In addition to offering practical training for students, a WIL program must clearly specify expected learning outcomes and learning assessment methods. This WIL model can be referred to as a **"Cooperative program"**, **"Practicum"**, or **"Internship"**.
- **Institution.** A higher education institution that provides a WIL program for students.
- **Placement.** An organisation that provides an opportunity for students to practice and gain work experience.
- **Mentor.** An industry engineer, also termed "**Sponsor",** who supervises WIL students at an industrial site or placement.
- **Academic.** A university staff involved in the WIL program who supervises students and / or manages administrative tasks. An academic supervising students is also termed a "**Site Director"**.
- **Program stakeholders.** People or organisations involved in a WIL program. They include the institution where students are enrolled, the placement organisation, the student themselves, the academics involved in the program, and the industrial mentors.
- **Placement project.** A project or real-life problem that student needs to address and solve during placement.
- **Working skills.** Skills which are essential for students' future careers such as communication, teamwork, and problem solving.

2.3 Learning theories underpinning WIL pedagogy

As WIL aims at developing student learning through working with professionals in an authentic environment, there are a number of learning theories underpinning WIL, especially the theories relevant to the development of the learning process and the importance of learning contexts. The following theories that have been cited by several researches have been chosen to frame this thesis work (Knowles, Holton & Swanson 2005; Moon 1999b; Gagne 1997; Schön 1983; Bandura 1977; Atkinson 1964; Dewey 1933).

Regarding the development of the learning process, Dewey (1933), Moon (1999b), and Kolb (1984a) explained that the learning development can occur during the process of knowledge construction through active learning. These learning theories comprise three main components:

- Observation is an important skill to acquire new information. However, students do not learn every time they observe; instead, they need to think critically on what they observe (Moon 1999b; Kolb 1984a). For instance, students may compare new information from observations with their existing knowledge and try to construct their own abstract knowledge, hypotheses, or ideas that students have not proved them yet.
- Students need to be actively engaged in learning activities. These students are required to test their abstract knowledge. During the testing, students need to analyse and evaluate what they have done by asking themselves what is happening, why it happened, and what else needs to be done, etc. These lines of inquiry galvanize the students into action and allow them to better understand the constructed abstract knowledge. This step is also known as **learning-by-doing**.
- The repetition of learning cycle: testing, analysing, and evaluating, is important. The repetition of these steps allows the students to better understand the generalisation and limitations of their abstract knowledge, which finally leads to the construction of new knowledge.

Another theory, which explains how adults can construct their own knowledge, is called Adult Learning (Knowles, Holton & Swanson 2005). Adult learners are defined as people who have a wealth knowledge and know the goals they want to achieve. These learners can find ways to achieve goals and evaluate results of their actions. It can be seen that, reflection is an important step for knowledge construction in each theory. Schön (1983) stated that reflection helps students develop learning, as it allows them to communicate with themselves and evaluate the outcomes of actions.

The influence of workplace environments on student learning development has been explained by Dewey (1933), Kolb (1984a), Bandura (1977), and Gagne (1997). Dewey (1933) argued that workplace allows students to have many opportunities to test their abstract knowledge and repeat the learning cycle while Kolb (1984a) claimed that working environments that stimulate students' curiosity can engage them in learning activities. Bandura (1977) stated that students can learn from imitating behaviors of their colleague or professionals whom they perceive as their role models, and Gagne (1997) claimed that workplace provides an opportunity for students to understand the usefulness of what they learn in the classroom which allows students to become more engaged in learning. Another theory that underpins students' learning in placement is Achievement Motivation

(Atkinson 1964). This theory claims that the success of projects can enhance students' self-esteem and engage them in learning. A summary of these theories is presented in Table 2.1.

Table 2.1: A summary of theories underpinning WIL pedagogy

Theory	Description	Application to WIL
How conceptions arise (Dewey 1933)	Dewey (1933) explained how people learn as follows: • Observe different properties of things; • Work on the information and try to construct one's own concepts; • Try to use the constructed concepts in a practical way; • Analyse the results from action; and • Extend and generalise the concepts to other cases.	A WIL program should: • Prepare students in acquiring knowledge through observations, discussion, and self-learning; • Encourage students to learn proactively; and • Allow students to apply theories in various circumstances.
Stages of learning (Moon 1999b)	Moon's (1999) learning stages comprise: • Noticing what happens; • Classifng the acquired knowledge from observations; • Relating new knowledge to existing knowledge and construct new concepts; • Trying to find a way to use the new concepts; and • Evaluating the process of knowing and knowledge.	
Knowledge construction (Kolb 1984b)	Kolb's learning stages comprise: • Embedding in a learning environment that engages students in learning; • Observing a particular situation and reflecting upon what is happening; • Constructing abstract knowledge upon reflection; and • Verifying the abstract knowledge in a new situation.	
Adult learning (Knowles, Holton & Swanson 2005)	The four interconnected stages of adult learning: • Know what one wants to learn; • Create strategies to obtain the knowledge; • Implement the strategies; and • Evaluate the strategies and knowledge.	It is important for a WIL program to: • Use an effective assessment tool to assure that students are able to demonstrate the requisite ability at each step; and • Encourage students to demonstrate the whole process of adult learning.
Reflection-in-Action (Schön 1983)	While applying theories to practice, students need to reflect upon what they are doing by communicating among themselves and evaluating the outcomes of actions; as a result, students can learn from the practice.	Referring to Schön (1983), it is important for a WIL program to: • Encourage students to demonstrate reflective practice during the placement; and • Use an effective tool to evaluate the development of student reflective practice.

Table 2.1: A summary of theories underpinning WIL pedagogy (Con't)

Social Learning Theory (Bandura 1977)	Students learn through observing and imitating behaviors of people surrounding them.	According to Bandura (1977): • Placement preparation courses should highlight the importance of learning through observation. • An assessment tool to reveal what students learn at placement is required since the students may be misguided by inappropriate conduct of their colleagues.
Conditions of Learning (Gagne 1997)	Students will pay attention to what they learn when they realise the usefulness of the knowledge.	A placement project should: • Be of interest to students; and • Relate to students' academic background.
Achievement Motivation (Atkinson 1964)	Students are motivated when the project mission is accomplished, or when they learn something from it even though the project is unsuccessful.	Two important aspects involving WIL pedagogy are as follows: • The difficulty of placement projects should be suitable for students. The students may be discouraged by an overly complicated task, and similarly not motivated by a very simple task. • Supervisors need to ensure that when a project is unsuccessful, students do not feel discouraged and can learn from their mistakes.

Based on the analysis of the theories that underspin the WIL concept (Table 2.1), key WIL features that help students develop learning can be summarised as follows:

1. **Suitable placements.** The placement should allow students to work on hands-on projects to help them develop their learning. In addition, students should have a chance to work in industry that is of their interest and is related to their academic background so that students become more engaged in learning.
2. **Suitable projects.** The placement projects should:
   a. Allow students to use theories in workplace to enhance their understanding in what they learn in classroom, develop application skills, and improve learning skills;
   b. Are of interest to students so they become engaged in learning;
   c. Relate to students' academic backgrounds to allow them to realise the usefulness of what they learn;
   d. Be fairly difficult and complex to encourage and provoke students' curiosity to learn.
3. **Prepared students for learning in placement.** Prior to placement, students should be made aware of the importance of proactive learning such as learning by doing, learning through observation, and learning through discussion.
4. **Effective communication.** At placement, students can observe professionals' behaviours and have a chance to be misguided by inappropriate conduct of their colleagues. Effective

communication between academics and students is important to ensure that students can develop learning as expected and are not misled by their peers.

5. **Constructive feedback.** It is possible that some of the failures in the projects students work on at placement rattle their confidence. Academics need to provide students with constructive feedback to help them learn from their mistakes and not become easily discouraged by temporary setbacks.
6. **Suitable assessment tools.** A tool for assessing students' learning in placement should demonstrate and assess the requisite ability at each learning step. Reflective practice is a well-known method for assessing students in industry, as this practice can be used as a way to communicate between academics and students while allowing academics to provide feedback for students' learning development.

In addition to the key features of a WIL program for developing student learning, recommendations for operating a WIL program before, during, and after placements are presented in Table 2.2.

Table 2.2: Recommendations for operating a WIL program before, during, and after placements

Before placement	During placement	After placement
• Raise students' awareness of learning through various ways such as observation, discussion, and reflection.	• Ensure that students actively participate in learning activities; • Ensure that placement projects are of interest to students and are sufficiently complex to motivate them to learn; • Ensure that when unexpected results occur, students do not feel discouraged but can learn something from the results; and • Assess the development of students' learning process and outcomes, and reflection can be used as an effective tool to demonstrate their learning development.	• Encourage students to reflect with their supervisors and amongst themselves on what they learn at placement. • Assess if students can improve their learning process and develop learning outcomes as expected.

These key features are important in this research, as they are used as guidance to recommend an effective operational framework for WIL programs.

Explanations of graduate attributes that industry needs and how WIL can improve these attributes follow.

2.4 Industry requirements of WIL

A number of researchers (Hodges & Burchell 2003; Coll & Zegwaard 2006; Fleming, Martin & Hughes 2009; Davis, Beyerlein & Davis 2005) have identified skills that industry expects graduates to have developed. Table 2.3 shows a list of these graduate attributes, while definitions of these attributes are detailed in Figure 2.1.

Table 2.3 shows that the expected attributes can be classified into three categories: Professional-related skills, Generic skills, and Personal effectiveness (Sim, Zadnik & Radloff 2003; Spencer & Spencer 1993). Professional-related skills encompass sufficient professional knowledge for a new graduate to complete a task such as professional ethics, problem solving, and critical and analytical thinking. Generic skills are defined as those that are necessary to work effectively and efficiently such as teamwork, communication, and leadership. Personal effectiveness is defined as personal characteristics that govern the effectiveness of individual's performance such as adaptability, self-management, and self-confidence.

It can be seen that, generally speaking, important graduate attributes required by industry are similar. Three attributes that are deemed highly desirable by industries across disciplines are Professional ethics (1.1), Teamwork (2.1), and Ability and willingness to learn (3.1), despite the fact that no other industry ranked Professional ethics (1.1) as being important except engineering. In fact, ethics can be considered an important attribute for graduates in the schools of business and science ever since the Journal of Business Ethics and the Journal of Science and Engineering Ethics have been published for a number of years. Even though, professional ethics is important since it relates to morally acceptable standards of practices, an individual's ethical attitude and behaviour may influence the ranking of importance (McGinn 2003). Velthouse and Kandogan (2007) noted that *"…it was surprising and disappointing that the managerial sample ranked ''ethics and integrity'' as 14th in importance out of 22 managerial skill sets they used…."*

In engineering, ethics can be taught in classroom (Banik 2011; Moore 2005) but it is argued that allowing student experience ethical issues in the workplace through WIL could be a better option (McGinn 2003). An engineering student reports that " *I observed in action the unspoken rules of who may talk when, and gained an appreciation of how important it is to be punctual to particular types of meetings or event."* However, the ethical issues the student observes and learns at the placement should be explicitly discussed. At workplace, several uncontrollable factors such as the attitude of colleagues or mentors may distort students' perceptions of ethics (Campbell & Zegwaard 2011).

Table 2.3: Expected graduate attributes including the ranks of importance (lower values indicate higher importance)

Industry Expected Attributes (As defined in Figure 2.1)	Rank of importance								
	Business			Science & Technology		Hospitality	Sports	Engineering	
	(N=18)[(a)]	(N=19)[(b)]	(N=19)[(b)] (forecast in 2016)	(N=19)[(b)]	(N=19)[(b)] (forecast in 2016)	(N=19)[(c)]	(N=19)[(d)]	(N=18)[(e)]	Overall Ranking (Average)[(f)]
1) Professional-related skill - Sufficient profession knowledge for a new graduate to complete a task									
1.1)Professional ethics	*(g)*	*(g)*	*(g)*	*(g)*	*(g)*	*(h)*	*(h)*	1	Highly important to Engineering and Business
1.2) Problem solving	9	2	2	3	4	10	2	7	3 *(0.26)*
1.3) Critical and analytical thinking	7	9	8	4	5	10	12	7	6 *(0.41)*
1.4) Knowledge acquisition	*(i)*	8	8	11	6	3	17	7	8 *(0.45)*
1.5) Technical knowledge competency	16	18	18	12	14	17	13	6	16 *(0.75)*
2) Generic skills - Necessary skills to work effectively and efficiently.									
2.1) Teamwork	2	5	5	2	3	3	5	4	2 *(0.19)*
2.2) Achievement	8	4	4	8	7	7	7	1	5 *(0.40)*
2.3) Customer-oriented awareness	4	3	3	14	10	2	10	18	7 *(0.42)*
2.4) Technological literacy	14	10	10	6	2	9	15	11	9 *(0.51)*
2.5) Detail-oriented awareness	5	16	16	5	10	10	6	15	10 *(0.55)*
2.6) Communications	3	13	13	15	13	15	4	12	13 *(0.58)*
2.7) Professional writing	12	7	7	7	12	14	19	12	14 *(0.59)*
2.8) Organisational commitment	13	15	17	17	19	13	14	14	17 *(0.79)*
2.9) Leadership	17	17	18	18	16	18	17	7	18 *(0.84)*
2.10) Mentoring	18	19	19	19	18	19	16	18	19 *(0.97)*
3) Personal effectiveness - Personal characteristics that control the effectiveness of an individual's performance.									
3.1) Ability and willingness to learn	1	1	1	1	1	1	1	1	1 *(0.05)*
3.2) Adaptability	6	6	6	10	8	8	9	4	4 *(0.37)*
3.3) Self-management	11	11	11	9	9	15	3	5	11 *(0.56)*
3.4) Self-control	10	12	12	13	14	3	11	*(j)*	12 *(0.57)*
3.5) Self-confidence	15	14	14	16	16	3	8	*(j)*	15 *(0.65)*

NOTE: [(a)] Hodges et al. (2003), [(b)] Coll et al. (2006), [(c)] Spowart (2011), [(d)]Fleming et al. (2009), [(e)] Davis et al.(2005), [(f)]Calculated as the average of (rank/N); lower values indicate higher importance

[(g)] Ethics is considered to be important in the areas of business and science and technology; extensive research related to ethics in these professions has been documented.

[(h)] Ethics is considered to be of little importance in the areas of hospitality, sports, and recreation; less research related to ethics in these professions has been documented.

[(i)] This work, *knowledge acquisition*, is included in *analytical thinking*, *critical thinking*, and *initiative*.

[(j)] It can be assumed that *assertiveness*, *self-control*, and *self-confidence* are included in *team leadership.*

1) Professional-related skills *are defined as sufficient professional knowledge for a new graduate to complete a task.*

1.1) Professional ethical skills - *The ability to demonstrate trustworthy and ethical behaviours in societies and to conform to professional practices and standards.*

1.2) Problem solving - *The ability to create and develop strategies to tackle a problem.*

1.3) Critical and analytical thinking – *The ability to identify or simplify a complex problem into manageable tasks and to evaluate the outcomes of the managed tasks.*

1.4) Knowledge acquisition - *The ability to investigate process behaviours and identify causes of problems.*

1.5) Technical knowledge competency - *The ability to demonstrate in-depth technical knowledge and to apply the knowledge to real situations.*

2) Generic skills *are defined as necessary skills to work effectively and efficiently.*

2.1) Teamwork - *The ability to solicit ideas and opinions to help form specific decisions or plans, keep people informed and up-to-date about the group process, and share all relevant or useful information.*

2.2) Achievement - *The ability to work to meet the company's standard or to reach a challenging goal for oneself.*

2.3) Customer-oriented awareness - *The ability to match the needs of clients to available products and services, and take responsibility for correcting customer problems, if any.*

2.4) Technological literacy - *The ability to use tools related to professions, such as engineering software.*

2.5) Quality-oriented awareness - *The ability to show concerns for order, check the accuracy of one's work, monitor work progress, and develop a system to organise and keep track of information*

2.6) Communication - *The ability to understand attitudes, interests, needs, and perceptions of others and respond appropriately, such as making persuasive arguments or explaining ideas, to make work-related and social contacts and build connections, and to make public presentations.*

2.7) Professional writing - *The ability to make professional documents such as reports, minutes, memo or e-mail.*

2.8) Organisational awareness - *The ability to understand the organisation's structure, culture, and constraints and then align oneself accordingly.*

2.9) Team leadership - *The ability to motivate team members to achieve desired outcomes, demand high performance, give detailed directions to get a job done, and purposely give or withhold information to gain specific results.*

2.10) Mentoring - *The ability to express positive expectations of others, even in "difficult" cases and give directions or demonstrations with reasons or rationale as well as providing training strategies.*

3) Personal Effectiveness *is defined as personal characteristics that control the effectiveness of an individual's performance.*

3.1) Ability and willingness to learn – *The ability to learn on his/her own and show internal motivations to learn new knowledge.*

3.2) Adaptability - *The ability to adapt his/her intentions to unexpected events.*

***3.3)* Self-management** – *The ability to effectively manage to complete oneself and group tasks within a time constraint.*

3.4) Self-control - *The ability to maintain performance under stressful or hostile conditions.*

3.5) Self-confidence - *The ability to maintain performance against discouraging circumstances and uncertainties.*

Figure 2.1: The definitions of graduate attributes adapted from Coll and Zegwaard (2006), Davis et al. (2005), Sim et al. (2003), and Spencer and Spencer (2007)

With respect to teamwork skills (2.1), effective teamwork can contribute to the success of a project (Berge 1998; Hoegl & Gemuenden 2001; Hirsch & McKenna 2008). In workplace, solving problems requires the collaboration of experts from various disciplines. Berge (1998) explained that the collaboration can happen via knowledge exchange, problem identification, decision making, and project evaluation. Consequently, the company needs a team player who is able to demonstrate knowledge competency, the balance of responsibility, clear delivery of ideas , and cooperation to achieve a shared mission (Hoegl & Gemuenden 2001; Hirsch & McKenna 2008).

Working environments in placement allows students to develop the teamwork skills. At placement, students can work amongst themselves or as part of an engineering team. Ku et al. (2007) and Michaelsen (1993) claimed that working in team with professionals enables students to experience a sense of reality in workplace and communicate with people from different backgrounds such as managers, engineers, and operators. As a result, these students can appreciate the importance of working in teams and develop such skills.

The ability and willingness to learn (3.1) are the most required graduate attribute across disciplines including engineering. Possibly, the connection between these abilities *and* other attributes (Meade & Andrews 1995; Davis, Beyerlein & Davis 2005). Meade and Andrews (1995) implied that an individual who shows enthusiasm to learn is able to manage and get things done, adapt themselves along with unexpected circumstances, and finally achieve what they want. Moreover, it can be argued that it is difficult to change one's personal attitude toward learning (Meade & Andrews 1995; Sim, Zadnik & Radloff 2003). So it would be better for a company to hire a graduate who already possesses this ability.

An authentic environment can stimulate the student's eagerness to learn (Kolb 1984a). At placement, the student is provided with a chance to work with professionals, understand how theories can be used in the reality, explore new knowledge, and observe the differences between existing and new knowledge. Arguably, these circumstances can pique the student's curiosity. Jain (1997) claimed that the variety of work, people's background, and organisational culture could enhance the student's learning interest.

In addition to stimulating a student's curiosity, practicing at placement can foster student learning development. According to Kolb's theory, the student would construct their own knowledge or better understand their existing knowledge when they use it in real circumstances. At placement, students would be provided with various circumstances which allow them to test their knowledge (Brown 2010).

In engineering education, accreditation body standards have been established in many countries to ensure that the graduates possess attributes industry expects (ABET 2010; Engineers Australia 2013; Seddon 2014). Institutions can use these standards as a benchmark to organise and manage their curricula to produce graduates that industry needs. These standards are presented in Table 2.4.

Table 2.4: Key engineering graduate attributes from other standards and research.

Key Engineering Graduate Attribute	ABET	EA	UK (Engineering Council)	Industry Expected Attributes (Table 2.3)
Professional-related skills				
Ability to understand and demonstrate professional and ethical responsibilities	●	●	●	1.1
Ability to use a systems approach for design and operational performance	●	●	●	1.2
Ability to undertake problem identifications, formulations, and solutions	●	●	●	1.3
Ability to demonstrate in-depth technical competence	●	●	●	1.5
Ability to design a system or a process	●	●	●	1.5
Ability to apply science and engineering fundamental knowledge	●	●	●	1.5
Generic skills				
Ability to work in teams	●	●	●	2.1
Ability to use engineering tools to analyse and solve engineering problems	●	●	●	2.4
Ability to communicate effectively	●	●	●	2.6
Personal effectiveness				
Ability to understand and demonstrate lifelong learning	●	●	●	3.1
Ability to understand and demonstrate social, cultural, and environmental responsibilities	●	●	●	3.2

NOTE: ABET = Accreditation Board for Engineering and Technology (ABET 2010)**,** EA = Engineering Australia (Engineers Australia 2013), Engineering Council (Seddon 2014), The Council of Engineers in Thailand does not stipulate graduate attributes in all engineering curricula; instead, the Council is responsible for their accreditations (Engineer 2010).

Table 2.4 shows that, apart from competency in technical knowledge, accreditation body standards require engineering graduates to demonstrate the ability to work effectively and improve themselves. Even though a number of graduate attributes required by the accreditation body (Table 2.5) are not as comprehensive as those desired by industry (Table 2.4), the important skills such as professional ethics, teamwork, and willingness to learn are still included in the three standards.

As mentioned previously, WIL is argued as an ideal mechanism to help students develop the skills required by industry (Jain 1997; Patrick, Peach & Pocknee 2009) because it allows students to understand the application of technology in different circumstances, work with people who have different backgrounds, and improve themselves through working with professionals. Currently, there are a number of ways to integrate WIL into educational programs and a discussion of the ways in which WIL has been operating within educational curricula will follow.

2.5 WIL operational models

An extensive review of the integration of WIL concepts into educational programs was conducted by Calway and Murphy (2006). They divided WIL operational models in terms of objectives and operation into eight categories:

1. **Pre-course experience.** This model requires students to have some practical experience and expects them to possess a certain level of specific competency prior to enrolling a course. However, there is no requirement for working during the course.
2. **Project-based experience.** Students are required to work on a project that allows them to apply theories to solve a problem and the project is undertaken as part of a course. This model allows students to carry out their projects at universities, and work experience in industry is not required in this model.
3. **Contextual learning**. This model aims at bringing real-life experience to the classroom through actual case studies. Students are required to discuss and reflect upon theories or applied theories relevant to the real case studies. For this model, it is not necessary for students to have industrial experience during their studies.
4. **Work experience.** This model aims at providing an opportunity for high school students to obtain a glimpse of the real work environment. There are no specific requirements for the students to undertake these experiences.
5. **Vocational education.** This model is commonly employed for learning certain crafts such as plumbers, carpenters, and electricians who need to develop specific skills. The skills are developed through on-the-job training in workplace, and the training is compulsory as a component of classroom courses.
6. **Supervised experience.** This model aims at providing an opportunity for students to apply knowledge to real work. Generally, the work experience is compulsory for graduation and undertaken at the end of a course or degree. The duration of the training depends on students' professions.
7. **Work-based learning.** Similar to the supervised experience model, this model requires students to work in industry to integrate what they learn in the classroom with what they work in industry. However, the industrial training is not compulsory. Generally, the student

is the person who takes the initiative to approach industry and the duration of the training ranges from 6-12 months.

8. **Joint industry / university courses.** This model is a partnership between university and industry. The industry works with the university to ensure that a curriculum is up-to-date and students have employability skills. The skills are supposed to develop through working in industry so work experience is required.

Due to the investigation of Calway and Murphy (2006), some models are intended to allow students to obtain a glimpse of the real work environment with no requirement for them to be actively involved in learning at placement, while others require students to actively participate in placement for a period of time to increase their learning ability and develop their working skills.

According to the WIL pedagogy (Section 2.3), learning by doing in an authentic environment is important for developing student learning. The details of active participation in WIL operational models: Vocational education, Supervised experience, Work-based Learning, and Joint Industry/University courses, are presented in Table 2.5.

According to Table 2.5, the “Work-based learning” model is similar to the context of WIL being referred to in this thesis, as it requires students to apply theoretical knowledge to practical work under the supervision of industry mentors and academics. More importantly, this model needs to be well-structured and organised to maximise the development of student learning and working skills.

With respect to the WIL models that require students to work on hands-on projects in an authentic environment, Cooper, Orrell and Bowden (2010) categorised these WIL models into three categories as follow.

1. **Professional Learning.** This model is designed for WIL programs in professional education including nursing, medicine, dentistry, social work, teacher education, law, surveying, forestry, speech pathology, physiotherapy, occupational therapy, engineering, veterinary practice, pharmacy, and optometry. Students are expected to develop the skills relevant to their professions. Key requirements of the professional learning model are as follows.
   - Students’ learning outcomes need to be clearly specified (Schön 1983).
   - Expectations and roles as well as responsibilities of students, academics, and placement staff are required.
   - It is imperative that universities and placements work together in the supervision, the support, and the assessment of students’ competency (Ralph, Walker & Wimmer 2008).

Table 2.5: WIL operational models focusing on active student participation (adapted from Calway and Murphy (2006))

Criteria	**WIL operational model**			
	Vocational education	**Supervised experience**	**Work-based learning**	**Joint-industry / university courses**
Course requirement	Compulsory	Compulsory	Optional	Compulsory
Placement operation	Separate from classroom	Separate from classroom	Separate from classroom	Depending on curriculum
Length of work placement	Generally at least a year	Dependent on the curriculum	Typical 6-12 months	Dependent on curriculum
Operation	• This model aims at enhancing students' working skills in a specific field such as plumbing, carpentry, electrical, etc. • Learning outcomes are not necessarily related to the content in the classroom, and most of the skills are developed through on-the-job training.	• This model provides an opportunity for students to apply the knowledge they study in classroom to real-life work. • It is normally operated in a professional field such as medical internship where the development of specific skills is needed.	• Similar to the Supervised experience model, Work-based learning allows students to integrate theories taught in classroom into real work in a placement. • It is operated across disciplines such as sports and recreation, hospitality, business, and science and technology, etc. • It is well structured and organised to allow students to gain the most from their placement.	• This model strengthens the partnership between the institution and the industry through joint industry/university courses. • Industry plays an important role in the curriculum design.

2. **Service Learning.** This model aims at promoting students' learning and development through their engagements in social activities that address human and community needs (Butin 2005). Key requirements of the service learning model are as follows.
    - Students must develop their learning as expected.
    - Reflection is an important learning activities that helps students improve their learning process and allow them to enhance their understanding of community issues (Jacoby 1996; Eyler & Giles 1999).
    - The outputs of activities are useful to the community, which is supported by Dewey (1933; 1938).
3. **Cooperative Learning.** Differing from the service learning model, this model requires students to work in placement which allows them to develop skills, such as people skills, communications, and teamwork, which are useful to their working lives. Key requirements of the cooperative learning model are as follows.
    - It is imperative that students can gain learning benefits from working in industry.
    - Learning outcomes are clearly specified (National Commission for Cooperative Education 2002).
    - There is a clear job description but theory application is encouraged (Sovilla & Varty 2004).

In Thailand, an extensive review of WIL was conducted by Chinintorn (2011). Chinintorn (2011) investigated various WIL models, including those at the vocational level, the undergraduate level, and the graduate level. The author also identified common requirements in the WIL models in Thailand which are summarised below.

- Students are required to actively participate in learning activities in workplace.
- Problem-based learning is a key approach to learn in placement.
- Industry placements needs to understand objectives of the WIL models that are operated at their companies including their roles and responsibilities as being part of the model.
- Academics need to understand which knowledge or skills they expect students to achieve and how they can assess it.

Based on Chinintorn (2011)'s investigation, WIL operational models can be further divided into four categories as follows:

1. **Dual vocational training (DVT).** This model is similar to the Joint industry / university courses model (Calway & Murphy 2006) in which industries work with institutions to

identify expected students' learning outcomes and skills as well as designing teaching materials and learning activities. These learning activities can occur in the classroom and in the workplace, and this model focuses on the development of students in vocational schools. The improvement of students' skills is assessed by academics and industry people.

2. **Apprentice.** This model focuses on providing an opportunity for students who study in a vocational school or at the undergraduate level. The student is required to work as a temporary employee who works full-time in a company and is expected to develop general working skills such as the skills of teamwork, communication, and organizational awareness. Similar to the DVT model, students' performance is evaluated by supervisors from the institution and the industry.
3. **Co-operative education**. This model is similar to the apprentice model in terms of what students need to be achieve and how students are managed, administered, and assessed at the company (Sirijeerachai et al. 2014). However, this model focuses on the students at the undergraduate and the graduate levels. In addition, these students are required to work at placement for at least four months to integrate what they learn in the classroom with real-life problem solving. Before graduation, students are required to submit a report pertaining to the experience they gain from the training.
4. **Internship.** This model has been operated in schools that are related to certain professions such as medicines, nursing, teacher education, etc. Students are required to work with professionals in an authentic environment that allows them to hone specific skills that are important for their professions. These specific skills are specified by commissions responsible for overseeing each profession.

In addition, there is a WIL model that has been operating in Thailand for over 15 years labelled "Practice Schools" (Ku et al. 2005). This practice school model is similar to the co-operative education (Chinintorn 2011), but it focuses on science and engineering students at the masters level. The student is required to work in a placement for one semester, and each placement is expected to accommodate four to nine students. To alleviate the burden placed on the placement, this model employs an academic to work full-time at placement to supervise students and deal with administrative issues. More importantly, the academic is able to ensure that the development of student learning actually takes place at placement and that interned students acquire working skills as expected.

Based on an analysis of existing literature, a WIL program that helps promote student learning should:

- Clearly specify expected learning outcomes (Schön 1983);
- Clearly specify expectations and roles of each stakeholder (Calway 2006; Cooper, Orrell & Bowden 2010);
- Prepare students to learn on their own prior to placement (Bandura 1986);
- Provide students with placement projects to which they can apply theories taught in classroom (Sovilla & Varty 2004); and
- Encourage reflections through learning activities (Jacoby 1996).

In addition, collaboration between academics and industry mentors is required to ensure that the value of projects and the developed skills meet the expectations of each stakeholder (Ralph, Walker & Wimmer 2008). A framework of a WIL program that fosters student learning is described in Figure 2.2.

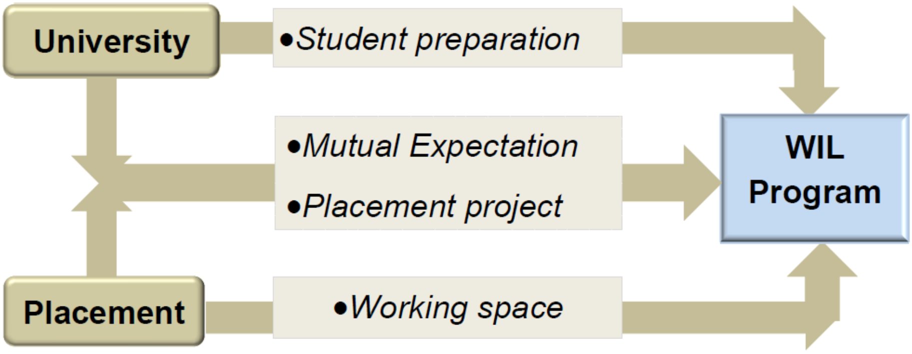

Figure 2.2: A framework of a WIL program fostering student learning

The framework will be used to develop a questionnaire survey and interview questions for program stakeholders in this study. As WIL is designed to develop student learning in the workplace, the next section focuses on the assessment of such development.

2.6 WIL assessment – student learning

Learning assessment in a WIL program comprises three key issues: expectations of skills being developed, definitions of skills, and reliability of assessment outcomes. What needs to be assessed should be clarified in the early stage of the program's implementation. Academics tend to focus on technical knowledge whereas industry mentors can value non-technical skills such as teamwork, communication, and adaptability as well (Hodges & Burchell 2003; Ferns & Moore 2012). It would be beneficial if the expected skills are clearly described by the stakeholders before the placement begins.

How to define these expected skills can be a challenge. Non-technical skills can be defined in several ways (Spencer & Spencer 1993; Sim, Zadnik & Radloff 2003; Davis, Beyerlein & Davis 2005; Coll & Zegwaard 2006; Cooper, Orrell & Bowden 2010). The effectiveness of learning assessment will be improved if the expected skills are clearly defined. Reliability of assessment outcomes is also an important issue. It has been reported that learning assessment can be influenced by the background and attitude of evaluators, and thus verification of assessment results is needed (Cooper, Orrell & Bowden 2010).

Timing and assessors are also important for WIL program assessment. To promote student learning and investigate their improvements in each skill, the assessment should be done throughout the entire program: prior to, during, and post placement. In addition, the development of students' skills and performance should be evaluated in a number of ways: by academics, industries mentors, their peers, or even among themselves.

It is necessary for WIL to use specific approaches to assess student learning in an authentic environment. Several methods can be used, depending upon the assessment objectives and the placement phases: prior to placement, during placement, and post placement. However, the clarification of the expected non-technical skills, the definitions of these skills, and their resultant verifications are important components of an effective assessment program. An explanation of approaches to assess student learning in a WIL program will follow.

2.6.1 Student learning prior to placement

The assessment is to ensure that students possess sufficient technical knowledge to work in industry placement, remind them of self-learning and other expected learning outcomes, and raise their awareness of safety issues and organisational culture.

In terms of technical competency, minimum academic performance and students' academic backgrounds relevant to placement projects are required. In addition, self-assessment should be conducted to allow students to think about their readiness to learn in industry. The following are examples of inquiries, which were adapted from Cooper, Orrell and Bowden (2010), that help raise students' awareness of self-learning and general issues at placement.

- What are the learning outcomes that the program expects you to demonstrate?
- What are your learning goals going through a WIL program?
- What skills and knowledge do you bring to placement?
- How do you plan to build on these skills during placement?

- What professional responsibilities do you think you will be required to undertake?
- Who will you work with and what do you think is important to them?
- What values and principles will you take to the placement that influence the way you work?
- What particular issues are you aware of that you might find challenging and why?
- What strategies would you use to respond to the above issues?

An assessment before placement is useful for academics to ensure that students have adequate basic knowledge to tackle technical problems in industry and for students to be reminded of program's expectations and the skills they should develop during placement. In the workplace, a student is expected to learn on his/her own but this learning ability can vary from individual to individual. To assure that each student can perform as expected, an investigation of the student's learning ability prior to placement is vital. However, it appears that the exploration of such ability is missing in most WIL programs. To address this gap, this thesis developed a tool to help academics identify students' learning abilities prior to placement to ensure that students can learn on their own during placement. The following is a summary of assessment methods used during placement.

2.6.2 Student learning during placement

The objective of assessment methods is to demonstrate knowledge, abilities, and skills that students strive to gain or develop during placement (Cooper, Orrell & Bowden 2010). There are a number of ways to assess these skills. However, the following explains common methods used by WIL programs that clearly specify learning outcomes before students enter the workplace.

i) Competency-based approach

Students are required to demonstrate different levels of competency, with supporting evidence, in the skill areas that a WIL program stipulates. This approach will be effective if the definition of each competency level is clearly explained. The identified levels help students become mindful of their capabilities in each skill and provide them with guidelines to improve any deficient skills in the future. However, this approach focuses on the number of skills and the levels of competency that students develop rather than how these skills are developed.

ii) Project work approach

Project evaluation is a well-known assessment method, particularly in engineering education since project assignments are a naturally significant component of engineering work. In addition, project assignments encourage students to demonstrate their abilities to apply theories to practice which is the basic concept of WIL. The notion of this approach is that the students are able to develop skills as the project progresses. As a result, students can hone their skills to a certain level throughout the duration of the project. However, the development of these skills cannot be guaranteed.

iii) Critical incident analysis approach

In this approach, students are asked to generate a record of incidents from which they learn during placement. This approach requires students to report actual circumstances including their actions and evaluate what they have done and what they have learnt from the situations. In addition to assisting learning outcomes, students have a chance to develop analytical and critical thinking via this approach. This analysis allows students to think deeply about the development of each skill. However, due to the limitations of the training duration, students may not be able to demonstrate all the skills expected by the program.

In some cases, this approach is combined with the project work approach. The student is required to evaluate project outputs and analyse reasons behind those outputs. Discussions in teams are encouraged in order to provide students with opportunities to share their knowledge and learn from each other. This combined approach is sometimes referred to as the "***Reflective assessment approach***".

iv) Direct observation approach

During placement, academics and/or industry mentors will observe if students are able to demonstrate expected competency. However, to avoid any bias, assessment criteria need to be provided as clearly as possible.

In the engineering discipline, common assessment approaches are the competency-based model, the project work model, and the reflective model. These models foster applications and thinking skills, integrate the assessment into daily work, and exhibit learning outcomes and learning development. To make the assessment more effective, a system to monitor student learning and provide them with feedback is required to improve their abilities.

However, because of the limitations in each approach, it would be more effective if, in practicality, a combination of these approaches is used. For instance, in a WIL program in the school of chemical engineering (Doel 2009), the outputs of projects were evaluated in order to investigate students' ability to understand theories they studied in classroom, tackle problems that occurred in industry, and apply theories to the real world. Furthermore, the competency-based model is used to provide students with information about the skills they are expected to learn and develop during placement. Finally, students are required to reflect and analyse particular incidents to exhibit their analytical and critical thinking and the development of some skills.

2.6.3 Post placement assessment

Post placement assessment aims at reaffirming that the student's level of knowledge, particularly the technical aspects, meets the program's requirements. In most cases, the assessment is done through project evaluations (Cooper, Orrell & Bowden 2010). However, differences in the project contexts can cause the issue of unfairness, so usually more than one assessor is involved in the evaluation to validate the evaluation results. Another purpose of post placement assessment is to allow students to exchange knowledge and experience during the placement. The sharing forum can be done through focus groups and presentations. In addition, it will be worthwhile if feedback is added by experienced persons such as academics and /or industrial mentors.

2.7 Conclusions

Work Integrated Learning (WIL) is a mechanism that helps students develop their learning. Through WIL, the students are encouraged to use theories they study in the classroom to tackle problems in workplace, evaluate their actions, and sometimes change their actions for better results. In conjunction with these activities in the placement, students are able to complete the learning cycle and finally develop their learning.

WIL also assists students in improving graduate attributes that industry requires. The industry expects new employees to possess sufficient professional knowledge to complete a task, demonstrate efficient working skills, and possess characteristics that have positive influence on an individuals' performance. Students could develop these expected attributes through working with professionals in industry placement.

Despite the variety of WIL models, key common features for WIL operation fostering the development of student learning are:

- Specifying learning outcomes that students are expected to develop;
- Specifying assessment methods that aligns with the expected learning outcomes and also reveals what students learn in placement;
- Encouraging students to learn proactively and acquire knowledge through observations, discussions, and self-learning;

- Using reflections as a method to help students construct knowledge;
- Offering placement projects that are of interest to students, related to their academic backgrounds, and are sufficiently difficult to motivate them to learn; and
- Communicating with students at all times during placement to ensure that they can develop their learning as expected.

Learning assessment is an important aspect of WIL operation. Even though WIL allows students to develop their learning by working with professionals in industry, this ability to develop learning varies from individual to individual. An effective learning assessment is important to ensure that each student can develop their learning as the program expects.

To effectively investigate the development of student learning, a WIL program should:

- Specify the learning outcomes that a program expects students to develop;
- Describe clear definitions of expected learning;
- Use more than one assessment method and assessor to embrace all expected learning outcomes and verify assessment results; and
- Conduct the assessment before placement, during placement, and post placement to ensure that students can improve their learning process and develop graduate attributes that the program requires.

CHAPTER III:
CHEPS, PEPS, AND EQUIP PROGRAMS

3.1 Introduction

The reader is provided with an overview of three WIL programs in schools of chemical engineering comprising Chemical Engineering Practice School (ChEPS) program, Professional Engineering Placement Scholarship (PEPS) program and EQUIP program. The three programs were selected as case studies in this thesis because they are operated based on different models. This program diversity allowed the researcher to identify common problems that occurred and specific problems that happened in a particular context which is useful for generalisation of research outcomes (Case & Light 2011). Explanations of the three case studies with respect to the curriculum structure, student preparation for placement, placement operation, and program admission and enrolment will follow.

3.2 Chemical Engineering Practice School (ChEPS) program

3.2.1 Curriculum structure

The Chemical Engineering Practice School (ChEPS) program was established in 1997 at King Mongkut's University of Technology Thonburi (KMUTT) in Thailand. ChEPS is a two-year Master's degree program which was initiated based on the School of Chemical Engineering Practice at MIT in the US (Johnston et al. 1994). A major goal of ChEPS is to produce professional chemical engineers who possess strong attributes in technical knowledge, theory applications, problem solving, team-working, effective communication, time management, and English proficiency (Ku & Thonglek 2011). The timeline of the ChEPS curriculum is shown in Figure 3.1.

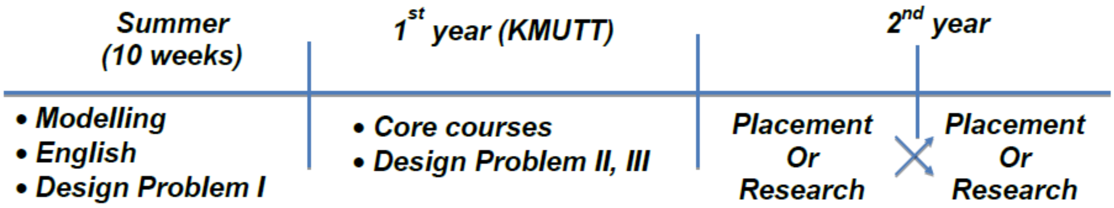

Figure 3.1: The timeline of the ChEPS curriculum (Thonglek, Howes & Kavanagh 2011)

ChEPS students start by spending the first summer (10 weeks) revising undergraduate subjects. After that, the students spend their first year taking core courses in advanced technical subjects, e.g. mathematical analysis, modelling and optimization, intermediate thermodynamics, and chemical reaction engineering, at KMUTT. In the second year, the students are separated into two groups. In the first semester, the first group experiences working in teams to solve industrial problems at placement, while the other group conducts individual research at KMUTT or overseas. In the second semester, the two groups are rotated.

3.2.2 Student preparation for placement

In the first year, ChEPS students are required to experience project-based learning called 'Design Problem'. The design problems are real-life problems that are simplified and sponsored by industry or come from the literature. To prepare students for ChEPS placement, the following three key features are integrated into the design problems (Ku & Thonglek 2011):

- The problems typically involve modelling, simulation, and optimisation of chemical process or systems which allows students to improve theory application skills.
- Students are required to work in teams of three or four people to develop teamwork skills.

- Oral presentations are regularly scheduled to update the faculty with the progress and to improve students' presentation skills. Written reports are also required at every stage of the design problems.

Through the design problems, students are expected to improve skills that are vital to effective working at placement, particularly the skills in theory applications, teamwork, and presentations. The development of application skills and presentation skills are assessed through students' written reports and oral presentations. With respect to the assessment of other working skills such as team-working, effective communication, and time management, ChEPS students are required to write reflection reports on what they have learnt during this preparation period. The format of the reports is shown in Figure 3.2. On the other hand, the implementation of this type of assignments only began in 2011.

3.2.3 Placement operation

In the early stages of the program, ChEPS placements were sourced by university executives using personal connections and networking. In subsequent years, because of the good reputation of the program and alumni linkage, industry begins to show interest in becoming a ChEPS placement. Companies who sponsor ChEPS placements are not necessarily the same as those who sponsor design problems, but there is a high degree of overlapping.

ChEPS' working team at KMUTT is generally responsible for allocating students for placements. But there are exceptions; students whose scholarships are sponsored by companies are usually required to practice at these companies. In some rare cases, a sponsoring company may wish to have a final say in its placement roster by asking for the permission to screen the students with interviews. But in most cases, the arrangement criteria for placement with most companies are flexible and depend on the agreement between the program and placements.

Generally, each placement accommodates 6-8 students to foster teamwork skills as well as encouraging them to learn from each other. In addition, having a big cohort of students in one placement increases the efficiency in program administration. With such a big cohort embedded at one placement for one semester, a university faculty member called 'site director' is assigned to work full-time at the placement to alleviate the workload of industrial mentors. Since this site director is stationed with the students, the number of 6-8 students is optimal in terms of the site director's workload and responsibilities.

Template for Reflective Practice (ChEPS)

Objectives:

- *Students demonstrate the ability to articulate their thoughts through writing.*
- *Students demonstrate the ability to think critically.*
- *Students demonstrate evidence of developed skills including the development strategy.*

Analysis of Learning Events

1. What did happen?

2. What did you think about the incident that happened?

3. What did you do about the incident?

4. What were the consequences of your actions?

5. What have you learnt from the incident?

6. Is this learning something new or something you already know?

7. Why is this learning outcome important?

8. How can you use the knowledge gained from this incident in the future?

Figure 3.2: ChEPS reflection template (Thonglek et al. 2014)

In addition, an even number of students at placement is preferred because usually two students are assigned to one team. Criteria for allocating students to placements include students' academic performance, their assigned design problem topics, and the status of their scholarships within ChEPS. Full-scholarship students tend to be better academically than those in the other categories. Therefore, a mix of students having varied GPAs is more desirable for a given placement.

To prepare for placements, sponsoring companies will first form a committee consisting of section managers, engineers, and shift operators. The committee is responsible for sourcing of technical problems within the companies that need to be solved. At the same time, academics are required to work closely with industrial mentors to prepare placement projects for students. Academics are consulted during project selections in order to ensure that, in addition to positive impacts made by these projects, students also develop learning outcomes as stipulated in the ChEPS curriculum. Academics and site directors are jointly responsible for supervising the students on technical issues and observing them as well as evaluating the developments of their learning processes and outcomes.

At placement, students need to work in teams to solve real-life problems and present the progress of their work every 3-4 weeks. In addition to industrial mentors, there are other industrial people with whom the students may come into contact. For example, students may need to access plant data from shift operators and technicians, or they may be required to present their work to a plant manager.

The operation of a ChEPS placement is presented in Figure 3.3.

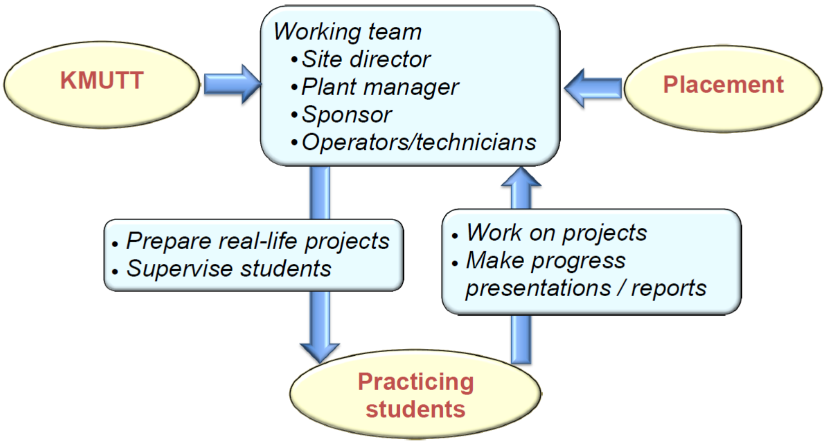

Figure 3.3: ChEPS placement operation (Thonglek et al. 2013)

Students are assessed in terms of their work performance and project outcomes. In the first part, the development of students' individual skills such as engineering, creativity, and leadership are assessed by academics. Students' other desirable skills including performance evaluation criteria are presented in Figure 3.4. The outcomes of placement projects are assessed by academics and industrial mentors in four aspects: problem-solving strategies, accuracy and completeness of work, presentation skills, and final reports (Ku & Thonglek 2011)

KING MONGKUT'S UNIVERSITY OF TECHNOLOGY, THONBURI

Chemical Engineering Practice School (ChEPS)

Performance Evaluation Sheet

Project:____

Student Names:____________________________ Phase:______Semester:_______

Overall Evaluation:

Major Strengths

Areas for Improvement

	Needs improvement	**Outstanding**		**Needs improvement**	**Outstanding**
	1 2 3	4 5		1 2 3	4 5
Engineering Skills			Organization skills		
Quality of technical work			Communication:		
Creativity			Oral		
Leadership			Technical writing		
Dependability			Personal		
Motivation			Engineering judgment		
Sense of responsibility			Ability to make decisions		
Response to technical guidance			Ability to work under pressure		

Name and Signature of Evaluator:______________________ Date:_____________

Figure 3.4: ChEPS performance evaluation criteria (Ku & Thonglek 2011)

3.2.4 Admission and enrolment

Each year, approximately a hundred chemical engineering students in the fourth year from various universities across Thailand apply to the ChEPS program. In almost every year, a number of graduated engineers with 1-2 year working experience also apply to the program. Selection criteria for enrolment in ChEPS are as follows:

- GPA ≥ 2.7 (maximum GPA is 4.0); this criterion may be exempted if applicants have some working experience,
- SAT-Math score,
- Simulated paper-based TOEFL score, and
- Interviews with academics and industry (if any).

At the end of the application process, the ChEPS program admits 20-24 students each year.

3.3 Professional Engineering Placement Scholarship (PEPS) program and EQUIP program

3.3.1 Curriculum structure

The Professional Engineering Placement Scholarship (PEPS) program and the EQUIP program were WIL programs in engineering schools at The University of Queensland (UQ) in Australia. The PEPS program was operated across the divisions of chemical engineering and mechanical engineering from 2005-2010 while The EQUIP program was operated in the School of chemical engineering in 2011. The objectives, structures, and operational models of the two programs were the same. The two programs were designed for 4th year students at UQ to help develop engineering graduate attributes while they undertake research projects at placement. The placement period combined vocational work of the 3rd year students and the 1st semester of the 4th year students. The structure of the PEPS & EQUIP programs is presented in Figure 3.5.

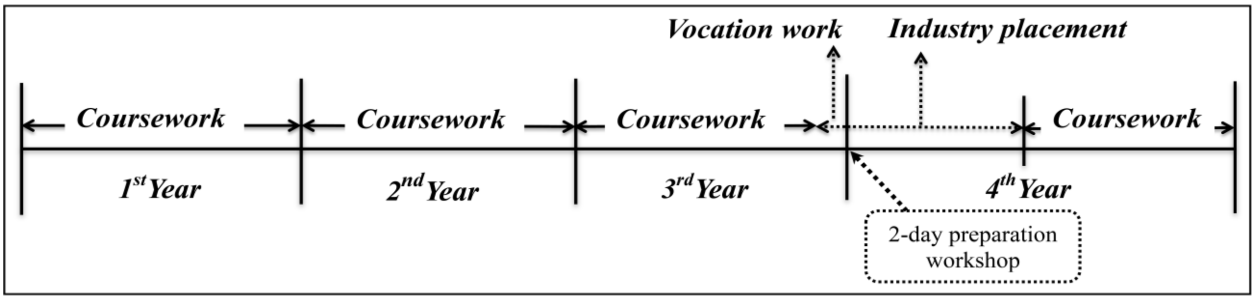

Figure 3.5: The structure of the PEPS & EQUIP programs

3.3.2 Student preparation for placement

Before starting their placements, students are required to attend a two-day preparation workshop at the university. The workshop provides students with the knowledge of (Doel, Smith & Tibbetts 2009):

- PEPS contexts related to safety issues at placement, professional ethics, and program expectations,
- Information acquisitions from university facilities for remote projects,
- Project structure and writing, and
- Assessment tools during PEPS & EQUIP placement.

By the end of the workshop, the students are expected to;

- Create strategies to manage the start-up phase of the placement;
- Build self-confidence so they could manage themselves professionally throughout the program;
- Understand and establish learning objectives and assessment requirements for their courses;
- Be prepared to integrate their work and their learning;
- Be able to locate and use information resources; and
- Understand the administrative and operational aspects of PEPS & EQUIP and develop strategies for dealing with contingencies that may arise.

3.3.3 Placement operation

The PEPS & EQUIP placements are asked to provide research topics for students to ensure that the companies can benefit from the program. However, academics need to ensure that the complexity of the proposed problems and the depth of the required knowledge suit the levels of technical competency of students.

In contrast to the ChEPS program in which an academic supervisor stays full time at placement, the PEPS & EQUIP supervisors contact and advise students via email, phone calls, and teleconferences. To ensure that PEPS & EQUIP students are making good progress and developing their learning outcomes as expected, these students are required to complete a set of learning assessment tools, to be assessed subsequently by academics and engineers. These tools assess the students in five areas: communications with academic supervisors, development of learning through reflection, improvement of professional attributes, understanding of WIL benefits, and competency in technical knowledge. The following are brief explanations for these assessment tools.

Communication with academic supervisors

Because PEPS & EQUIP students work distantly from the university, it is important for academics to maintain communications with students to ensure that they can learn independently at placement and their work are progressing well. The work progress, presented in the form of the Student's Weekly Contact Sheet (Figure 3.6), is submitted to academic supervisors via email each week. In addition, students are required to keep in touch with their advisors through the Student's Contact Log (Figure 3.7).

Student's Weekly Contact Sheet

Date____

Student______________________________________

Placement____________________________________

Complete the table below to reflect progress on your ***research*** project, and email to your supervisor each Friday during placement.

Action list from this week		
Actions	**Status**	**Comments**
Talk to John Smith about	Done	
Do two batches of tests on Wednesday	Not complete	Equipment failed on 2nd run

Action list for next week		
Actions	**Status**	**Comments**
Need to work out how to display results		Need inputs from supervisor
Arrange a meeting with site manager		

Figure 3.6: PEPS & EQUIP student's weekly contact sheet (Doel, Smith & Tibbetts 2009)

Student's Contact Log

Supervisor____

Student____

Placement____

Please use the table below to record all contact with your academic supervisor.

Date	**Initiated by supervisor**	**Initiated by student**	**Type of contact**	**Brief description**
28/2/08	**X**		e-mail	Sent background information
4/3/08		**X**	phone	Discussed number of tests to take
28/4/08		**X**	phone	Agreed visit date

Figure 3.7: PEPS & EQUIP student's contact log (Doel, Smith & Tibbetts 2009)

These tools can encourage students to focus on their work, raise their awareness of the importance of communicating with their supervisors, and allow them to demonstrate their proactive management skills. On the other hand, the tools also allow academics to monitor the students' progress and render assistance to them in time if an unexpected circumstance arises.

Development of learning through reflection

To demonstrate learning through reflection, PEPS & EQUIP students are required to implement the Professional Development Log (PDL). The PDL is a keystone of the PEPS & EQUIP programs, as it allows students to reflect on circumstances in placements in a systematic way, thus enabling them to learn from the reflection (Dewey 1933). The students' reflections are guided by a set of trigger questions: '*What actually happened?*', '*What was its impact on you personally?*', '*What did you learn from the experience?*', and '*What did you decide to do as to become a better engineer?*'. The explanations of these questions and the template of the PDL are presented in Figure 3.8. In addition, to help students develop learning effectively, academics are required to provide feedback within 48 hours after the students' submissions of their PDLs. This allows students to have sufficient time to review and learn from the comments before the completion of the next PDL.

At the end of the semester, all students are required to make an oral presentation, which is a 10-minutes talk (maximum) plus a two-minutes Q&A, on what they have learnt at placements. This presentation allows students to share their learning experiences while gaining more insight about learning from other students' experiences.

Professional Development Log

Template

Name:	Week Beginning:

Date	Critical Learning Event	Brief Description

Analysis of this week's **Most Significant** Learning Event

Situation: **What actually happened?**
Describe the event, the circumstances, and the people involved. Keep it factual.

(Expand as required)

Affect: **What was its impact on you personally?**
Describe how you reacted to the event (positive or negative), perhaps in terms of how felt about it at the time or subsequently. This description might explain why the event was so significant for you; why it was an "A-ha moment".

(Expand as required)

Interpretation: **What did you learn from the experience?**
Describe what you learned from the event. Explain in what ways this new learning either confirms or contradicts your prior knowledge, theories, or understandings about the practice of engineering, in particular the knowledge you have gained at university.

(Expand as required)

Decision: **What did you decide to do as to become a better engineer / IT or software engineer?**
If it was a 'positive' (affirming) learning event, describe how you will ensure that the skill / ability you demonstrated will become part of your regular professional arsenal and be routinely applied in a wider range of circumstances, not just those like the particular event. If it was a 'negative' learning event, describe what you will do differently in the future to avoid having to learn the same lesson again the hard way.

(Expand as required)

Figure 3.8: The template of professional development log (Doel, Smith & Tibbetts 2009)

Improvement of professional attributes

Developing professional attributes is one of the key benefits that students gain from WIL programs. To demonstrate the development of such attributes, the students are asked to record the developed professional attributes with relevant supporting evidence through the Professional Abilities Inventory. The template of the Professional Abilities Inventory and a list of expected professional attributes are shown in Figure 3.9. To make the inventory meaningful, the students are also required to show examples of the developed attributes as evidence before they can complete an application for an engineering position.

Professional Abilities Inventory

Template

Name:	Student Number:

(This table is expandable.)

Ability/skill	Critical Experience Demonstrating the Ability/Skill
Problem identification/ formulation	
Innovative analysis/ Problem solving	
Leadership	
Negotiation	
Influencing others (Written or oral communication)	
Systems thinking	
Effective teamwork	
Time and self-management	
Range of interests (Balanced lifestyle)	
Initiative and accountability	
Adaptability / resilience	
Lifelong learning	
Others	

Figure 3.9: The template of Professional Abilities Inventory (Doel, Smith & Tibbetts 2009)

Development of critical thinking of WIL experience

PEPS & EQUIP students are required to conduct a critical review of the literature on a work-integrated learning aspect, which can be related to career potential, contact with university during placement, improving employability, graduate attributes, and relevance of projects to coursework. This critical review allows students to gain better understanding of the objectives and the benefits of WIL programs and improve students' critical thinking skills. Students' experiences at placement are used as supporting evidence for their arguments.

Understanding of technical knowledge

In addition to submitting a weekly progress report for each research milestone, PEPS & EQUIP students are required to submit three reports: proposal, progress, and final reports, to update academic supervisors on their work status. At the end of the semester, the students are required to make an oral presentation on their project findings. This requirement allows students to improve their presentation skills and exchange their knowledge and placement experiences with their peers who work on different projects at other companies.

3.3.4 Admission and enrolment

In one semester, each PEPS & EQUIP placement accommodates 1-2 students. The placements are sourced either by academics or students. For placements sourced by academics, students are interviewed and selected by academics and industrial people. Selection criteria do not focus on students' academic performance; instead, students' motivation, enthusiasm, and maturity are the deciding factors. However, all PEPS & EQUIP students generally have an average GPA of 4.5 and above (the maximum GPA is 7).

A summary of curriculum structures and operational models of ChEPS, PEPS, and EQUIP programs is shown in Table 3.1.

According to Table 3.1, ChEPS and PEPS&EQUIP are operated in different ways except for the criteria for placement projects. This common element shows that placement projects of the three programs are proposed by placements, but academics need to ensure that the proposed projects suit students' competency.

3.4 Conclusions

This thesis studied three WIL programs in schools of chemical engineering: Chemical Engineering Practice School (ChEPS), Professional Engineering Placement Scholarship (PEPS), and EQUIP programs. These three WIL programs have similarities in:

- Producing chemical engineering graduates who possess working abilities that industry requires;

Table 3.1: A summary of curriculum structures and operational models of ChEPS, PEPS, and EQUIP programs

Detail	ChEPS	PEPS & EQUIP
Initiation	• By university executives	• By academics interested in developing student learning
Student level	• Master's degree (2 years)	• Undergraduate level (the 4th year)
Compulsory / elective course	• Compulsory	• Elective courses
Student profession area	• Chemical engineering students	*PEPS* • Chemical engineering students • Mechanical engineering students *EQUIP* • Chemical engineering students
Criteria for student selections	*Program admission* • GPA ≥ 2.7 (maximum GPA is 4.0); this criterion may be exempted if applicants have some working experience, • SAT-Math score, • Simulated paper-based TOEFL score, and • Interviews with academics and industry (if any). *Allocating students to placements* Program director and a working team are responsible for allocating students for placement under the criteria of: • Academic performance, • Design problem topics, and • Status of students' scholarships.	*Program admission and allocating students to placements* Students are interviewed by academics and industry under the criteria of students': • Maturity, • Motivation, and • Enthusiasm.
Student preparation for placement	• Grades in the three Design Problem courses	• 2-day workshop
The number of students / placement	• 6-8 students	• 1-2 students
Placement duration	• One semester	• One vocation summer and the first semester
Placement operation	• Students work in teams amongst themselves.	• Students work individually.
Placement project	• Projects are offered by placements but academics need to ensure that the projects suit students' competency	• Projects are offered by placements but academics need to ensure that the projects suit students' competency
Academic supervision	• An academic supervisor works full-time at placement.	• Academic supervisors supervise and contact students via email, phones, and teleconferences.
Assessment approach	• Student work performance • Project evaluation	Assessment tools evaluate students in the areas of: • Communication with academic supervisors, • Development of learning through reflection, • Improvement of professional attributes, • Understanding of WIL benefits, and • Competency in technical knowledge.

- Being well-structured with respect to program operation, student preparation, and learning assessment;
- Allowing their students to be exposed to industry for at least one semester; and
- Allowing the industry placement to offer projects to students.

With respect to dissimilarities, the ChEPS program places students to work in teams at placements and each placement accommodates 6-8 students in a semester. At a placement, there is a ChEPS academic working full-time to help engineers supervise students in fundamental theories and assess the development of students. The assessment of ChEPS students' working performance relies on academics' and engineer supervisors' observations and project output evaluation.

In contrast, the PEPS and the EQUIP students are required to work on their individual projects at placement which accommodates a maximum of 2 students in a semester. As the PEPS and the EQUIP students work distantly from their supervisors, several assessment tools:

- Student's Weekly Contact Sheet, the Student's Contact Log,
- Professional Contact Log,
- Professional Abilities Inventory, and
- Project Presentation,

are employed to ensure that these students can develop their learning as the programs expect and that academics can offer help in time if something that may interfere with student learning occurs.

CHAPTER IV:
STAKEHOLDERS' PERCEPTIONS OF CHEPS, PEPS, AND EQUIP PROGRAMS

4.1 Introduction

This chapter investigates ChEPS, PEPS, and EQUIP stakeholders' perceptions in order to recommend best practices for operating WIL programs that can maximise these stakeholders' benefits. The reader is firstly provided with an overview of stakeholders' perceptions of the values in participating in a WIL program and their concerns about the program's operation. Then, stakeholders' perceptions of the three programs are investigated. Data were obtained by student reflection analysis, a questionnaire survey, and interviews with program stakeholders. Finally, results of the investigation are discussed.

4.2 Stakeholders' perceptions of WIL programs

Operating a WIL program needs collaboration amongst three stakeholders: the student, the industry, and the institution (Coll & Eames 2004). How these stakeholders perceive benefits they receive in joining a WIL program and its operation follows.

4.2.1 Students as stakeholders

i) Employability

Employability is one of the benefits students expect from a WIL program. As WIL students are more familiar with the staff in their host placement company and its corporate culture, they often have a better chance of receiving job offers, sometimes called return offers, from their placements prior to graduation (Ku, Thonglek & Bhumiratana 2005; Friel 1995; Deane, Rankel & Cohen 1978). Friel (1995) found that 54% (28 out of 51) placements hired their WIL trainees as permanent staff after the program's completion.

Another benefit for WIL students is the enhancement of their self-confidence during job interviews. Based on informal feedback from industry, students experiencing placement practice could demonstrate higher self-confidence during the interviews than those without the experience (Ku & Thonglek 2011). Placement provides an opportunity for students to better understand theory applications, career paths, and organisational structure which help students boost their confidence when interviewing with employers (Dressler & Keeling 2004).

ii) Academic performance improvement

Working with professionals in an authentic environment can inspire students to pay more attention to study in classroom. Van Gyn et al. (1997) reported that after experiencing a placement, WIL students performed better than non-WIL students. However, it was argued by McCurd and Zegward (2009) that there were no significant differences between the average grades of the students with placement experience and those without.

Placement experience can influence academic performance in courses relevant to the skills developed during the practice. Kramer (2008) found that, amongst students with a GPA (USA) ranging from 2.50 to 3.49, those with WIL experience performed better than those without in courses related to project management. It is possible that succeeding in these courses depends on students' maturity, self-management, teamwork, and real-life applications which they had developed during placement.

4.2.2 Industry as a stakeholder

i) Placement benefits

Student outcomes

At placement, WIL students are responsible for two types of work: regular tasks and separated tasks. Regular tasks are routine work that is also performed by permanent employees of the placement. Separated tasks are extra projects that are specifically assigned to WIL students. For engineering students, the latter is preferable. However, some placements allow students to cope with both types of task. Deane, Rankel and Cohen (1978) found that 40% of placements benefited from the projects students studied during their training. This result has been confirmed by Cullen (2005) who stated that WIL students could help industry mentors complete some projects.

It has been reported by Ku et al. (2007) and Johnston et al. (1994) that projects which focus on the improvement of product yield, process or system efficiency, or on the reduction of operating and production costs are perceived as most important by the placement host company. In addition to project output, the company is generally satisfied with fresh ideas proposed by WIL students. Metzger (2004) found that 68% (151 out of 223) of placements did benefit from students' new ideas.

In addition, companies preferred to work with students who were energetic and highly motivated in learning. Cullen (2005) stated that, generally, WIL students are motivated students and this is reflected in their quality of work and performance. How industry perceives students' project outcomes and work performance is very important to any WIL program's operation and sustainability. It was observed that a placement organisation tended to continue participating in and supporting a WIL program if the project results were found to be useful (Ku et al. 2007; Ku & Thonglek 2011).

Recruitment benefits

Having placement students interned at a company provides it with an opportunity to work with students and observe their performance and attitude. The placement organisation can offer jobs to WIL students who have demonstrated excellent performance and positive attitude prior to program's completion. This arrangement enhances the effectiveness of company's recruitment process. Deane, Rankel and Cohen (1978) indicated that 37% of WIL students continue to work for the placement as permanent employees after their graduation. This recruitment benefits have been confirmed by Ku and Thonglek (2011) who reported that a few industry placements in Thailand have been able to offer and secure jobs for their trainees before these students graduate each year.

In addition, it was found that 88% (202 out of 229) of placement organisations considered WIL programs one of the channels for networking with institutions in the recruitment of future non-WIL students (Deane, Rankel & Cohen 1978).

Training cost reduction

Employing WIL graduates can help industry reduce the training costs of new employees. Experiences at the placement allow WIL graduates to be familiar with the company's structure, its organisational norm, and the people in the workplace prior to graduation. Thus, the training period for these WIL graduates as new full-time staff is greatly reduced. Friel (1995) showed that 56% (45 out of 80) of employers admitted that hiring WIL graduates who used to be their companies' trainees could reduce the cost of training for new staff. However, Hurd and Hendy (1997) argued that the cost of training WIL students during placement might somewhat offset this cost saving.

Improvement of the industry's image

Contributing to higher education can bolster the image of an organisation. Metzger (2004) found that 77% (172 out of 223) of employers had realised that being placements could boost the image of their companies, while Braunstein and Stull (2001) discovered that 42% (39 out of 92) of employers had noticed some enhancement of the companies' reputation due to their participations in a WIL program.

On the other hand, placement companies may not view this reputation value as a top priority. Amongst benefits offered by a WIL program to a placement, the improvement of company image was ranked 13th out of 22 and 8th out of 11 by Metzger (2004) and Braunstein and Stull (2001), respectively. In addition, this placement benefit was not even included in some research involving WIL and engineering education (Friel 1995).

ii) The cost of placement

The costs of a WIL placement are divided into two categories: direct costs and indirect cost or in-kind contributions (Deane, Rankel & Cohen 1978; Ku et al. 2007). Direct costs comprise start-up costs, student wages, student scholarships, and project expenses. Indirect costs normally refer to the time that company staff spends on project preparation, student supervision, and general administration such as office space, housing, and transportation, etc. However, a company is not required to cover all the expenses (Ku et al. 2007). Ku et al. (2007) explained that the cost of being a placement was negotiable and adjustable, depending upon the agreement between the university and the company.

Student wages

Amongst the costs mentioned above, students' wages or stipends are a common cost of placements. Deane, Rankel and Cohen (1978) studied a comparison between the wages of WIL students and regular employees and the results are shown in Table 4.1.

Table 4.1: A comparison between wages of WIL graduates and those of regular employees (adapted from (Deane, Rankel & Cohen 1978))

WIL students' wages compared to those of regular employees	Number of employers	%
More	17	9
Less	96	46
No difference	94	45
Total	207	100

Table 4.1 shows that about 90% of placements did not pay higher wages to WIL students relative to their permanent staff. However, this information is slightly different from the work of Edwards, Jancauskas and Goldston (1999) who found that placements slightly pay higher wages to WIL students than some company staff. It is possible that these WIL students have been working as trainees at the company for a certain time and their experience during work placement was regarded as equivalent by employers.

iii) Placement concerns

There are two issues commonly raised by stakeholders during placements: ambiguous or poorly defined roles and responsibilities, and student misbehaviours. Cooper, Orrell and Bowden (2010) stated that industry mentors could be confused when it comes to their roles and responsibilities, particularly in the area of student supervision. In addition, 27% (13 out of 49) industrial sponsors noticed some lack of knowledge in the codes of conduct of WIL students. For instance, most WIL students do not know how to behave or how to dress properly in a workplace (Friel 1995).

Even though being a placement host company incurs costs in many ways and causes some potential operational issues, the benefits still generally outweigh these costs. Referring to Table 2.6 and 2.7, a placement can gain the benefits of better work quality from WIL students while avoid having to pay more wages. In addition, it has been reported that some project outcomes could help companies significantly reduce the cost of production and operation (Ku & Thonglek 2011).

An understanding of how industry perceives a WIL program is important. In this thesis, the industry's perceptions of WIL graduates, WIL students, and program operation were investigated. The outcomes of this investigation are useful for academic institutions, allowing them to explore strategies to effectively operate and sustain their WIL programs.

4.2.3 Institution as a stakeholder

i) Increase in student enrolment

WIL can increase enrolment in a university. It has been reported that each year there are about a hundred applicants who show keen interest in applying to a WIL program in Thailand (Ku & Thonglek 2011). Three factors that attract students to enrol in the program are its curriculum structure, employability enhancement, and scholarship support. Weisz and Chapman (2004) claimed that some students were interested in a WIL-focussed curriculum because it allowed them to be exposed to a real working environment at an early stage in their learning. On the other hand, other students expect the experience in the workplace to help them enhance their confidence in job interviews and increase their chances of receiving job offers (Ku & Thonglek 2011). Furthermore, scholarship support from institutions is an important criterion which students use to make their decisions in whether to attend the program (Ku & Thonglek 2011).

ii) Curriculum and course development

The impacts of WIL on educational development include curriculum innovations, course initiations, and course content modifications. A new WIL curriculum can be created as a joint venture amongst industry, institutions, and government to produce graduates in fields where there is a shortage of human capital (Fry & Hughes 1997). A new course could also be developed to prepare students for WIL placement. This type of course encourages students to demonstrate skills needed for a workplace such as theory applications, teamwork, and communications (Ku et al. 2007).

By gaining experience from placement, academics can modify and update their course contents in classroom. Academics' experiences are enhanced through working with industrial mentors and supervising students (Weisz & Chapman 2004). However, this modification of course contents depends on individuals since it has been reported that not all academics participating in the WIL program adjust teaching materials in accordance with their WIL experiences (McCurd & Zegwaard 2009).

iii) Development of an industry-institution collaborative research

Collaborative research is another valuable benefit of WIL programs. New research can evolve from placement projects or new topics proposed by academics. In general, projects that students work on at placement do have solid impacts on industry. However, since the placement duration and students' knowledge are limited, project outcomes tend to be preliminary results. To make the outcomes more valuable leading eventually to implementations and commercialization, these projects must be further explored under collaboration between experts from institutions and industry. This is one area where new collaborative research could take place.

In addition, academics can come up with new research ideas through WIL. Being exposed to a workplace environment and working with professionals allows the academics to better understand the problems facing the industry. New collaborative research programs can arise to respond to these problems.

vi) WIL issues

Even though institutions benefit from a WIL program, a couple of issues, namely academics' perception and financial problems, have been reported (McCurd & Zegwaard 2009; Thonglek, Howes & Kavanagh 2011). McCurd and Zegwaard (2009) found that some academics felt that their contributions to a WIL program went unrecognised and under-appreciated, and these rather uncomfortable feelings could adversely impact the effectiveness of the program's operation.

Financial issues are another problem often facing WIL programs. Since the nature of a WIL program is different from that of conventional classrooms, the costs of running a WIL program are higher than those of operating a regular curriculum. Even if a WIL program is subsidised by the government and funding agencies, a shortfall is often reported (Coll & Eames 2004; Ku & Thonglek 2011). In addition to the issue of cash flow, WIL programs face the problem of long term sustainability. To address these financial problems, strategies to solicit more money from industry and WIL alumni have been investigated (Thonglek, Howes & Kavanagh 2011; Weisz 2001).

Next, an investigation of stakeholders' perception of ChEPS, PEPS, and EQUIP programs follows.

4.3 Stakeholders' perceptions of ChEPS, PEPS, and EQUIP programs – Data collection methods

The steps of investigating stakeholders' perception are shown in Table 4.2.

Table 4.2: The steps of research approach to investigate stakeholders' perceptions

Step	Detail
1. Develop a WIL logic model	The program logic of the University of Wisconsin Extension is adapted to develop a WIL logic model. The developed WIL logic model helps design data collection methods in this thesis.
2. Identify program stakeholders	WIL stakeholders are divided into nine groups, depending on their backgrounds, roles, and responsibilities in the programs.
3. Data collection methods and analysis	
3.1 Analyse student reflection reports	Reflection reports of students from the three programs were analysed to investigate their learning development and learning outcomes through WIL.
3.2 Conduct a questionnaire	A questionnaire survey was disseminated across schools of chemical engineering in Thailand and Australia to explore WIL operational models and issues encountered in implementing WIL in these schools.
3.3 Conduct interviews with program stakeholders	Interviews with WIL program stakeholders were conducted to investigate what benefits they gained from participating in the program, how they perceived these benefits, and the problems that occurred due to their participation in the program.

4.3.1 WIL logic model

A program logic model is a 'picture' that describes how a program works. The program logic allows the user to plan an overview of what they need to do and what they expect to achieve (Cooksy, Gill & Kelly 2001). In addition, the model helps the user identify who needs to get involved in the program, why they need to get involved, and how these users implement their plan to achieve program goals (Flinders University 2006). The well-known program logic cited by several researches was developed by the University of Wisconsin Extension (UWE). The UWE logic model is shown in Figure 4.1 (Taylor-Powell & Henert 2008).

Referring to Figure 4.1, the UWE program logic divides the process of program operation into three main parts:

- **Inputs** refer to what is invested in this program such as manpower, money, technology etc.

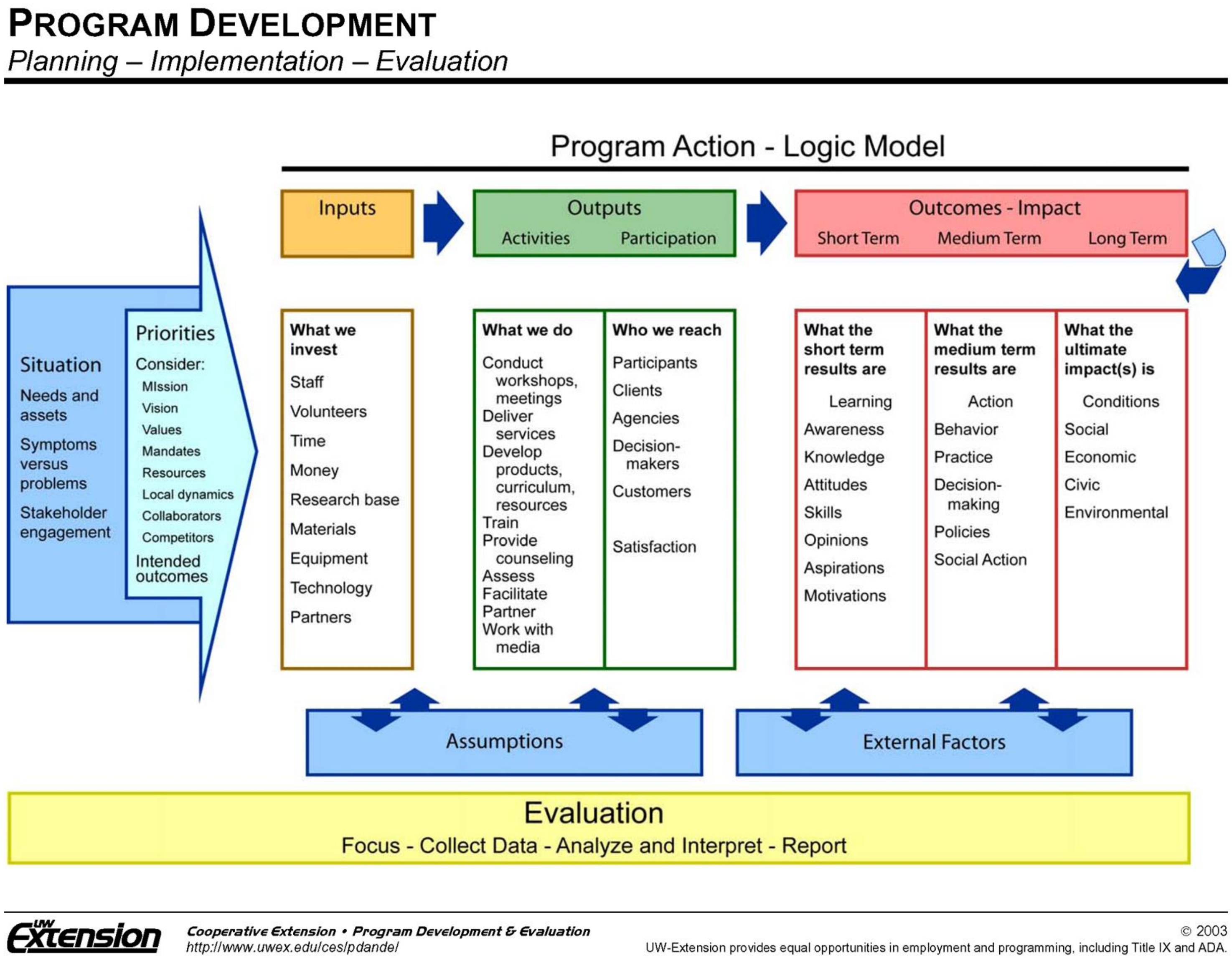

Figure 4.1: The University of Wisconsin Extension (UWE) program model (Taylor-Powell & Henert 2008)

- **Outputs** refer to the activities that are designed or have been conducted to help the program achieve its goals and the program clients who are expected to gain benefits from the program or to be impacted by program operation.
- **Outcomes** refer to the activity results that can be further divided into three stages: short-term results, medium-term results, and long-term results. Short-term results refer to the outcomes that can be measured immediately after the program's completion such as the development of student skills after they undertake the program. Medium-term results refer to the outcomes that require certain time for its effect such as student behaviours to be seen, while long-term results refer to the outcomes related to public attitudes or behaviours such as environmental changes, economics impacts, and social values.

The logic model can provide the user with benefits as follows (Holt 2009):

- **Planning tool.** The logic model allows users to think about what expected program outcomes are and how investments are linked to activities to achieve the desired results. Due to the overview picture of the process, the user can design his or her strategies to achieve the goals.
- **Communication tool.** The model provides a graphic representation that helps program stakeholders perceive the same picture of program operation and this allows them to have the same understanding of where they are or where they want to be.
- **Implementation tool.** As the logic model shows the connections between resources, activities and outcomes, it is used to explain, track, and monitor operations, processes, and functions. At the management level, the logic model can be used as a framework to monitor the status quo of the program.
- **Measurement tool.** As the logic model shows program activities, outputs, and impacts (outcomes), it allows the user to realise what data need to be collected, when it needs to be measured, and how it should be measured.
- **Evaluation tool.** Even though this logic model is not an evaluation model but it assists the users to evaluate the effectiveness of a program by:
    - Identifying significant program components and what needs to be evaluated;
    - Identifying program outcomes and specify program milestones;
    - Determining when to collect data; and
    - Determining data collection sources, methods, and the selection of instrumentation.

However, the logic model has limitations (Holt 2009; Taylor-Powell & Henert 2008). It is possible that there are many factors influencing the program process and outcomes, so a logic model needs to show situations or conditions of the studied program. In addition, the logic model does not take into account unexpected program outcomes that may occur and influence the effectiveness of program operation. Finally, the logic model does not address the question whether or not what is being done is the right thing.

In this thesis, the UWE model has been adapted to develop a WIL logic model as shown in Figure 4.2. The resulting WIL logic model allows the reader to understand the overview of WIL operation with respect to:

- Stakeholders involved in a program,
- Necessary resources,
- Roles and responsibilities of each stakeholder; and
- Expected benefits that each stakeholder could gain from program participation.

This model can be used as a guideline to operate and evaluate a WIL program. In this thesis, the model was used to evaluate if stakeholders benefit from participating in a WIL program and how they perceive the effectiveness of the program operation.

4.3.2 Stakeholder identification

Stakeholders' backgrounds and their roles and responsibilities can influence the effectiveness of WIL program operation (Thonglek, Howes & Kavanagh 2011; McCurd & Zegwaard 2009). This thesis classifies WIL stakeholders into nine categories that are underpinned by the logic model:

1. **University executives** who direct the institution's policy towards the directions of WIL.
2. **Academics** who are responsible for:
    - Preparing students for learning at WIL placements;
    - Ensuring that placement environments and projects allow students to fully develop their learning;
    - Supervising and assessing students with respect to technical knowledge and working skills; and
    - Coping with managerial and administrative tasks.
3. **Current students** who are working at placements or had placement experience but have not yet graduated.
4. **Alumni** who graduated from a WIL program

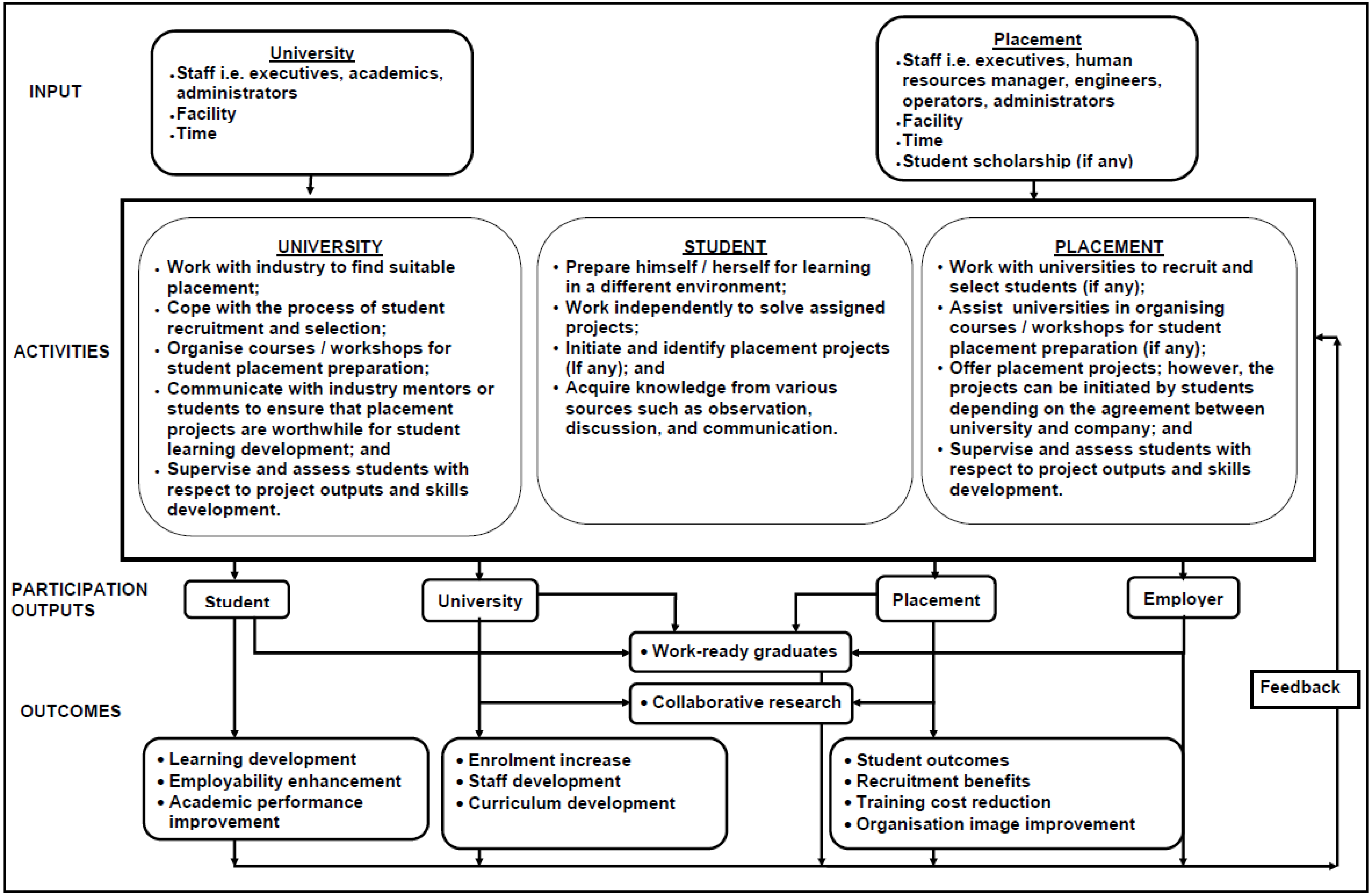

Figure 4.2: WIL logic model (Based on the University of Wisconsin Extension (UWE) model) (Taylor-Powell & Henert 2008)

5. **Industrial mentors,** here called "**sponsors**" who supervise and assess students' placement projects.
6. **Employers** who hire WIL graduates but are not involved in any WIL program operations.
7. **Alumni and sponsors** who are WIL alumni and now working for WIL placements. They are assigned by the placement to supervise current students.
8. **Alumni and employer** who are WIL alumni and now they are self-employed and hiring junior WIL graduates.
9. **Sponsors and employers** who experienced supervising WIL students and currently are working with WIL alumni.

4.3.3 Data collection methods

ChEPS stakeholders' perceptions were obtained through three methods: student reflection analysis, a questionnaire, and interviews with program stakeholders. The students' self-reflections revealed learning outcomes that they could develop during placement and how they were able to achieve them. The questionnaire showed academics' perceptions with respect to program background, program operation, and students' learning outcomes. In-depth interviews disclosed how WIL stakeholders (Section 4.3.2) perceived WIL programs in terms of student development, operational effectiveness, long-term operation, and other concerns. Results from each method were triangulated to validate findings of this thesis.

An overview of the information gathered by these three methods is presented in Figure 4.3.

i) Student reflection analysis

Reflection reports of students from the three programs were analysed. The ChEPS students produced their reports before the placement and during the Design Problem phase (Figure 3.2). These reports were investigated to see if the students could demonstrate learning process development and graduate attribute improvement during placement preparation. On the other hand, the PEPS and the EQUIP students reflected upon the learning skills and graduate attributes that they have developed during their placement periods (Figure 3.8).

The reflections were analysed in terms of student learning development and graduate attribute improvement. Details of the analysis follow.

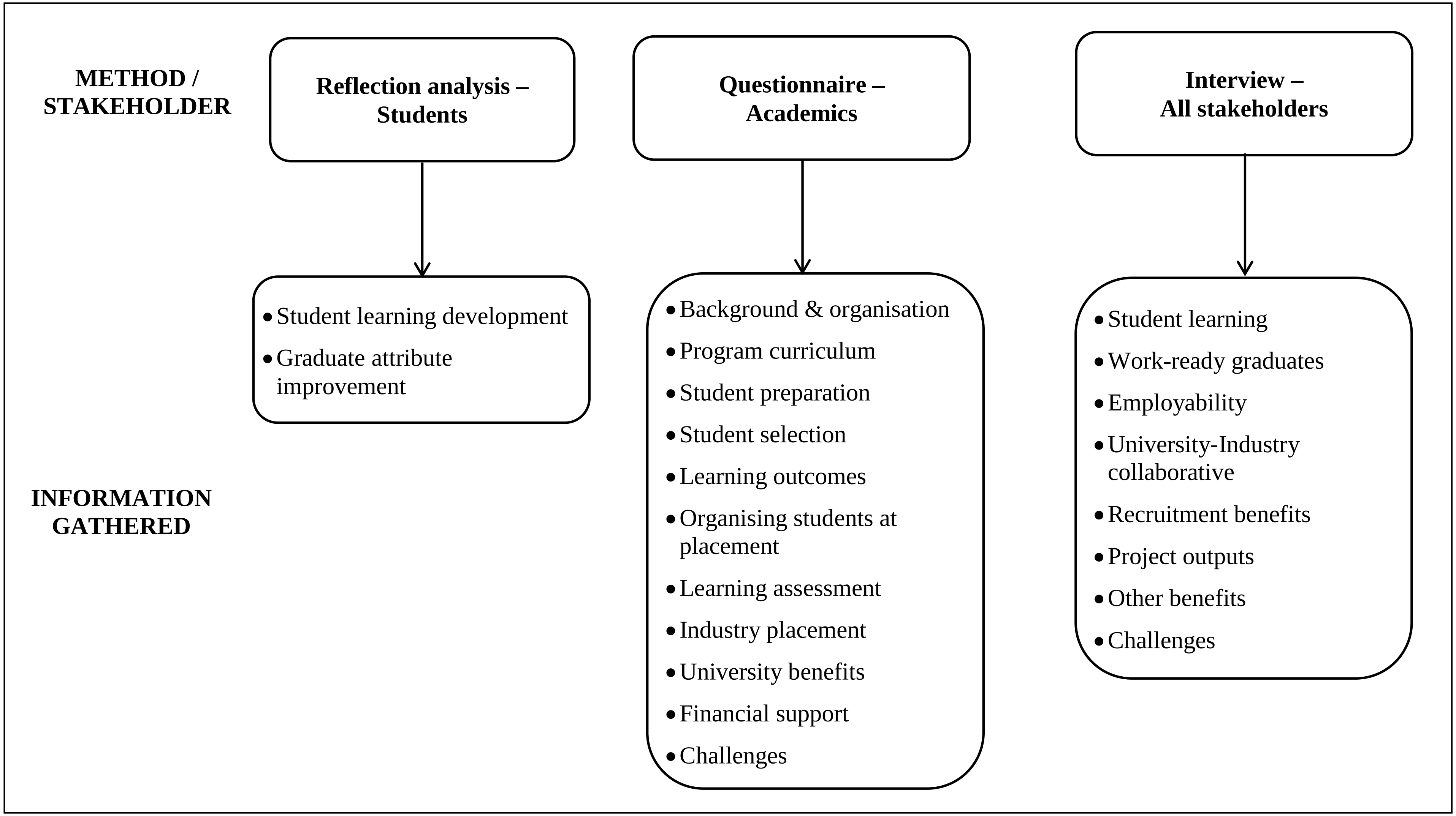

Figure 4.3: Data collection method overview

Boud, Keogh and Walker (1985b) asserted that after reflecting their actions, students gain a better understanding of their actions; consequently, they could change their behaviours and attitudes. As a result, reflections of students who are expected to be able to learn independently in placement should demonstrate the components shown in Figure 4.4.

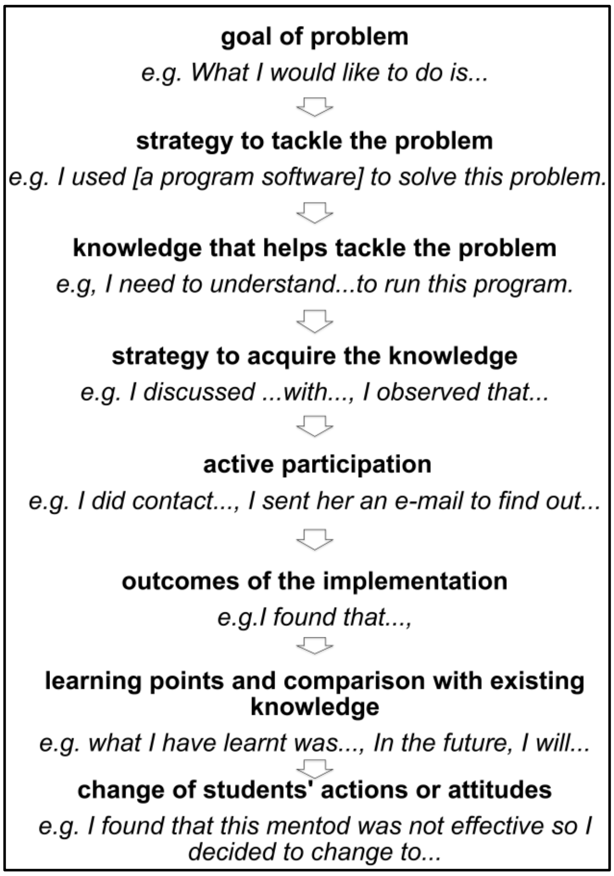

Figure 4.4: Data analysis of learning development (Thonglek et al. 2014)

Words or phrases that demonstrated learning process components were investigated. Definitions and examples of learning steps are shown in Appendix C. Note it is unnecessary for students to reflect these steps in an orderly fashion (Boud 2001; Boud, Keogh & Walker 1985b).

Graduate attribute improvement

The learning outcomes were investigated by words or phrases that demonstrated the development of graduate attributes (Table 2.4 and Figure 2.1). The results of the reflection analysis are presented and discussed Section 4.4.1.

However, there have been concerns about using reflections as a learning assessment tool (Lay & Paku 2013; Bolton 2005; Boud 2001; Boud 1999). Some students especially engineering students perceive that reflections are considered as a “fluffy” subject so they do not pay attention to their reports. In contrast, some students try to guess what academics look for from their reflections and then they reflect accordingly. The issues of trust and confidentiality can obstruct students to entirely reveal what they learn through reflections. Finally, some students have problems with writing skills so their reflections may not reflect what actually happens and what they truly learn.

ii) Questionnaire

A questionnaire (Appendix E) was developed to explore WIL operation models in schools of chemical engineering in Australia and Thailand. . Identifying what should be included in the survey is significant. An extensive review on several aspects of WIL have been conducted. These aspects include types of WIL operational models, learning outcomes that WIL students can develop through placement, how to assess these learning outcomes, and factors that influence the success of program operation including program sustainability (Ku & Thonglek 2011; Cooper, Orrell & Bowden 2010; Patrick, Peach & Pocknee 2009; Coll & Eames 2004). Common issues that were mentioned in these papers were selected to ensure that the questions are suitable for any WIL program, both in Australia and in Thailand. In addition, important operational issues that were raised by each researcher were also included in this questionnaire to ensure that important factors that could affect program operation were not omitted.

The survey was administered as follows:

1. Eleven Schools of Chemical Engineering in Australia and nineteen Chemical Engineering Departments in Thailand were identified.

2. Heads or academics from the schools were contacted via e-mail or interviewed by phone to determine whether the school or the department was running or proposed to run a WIL program.

3. The on-line survey was disseminated to the schools identified as running WIL programs.

Survey results were collected through the Survey Monkey program. Initially, seven participants, one from Australia and six from Thailand, responded to the questionnaire. Then, a second follow-up email was sent out. As a result, five more participants, four from Australia and one from Thailand, responded. However, two participants from Australia replied that their schools did not operate a WIL program as described in this survey. In total, ten participants, three from Australia and seven from Thailand, responded to the questionnaire and seven of them fully completed the questions. The results are presented and discussed in Section 4.4.2.

iii) Interview

Interviewing is a common way that qualitative researchers use to gather information. Referring to Lichtman (2010), interview allows researchers to learn how participants think and feel, which yields valuable qualitative research data. In this research, interviews with stakeholders of WIL programs were conducted to investigate their perceptions of the values of program benefits and the effectiveness of program operation. The interview was undertaken using the following approach:

> '*…the purpose in this style (In-depth) of interviewing is to hear what the participant has to say in his own words, in his voice, with his language and narrative. In this way, participants can share what they know and have learnt and can add a dimension to our understanding of the situation that questionnaire data or a highly structured interview does not reveal.'* (Lichtman 2010)

Regarding the quote of Lichtman (2010), it is suggested that, during the interview, the researcher be a good listener and that the participant feels comfortable. A good listener can encourage the participant to engage in the conversation and realise the meaning behind the participant's voice and body language. The participant who feels comfortable can engage in conversations quickly, effortlessly expressing their feeling and thoughts, and providing the researcher with insightful information.

Participants for the interview were selected from those who had been involved in the programs for more than three years, except current students, to ensure that the participants understood basic characteristics of WIL programs. These participants were initially contacted through an electronic letter to describe research goals. The participants could then make decisions as to whether they wanted to participate in this research. In total, there were sixty-one participants from the nine stakeholder categories (Section 4.3.2) and the distribution of interview participants is presented in Table 4.3.

Subsequently, introductory letters were electronically sent to these participants to provide them with the brief of research details and to request an interview appointment. Interviewing questions were derived from the review of literature relevant to stakeholders' perceptions of WIL programs. The interview questions are presented in Table 4.4.

Table 4.3: Participant distribution

Stakeholder	Australia (A)		Thailand (T)	
	N	Detail	N	Detail
University executive (U)	-	-	2	$T(U)_1$, $T(U)_2$
Academic (Ac)	6	$A(Ac)_1$ - $A(Ac)_6$	9	$T(Ac)_1$ - $T(Ac)_9$
Current student (St)	5	$A(St)_1$ - $A(St)_5$	3	$T(St)_1$ - $T(St)_3$
Alumni (Al)	-	-	16	$T(Al)_1$ - $T(Al)_{16}$
Sponsor (Sp)	-	-	1	$T(Sp)_1$
Employer (E)	-	-	5	$T(E)_1$ - $T(E)_5$
Alumni & sponsor (Al/Sp)	-	-	8	$T(Al/Sp)_1$ - $T(Al/Sp)_8$
Alumni & employer (Al/E)	-	-	1	$T(Al/E)_1$
Sponsor & employer (Sp/E)	-	-	5	$T(Sp/E)_1$ - $T(Sp/E)_5$
Total	**11**		**50**	

Table 4.4: Interview questions for each stakeholder

Stakeholders	Questions
University executive	• What were the motivations to initiate WIL programs? • How do you perceive the WIL program's values and operation? • What is the future plan for the WIL program?
Academic	• What are / were your roles and responsibilities for this WIL program? • What did students gain from working in industry? • What other benefits did / do you personally or the institute gain from participating in WIL program? • What are / were obstacles encountered while operating or participating in WIL program?
Current students and alumni	• What was your motivation to enrol in the program? • What did you do or learn at the placement? • Do you gain benefits from the program as you expected? Why or why not? • What do you want to recommend to improve the program?
Industry sponsor	• What are / were your roles and responsibilities in this WIL program? • What do you expect from students with respect to their personal abilities and work outputs? • Do the performance of WIL students and their work quality meet your expectations? • What do you want to recommend to improve the program?
Employer	• What attributes do you expect from new graduates? • Do you find any advantages of hiring new graduates having WIL experiences?

Some participants, especially employers, received the questions (Table 4.4) prior to the interview. These participants asked that the questions be given to them before the interview to ensure that they were comfortable during the interview and could make the most contributions to the research.

To make participants comfortable for the interviews, they were asked to select a venue for the conversations and to choose to have either a group interview or an individual session. A few of them participated in both interviews. In the end, twenty-seven interviewees chose individual interviews while thirty-four participants chose group interviews. Most interviews were conducted in conference rooms or participants' offices at their workplace. The detail of group interviews is presented in Table 4.5.

Table 4.5: Group interview detail

Category	N	Group detail
Current student (St)	4	$A(St)_1$ - $A(St)_4$
	2	$T(St)_2$, $T(St)_3$
Academic (Ac)	2	$T(Ac)_2$, $T(Ac)_3$
	2	$T(Ac)_7$, $T(Ac)_8$
Alumni (Al)	2	$T(Al)_1$, $T(Al)_2$
	2	$T(Al)_8$, $T(Al)_9$
	3	$T(Al)_{10}$ - $T(Al)_{12}$
	3	$T(Al)_{14}$ - $T(Al)_{16}$
Alumni & Sponsor (Al/Sp)	3	$T(Al/Sp)_1$ - $T(Al/Sp)_3$
Employer (E)	2	$T(E)_1$, $T(E)_2$
Combination	2	$T(Al)_{3,}$ $T(Al/Sp)_4$
	3	$T(Al)_6$, $T(Al)_{7,}$ $T(Al/Sp)_6$
	4	$T(Al)_4$, $T(Al)_{5,}$ $T(Al/Sp)_{5,}$ $T(Al/E)_1$

It was observed that individual interviews allowed the researcher to focus more on each participant and gain more insightful information than group interviews. In group interviews, the researcher needed to ensure that each interviewee had a chance to speak their mind and that none of them felt intimidated by others or was left behind in the conversations. As a result, it was difficult for the researcher to concentrate on each person to draw insightful information.

It was important at the beginning of each interview to make participants feel comfortable so that they were able to speak their minds. This was less necessary with group interviews, as once a participant started to open up or brought up an issue, others would quickly chime in. Group conversations quickly took off, often resulting in a need to bring the conversation back to the interview questions.

With respect to individual interviews, there were differences during the start of the interviews between stakeholders who are involved and those used to be involved in the programs (e.g. academics, current students, and alumni, and those who did not experience a WIL program such as employers). In the first case, the participants were able to immediately engage in the conversations at the start of the interviews because they were familiar with the programs. They understood the differences between the characteristics of WIL programs and those of conventional programs, and they knew what they expected from the programs and how they wanted the programs to be improved.

In the latter case, interviewees needed to be given more information about WIL programs and, when applicable, about WIL alumni currently in their employ. These interviews therefore opened with a brief overview of WIL program operations and learning outcomes and clarifications of the goals and expected outcomes of research. Asking for employers' perceptions of the performance of their employees who graduated from WIL was a good way to engage them in the conversations.

Generally, the interviews took about 45–60 minutes for individual interviews and about 60–90 minutes for group interviews. However, sometimes interviews were shortened due to the time constraints. For example, there was one interview with an employer that lasted only 15 minutes due to some unexpected urgent tasks that he had to attend to.

Interviews were recorded by tape or notes, depending on the preference of the interviewees. It was observed that, in most cases, taking notes would interrupt the interviews. Where possible, the interviews were recorded, as participants were often distracted when the researcher started to take notes.

The researcher learnt two lessons during the interviews. First, it is useful to prepare information about the list of WIL alumni, who currently are working for the companies, as well as their academic performances and personalities. This information allowed the participants to engage in the conversation as it helped the researcher to 'break the ice' at the beginning of the interviews.

Different corporate positions of group members within the same company could affect the interview results. As the researcher allowed the participants to choose individual or group interviews, it appeared that most alumni who worked in the same company chose group interview, and noticeably young alumni seemed to be intimated by older ones.

After the completion of each interview, recorded data were directly transcribed, instead of notes-taken, to ensure that the information was complete. Then, initial codes were developed by starting with benefits that each stakeholder expected or gained from participating in the program. Finally, the data and the developed initial codes were revisited to ensure that important information were not missed.

A codebook for analysing student reflections and interview data was developed. The developed codebook adapted the work of DeCuir-Gunby, Marshall and McCulloch (2010) who stated that the definitions of codes should be clear, concise, and encompassing the data that were being referred to. An example of the codebook is attached in Appendix C.

4.4 Stakeholders' perceptions of ChEPS, PEPS, and EQUIP programs – Results and discussion

4.4.1 Student reflection analysis

i) Learning development

The results show that all EQUIP students could show evidence of all learning components in Figure 4.3, while 60% of the ChEPS students did not show evidence of what they had learned from their implementations and how they had changed their actions or attitudes.

It can be argued that working environments at placement can encourage students to develop their learning. In industry, students have a chance to come into contact with professionals and observe how these professionals think and tackle problems. To solve real-life problems, professional engineers need to use the ability to reflect upon what they are doing or what they have done. Hence, working with engineers at placement encourages EQUIP students to evaluate what they have done, which sometimes require that they change their actions or methods to obtain better results.

On the other hand, students within the ChEPS program are required to reflect upon what they have learnt during preparatory courses involving Design Problems. Even though these problems are provided by industry, ChEPS students are assigned to work with their classmates under the supervision of their academic supervisors at the university. This means that ChEPS students will not have had a chance yet to work with engineers and learn to develop the reflection skills. As a result, fewer than 50% of the ChEPS students showed evidence of all learning components in Figure 4.3.

ii) Industry required attributes

The distribution of the graduate attributes of the students from the three programs is shown in Table 4.6 and summarised in Table 4.7.

Table 4.7 shows that most students from the three programs can demonstrate abilities related to professional skills except **professional ethics**. It can be seen that none of the ChEPS students showed evidence of the development of professional ethics attribute, while few EQUIP and PEPS students did show the attribute. Possibly, working with professional engineers in industry could influence engineering students to develop the professional ethics attribute.

ChEPS students are required to reflect upon what they learnt from solving Design Problems in academic settings so they might have missed an opportunity to work with professional engineers

Table 4.6: The distribution of developed graduate attributes from the three programs

Student attributes (Rank of importance by engineering industry in Section 2.3)	**Placement preparation course**																							**At placement**																		
	ChEPS																							**PEPS**														**EQUIPS**				
	C#1	**C#2**	**C#3**	**C#4**	**C#5**	**C#6**	**C#7**	**C#8**	**C#9**	**C#10**	**C#11**	**C#12**	**C#13**	**C#14**	**C#15**	**C#16**	**C#17**	**C#18**	**C#19**	**C#20**	**C#21**	**C#22**	**C#23**	**P#1**	**P#2**	**P#3**	**P#4**	**P#5**	**P#6**	**P#7**	**P#8**	**P#9**	**P#10**	**P#11**	**P#12**	**P#13**	**P#14**	**E#1**	**E#2**	**E#3**	**E#4**	**E#5**
Professional skills																																										
Professional ethics (1/19)																									●							●	●								●	
Technical competency (6/19)	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●
Critical & analytical thinking (7/19)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●	●	●		●	●	●	●	●
Problem solving (7/19)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●	●	●		●	●	●	●	●
Knowledge acquisition (7/19)	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●	●
Working skills																																										
Ability and willingness to learn / Achievement (1/19)			●	●	●	●	●			●	●	●	●	●		●		●		●	●	●	●	●	●	●	●	●	●			●	●		●	●		●	●	●	●	●
Leadership (7/19)	●																		●	●						●							●		●	●			●			
Teamwork (3/19)	●	●		●	●	●	●	●	●	●		●	●		●	●	●	●	●	●		●	●	●	●	●						●				●		●				●
Technological literacy (13/19)																								●						●				●	●						●	
Communications (14/19)	●	●		●	●		●	●	●	●	●	●	●		●		●	●	●	●		●		●	●			●			●	●	●		●	●		●	●	●	●	●
Professional writing (14/19)					●	●								●				●		●		●			●								●									
Organisational commitment (16/19)																								●		●										●						
Detail-oriented awareness																	●																							●	●	
Customer-oriented awareness (18/19)																																								●		
Mentoring (18/19)																			●																							
Personal effectiveness																																										
Adaptability (3/19)	●					●							●	●	●			●		●	●		●			●			●							●		●				●
Self-management (5/19)	●	●	●		●								●	●		●		●			●		●	●	●	●			●			●	●	●	●	●		●	●	●	●	●
Self-control (7/19)	●	●				●							●		●							●																●	●	●	●	●
Self-confidence (7/19)																					●			●	●	●		●	●				●	●	●	●		●			●	●

NOTE: Student P#7, P#8, and P#14 reflected on administration issues so their reports were excluded from this analysis.

Table 4.7: Graduate attribute demonstration

Student attributes (Rank of importance by engineering industry in Section 2.3)	Number (%)		
	ChEPS (N=23)	PEPS (N=11)	EQUIP (N=5)
Professional skills			
Professional ethics (1/19)	0 (0)	3 (27)	1 (20)
Technical competency (6/19)	21 (91)	11 (100)	5 (100)
Critical & analytical thinking (7/19)	23 (100)	11 (100)	5 (100)
Problem solving (7/19)	23 (100)	11 (100)	5 (100)
Knowledge acquisition (7/19)	22 (96)	11 (100)	5 (100)
Working skills			
Achievement (1/19)	16 (70)	10 (91)	5 (100)
Teamwork (3/19)	19 (83)	5 (45)	2 (40)
Leadership (7/19)	3 (13)	4 (36)	1 (20)
Technological literacy (13/19)	0 (0)	3 (27)	1 (20)
Communications (14/19)	17 (74)	7 (64)	5 (100)
Professional writing (14/19)	6 (26)	2 (18)	0 (0)
Organisational commitment (16/19)	0 (0)	3 (27)	0 (0)
Detail-oriented awareness (17/19)	1 (4)	0 (0)	2 (40)
Customer-oriented awareness (18/19)	0 (0)	0 (0)	1 (20)
Mentoring (18/19)	1 (4)	0 (0)	0 (0)
Personal effectiveness			
Adaptability (3/19)	9 (39)	3 (27)	2 (40)
Self-management (5/19)	10 (43)	9 (82)	5 (100)
Self-control (7/19)	6 (26)	0 (0)	5 (100)
Self-confidence (7/19)	1 (4)	9 (82)	3 (60)

and observe their behaviours. In contrast, EQUIP and PEPS students have opportunities to discern professional engineers' behaviours during their placements so these students are mindful of the importance of professional ethics and are able to reflect how they develop such skills.

With respect to **working skills** and **personal effectiveness**, the table shows that the areas in which the PEPS and EQUIP students could better develop their abilities than those of the ChEPS students were achievement, leadership, self-management, and self-confidence. Possibly, working independently in industry allows students to hone these graduate attributes. WIL students working at placement are often located far from universities so they need a high degree of determination and leadership to tackle problems. WIL students also need to enhance their management skills to complete individual tasks in time, and as a result their self-confidence is enhanced.

Despite their exposure to industry, the percentage of the PEPS and EQUIP students who developed the teamwork skills was fewer than that of the ChEPS students. It is likely that how the students are placed influences the development of their **teamwork skills**. The ChEPS students were assigned to work in teams, whereas the PEPS and EQUIP students were placed to work on individual projects.

Working in teams allows students to learn to allocate work amongst their team members and manage their team to achieve the project goals in time. Students who work on their individual research can miss the opportunity to develop such skills even though they work in an authentic environment.

The results of student reflection analysis show that WIL could help students improve their learning process and develop graduate attributes. To operate a WIL program effectively, it is recommended that an effective tool for assessing student development at placement be used and that the program specifies expected learning outcomes and align learning activities with the specified outcomes. However, it should be pointed out that students might not have reflected all the attributes that they had developed through a WIL program (Boud 2001).

4.4.2 Questionnaire

Survey results from ten WIL programs are presented as follows.

i) Background

Motivations to set up a WIL program and the years of their inceptions including the number of alumni are presented in Table 4.8 and 4.9, respectively.

Table 4.8: The motivations to set up a WIL program

Motivations	N=10	Positive response (WIL program)
Improving the student experience	10	(1),(2),(3),(4),(5),(6),(7),(8),(9),(10)
Industrial collaboration	7	(3),(5),(6),(7),(8),(9),(10)
University policy	5	(2),(4),(5),(6),(9)
School initiative	3	(5),(6),(8)
Accreditation requirements	1	(3)
Collaboration between institutions	1	(3)
Personal interest	1	(1)

In Table 4.8, all participants indicated that their WIL programs aimed at improving students' experiences, while 70% of them also claimed to use their WIL programs as a channel to strengthen linkage with industry. However, it is possible that industry participating in WIL programs expects recruitment benefits and project outcomes rather than emphasising student development (Thonglek et al. 2013). To ensure that students can gain learning benefits which underpin the establishment of all WIL programs, it was suggested that students' benefits be prioritised if any negotiation amongst stakeholders' benefits occurred.

Table 4.9: Program inception including the number of alumni

	WIL program									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Inception (Approximately)	2000	2009	2005	2004	2006	1997	No response	2010	2005	2007
No. of alumni	200	2	11	15	15,000*	253	20	No response	300	25

NOTE: *It is assumed that the numbers included WIL graduates from other disciplines.

The results show that there are four programs that have been operating for about ten years and producing more than 200 graduates.

ii) Program organisation and curriculum

Levels of organisation in operating WIL programs, their curricula and student admission, and selection criteria are presented in Table 4.10 and 4.11.

Table 4.10: Level of organisation operating WIL

Level of organisation operating WIL	N=10	Positive response (WIL program)
Program (e.g. It is run by the coordinator of the Chemical / Metallurgical program which sits in the School of Chemical Engineering)	4	(2),(8),(9),(10)
School (e.g. It is run by the School of Chemical Engineering)	2	(4),(6)
Faculty (e.g. It is run across many schools of engineering)	2	(1),(7)
University (e.g. It is run by a university-wide office for many different disciplines.)	1	(5)
Other – Both the Graduate School and the program	1	(3)

Table 4.10 shows that WIL programs have been operated at all levels of academic organisations. This result is supported by the work of Chinintorn (2011), Cooper, Orrell and Bowden (2010), and Calway and Murphy (2006) who argued that WIL programs can be operated in a numbers of way depending on university policies, curriculum objectives, and placement availability. However, it can be observed that most of the WIL programs (six respondents) have been operating within their schools, either separately by coordinators or heads of school. Possibly, arranging students from the same curriculum is more convenient than those from a multidiscipline that tends to have different curriculum structures.

In Table 4.11, three out of four WIL programs at the graduate level are compulsory. The reason could be that graduate students are thought to possess sufficient knowledge to tackle industrial problems and could make bigger impacts on industry. In addition, graduate students are expected to be more mature than their undergraduate counterparts so the former can work independently without close supervision from academics and engineers.

Table 4.11: Program curricula, student admission criteria

WIL program	Undergraduate level	Graduate level	% Admission	Selection criteria	Remark
WIL as a compulsory subject					
(3)	-	•	50-60	English test and Interview	
(5)	3rd, 4th	•	100	GPA and passing a preparation course	-
(6)	-	•	20	GPA, interviews, TOEFL scores, SAT-Math scores	-
(9)	1st,3rd,4th	-	70	GPA	-
WIL as an elective subject					
(1)	4th	-	60	GPA, interviews (Industry and university approval required.)	The WIL program replaces two courses.
(2)	3rd	-	100	GPA	The WIL program is an extracurricular course.
(4)	3rd	-	100	GPA and industry criteria	The WIL program replaces 2 subjects.
(7)	3rd,4th	•	100	Student benefits	The WIL program replaces 1 subject.
(8)	3rd	-	No Response	GPA and English proficiency	The WIL program replaces a senior project.
(10)	4th	-	30	Leadership and academic merit, willingness and capability to take on extra load. Good grades but not solely grades. Apply via resume, and letter-shortlisted students also attend and interview.	The WIL program replaces research project, engineering management unit, and an elective unit.

Of the six optional WIL programs, most of them (five respondents) use WIL to replace other courses, while one program requires students to take WIL as extracurricular course. In the latter case, it could be convenient to add WIL into its original curriculum, as none of existing course are affected. However, students who take WIL courses need to do much more work than their classmates who do not take WIL courses. Possibly, the optional WIL program that requires students to take WIL as an extra course may not be well-known. This is supported by the result in Table 4.9 which shows that since its inception, there have been two alumni from the program No.#2.

With respect to selecting students, it can be seen that academic performance is the most popular criterion for student selection. However, the merit of this selection criterion is debatable. Students who have strong academic backgrounds may not demonstrate ability to learn independently during placement. To learn successfully at placement, students need to be open-minded and motivated in learning. In addition, Donkor, Nsoh and Mitchua (2009) and Cullen (2005) claimed that organisational cultures can influence the development of student learning. Hence, it is suggested that apart from academic performance, selecting students for WIL programs should involve other aspects such as students' values, learning attitudes, and working habits.

iii) Placement preparation

The objective and duration of placement preparation are shown in Table 4.12.

Table 4.12: The objective and duration of placement preparation

WIL program	Preparation duration	Objective
(1)	2-day introductory session	Lessons on reflection techniques, external library use, project planning, ethics
(2)	1 day workshop	Safety and behaviour
(3)	1 year before the internship	Provide the fundamental concepts related to the industry
(4)	1 course	What the industry expects from Co-op students and how the students can meet the requirements.
(5)	1 -2 years – special course, introductory session, and taking pre-Coop course.	Prepare soft skills for our students
(6)	No preparation	No response
(7)	7 days	Safety and initiative
(8)	No preparation	No response
(9)	1 week	To know more about the industry
(10)	1-day introductory session	Hope to cope with work and study at placements, and managing administrative tasks such as payment, OHSE, responsibilities, and assessment overview

In Table 4.12, most WIL programs (8 out of 10) indicated that they have a preparation session for students before the students enter placement except for program (#6) and (#8). Possibly, program No#6 is compulsory so all learning activities before placement are designed to prepare students for industry.

It should be noted that just one program mentioned about reflection technique preparation. Reflection has been argued as a key step of learning development and helping students learn successfully in placement. However, to conduct reflective practice effectively, students need to communicate among themselves and systematically deliberate their thoughts. Students' reflection ability varies from individual to individual. Hence, it will be useful if students are aware of this skills before placement to help them maximise their learning benefits.

The common objectives of the preparation are to provide students with knowledge related to industry such as safety issues, placement norms, and placement expectations. However, none of the participants mentioned about ways in which students could be taught to learn independently, which is an important learning approach at placement. To fill this gap, this thesis proposed a learning assessment tool to allow academics to measure students' independent learning ability and help them when necessary.

iv) Learning outcomes and learning assessment

Student learning outcomes are presented in Table 4.13.

Table 4.13: Student learning outcomes

Learning outcome	N=10	Positive response (WIL program)
Students demonstrate knowledge of fundamental engineering theories	4	(3),(5),(6),(10)
Students demonstrate the ability to apply theoretical knowledge to real-life problems	9	(1),(2),(3),(5),(6),(7),(8),(9),(10)
Students demonstrate professional engineering practice	9	(1),(3),(4),(5),(6),(7),(8),(9),(10)
Students demonstrate the ability to work in teams	8	(2),(3),(5),(6),(7),(8),(9),(10)
Students demonstrate the ability to communicate effectively	10	(1),(2),(3),(4),(5),(6),(7),(8),(9),(10)

Table 4.13 shows that less than half of the participants require students to demonstrate technical knowledge ability, while most of them are found to require students to develop theory application skills. Possibly, academics expect students to improve the skills that are difficult to be developed in classroom settings. Due to rigid curriculum structures and physical learning environments in universities, it is difficult for students to find a chance to use theories to solve real-life problems and develop application skills.

In addition to the application skills, Table 4.14 shows that academics expect their students to develop other working skills, namely professional practice, teamwork, and effective communication. In addition, the development of thinking skills and social skills are added by program (#3) and (#4) as parts of the expected student outcomes.

Even though the abilities related to working skills are expected by all participants, none of them mentioned the requirements of students' personal effectiveness development. Referring to Table 2.4, students who possess abilities related to personal effectiveness are required by industry, as it dictates the effectiveness of an individual's performance such as self-management, self-confidence and self-control. Hence, it is suggested that personal effectiveness improvement be specified as part of the expected learning outcomes to ensure that WIL students can develop the abilities that industry requires.

v) How students are placed at placements

How students are placed at placements is presented in Table 4.14.

Table 4.14: Placing students at placement

The students placed	N=9	Positive response (WIL program)
Individual task (A chemical engineering student who is responsible for his/her own project.)	6	(1),(2),(3),(4), (7),(10)
Multidisciplinary team (A group of students, which consist of at least one chemical engineering student and students from various disciplines)	1	(7)
Chemical Engineering student team (A group of students, which consist of only chemical engineering students)	2	(7),(9)
Industry team (A group with engineers from the working industries and chemical engineering students)	3	(5),(6),(7)

Table 4.14 shows that there are many ways to organise students at placements and that most WIL programs (6 out of 9) assign students to work on individual projects. The many degrees of freedom for placement probably make it convenient or easier for a program or a student to find a suitable placement.

Regarding Table 4.12, program (#2), (#3), and (#10) indicate that they expect students to develop the teamwork skills; however, they assign students to work on individual projects at placement (Table 4.14). Placing students in groups is crucial to the development of their teamwork skills (Section 4.4.1). It is suggested that students be required or encouraged to work either in students' teams or engineers' teams at placement if the program wants students to develop teamwork skills.

vi) Industry placement

Various types of industry placements are presented in Table 4.15.

Table 4.15: Industry placement

Type of the industry	N=10	Large (> 500 employees on site)	Medium (500-50 employees on site)	Small (< 50 employees on site)
Oil / Gas platforms	6	(3),(6),(9)	(1),(5),(7)	
Petrochemical industry	9	(1),(2),(3),(4),(6),(8)	(5),(7),(9)	
Food manufacturing	4	(1),(7)	(5)	(9)
Chemical manufacturing	9	(2),(3),(5),(7)	(1),(4),(9),(10)	(1)
Breweries / Distilleries	4	(7)	(1),(5),(9)	
Pharmaceuticals	3	(7),(10)		(9)
Consulting firms	2		(7),(9)	
Mineral processing	5	(1),(3),(9)	(1),(7)	
Water companies	4		(5),(7),(9),(10)	
Research	3	(7)	(3),(9)	
Total	**49**	**22**	**24**	**3**

Table 4.15 shows that chemical engineering students are capable of practicing in various industry placements. It is observed that the majority of placements are in the petrochemical industry, chemical manufacturing, and oil and gas platforms. It is possible that the nature of these industries is related to students' professional areas. In addition, the table shows that most of these placements (46 out of 49) are medium and large organisations. Possibly, medium and large companies have sufficiently available projects and engineers who can allocate their time to work with and supervise students..

vii) University benefits

Benefits that universities gain from WIL programs are presented in Table 4.16.

Table 4.16: University benefits

University benefits	N=10	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Promoting the university reputation	10	(2),(3),(5),(6),(7),(9),(10)	(8)	(1)	(4)	-
Increasing student enrolment	10	(3),(7),(9)	(5),(6),(10)	(1),(2),(8),	(4)	-
Developing curriculum	10	(2),(3),(4),(5),(7),(8)	(1),(6),(9),(10)	-	-	-
Building staff's expertise	10	(2),(3),(4)	(5),(6),(7),(9),(10)	(1),(8)	-	-
Attracting more funding	9	(3),(6)	(7),(8)	(1),(2),(5),(9),(10)	-	-
Initiating collaborative research	10	(2),(3),(7)	(4),(5),(6),(8),(10)	(1),(9)	-	-

The survey shows that most participants think that their WIL programs could make several contributions to universities. All participants admitted that WIL could help academics develop their curriculum and most of them (8 out of 10) agreed that WIL help build their academics' expertise. However, it needs to be aware that universities may not have maximised these benefits yet as McCurd and Zegwaard (2009) found that not all academics brought their experiences from working with industry to develop their own expertise or update teaching materials.

vii) Financial support

The distribution of funding resources for tuition fee and administrative costs is presented in Table 4.17.

Table 4.17 shows that most WIL programs have been partly supported by industry with respect to administrative expenses and / or student scholarships. This indicates that industry is involved in a WIL program not only as a placement, but it is also an important source of funding.

Table 4.17: Funding resources for tuition fee and administrative costs

WIL program	Administrative expense			Tuition fee		
	University	Industry	Government	University scholarship	Industry scholarship	Paid by students
(1)	√	√	X	√	X	√
(2)	√	X	X	X	X	√
(3)	√	X	√	√	X	X
(4)	X	√	√	X	X	√
(5)	√	X	√	X	√	√
(6)	√	√	√	√	X	X
(7)	√	√	√	X	√	X
(8)	X	√	X	X	√	√
(9)	√	X	X	X	X	√
(10)	√	√	X	X	√	X

It is observed that most programs at the graduate level (#3), (#6), and (#7) (Table 4.11) provide scholarships to all students. Perhaps, this scholarship is necessary to attract students to enrol in the programs, since these students with their bachelor's degrees are highly sought after by industry upon their graduation. It is recommended that offering scholarships to qualified students be an important factor to encourage students to apply to a WIL graduate program.

viii) Operational issues

The issues of operating a WIL program are presented in Table 4.18.

Table 4.18: Operation issues of WIL programs

Issue	N=10	Not a problem	Rarely	Occasionally	Often	Always a problem
Lack of university funding	10	(1),(4),(9),(10)	(5),(8)	(6)	(7)	(2),(3)
Lack of university administration	10	(9)	(5),(10)	(1),(8)	(6),(7)	(2),(3),(4)
Low student demand	9	(5),(6),(9)	(7),(10)	(1),(8)	(2)	(3)
Finding suitable industry	10	(6)	(3)	(2),(5),(7),(8)	(1),(10)	(4),(9)
Finding sufficient placements for students	10	-	(6)	(2),(3),(5)	(1),(7),(8),(10)	(4),(9)
Soliciting suitable projects from industries	10	-	(3)	(1),(6)	(2),(5),(7),(8),(10)	(4),(9)
Finding academic supervisors	10	(4)	(3),(5)	(2),(6),(8)	(1),(7),(9),(10)	-
Mismatch of university and industry expectations	10	-	(3)	(1),(2),(5),(6),(9),(10)	(4),(8)	(7)
Industry not committed to program objectives	10	(3)	(4),(5),(6)	(1),(2),(10)	(8),(9)	(7)
Ability to embed WIL program within a degree curriculum	10	(3),(4),(5),(6)	(1)	(2),(7),(8),(10)	-	(9)

From Table 4.18, it can be argued that there might have been two factors that attract students to a WIL program, namely curriculum designs and scholarship support. Referring to Table 4.11 and

Table 4.18, three WIL programs (#5, #6 and #9) which are designed as a compulsory subject indicated that they did not have an operational issue in low student demand. The curriculum that specifies the requirement of WIL experiences can attract students who are challenged to learn in non-traditional classroom and are interested in gaining work experiences that may help them with their job interviews. Due to the compulsory WIL curriculum, students can ensure that they have an opportunity to work in industry prior to graduation.

Scholarship support can also attract students to enrol in WIL programs. From Table 4.18, program (#7 and #10) indicated that they rarely have a problem with low student demand. Probably, these programs require industry to support tuition fee for the students (Table 4.17). Ku and Thonglek (2011) claimed that scholarship support is an important factor that attracts students to a WIL program especially the high performance students.

Even though program (#3) is compulsory (Table 4:11) and offers scholarships to students (Table 4.17), the survey showed that the program always faces the problem of low student demand. Possibly, this program requires high qualifications in applicants (TGGS 2015). This program requires applicants to have a minimum GPA of 3 (the maximum GPA is 4) or a GPA of 2.75 for those with experiences related to their professions or research of interest. In addition, the applicants are required to demonstrate good command of English with respect to reading, writing, and communications, and score 525 or more on the TOEFL. However, the number of Thai graduates who meet the program's enrolment requirements and want to pursue a master's degree in Thailand is limited.

Two issues were found while conducting the survey. First, less than a half of participants responded to the survey. Of the thirty participants, ten of them responded to the questionnaire. This low response rate could influence the subsequent generalisation of results.

In addition, a question that misled a participant was discovered. With respect to the question of courses of preparing students for placement, one participant indicated that his/her program did not have a preparation course. However, due to literature reviews (Ku et al. 2007; Ku, Thonglek & Bhumiratana 2005), it was found that even though this program does not have a particular course designed for preparing students for learning in placement, the program requires students to solve three simplified industrial problems which are combined with core chemical engineering courses. Solving these industrial projects allows students to be able to develop students' skills of problem solving and theory applications. Hence, it can be said that this program also has learning activities that prepare students for placement.

4.4.3 Interview

i) Stakeholders' perceptions of WIL benefits

Student learning

All academics agreed that students could develop their learning through working with professionals in industry. An academic $T(Ac)_1$ added, *'…at a practice site, students need to define the problem they want to tackle, explore possibilities to solve the problem, acquire information from various sources such as reading textbooks, researching journals, having in-depth discussion with industrial sponsors, and observing on their own. Next, the students need to select a method to solve the problem, implement the method, and evaluate the outcomes of the implementation. This process* Students themselves also see that they can gain valuable experience from working in industry in terms of technical and non-technical knowledge. A student said $T(Al/Sp)_8$, *I was assigned to solve a real problem which I did not know how to deal with at the beginning. Working with engineers allowed me to learn using a fishbone diagram to identify the scope of work. I've learnt how to analyse root cause analysis and need to make decisions to select an aspect of problem that needed to be tackled. Then, we would propose our ideas to our industry sponsors.*

With respect to non-technical knowledge, understanding what happens in the real world is a valuable benefit that students perceived. '… *getting an idea of what an everyday engineer does in the office and how he interacts with other people. Probably just getting an idea of what an everyday engineer does in the office and how he interacts with other people like his manager and other engineers, that kind of stuff.'* , said the $A(S)_5$ student. The $T(S)_8$ added, '*I think, I did a placement project on simulation which was not different from uni but what I've learnt from here [placement] was working under pressure*.'

Even though academics and students agree that WIL helped students develop their learning, factors that may influence student development at placement have been found. It was discovered that placement policies and engineers' behaviours could adversely affect the development of student learning. Placements or supervisors who focus on the outcomes of projects may interrupt an opportunity for students to develop working skills. As students needed to meet industries' or engineers' requirements which general emphasise technical knowledge, they can miss a chance to communicate with their colleagues and develop other working skills such as communication or people skills (Thonglek, Howes & Kavanagh 2011).

How engineers work with students can influence student learning. Interview results show that if advisors facilitate students through discussing with them or asking provocative questions, these students would develop learning. A student said $T(Al)_{13}$ '*my mentor was so nice when I needed his advice. After regular working hours, he always spent some time discussing about our problems. He never directly told me an answer but most of the time I learnt from his questions' (Thonglek, Howes & Kavanagh 2011)*. However, not all industry supervisors facilitate students through discussion. Some engineers prefer to lead by examples and let students find answers on their own. A student said $T(Al/Sp)_{8}$ *"my mentor never explained what and why he did. I had to observe it and try to find answers by myself".* In doing so, some students may not be able to develop learning as expected since they only follow what the engineers do without thinking. This concern was raised by an academic. '*Personally, I'm concerned whether these students could develop their learning as we expected"*, added the advisor $T(Ac)_{1}$ (Thonglek, Howes & Kavanagh 2011).

Engineers' academic background could affect how they facilitate students. Interview results reveal that most ChEPS alumni do not provide direct answers to students' inquiries but instead ask new questions to provoke their thoughts or let them search for answers on their own: *When the students ask me a question, I always start by asking for their opinions and reasons to support those opinions* $T(Al/Sp)_{6}$.

Different students have different perceptions of the same situation and these differences can play an important role in their learning (Thonglek *et al.*, 2011). For example, a student supervised by a demanding sponsor said, *I understood that he had good intention(s) so his behaviour did not bother me. I just learnt how to deal with him since I definitely had a chance to work with this kind of people in the future.* In contrast, another student working with the same sponsor said, *I did whatever he wanted so I could complete my project.* The importance of student learning attitude was highlighted by a site director $T(Ac)_{1}$who said, *I observed that learning attitude is important since no matter how tough a circumstance is, if a student has a positive attitude, he can learn something out of it. On the other hand, if his learning attitude is negative, he could always find an excuse not to learn anything.*

Academics' experiences can influence student learning development. As previously explained, there are several factors that influence student learning at placement. Experienced academics can notice the consequences of such factors and manage to assist students in overcoming obstacles. An academic $T(Ac)_{4}$ who has more than 10 years of experience in teaching and dealing with industry said, *If there were something that interferes with student learning, I would not hesitate to communicate with a sponsor and tackle the problem. However, I am not sure if others would do the* *same*. This is confirmed by inexperienced academic, *'sometimes I felt awkward to intervene with how engineers interacted with students.* said an academic $T(Ac)_6$.

Students' Employability

Placement experiences help students understand the real word and enhance their confidence in job interviews: *In a job interview, at the beginning I felt nervous; however, five minutes later, I was asked about my placement projects. I was confident to answer the questions. The experiences at the placement really helped me* (Alumni interview). In addition, working in placements allows students to develop networking with people in their career of interest which will increase an opportunity for the students to seek a job, $A(S)_1$ and $A(S)_4$ said.

However, not all students are able to reap this benefit: *If they (students) did not perform during placement, they might miss an opportunity to work for us* $T(Sp/E)_2$ (Human Resource manager interview). This was confirmed by an executive engineer who indicated that her Human Resource team did consult sponsors about the placement performance of job applicants graduating from ChEPS when making hiring decisions (Thonglek et al. 2013).

Industry-university collaborative research

University executives expect that WIL programs could result in strengthening the linkage between the university and the industry which leads to meaningful collaborative research. *'Through WIL, linkage between the university and industry can be strengthened. The strengthened linkage allows academics to understand what users [industry] need with respect to ….., and research development.'* said an executive $T(U)_1$. This result from the interview agrees with that from the questionnaire which shows that industrial collaboration is one of the motivations in setting up a WIL program.

Despite the university policy to augment industry collaborative research through WIL, difficulties in implementing such a policy were found. Workload facing academics is one of the obstacles that prevents collaborative research from happening. '*As I spent full time at placement, I could see heaps of problems that are worthwhile for collaborative research; however, I needed to focus on the students first* (Site director, $T(Ac)_2$, interview)'.

The issues of strengthening collaborative research through WIL were confirmed by industry sponsors. $T(Al/Sp)_7$ and $T(Al/Sp)_8$ admitted that there were possibilities for expanding student placement projects to university-industry research; however, the industrial sponsors were concerned about the issue of confidentiality in such a collaboration.

Placements' recruitment benefits

Placements expect WIL to be a good source of recruitment. Interviews with placement engineers revealed that being placements allow them to see students in certain lights that normal job interviews could not show. '*Being a placement allows us to get to know students, especially their attitudes and people skills. They work with us for one semester which is sufficient for us to know them well. The two important aspects, attitude and people skill, cannot normally be judged within the time constraint of a job interview.*' A Sp/E from another company added: we need people who can work with us and get along with our organisation norms. Participating in a WIL program can help us fulfil that requirement.

Placements' project outputs

Academics believe that placement gain direct benefits from placement projects. $T(Ac)_4$ said, *Before the placement started, there was a meeting between academics and engineers to select suitable problems for students. Engineers normally are asked to choose projects based on the company benefits while I just ensured that students could learn something from the projects and project objectives and scopes were realistic enough for the students to complete the work within the proposed timeframe. So I'm pretty sure that placement gain benefits from students' work outcomes.*

Engineers agreed that placement benefited from students' work; however, many of them felt that they also made significant contributions to the final output of the projects. *'I admitted that students helped us a lot but it cannot be said that it was a hundred percent of students' outputs. We also spend time with them, teaching and advising them',* said $T(Al/Sp)_4$

Professional development

Placement can use a WIL program as a channel to develop their engineers' work performance and being a knowledge source. $T(Sp/E)_2$ said that engineers in her company could develop their mentoring skills through supervising ChEPS students while $T(Al/Sp)_3$ said that he always encouraged his engineers to review ChEPS placement reports when useful information is needed.

Work-ready graduate

WIL can help prepare students for working in the real world. The readiness to work of ChEPS graduates has been confirmed by employers who have worked with ChEPS alumni for more than ten years. $T(Sp/E)_2$ and $T(Sp/E)_3$ said that, generally the ChEPS graduates are more ready to work than graduates from the traditional program and non-ChEPS graduates took about 1-2 years to be able to reach the level of work performance seen in ChEPS graduates.

However, some employers question the effectiveness of the WIL program. Two employers, $T(E)_3$ and $T(E)_5$ argued that the success of the ChEPS program could be attributed to the high calibre of enrolled students rather than ChEPS itself. However, the employers admitted that the ChEPS graduates working for their companies had high work performance: *I gave them A+ when I evaluated their performance* (Employer interview).

ii) Challenges for WIL operation

Scarcity of available placements

Available placements are a challenge for operating a WIL program. For the ChEPS program, a placement is required to accommodate at least 4 students for 5 months, and company engineers need to work with a site director to prepare projects for students and supervise them. At present, the opportunities open to the ChEPS program and KMUTT do not support a larger number of placements. In addition, an employer, $T(E)_5$, revealed that the number of engineers who could supervise students and meaningful projects were key factors that his company was concerned about when being asked to be a WIL placement (Thonglek et al. 2013).

Scarcity of available academics

Unaccustomed responsibilities can be issues that concern academics when asked to participate in a WIL program. Academics who are involved in a WIL program need to deal with industry people, develop students' soft skills, and manage administrative issues, and these activities differ from teaching in the classroom. These unfamiliar tasks can be an obstacle for an academic to participate in a WIL program (Thonglek et al. 2013).

With respect to the ChEPS program, it is also found that at times inexperienced academics may struggle with assisting students in their learning development. In addition, the ChEPS academics are required to work full-time at the placement which is likely to be located in a distant area requiring long daily commutes (Thonglek et al. 2013).

4.5 Conclusions

Three data collection methods: student reflection analysis, a survey, and interviews, were used in this study to investigate the motivation behind establishing a WIL program, the benefits that WIL stakeholders gained from participating in the program, and how these stakeholders perceived the values of these benefits as well as the effectiveness of operating the WIL program. The information from the gathered data allowed us to better understand operational issues of a WIL program and recommend best practices for its operation in order to maximise the benefits of WIL stakeholders.

The results showed that enhancing students' experiences and improving student learning underpinned the establishment of WIL programs. WIL can help students improve their learning; however, the study also revealed factors that could affect the improvement of student learning. The factors comprised well-structured program curriculum, placement policies, engineers' expectations, engineers' academic backgrounds, students' attitudes towards learning, and the strategies that engineers and academics used to supervise students.

A well-structured WIL curriculum, which comprises aligning students' activities and assessment methods with learning objectives, helps students develop the expected learning. Placements and engineers that only focus on the results of project outputs can put pressure on students and interfere with the development of student learning. Engineers who have WIL experiences can appreciate the characteristics of WIL programs and understand how to facilitate the students properly, while those who do not have the experiences may not able to supervise students appropriately.

Students who have positive attitudes towards learning can learn from any situation at placement regardless of the nature of the situations, while those who have negative attitudes try to find excuses not to learn. Engineers who facilitate students can better help students improve learning than those who only lead by examples or allow students to follow instructions. Academics who have experiences dealing with industries and supervising students can help students cope with problems in industry and develop their learning, while the academics who do not have such experiences may struggle with helping students.

Strengthening industry-university linkage is another benefit that universities expected from establishing a WIL program. The interviews revealed that WIL could help universities increase this linkage with industry. However, academics' workload and administrative issues can be hurdles in the further expansion of university-industry collaboration.

With respect to advantages to industry, recruitment benefits and project outputs are the values of WIL programs. The study showed that the placement could use a WIL program as a knowledge source and a channel to help their engineers develop mentoring skills. However, these benefits currently can only be realised and utilised by few companies.

Even though all stakeholders could gain various benefits from participating in a WIL program, some issues have been found. Employers did agree that WIL graduates could perform very well but these employers believed that these students' performance was more directly linked to individual attributes rather than to the WIL system. Enhancing networking is an employable benefit that students expect from enrolling in a WIL program; however, if the students do not prepare for work in industry and perform well during placement, they might not be able to obtain this benefit as expected. With respect to placement projects, academics perceived that industry gained direct benefits from project outputs, while engineers thought that students could also develop their learning through problem-solving in projects.

Pertaining to operational issues, the availability of placements and academic supervisors is a major challenge in operating a WIL program. Currently, the number of companies that are suitable for being placements is limited since placement companies must have a policy of encouraging student learning and offer students with meaningful projects. Since academics involved in a WIL program need to cope with tasks that differ from teaching in classroom, such as dealing with industry people, managing administrative issues, and supervising students with non-technical skills, these unfamiliar tasks can become obstacles for academics, preventing them from participating in a WIL program.

CHAPTER V:
FRAMEWORK FOR WIL OPERATION
TO MAXIMISE STAKEHOLDERS' BENEFITS

5.1 Introduction

A WIL operational framework drawn from the literature has been presented in Figure 4.1 and modified for this study in Figure 4.2. This operational framework focuses on the development of student learning. However, not only does a framework foster student learning, but it also provides benefits for the university and the industry. Therefore, this chapter recommends a new operational framework that allows each stakeholder: students, universities, and industries, to gain benefits from the WIL program that they are involved in.

The new framework embraces the results from the previous chapter that could influence the development of student learning and the effectiveness of program operation. These results are summarised as follows:

- Conflicts of stakeholders' expectations from participating in a WIL program could adversely affect student learning in placements.
- Students could maximise their benefits from participating in a WIL program if they:
    - Are able to learn independently prior to placement;
    - Are aware of advantages they gain from working in industry;
    - Work with industrial mentors who facilitate their learning or allow them to learn independently; and
    - Are supervised by academics who have experience in helping students learn independently.
- A WIL program will help students develop attributes that industry requires if its curriculum:
    - Specifies expected learning outcomes, including skills related to technical competency, working skills, and personal effectiveness; and
    - Aligns students' learning activities and learning assessment methods with expected learning outcomes.
- A university could strengthen collaborative research with industry via a WIL program if the issues of staff's workload and administrative management are addressed.
- Industry placements can utilise benefits from WIL if they are aware that WIL could be a knowledge source for the companies and could also help them develop their engineers' mentoring skills.

Based on these results, this thesis recommended an operational framework that can help universities, industries, and students maximise benefits from participating in a WIL program. These benefits can be an important factor for the stakeholders to continually support and participate in the WIL program.

5.2 WIL operational framework for maximising stakeholders' benefits

Figure 5.1 presents a WIL operational framework which can maximise stakeholders' benefits and the framework comprises:

Specifying each stakeholder's expectations from participating in WIL programs

Discrepancies in WIL stakeholders' expectations have been found. The survey results showed that the university aims at enhancing students' experience, and interviews with academics revealed that students could develop their learning through working with professional in industry. However,

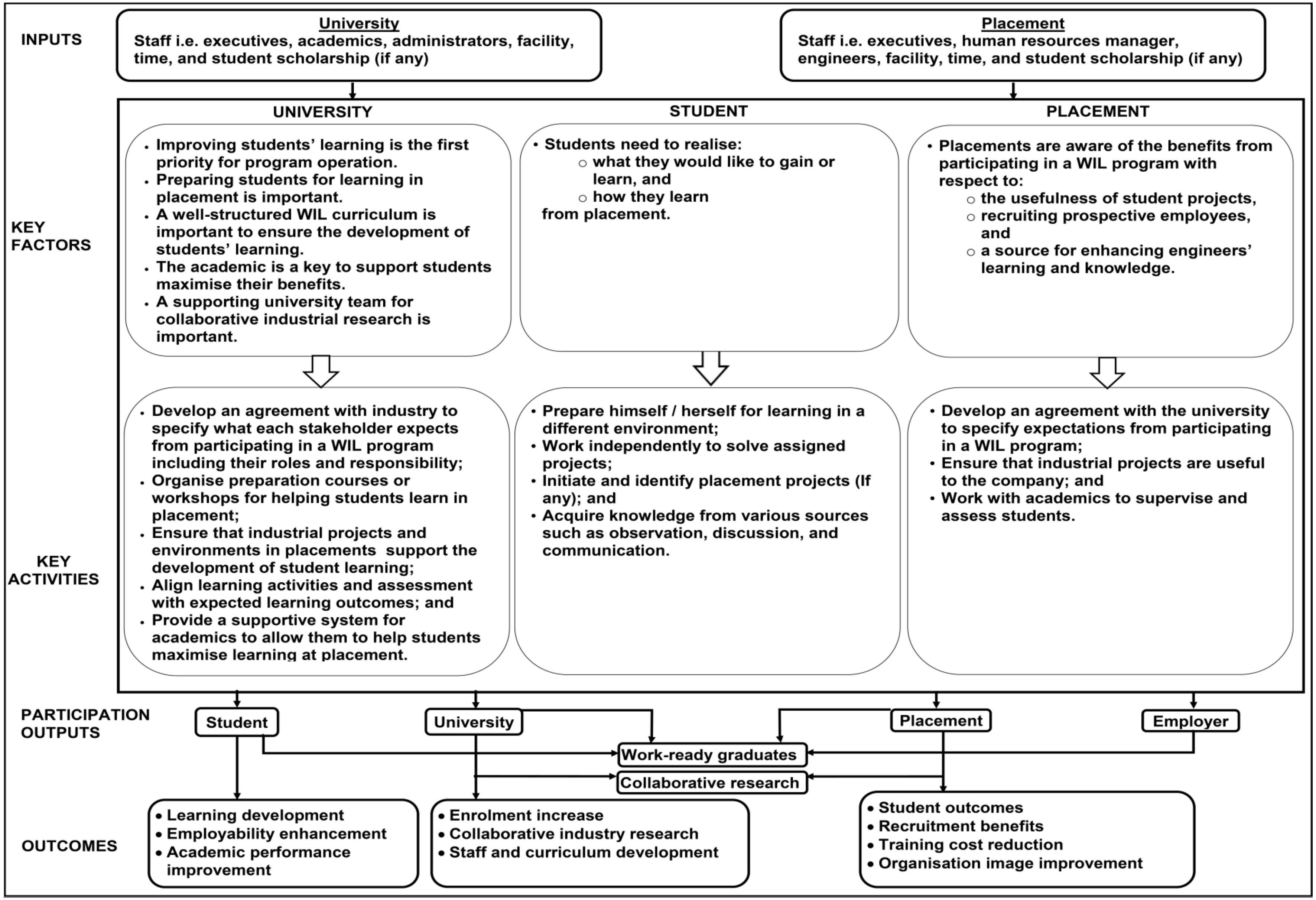

Figure 5.1: A WIL operation framework for maximising stakeholders' benefits

interview results also revealed that organisations and engineers sometimes focus more on the outcomes of the projects and neglect aspects associated with students' benefits. Hence, clarifying all stakeholders' expectations when participating in a WIL program is an important key in operating a WIL program effectively. At the same time, the development of student learning should be prioritised in any negotiation that occurs between the university and the placement company.

The importance of specifying each stakeholders' expectations has been stated numerous times in past research (Winberg et al. 2011; Cooper, Orrell & Bowden 2010; Calway & Murphy 2006). Winberg et al. (2011) stated that academics are responsible for working with industrial people to identify students' learning outcomes, while Cooper, Orrell and Bowden (2010) stated that stakeholders' expectations from participating in a WIL program should be included in the contract between the university and the industry. In addition, the contract should be written in such a way that it supports student development.

Preparing students for learning in placements

Prior to placement, students should be aware of what they want to learn and understand how they will develop their learning at placement. Students who are mindful of what they want to learn from placement will be able to maximise the benefits from placement. A student said that, in addition to working on the assigned projects, she intended to allocate some of her time to communicate with industrial people to find out the differences in each engineering position so she could apply for the one that best suited her after graduation.

In addition, interviews with academics and students revealed that students could develop their learning in several ways at placement. For instance, students can learn through working with professionals, observing how these professionals work, reflecting and developing their own problem solving strategies, identifying problems, acquiring knowledge from various sources, discussing with their peer, and evaluating their outcomes. These learning skills differ from classroom study. As a result, preparing students for learning in placements could help them maximise their benefits.

Even though preparing students for learning in placements is important, based on questionnaire results, none of participants mentioned about ways in which students could acquire the skills prior to placement (Table 4.13). Hence, this study developed a tool for academics to help students develop their independent learning before placement to ensure that they could maximise their learning benefits (Chapter 6).

Designing well-structured curricula

Specifying learning outcomes including attributes that industry requires

Surveys show that industry requires students to demonstrate skills in three categories: professional skills, working skills, and personal effectiveness (Table 2.4). However, questionnaire results show that most WIL programs omit to specify learning outcomes that show the improvement of personal effectiveness (Table 4.12). To produce students expected by industry, it is important that all WIL programs ensure that students' learning outcomes be specified to fulfil the three categories.

WIL students should develop learning outcomes that fulfil industry's needs. Industry expects new graduates to possess skills related to professional knowledge, working lives, and personal development. Generally, learning outcomes regarding professional knowledge and working skills are specified as program requirements, while learning outcomes pertaining to personal improvement are not required but expected. However, according to the literature review (Davis, Beyerlein & Davis 2005; Hodges & Burchell 2003; Coll & Zegwaard 2006), skills related to personal development, especially the willingness to learn and self-management are ranked highly in terms of importance by industry. As a result, the development of those attributes categorised as personal improvements such as the willingness to learn and self-management ought to be specified as one of the program requirements. To ensure that students can develop attributes that industry requires, learning outcomes of a WIL program should be agreed upon and clearly specified jointly by the industry and the university (Winberg et al. 2011).

Aligning placement activities and assessment methods with learning outcomes

Aligning students' activities with learning outcomes is important. The analysis of student reflections shows that assigning students to work in teams can help them develop the teamwork skills. However, the survey results also show that some WIL programs that require students to develop teamwork skills actually organise students to work individually at placement (Table 4.13). To ensure that students could develop the teamwork skills as expected, placing students to work in teams or as part of a team is necessary.

Using a communication tool is another good example of aligning activities with student learning outcomes. The PEPS program requires that its students demonstrate the development of their communication skills. During placement, the students were assigned to use the Contact Log to record communications with their academic advisors (Figure 3.7). A student reflected that using the log raised her awareness of the importance of communication and also encouraged her to contact her supervisors.

The survey shows that most WIL programs use the project work approach to assess students' placement outcomes. The project assessment evaluates students with respect to their technical competency and application skills but not in the areas of working skills and personal effectiveness. To assess the improvement of the working skills and personal effectiveness, a few WIL programs also combine the project approach with the reflective practice approach. It is recommended that a WIL program aligns assessment methods with learning outcomes to ensure that students can develop skills in all categories as expected.

Aligning learning activities and assessment methods with learning outcomes is important for developing students' learning in industry (Cooper, Orrell & Bowden 2010). At placement, the development of students' learning can be influenced by organisational contexts and individual contexts (Thonglek, Howes & Kavanagh 2011). The placement that focuses solely on project output will have adverse impacts on the development of student learning, in which case students must rely on themselves to develop learning abilities. Learning activities and assessment methods that align with learning objectives are thus vital to ensure that students can engage in learning and develop learning outcomes as expected.

Organising a supporting system for academics

Interviews show that academic supervisors play an important role in the development of student learning. Through contact with students, these academics are able to know or observe whether the students could develop their learning as expected or they must offer help to the students. However, academics revealed that sometimes they struggled with how to help students develop learning or deal with problems in placements since the problems required skills that are different from teaching technical contents. It is recommended that a supporting system for academics be organised to ensure that these academics could help students develop learning and maximise their benefits at placement.

McLennan and Keating (2008) reported that some institutions initiated professional development programs as a supporting system for academics who are new to the WIL concept, which leads to these academics having developed the skills related to managing and facilitating students in placement.

The recommended system should enhance academics' abilities to help develop student learning in placement. Facilitation is a strategy that academics use to develop student learning (Brookfield 1986). Academics play a role as co-workers who facilitate rather than instruct students, shares responsibilities with students for the directions and methods of learning, and gives students moral support whenever necessary.

Reflection is another teaching pedagogy that academics use to develop student learning (Moon 1999b). Academics need to encourage students to articulate their thoughts and opinion honestly and provide constructive feedback to help students develop their learning. To assist students in learning through facilitation and reflection, the recommended system should enhance academics' understanding in the knowledge of student learning and how to provide students with constructive feedback.

Organising a supporting team for developing industrial research collaboration

The survey shows that strengthening linkage with industry is a key that underpins the establishment of WIL programs (Table 4.7). However, interviews with academics and industry sponsors revealed that issues of their workload and administrative management, such as confidentiality, pose significant hurdles to establishing this research linkage. It is recommended that universities organise a supporting team that promotes industrial collaborative research to ensure that the collaboration is fully developed and the university can maximise their benefits from WIL as expected.

It is necessary for universities to set up a working team to help WIL programs increase collaborative research with industry. Even though WIL programs have been claimed as a channel for universities to initiate and collaborate research with industry, successful collaborations are still rare (Coll & Eames 2004). Possibly, this collaborative research involves specific types of work which requires a particular kind of people to cope with.

Edmondson et al. (2012) reported that successful university-industry collaboration requires a person who understands cultural differences between industries and universities, is able to effectively communicate between the two sides, and is capable of building partnerships and managing administrative issues. However, these skills and responsibilities may not suit the academics who participate in WIL programs. Academics' tasks generally focus on taking care of student development and assessing project outcomes. Consequently, a supporting team to strengthen the industrial linkage is necessary to ensure that universities can utilise benefits resulted from operating WIL programs.

Raising placements' awareness of WIL as a source for enhancing engineers' learning and knowledge

Placements can use a WIL program as a channel to enhance their engineers' performance. However, this benefit has not yet been fully realised. Based on the interviews, employers revealed that mentoring skills is necessary for young engineers. However, interviews with these young engineers who supervised WIL students revealed that few of them took this opportunity to hone such skills. It is important for academics to raise placements' awareness of this benefit so they can encourage their engineers to develop the mentoring skills through WIL. In doing so, placement can maximise this benefit from participating in a WIL program.

WIL can help promote learning environments in a placement but well-organised activities are still required. A few sponsors said that they could gain more knowledge from discussion with academics and students; however, this discussion forum occurred haphazardly. To maximise this benefit, it is suggested that discussion forums between academics and engineers be organised.

A WIL program can be a valuable source of knowledge for placement. A senior sponsor involved in the ChEPS program for longer than ten years revealed that their company had set up a library to keep and organise all student project reports. Engineers in this placement are encouraged to visit the library and consult the student reports from time to time when they need useful information. It is recommended that a system to keep student work outcomes be required by placements to ensure that the company can utilise benefits from participating in a WIL program.

WIL can also help drive industrial placements to become learning organisations. Janchai (2013) found that, as industrial sponsors, placement staff needs to acquire knowledge to advise students, develops mentoring skills, and adjust the scope of work to match students' competency. These processes allow these staff to enhance their own professional knowledge and skills while cultivating the habit of becoming lifelong learners. As a result, the staff having lifelong learning habits will change the companies to become a learning organisation.

It can be said that important attributes required by several industries are similar (Table 2.3), as a result, this recommended framework can be applied to WIL programs across disciplines and this framework is suitable for the WIL programs that:

- Have been operational for a certain time (more than three years) to ensure that stakeholders can gain benefits;
- Need strong support from industry with respect to funding and being a placement;

- Clearly specify students' learning outcomes;
- Require students to apply theories they study in the classroom to real work in a placement; and
- Are well structured and organised to allow students to gain the most from their placements.

5.3 Conclusions

An operation framework for maximising WIL stakeholders' benefits is suggested. The framework embraces the benefits that universities, students, and industries could gain from participating in a WIL program. Important aspects of the framework comprise:

- All stakeholders should specify their expectation from involving in a WIL program.
- During placement, students should be able to learn independently and know what they want to learn.
- A WIL program needs to be structured with respect to specifying learning outcomes, organising activities, and designing assessment methods.
- The university should support academics to help students develop their learning and develop collaborative industry research.
- The placement should be aware of a WIL program as a source for enhancing engineers' learning and knowledge.

If a negotiation amongst these stakeholders occurs, the development of student learning should be prioritised.

CHAPTER VI:

STUDENT PREPARATION FOR WIL PROGRAMS: A STRUCTURED REFLECTIVE PRACTICE

6.1 Introduction

To ensure that students could learn independently and maximise their benefits at placement, a preparation tool, structured reflective practice (SRP), was developed. This chapter will provide the reader with an overview of SRP with respect to its importance, development and implementation results. At the end, the development of this preparation tool in the format of a paper that has been accepted by Australasian Journal of Engineering Education (AJEE) will be presented.

6.2 Accepted paper: Using a structured reflective practice for Work-Integrated Learning placement preparation

An accepted paper to Australasian Journal of Engineering Education is attached to present outcomes of the tool.

Using a structured reflective practice for Work-Integrated Learning placement preparation

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ABSTRACT: *The ability to learn independently is important if students are to benefit from Work-Integrated Learning (WIL) at placement. Students who possess this ability will take ownership of what they do, understand what they want to achieve, identify how to achieve the objectives, and evaluate the outcomes of their actions. This ability varies from student to student and is rarely developed through traditional lecture-based programs. If this learning ability could be identified and developed prior to placement, it would maximise students' learning during placement. A structured reflective practice, including a set of trigger questions, a framework of reflection analysis, and a framework for providing feedback, was developed. The proposed reflective practice was implemented with a cohort of WIL students in a school of chemical engineering in Thailand. Results show that this reflective practice was instrumental in preparing students for their placements and identified students who might not have been able to develop learning on their own. It is suggested that this structured reflective practice be used over a period of time such as one semester to allow students to develop the ability to learn independently.*

KEYWORDS: *Work-integrated Learning, Placement preparation, Structured reflective practice*

1. INTRODUCTION

Work-Integrated Learning (WIL) is a concept introduced to the educational curriculum whose aim is to develop students' work skills in such areas as teamwork, communication, and problem solving as well as personal effective attributes in self-management, self-control, and self-confidence (Davis et al., 2005, Engineers Australia, 2013). The WIL concept allows students to work with professionals in an authentic environment so that these students can observe how the professionals work, which could help them emulate the professionals' behaviours and develop the required skills and attributes.

To achieve the goals of WIL, students are required to possess the ability to learn independently. i.e. students need to understand the objectives of their actions, develop strategies to tackle problems, implement these strategies, and evaluate the outcomes of their implementations (Knowles et al., 2005). However, this independent learning ability varies from person to person, and so there is no guarantee that every student will benefit from placement. Some students are able to reap benefits from the start of their internships, while others need assistance in order to benefit at all (Sim et al., 2003, Timmins, 2008). Hence, it would be useful for students if their learning ability can be first identified and then developed if needed before the internship begins in order to help the students maximise the benefits of placement.

A number of methods to prepare students for WIL placement have been reported (Cooper et al., 2010, Thonglek et al., 2011). In general, these methods involve coursework and workshops before placement. These methods aim at helping students better understand workplace contexts, which differ from academic settings, particularly with regards to organisational structures, professional ethics, and safety issues. The coursework and workshops also help students improve their problems-solving skills. Despite their importance, these preparatory activities rarely investigate students' learning skills or ways in which academics can help students develop the skills needed for them to fully realise the benefits of placement.

Reflective practice is one way to help students improve their learning skills. The practice allows students to understand their own learning processes and also deepen the quality of their learning in the form of critical thinking (Moon, 1999). However, for reflective practice to be effective, it should be well structured (McGuire et al., 2009, Brookfield, 1995). This can be achieved by leading students through the process of pondering, followed by answering a set of specifically designed trigger questions. Providing feedback is another important component of reflective practice. The feedback should be constructive so as to provoke students' thoughts and enable them to see the value of reflective practice through an assessment of their work. However, the process of providing feedback is both time-consuming and difficult to carry out consistently so it can be problematic for academics and students if the feedback is not implemented properly (Abdekhodaee and Dini, 2013).

In engineering education, reflective journals have been used to promote student learning, both inside and outside classroom (Brankovic et al., 2013, Doel, 2009). Brankovic et al. (2013) and (Cvetkovic & Chandran 2013)Cvetkovic and Chandran (2013) claimed that reflective practice helped students engage in teaching-learning activities and improve their problem-solving and decision-making skills. In addition, students experiencing WIL felt that reflective practice helped them achieve a deeper understanding of both technical and non-technical issues they encountered, and that it raised their awareness of the outcomes of their actions (Doel, 2009, Lay and Paku, 2013.

On the other hand, students' attitude towards the value of reflective practice is a common problem in engineering contexts. Lay and Paku (2013) reported that many engineering students perceived writing reflections as 'fluffy' and, if possible, tended to avoid it. As a result, this kind of practice faces big challenges when it is implemented in engineering contexts.

This study reports reflective practice as a means to monitoring and facilitating students' independent learning to ensure that they can fully realise learning benefits at WIL placements. In addition, a framework that allows academics to provide systematic feedback crucial to the success of reflective practice was proposed.

2. REFLECTIVE PRACTICE PRIOR TO WIL

2.1 ChEPS

Established in 1997, the Chemical Engineering Practice School (ChEPS), is a two-year Masters-level English-based curriculum offered by King Mongkut's University of Technology Thonburi (KMUTT) in Thailand. During the first year, core chemical engineering courses such as Advanced Thermodynamics, Transport Phenomena, and Systems Engineering are taught. In the second year, ChEPS students spend one semester working full-time at an industrial placement and another semester conducting individual research at the university. In preparing for the placement, students in the first year are assigned three "Design Problems" which require them to solve some typical industrial problems. These problems provide an opportunity for the students to apply theories to authentic engineering situations and experience WIL before they are immersed in the actual industrial environment. Thus, the ChEPS students are expected to develop learning outcomes such as teamwork skills, communication skills, and problem solving skills during these preparatory courses (Ku et al., 2007).

ChEPS has no formal assessment tool to analyse students' learning skills before placement. Neither are there specific instructions to help them develop these skills. Yet, learning at placement is clearly optimal when students have the ability to learn on their own. Therefore, to overcome this deficiency, a structured reflective practice was implemented with the commencing 2011 cohort of ChEPS.

2.2 Reflection - practice

The cohort was directed to write a reflective paper every month for a period of three months. The three papers were termed R-1, R-2, and R-3. As reflective practice is more effective when students are aware of its value (Butler, 1996), the students were encouraged to reflect upon any personal circumstances including learning outcomes related to the Design Problems. The timing of the reflective papers within the program is shown in Figure 1.

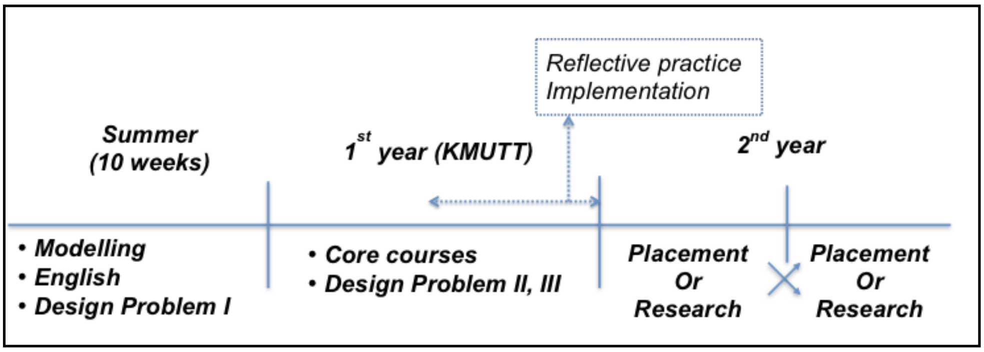

Figure 1: The period of reflective practice implementation (adapted from Ku et al. (2005))

The practice was initially introduced via a lecture which detailed the concept of reflection and its usefulness. Specifically, the lecture was used to:

- motivate the students with questions concerning their future plans. The goal was to use this case study to highlight the importance of self-reflection which in this case sought to improve the students' self-understanding, enabling them to clearly state their goals in life and how they planned to achieve them;
- provide students with the benefits of reflective practice; and
- explain the structured reflective practice.

The template for the structured reflective practice (Appendix A) comprises two parts: the first page contains desirable learning outcomes stated in the ChEPS curriculum and sought by industry, and the second page contains trigger questions. The trigger questions in the template aim at framing the students' thoughts and structuring their writing (Brookfield, 1995, McGuire et al., 2009). The following questions were adapted from those used by Doel (2009) to guide the ChEPS students:

1. Situation: *What actually happened?*
2. Affect: *What was its impact on you personally?*
3. Interpretation: *What did you learn from the experience?*
4. Decision: *What did you decide to do about the situation that would make you become a better engineer*?

The adaptation was based on the Realistic Evaluation (RE) framework (Pawson and Tilley, 1997) which investigated what happened to students at placement and how the placement context affected its outcomes. The RE framework:

$$\text{Context (C)} + \text{Mechanism (M)} = \text{Outcome (O)}$$

was adapted (Thonglek et al., 2011) through a detailed definition of each term:

- Context (C): program procedure, stakeholders' backgrounds and attitudes,
- Mechanism (M): what students do or decide to do, and
- Outcome (O): results students are able to obtain.

The proposed trigger questions (Figure 2) were therefore specific to the ChEPS context.

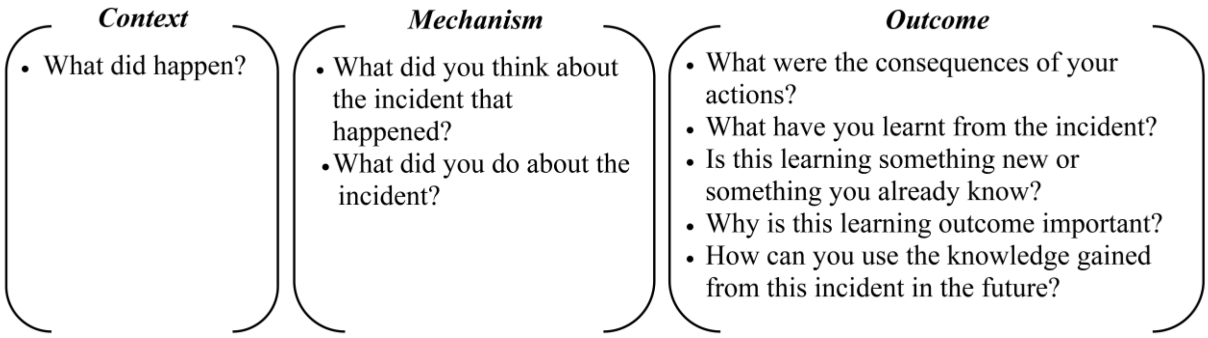

Figure 2: Trigger questions for the structured reflective practice

Even though the format of reflective papers in the form of trigger questions was provided to the ChEPS students (Appendix A), essays were also allowed as an alternative as long as the trigger questions were addressed.

2.3 Reflection – analysis

An analysis framework of reflective practice (Figure 3) was then proposed based on the work of Knowles et al. (2005) who defined self-learners as persons who took ownership of what they did, understood what they wanted to achieve, identified how to achieve the objectives, and evaluated the outcomes of their actions. This framework was subsequently combined with the work of Boud, Keogh and Walker (1985b) who asserted that reflection could effect changes in students' behaviours and attitude. Words, phrases, and contexts showing learning stages in this proposed analysis framework for reflection are summarised in Figure 3.

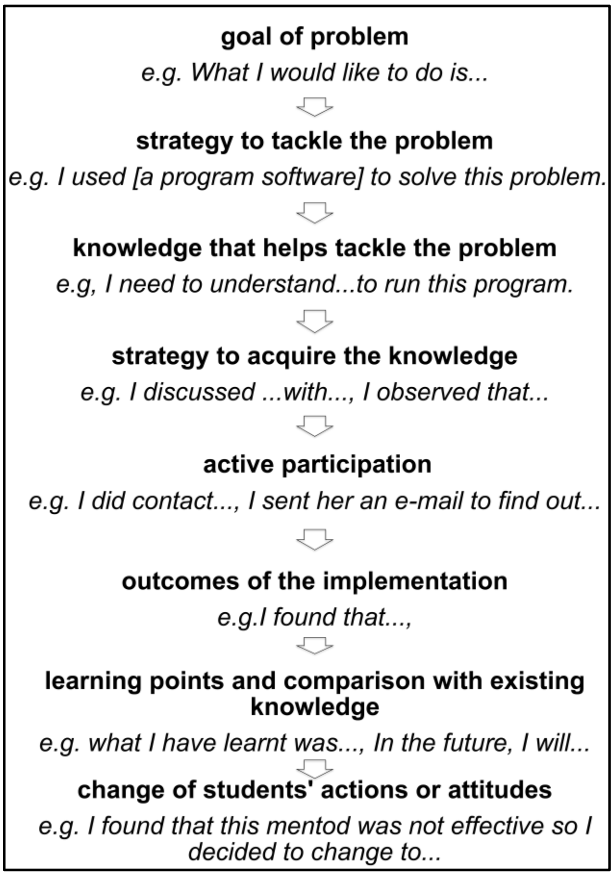

Figure 3: Analysis framework for the structured reflective practice

Based on the framework, the results of the ChEPS reflections were analysed and classified into three categories: action, evaluation, and adjustment. The description and examples of each category are explained in Appendix B. Note that there are two additional categories here that are explained in Section 3.

2.4 Reflection – feedback

Feedback aims at provoking students' critical thinking and encouraging them to improve their learning steps (Knowles et al., 2005). The key concepts adopted for providing feedback to the ChEPS students in this study include:

- encouraging students to think critically;
- highlighting the importance of evaluation, which may lead to changes in what students have done or what they are doing. These are important steps in learning development (Lay & Paku 2013); and
- encouraging students to apply these learning steps to other circumstances, allowing them to gradually develop reflection skills which is important for engineering students to become professionals (Harlim and Belski, 2013).

The framework for providing feedback for the ChEPS reflection is shown in Figure 4.

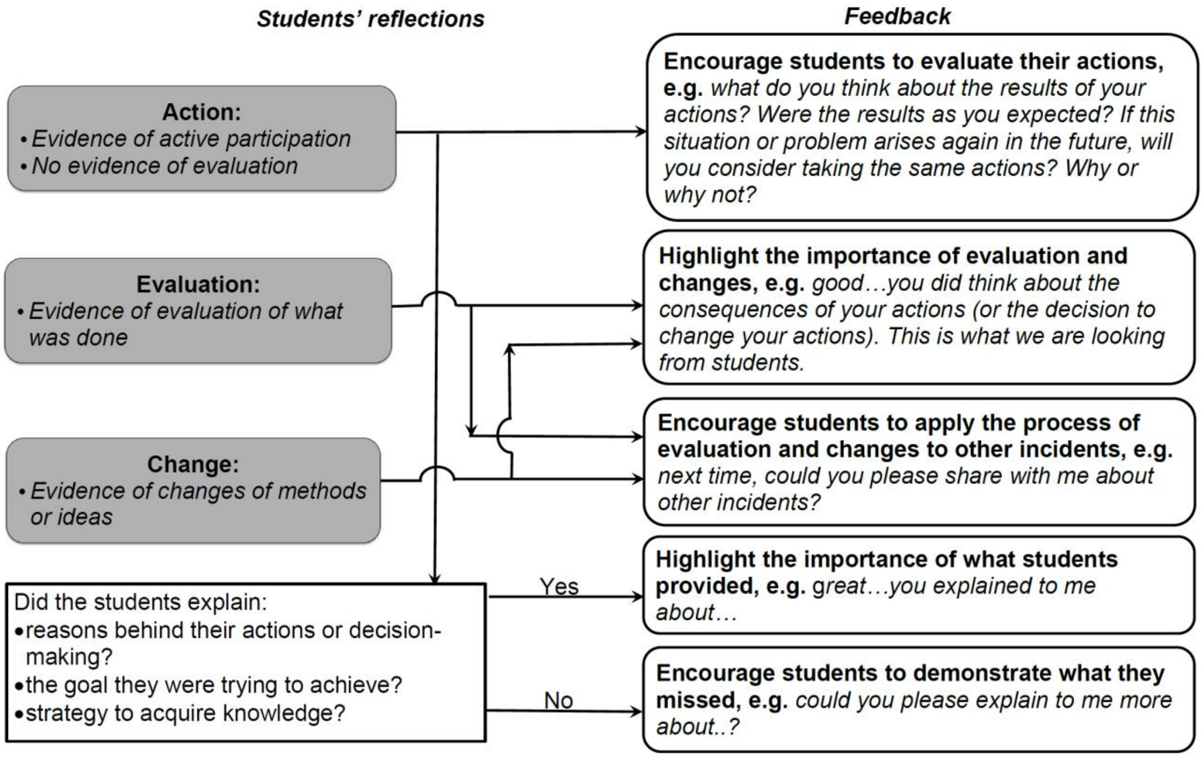

Figure 4: Feedback framework for the structured reflective practice

Learning theories (Kolb, 1984b, Knowles et al., 2005, Boud et al., 1985a) stipulate that students will develop learning when they reflect upon their actions which sometimes leads to changes in attitudes or behaviours. Consequently, it can be argued that the reflections classified as Evaluation and Change show evidence of student learning development.

To ensure feedback was provided in a timely manner, thus maximising student learning (Doel, 2009), the feedback was provided within a week of assignment submission. The feedback to the first assignment (R-1) was delivered in writing. However, to ensure that the students better understood the objectives and the contents of the feedback clearly, subsequent feedback was given verbally. As the researcher and students were in different countries, this verbal feedback was recorded (an average of 3 minutes) and emailed to each student.

3. RESULTS

3.1 ChEPS reflection journals

The ChEPS cohort comprised 11 males and 12 females. They had an average undergraduate GPA of 3.37 out of 4 with a range of 2.87 to 3.85. All had a chemical engineering background with the exception of one student whose academic background was in industrial chemistry.

Following the analysis of their reflection papers, two unexpected reflection categories, namely Observation and Realisation, which were previously absent from the feedback framework in Figure 4, were identified. The descriptions and examples of the two new reflection categories are provided in Appendix B. According to Kolb (1984b) and Boud, Keogh and Walker (1985a), action on the part of the student is important for the development of learning. However, reflections categorised as Observation and Realisation did not show evidence of action, and therefore feedback to these students was designed specifically to encourage them to implement their ideas and thus develop their learning (Figure 5).

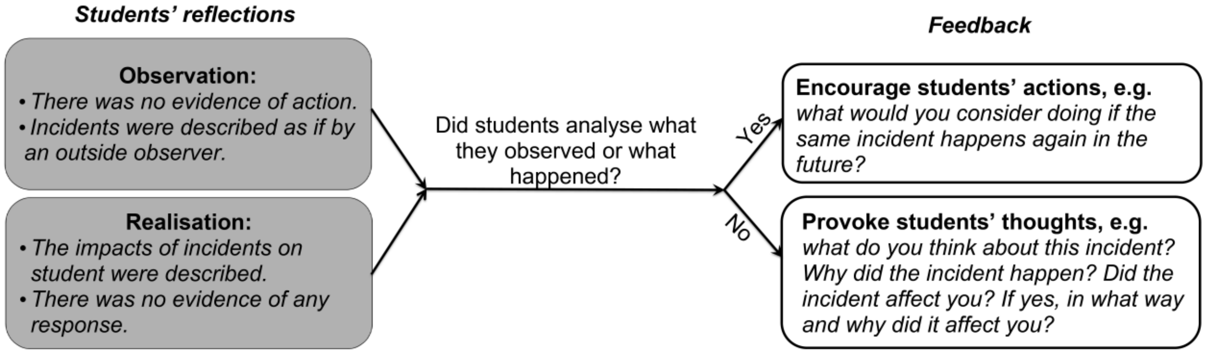

Figure 5: Feedback framework for student reflection without action

The new feedback framework was then used for all three reflection papers collected from the students. The reflection outcome of all ChEPS students is shown in Table 1.

In Table 1, the numerals I, II, III, IV, V stand for the reflection categories of Observation, Realisation, Action, Evaluation, and Change (Figure 4 and 5) respectively, while the letters *E* and *T* stand for reflection papers being written in the essay format and in the provided format (Appendix A), respectively. The table divides the ChEPS students into three groups with respect to their reflection categories. The first group (CLD) comprised students whose reflections showed evidence of learning development (Category IV and V) in all three reflections. The second group (ILD) consisted of students whose reflections sometimes showed evidence of learning. The last group was classified as students who may have problems with independent learning (PILD) and whose reflections showed minimal evidence of learning, indicating that they could struggle with learning at placement.

Table 1: Reflection outcome of ChEPS students

Consistency in Learning Development (CLD) (11 students, 48%)				Inconsistency in Learning Development (ILD) (9 students, 39%)			
Student	**R-1**	**R-2**	**R-3**	**Student**	**R-1**	**R-2**	**R-3**
#1	V *(E)*	IV *(E)*	V *(E)*	#3	V *(T)*	IV *(T)*	II *(T)***P1**
#6	IV *(T)*	IV *(T)*	IV *(T)*	#7	I *(T)*	V *(T)*	V *(T)*
#9	IV *(T)*	V *(T)*	V *(T)*	#8	II *(E)*	III *(E)*	IV *(E)*
#13	IV *(T)*	V *(T)*	V *(T)*	#10	IV *(E)*	III *(E)*	V *(E)*
#15	IV *(T)*	IV *(T)*	V *(T)*	#11	IV *(E)*	V *(E)*	II *(T)*(1)
#16	V *(E)*	IV *(T)*	IV *(T)*	#12	IV *(T)*	IV *(T)*	II *(T)*(1)
#18	IV *(T)*	IV *(T)*	IV *(T)*	#14	II *(T)*	IV *(E)*	III *(T)*
#19	IV *(T)*	IV *(T)*	IV *(T)*	#17	II *(T)*	V *(T)*	V *(T)*
#20	IV *(T)*	IV *(T)*	IV *(T)*	#22	II *(E)*	IV *(T)*	IV *(T)*
#21	IV *(T)*	IV *(T)*	IV *(T)*				
#23	IV *(T)*	IV *(T)*	IV *(T)*				

Problematic Independent Learning Development (PILD) (3 students, 13%)			
Student	**R-1**	**R-2**	**R-3**
#2(3)	II *(T)*	II *(T)*	II *(T)*
#4(2)	IV *(E)*	II *(E)*	II *(T)*
#5(3)	III *(E)*	III *(E)*	III *(E)*

NOTES:

(1)Reflection on the feelings of being under stress (No.#3) or upset with an instructor (No.#11,12),
(2)Reflection only on academic performance; no WIL learning,
(3)No evidence of learning improvement or response to feedback

The table, to be discussed in more detail later, shows that reflective practice can assist academics in identifying students who may have problems with independent learning.

3.2 Students' perception of reflective practice

Of the 23 students participating in the structured reflection system, 12 voluntarily attended a subsequent focus group session aimed at exploring their perceptions of the practice and identifying improvements for future executions. The 90-minute session, which was organised after the feedback of R-3 reports, was chaired by the researcher and took the form of informal conversation. This informality encouraged students to share their thoughts about the advantages, disadvantages, and obstacles in using reflective practice. A thematic analysis of these conversations is shown in Table 2.

Table 2: Thematic analysis of students' perception (N = the number of students who agreed with the item)

Benefits	Obstacles
1. Realise one's good and bad habits from academic feedback (N=12) 2. Increase the awareness of learning from any circumstance (N=12) 3. Provide an opportunity to think critically about a problem and systematically find a solution (N=11) 4. Better prepared for what will happen in the future (N=10) 5. Increase self-understanding (N=10) 6. Practise how to articulate thoughts through writing (N=8) 7. Be able to set one's future directions (N=1) 8. Practise English writing (N=1)	1. Have difficulties in reflecting on confidential issues (N=12) 2. Cannot answer all the trigger questions (N=6) 3. Uncertain if the approach to solve problems is right or wrong (N=4) 4. Cannot remember details (N=4) 5. Realise that they are complaining, not reflecting (N=4) 6. Need a certain amount of time to analyse a problem (N=1)

The table shows that the participants were more likely to comment on the benefits (N=65) than the obstacles (N=31) of reflective practice, and all of them became more aware of learning and felt they had benefited from the academic feedback. However, as the students' feedback were obtained through the focus group without anonymity, peer pressure and questions posed by the researcher may influence the students' perceptions of reflective practice.

4. DISCUSSION

The proposed structured reflective practice can help academics identify learning issues in students and prepare them for WIL placements. In Table 1, 48% of the ChEPS cohort showed consistent evidence of learning development throughout all three reflections which implies that these students possess good reflection habits and can learn on their own prior to placement. As a result, the students in this group should be in a position to maximise benefits from their experiences at placement. However, 39% of the students inconsistently showed evidence of learning throughout all three reflections, while 13% of students showed minimal evidence of learning.

According to Table 1, some students who inconsistently showed evidence of learning were under stress during the practice (Student No.#3,11, and12). Possibly, stress can influence students' reflective practice so they used the reflections as a way to relieve the pressure. In addition, there are several factors that can influence students' reflective practice such as problems with written communication and thought articulation, and misconceptions of reflective practice (Moon, 2006, Boud, 1999). Perhaps, a longer preparation period may allow academics to identify issues associated with these students, particularly the PILD students. The longer period will lead to more effective feedback by the academics, helping these students better utilise reflective practice as a preparation tool for learning in the placement.

The proposed reflective practice also helps raise students' awareness about learning and self-development. All participants in the feedback session (Table 2) agreed that going through reflective practice raised their awareness of learning. A student said, *'Writing reflections allowed me to think about what I could learn from some incidents, and I might never have thought about this learning point if I hadn't done the reflections.'* In addition, after R-1, two students personally emailed the researcher to ask if they could do more than one learning incident in each reflective practice since they found that the practice had enhanced their self-understanding and self-improvement.

Although reflective practice is accepted by academics as a tool to help students develop learning, there are obstacles in implementing the practice, particularly within engineering contexts. Engineering students seem to focus on 'what they have learnt' rather than 'how they have learnt'. All participants in Table 2 perceived gaining new knowledge from academic feedback as a major benefit of reflection. In addition, one-third of the students (4 out of 12) wanted academics to make judgements on their reflections, i.e. they wanted to know if the hypotheses or problem-solving techniques mentioned in their reflection papers were right or wrong without realising that the academics were not supposed to make judgements on students' reflections during the feedback process.

With respect to the learning process, even though most of the students could show evidence of learning through the reflections (Table 1), none of the participants in the feedback session (Table 2) mentioned learning improvement as a major benefit. This supports findings by Lay and Paku (2013) who observed that a student, having already demonstrated the attribute of critical thinking, might not be aware of this ability and could still think that they did not learn anything from writing reflection.

Another issue is students' perception of going through reflective practice. Engineering students tend to consider writing the reflections as 'fluffy' and may not pay sufficient attention to the activity to render it effective. An example was a student who showed learning evidence of learning of R-1 but did a very poor job in R-2 by submitting a very brief explanation of an incident and what was learnt. However, after the researcher provided constructive feedback and pointed out the usefulness of reflections, the student emailed the researcher to apologise for her poor job and re-sent a new R-2 which was then classified in the

Evaluation category. With regards to the PILD students, it is possible that some of them could learn independently but failed to conduct the practice and respond to feedback effectively.

The developed framework helps improve the effectiveness of providing feedback. This framework allows the researcher to give students advice consistently and systematically, particularly if more than one academic participates in the feedback process. In addition, the feedback needs to be constructive to ensure the effectiveness of the process.

5. CONCLUSIONS AND RECOMMENDATIONS

Work-Integrated Learning or WIL is known to be an effective platform for learning in higher education, but to reap benefits from WIL, students must be well-prepared, highly motivated, and willing to learning independently. Structured reflective practice, including well-designed trigger questions, as presented in this study can be an effective tool in preparing students for learning at WIL placement. Student learning can be maximised if this practice is used in conjunction with a consistent and systematic framework for feedback as per Figures 4 & 5.

The reflection process allows academics to identify students who may not be able to capitalise on the WIL experience. An extended period of reflection, e.g. one semester or longer, may be required to allow academics to help these students improve their learning. It is important to ensure that students realise the usefulness of the reflection; if they do not they may be identified incorrectly as PILD students. Therefore, it is recommended that the practice's benefits be made explicit at the beginning of the program as outlined in this paper.

In addition, the students who are classified as PILD students should be further examined to see if they actually struggle with the development of independent learning. Finally, implementation of this structured reflective practice to undergraduate students is recommended.

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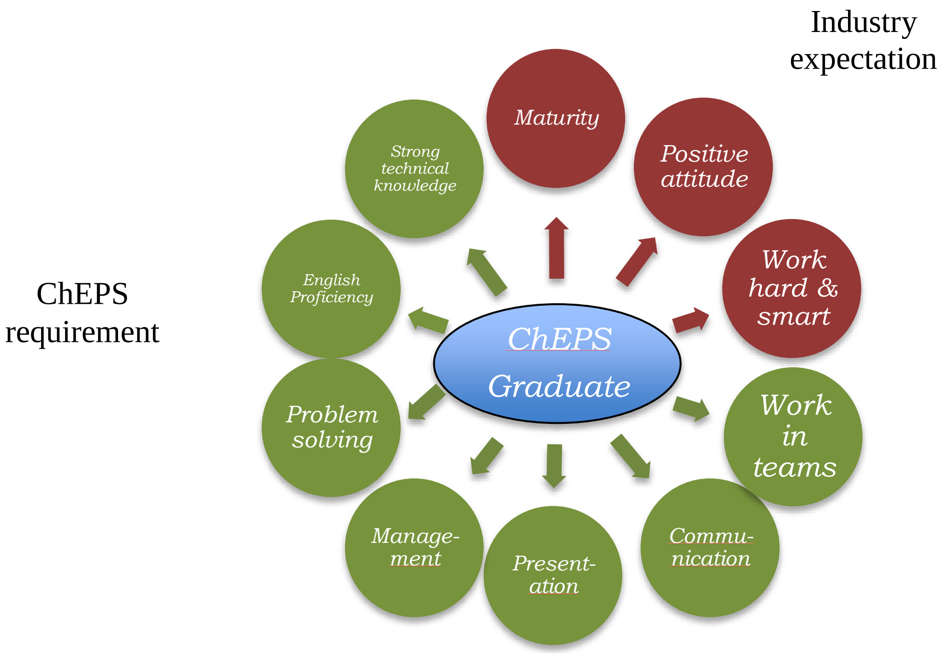
Appendix A: Template for Reflective Practice (ChEPS)

Professional Development Log

Objectives:

- *Students demonstrate the ability to articulate their thoughts through writing.*
- *Students demonstrate the ability to think critically.*
- *Students demonstrate evidence of developed skills including the development strategy.*

Learning outcomes



Remarks: - It would be great if you can observe and articulate other learning points such as self-understanding etc.

AJEE 2014

Analysis of Learning Events

- **What did happen?**

- **What did you think about the incident that happened?**

- **What did you do about the incident?**

- **What were the consequences of your actions?**

- **What have you learnt from the incident?**

- **Is this learning something new or something you already know?**

- **Why is this learning outcome important?**

- **How can you use the knowledge gained from this incident in the future?**

AJEE 2014

Appendix B: The descriptions and examples of categories of ChEPS student reflection

Reflection category	Description	Example
I. Observation	Students describe the situation as if they were outside observers and explain their thoughts and feelings. They do not take any action or are not affected by the incidents, either.	*'When I was assigned to work in a team, there was a conflict between our colleagues… I observed that miscommunication caused the conflict.'*
II. Realisation	Even though students describe how incidents affect them (i.e. feeling uncomfortable), there is no evidence of action.	*'I felt uncomfortable. They did not talk to each other. Our work progressed slowly.'*
III. Action	Students describe what happened and the impacts of incident and also explain what they have done to address the issues. However, an evaluation of the consequences of their actions was not conducted.	*'I learnt that the reliability of data sources was important. The source we selected was unreliable… so I volunteered to search for new data from other sources.'*
IV. Evaluation	Apart from an explanation of the incident, its effects, and what they have done, students reflect upon the consequences of their actions.	*'At the beginning I was under stress.... After I decided that quitting was not an option, I asked myself what I should do to tackle the problem. First, I changed my attitude not to dislike any subjects and then I managed my time ... I tried to relate new lessons to what I had already known... At present, I am getting more confident about exams, especially when I can offer my thoughts and make arguments with my friends.'*
V. Change	After evaluating the consequences of their actions, students show changes of methods to improve their action outcomes.	*'My group was assigned to design a unit in a chemical plant. I was first responsible for programming which I was good at... Half way through the project, I found that the strategy in allocating work was not effective…I decided to change how we managed work tasks. I asked my colleagues to share responsibility for programming and I also helped in other tasks. I found that this new strategy worked quite well.'*

6.3 Conclusions

The structured reflective practice including well-designed trigger questions, an analysis framework, and feedback frameworks can be used as an effective tool in preparing students for learning at placement. The tool helped academics identify, prior to placement, if students possess the independent learning ability which allows the students to maximise their benefits from working at placement. In addition, it assisted academics to provide systematically and consistently feedback to help students develop their learning. However, it is suggested that implementing the structured reflective practice be extended to one semester or longer to allow academics to help students effectively. It is also noted that the benefits of reflective practice should be highlighted at the early stage of the practice to ensure that students realise its importance; if they do not they may be identified incorrectly as at-risk students.

CHAPTER VII:
CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This chapter firstly provides the reader with thesis outcomes that answer two research questions: "What are the best practices for WIL operation that maximising its stakeholders' benefits?" and "Can reflective practice be used as a tool to help academics prepare students for placements?. Next, applications of these thesis outcomes and finally what should be further studied are recommended.

7.2 Best practices for maximising WIL stakeholders' benefits

Referring to the first research question,

> *"What are the best practices for WIL programs that maximise stakeholders' benefits while supporting student learning at the same time? (The importance of stakeholders' perception on WIL operation and sustainability will be detailed in* Section 4.2)*. The practices must address issues related to students' learning outcomes, program operation, and program sustainability"*,

a framework for operating a WIL program (Figure 5.1) was recommended and best practices for maximising WIL stakeholders follows.

- Even though student learning development underpins the WIL concept, the interview revealed that organisations and engineers sometimes focussed more on the outcomes of the projects and neglect aspects associated with students' benefits. Hence, clarifying all stakeholders' expectations when participating in a WIL program is crucial and students' learning development should be prioritised if any negotiation occurs.
- Interviews showed that several factors: organisational policies, engineers' attitudes and behaviours, students' learning attitude, students' independent learning ability, and academics' capability in helping students, could influence students' learning in placement. As a result, effective learning assessment tools are important to investigate if students could develop their learning as expected.
- While literature reviews showed that industry expected graduates to possess professional skills, working skills and personal effectiveness, the survey revealed that most WIL programs participating in this thesis did not include personal effectiveness as programs' expectations. It is important to specify expected graduates' attributes, including these three skills, to ensure that the students who experience WIL can demonstrate abilities that industry requires.
- The survey results showed that most preparation courses provided students with knowledge related to an organisational structure, safety issues, and professional report writing. However, interviews also revealed that it would be useful if students were aware of what they wanted to know and how they learnt in placement. Therefore, it will be helpful if, prior to placement, academics can raise students' awareness of what they want to learn or achieve and help students improve their independent learning ability.
- It will be useful if universities can support academics in terms of assisting students in learning in industry. Interview revealed that the skills academics used to teach students in classroom differed from those they used to help students learn in placements. For instance academics probably prefer facilitating to instructing at placement. However, these academics, especially inexperienced ones, sometimes struggled with facilitation since they were not accustomed to it. Consequently, a system that helps academics assist students in learning in placement is vital.
- An additional working team on developing industrial collaborative research is useful. The survey results showed that most academics expected to use their WIL programs as a mechanism to strengthen industry linkages or develop industrial collaborative research. Because of the interview results, some academics came to realise that the outcomes of some

projects that students worked on at placements could be further investigated and developed into industrial collaborative research. These academics also noticed a number of problems in industry that could become valuable research projects whose results potentially pose enormous financial benefits to the companies. However, these academics were so overwhelmed with their regular tasks regarding teaching, supervising, and managing administrative issues that it was difficult for them to generate such a collaborative research themselves. Hence, a supporting team to help these academics develop industrial collaborative research would be useful.

- From the interview results, engineers could use WIL programs as a mechanism to develop mentoring skills of their engineers and as a knowledge source for their staff. However, the results revealed that a few engineers could realise and utilise these benefits. Consequently, it will be useful if academics can raise engineers' awareness of how WIL programs could help engineers improve their mentoring skills and enhance their knowledge.

The best practices suitable for WIL programs are those that help students develop graduate attributes industry requires, assist universities in consolidating industrial linkage, and help placement become a learning organisation.

7.3 A tool for helping academics assist students in developing learning

Referring to the second research question,

> '*Can reflective practice be used as a tool to help academics prepare students for placements, thus ensuring that students maximise their learning? If so, how?*'

Interview data revealed that it would be useful if students realised how they learnt independently in placement. Therefore, it will be helpful if, prior to placement, academics can help students improve their independent learning ability. As reflective practice can be used as a tool to disclose what and how students learn at placement (Kolb, Rubin & McIntyre 1984; Boud, Keogh & Walker 1985b), this thesis employed the practice to reveal students' abilities to learn independently and also proposed a way to help academics assist students in independent learning.

A structured reflective practice was developed to help academics prepare students for learning in placement. The developed reflective practice comprises three key parts:

- trigger questions (Figure 2, Chapter 6) which help provoke students' thoughts, allowing them to think critically and systematically, and helping to structure their writing,

- reflection analysis framework (Figure 3, Chapter 6) which assists academics in examining steps in student learning, and
- feedback framework (Figure 4 and 5, Chapter 6) which helps academics to advise students consistently and systematically.

Results showed that academics could use the structured reflective practice to identify students' independent learning ability as well as providing them with feedback to help develop their learning. Of the 23 students who conducted the reflections, 48% of the students showed evidence of consistency in learning development (CLD) while 39% of those showed inconsistency in learning development (ILD). The remaining (13%) were students who might have problems with learning development. However, results of identification may not be accurate unless the students pay special attention when conducting the practice.

With regards to students' perception of the structured reflective practice, the number of students who commented on its benefits was higher than that of students who commented on the obstacles. Still, as these feedback was gained through a focus group without anonymity, peer pressure and questions posed by the researcher may influence these students' perceptions.

7.4 Application of the research

7.4.1 Best practices for maximising WIL stakeholders' benefits

Maximising stakeholders' benefits is important for long-term operation of a WIL program. The suggested operational framework (Figure 5.1) can be applied to WIL programs in professional areas such as medicines, nursing, and education. These WIL programs should:

- Aim at developing student independent learning and produce graduates who possess attributes that industry requires;
- Specify learning outcomes and requires students to develop these expected outcomes;
- Allow students to tackle real-life problems under the supervisions of academics and professionals in an authentic environment;
- Require students to work on the projects that are of importance to industry;
- Are expected by their universities as a mechanism to consolidate linkage with industry; and
- Expect support from industry with respect to being a placement and a source of funding.

7.4.2 A tool to develop student learning

The structured reflective practice developed in this thesis can be used by students at any level across disciplines to enhance their thinking skills and reflection skills. The developed tool was designed to provoke students' thinking and help them systematically articulate their thoughts through writing. Writing reflective practice allows students to understand their own learning processes and deepen the quality of their learning in the form of critical thinking (Moon, 1999).

Independent learning ability is a key graduate attribute that industry requires. Unfortunately, this ability cannot be measured through traditional exams. However, this developed tool can help academics identify students' ability to learn independently. Specifically, this tool can help academics investigate students' abilities to identify problems, construct hypotheses to solve the problems, apply the hypotheses, and evaluate their results. Students who fail to show evidence of these abilities may not be able to learn independently. On the other hand, for the tool to be effective, students should be made aware of the importance of reflection and must pay attention when conducting the practice to ensure that the identification of students' learning abilities is accurate.

Academics can use the developed feedback framework to provide students with comments systematically and consistently. The framework allows academics to examine students' learning steps and provide step-by-step feedback that can improve students' learning. In addition, this framework can help academics provide feedback on a consistent basis especially when more than one academic is involved in the feedback process. Feedback for students' reflections can take different forms, such as writing, individual discussion, or group discussion. However, this study used an audio recorder to provide feedback to students to ensure that they understood the researcher's comments. In general, the process of reflective practice and subsequent feedback is time-consuming. Thus, it will be a challenge to apply this tool to a large cohort of students (more than 100 students).

7.5 Further studies

The recommended operational framework in this study drew data from the WIL programs that have been operating more than ten years, and most of stakeholders, who are participants in this research, have been stakeholders in the program for more than seven years. These stakeholders could realise the benefits of WIL programs at a certain level but may not be aware of some benefits that they miss from the program. This study then recommends a WIL operational framework that allows the stakeholders to fully realise the benefits of the program, including how to operate the program to maximise these benefits. However, if the operation of a WIL program is in its early stage (1-2 years), the perceptions of stakeholders may be different. For example, academics may be concerned about the quality of students, or industry may not recognise the benefits of outputs from placement projects. An effective framework in the early stage of WIL operation is recommended.

The industry placements involved in the interviews in this study were large organisations who:

- Supported their engineers in allocating their time to supervise students;
- Realised the importance of professional development; and
- Were able to provide facilities and meaningful projects for students.

However, the questionnaire results reveal that industry placements can be small, medium, and large organisations. It will be useful if the perceptions from small and medium organisations are investigated.

In addition, the interviews showed that some academics struggled with facilitating students to learn independently in placement. However, the academics' abilities to help students develop their learning vary from person to person and differ from teaching students in classroom. Hence, it will be useful if a framework to help academics develop students' independent learning is studied.

With respect to the developed learning assessment tool, it is recommended that the PILD (Problematic Independent Learning Development) students who have actual learning problems be further investigated. It is possible that these students did not pay attention to the reflective practice so their reflections might not reflect their actual learning abilities.

With respect to students' feedback on conducting the reflective practice, it is possible that peer pressure and questions posed by the researcher could influence the students' perceptions since the focus group was conducted without anonymity. It is recommended that future research obtains feedback from students with anonymity in order to avoid peer pressure and influence.

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Stakeholders’ Perspectives of a Work Integrated Learning Program: The Chemical Engineering Practice School

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Introduction

The King Mongkut University of Technology Thonburi (KMUTT) Chemical Engineering Practice School (ChEPS) was initiated to address the problem of engineering students’ weak aptitude in applying theories (Ku et al., 2005). KMUTT adopted the concept of Chemical Engineering Practice from MIT (Johnston et al., 1994) and founded the ChEPS program for engineering graduates in 1997. Since then, ChEPS has produced over 300 graduates who are highly sought after by industry (Ku and Thonglek, 2011). ChEPS graduates appear to possess better problem-solving skills than graduates from traditional engineering programs possibly as a result of their placement experiences.

Despite the good reputation of ChEPS graduates, some issues need to be investigated. Firstly, as the environment at placement cannot be fully controlled (Thonglek et al., 2011), several factors which may affect student learning should be further examined (e.g. industry mentor supervision techniques, level of mentoring provided, and placement expectations).

Secondly, since operating a Work Integrated Learning (WIL) program incurs higher costs than a traditional program (Eames and Kumer, 1997) and requires strong commitment from industry (Ku and Thonglek, 2011), it is important to study how industrial stakeholders perceive the program.

ChEPS can be classified as one form of WIL since it provides an opportunity for students to experience an authentic work environment. In addition to enhancing learning opportunities for students, the benefits to WIL stakeholders – students, institutions, and industries – underpin the operation of the program (Patrick et al., 2009). It has been reported that stakeholders’ expectations can affect student learning (Thonglek et al., 2011) and conflicts of interest have also been found (Martin, 1997). Hence, it is helpful to understand how stakeholders perceive the program, and how that perception influences student learning.

Results of this research allow us to understand factors affecting student learning and other program outputs. The understanding increases the knowledge of how to operate the ChEPS program effectively to maximise student learning and this knowledge can be applied to other WIL programs

ChEPS Context

ChEPS is a two-year Masters program whose curriculum structure is shown in Figure 1.

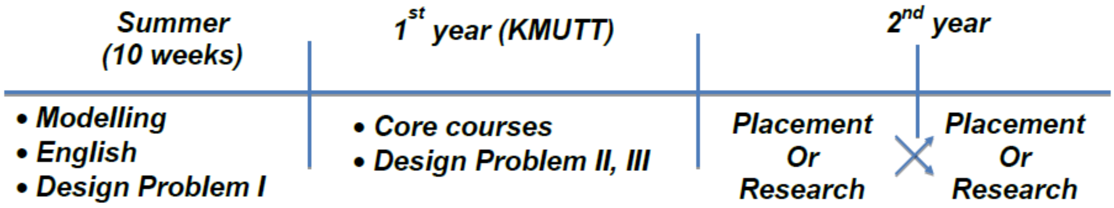

Figure 1: Curriculum structure of the ChEPS program (Ku et al., 2005)

ChEPS students in the first summer and in the first year are required to study Chemical Engineering core courses at a post graduate level such as Thermodynamics, Transport Phenomena, and Chemical Reaction Engineering. Design Problem I, II and III are designed to prepare students for placement in terms of knowledge integration, problem-solving skills, and communications (Ku et al., 2007); industrial problems are modified to suit the students' level of knowledge and thereby underpin this preparation. Students also learn that there is no one correct answer to real-life problems and that they differ from close-ended problems found in textbooks. In addition, students are required to work in teams and communicate with engineers at placement to acquire data and discuss results. As such, teamwork and communication skills are developed through the Design Problem courses.

During the first semester of the second year, the cohort is split with one half working at placement while the other conducts individual research at the university. The roles of the two halves are then reversed in the second semester. The framework of ChEPS' operation at placement is presented in Figure 2.

At placement, students are required to work in teams to tackle industrial problems under the supervision of academics and company engineers. An academic Site Director, who works full time at placement, supervises these industrial projects, advises students in both technical and soft skills, and assesses students' academic performance. In one semester, a ChEPS site director is typically responsible for 6 - 9 students. Engineers involved in the program, called Sponsors, provide students with suggestions about methodology as well as specific knowledge related to the industry. Students are required to regularly present the progress of their projects and submit final reports upon the completion of the projects.

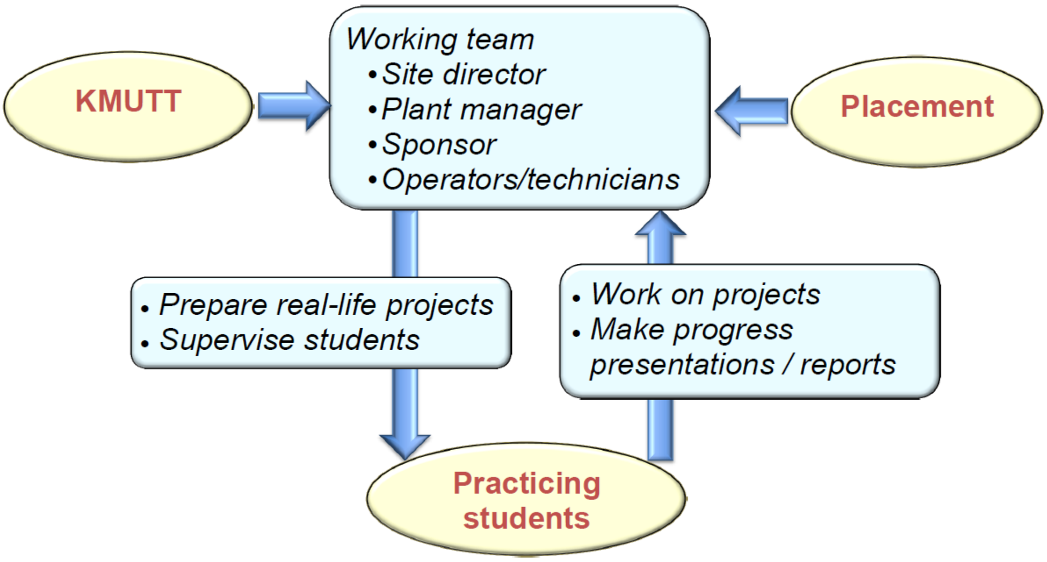

Figure 2: ChEPS' operation at placement (Adapted from Ku et al. (2007)).

Data Collection Methods and Analyses

In this investigation, 51 ChEPS stakeholders were interviewed. Open-ended interviews were conducted either with individuals or in small groups as agreed upon by the participants and the researcher. Each interview was 30 - 90 minutes in duration. The participant distribution including the interview timetable is presented in Table 1.

Table 1: Participant distribution

Stakeholder	No. of Stakeholders
University executive	2
Program director (KMUTT)	1
Site director (KMUTT)	9
Current student	3
ChEPS alumni	15
Sponsor (Not alumni / ChEPS alumni)	2 / 9
Employer (Not involved with ChEPS / Involved with ChEPS / ChEPS alumni)	5 / 4 / 1
Total	**51**

Benefits to each stakeholder were extracted from literature (Coll and Eames, 2004, Brown, 2010, Benjamin and Meghan, 2004, Metzger, 2004, Patrick et al., 2009) and the evaluation framework of these stakeholder benefits is presented in Figure 3. Content analyses and stakeholder interviews are employed. Reports related to administration and students' performance are analysed.

Stakeholder Perceptions

Student learning development

One of ChEPS' missions is to encourage students to learn on their own and develop the ability to take ownership of what they are doing, understand what they want to achieve, identify how to achieve the objectives, and evaluate the outcomes of their actions. This goal was reflected by a site director: *at a practice site, students need to define the problem what they want to tackle, explore possibilities to solve the problem, acquire information from various sources such as reading textbooks, researching journals, having in-depth discussion with industrial* *sponsors, and observing on their own. Next, the students need to selectmethod to solve the problem, implement the method, and evaluate the outcomes of the implementation. This process allows the students to experience learning on their own.* However, there are several factors that influence this goal and these are acknowledged by ChEPS' stakeholders. They include the placement environment, and the attitudes of sponsors, site directors, and students themselves. The impacts of these factors will be explained later

Employability

An increase in employability is one of student benefits from the WIL program (Braunstein, 1999, Dressler and Keeling, 2004). It was found that at least a few ChEPS students had secured jobs because of their placements each year. All placements agree that ChEPS is a good source for employee recruitment. However, not all students are able to reap this benefit: *If they (students) did not perform during placement, they might miss an opportunity to work for us* (Human Resource manager interview). This was confirmed by an executive engineer who indicated that her Human Resource team did consult sponsors about the placement performance of job applicants graduating from ChEPS when making hiring decisions.

ChEPS graduates are highly sought-after by industry. Normally, about half of each ChEPS cohort has job offers before graduation. It is possible that placement experiences help students understand the real word and enhance their confidence in job interviews: *In a job interview, at the beginning I felt nervous; however, five minutes later, I was asked about my placement projects. I was confident to answer the questions. The experiences at the placement really helped me* (Alumni interview).

Despite ChEPS' reputation, some employers question the effectiveness of the program. Two employers argued that the success of the ChEPS program could be attributed to the high caliber of enrolled students rather than ChEPS itself. However, the employers admitted that the ChEPS graduates working for their companies had high working performance: *I gave them A+ when I evaluated their performance* (Employer interview).

Industry-university linkage

Through WIL, linkage between industry and the university is often strengthened and shared benefits are anticipated (Weisz and Chapman, 2004). Sponsors can improve their mentoring skills: *Being a ChEPS sponsor helps improve the mentoring skill of our senior engineers. It was good for them when they need to train young engineers* (Executive engineer interview) and site directors can enhance their knowledge and improve their teaching pedagogy: *I can use the experience from the placement to teach students in my class. In addition, sometimes I can explain the differences between theories and real-life situations* (Site director interview).

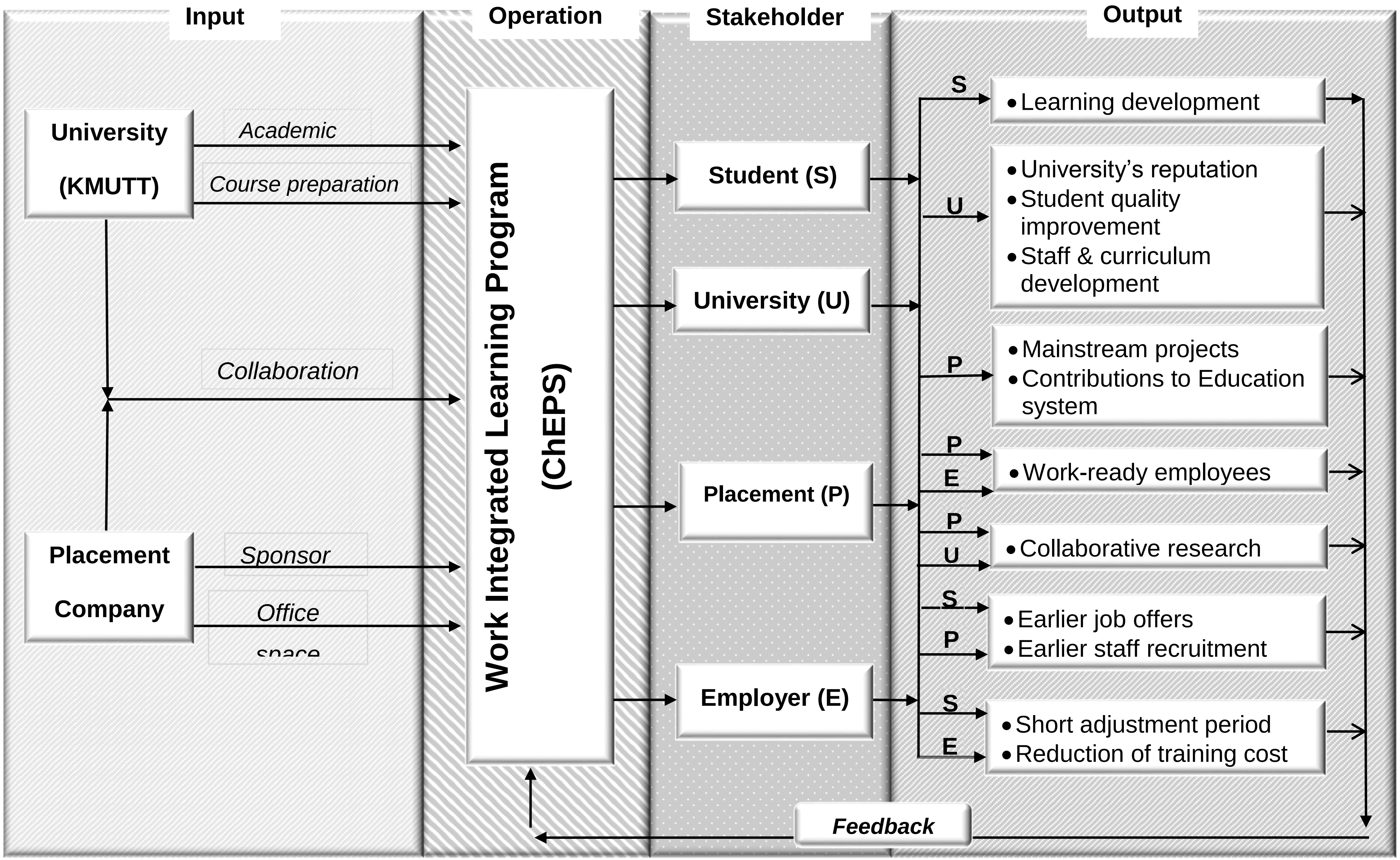

Figure 3: Framework of ChEPS Evaluation

Collaborative research

Collaborative research is another valuable benefit of the linkage. However, for ChEPS, the benefit has not yet been fully realised. Every year, a few ChEPS students conduct individual research theses that are sponsored by industry, however, ChEPS has difficulties expanding the students' research into a closer industry-university linkage in which companies fully fund these collaborative research projects. The workload of academics is seen to be one of the problems: *As I spent full time at placement, I could see heaps of problems that are worthwhile for collaborative research; however, I needed to focus on the students first* (Site director interview)

Discrepancies in stakeholders' perceptions

ChEPS has been operating for over 15 years in collaboration with industry. Even after this time, differences in expectations were found amongst program stakeholders.

Expectations from placement

A major goal of the university is to develop students' skills while the goals of the placement organisation can be varied. It was found that some companies use the placement to focus on employee recruitment while others emphasise project output: *In general, we do not doubt the technical knowledge of ChEPS students but site practice can provide us with an opportunity to work with the students, search for the ones who can work well with us, and make early job offers to those with good prospects. We do not focus on the results of site projects (*Human Resource manager interview). On the other hand, an executive engineer who is a ChEPS alumnus said, *I assigned to some ChEPS students a project related to simulation and modeling which I think is the strongest point of ChEPS because I needed to implement the results of the project.* Studying these different expectations is important because (Thonglek, Howes and Kavanagh (2011)) found that sponsors' expectations can affect student learning during placement.

Benefits of site projects

KMUTT perceives ChEPS students as a valuable resource to help each placement company's engineers tackle important problems, however placement organisations perceive their contributions as helping students learn to solve real-life problems. In other words, each stakeholder believes that the other has more to gain from this placement collaboration. However all of the site directors interviewed agreed that solving meaningful problems was the key to the placement as their companies benefitted from project results. On the other hand, many sponsors believed that companies supported the program by opening up their facilities and providing projects for students to learn. Other companies feel they are contributing to ChEPS by encouraging their engineers to spend time with students to discuss technical and non-technical issues. Finally, despite the best efforts made by the students, many sponsors feel they themselves make significant contributions to the final output of the projects.

Sponsors' background - ChEPS and non-ChEPS

It was found that sponsors who were ChEPS alumni had different approaches to mentoring students and different expectations on their subsequent performance than those who were not ChEPS alumni. The former generally had a higher expectation on performance than the latter: *Personally, I am impressed by ChEPS students since they are more mature and more responsible than students from other programs* (Non ChEPS alumni sponsor), and *I know I sometimes put pressure on the ChEPS interns but I learnt a lot during my own placement. I wanted them to get the most out of it* (ChEPS alumni sponsor). Another sponsor having ChEPS background said *"I know they [the students] could do it [handle a site project] and I was very disappointed every time they did not perform."* This finding is supported by an executive engineer who supervises both sponsors who are ChEPS alumni and those who are not: *ChEPS alumni seem to be proud of the program and sometimes are hard on current students.*

With respect to their approach to mentoring, most ChEPS alumni do not provide direct answers to students' inquiries but instead ask new questions to provoke their thoughts or let the students search for answers on their own: *When the students ask me a question, I always start by asking for their opinions and reasons to support those opinions* (ChEPS alumni sponsor).

Factors affecting student learning at placement

As mentioned earlier, the development of student learning at placement can be influenced by a number of factors. The impacts of these factors are discussed below.

Placement policies and sponsors' personalities

It was found that students tend to feel under pressure when a placement organisation or a sponsor focuses only on the project output. In addition, some sponsors tend not to allow students to think on their own rather giving them a set series of tasks to solve a problem. These circumstances can interfere with students' learning during their placement. On the other hand, some sponsors who are personally interested in learning tend to spend more time with students to motivate their self-learning and discuss the projects (Thonglek et al., 2011).

Student learning attitude

Learning attitude is a significant factor of student learning development. Different students have different perceptions of the same situation and these differences can play an important role in their learning (Thonglek et al., 2011). For example, a student supervised by a demanding sponsor said, *I understood that he had good intention(s) so his behavior did not bother me. I just learnt how to deal with him since I definitely had a chance to work with this kind of people in the future*. In contrast, another student working with the same sponsor said, *I did whatever he wanted so I could complete my project*.

The importance of learning attitude was highlighted by a site director who said, *I observed that learning attitude is important since no matter how tough a circumstance is, if a student has a positive attitude, he can learn something out of it. On the other hand, if his learning attitude is negative, he could always find an excuse not to learn anything.*

Site director

It is important for a site director to have experiences in helping students learn. As previously explained, there are several factors that influence student learning at placement. An experienced site director can notice the consequences of such factors and manage to assist students in overcoming obstacles. A site director who has more than 10 years of experience in teaching said, *If there were something that interferes with student learning, I would not hesitate to communicate with a sponsor and tackle the problem. However, I am not sure if others would do the same*. Unlike teaching in a classroom, assisting students to learn at placement requires psychology and ethics (Betts, 2004) and this is difficult for people without any experience.

Program challenges

As a result of stakeholder interviews, a number of challenging issues came to light.

Students' maturity

Maturity was found to be a very highly sought attribute by all employers. Even though they could not clearly define maturity, four attributes, namely ethics, emotional quotient, self-learning, and work-life balance, were mentioned. However, it was found that none of the four attributes was emphasised by site directors or ChEPS. So how to improve student maturity can be a challenging issue for the program.

Reflective practice for ChEPS

Reflective practice is a well-known strategy for developing learning at placement (Schon, 1991, Moon, 1999, Doel, 2009). It is claimed that through reflective practice, a student is able to demonstrate their abilities to develop analytical and critical thinking, evaluate their actions, and construct knowledge. Moreover, the practice allows academics to monitor a student's development and help them improve learning. However, limitations involving the use of reflective practice as a learning tool have also been identified (Boud, 1999). For example, a student needs to understand the objective and principle of the practice so they can reflect upon facts and true feelings without fears of being judged by advisors.

Funding

Similar to other WIL programs, the operation cost of ChEPS is higher than that of a conventional program. Thus it is important for the ChEPS program to be financially sustainable. Ideally, all stakeholders of ChEPS should contribute towards the financial costs. In the past, ChEPS has been supported by a number of funding agencies (Ku et al., 2005). This initial seed funding was provided with the understanding that industry funding would increase and make the program sustainable. However, this was not occurred and despite increasing financial support from alumni, the program struggles financially. Not surprisingly, it has been found that other WIL programs also face the same issue of financial support in their long-term sustainability (Weisz and Chapman, 2004).

Site Director

It is difficult to find a ChEPS site director. Three underlying issues have been identified: unaccustomed responsibilities, remote working places, and extra research work. A site director needs to cope with new tasks, such as dealing with industry, improving students' soft skills, and managing administrative issues, with which they may not be familiar. In addition, it is also found that at times inexperienced site directors may struggle with assisting students in their learning development. A site director also is required to work full-time at the placement which is likely to be located in a distant area requiring a long daily commute. Finally, most ChEPS site directors need to work extra hours in order to address the academic requirement to research as well as teach.

Scalability

At present, ChEPS has the capacity to operate with a cohort size of 24 students a year. If the cohort size were to increase it is thought that there may be issues with respect to the availability of suitable placements and site directors. In general, a ChEPS placement is required to accommodate at least 4 students for 5 months and company engineers need to work with a site director to prepare projects for students and supervise them. At present, the opportunities open for the ChEPS program and KMUTT do not support a larger number of placements. In addition, as previously explained, unfamiliar duties, distant working areas, and additional research work are major impediments to the recruitment of site directors.

Conclusions and recommendations

All ChEPS' stakeholders benefit from program participation as expected, however differences in expectations were found. These discrepancies can have the capacity to adversely affect student learning development so it is suggested that the program:

- clearly articulates stakeholders' expectations so that mutual benefits can be achieved and /or agreed;
- prioritises the development of student learning if any negotiation occurs;
- uses an assessment tool to measure and develop student learning at placement; and
- develops a support system to help site directors cope with unfamiliar tasks.

In addition, how to deal with challenges in the program, such as improving students' maturity, searching for funding, finding site directors, and increasing student numbers, should be further explored.

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Appendix B: Thonglek, S., Howes, T., & Kavanagh, L. (2011). "*Work integrated learning: A realistic evaluation of KMUTT 's chemical engineering practice school"*. Paper presented at the 22nd Annual Conference for the Australasian Association for Engineering Education (AAEE), Fremantle, WA, Australia.

Work integrated learning: a realistic evaluation of KMUTT's chemical engineering practice school

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Introduction

Work integrated learning (WIL) and the chemical engineering practice school (ChEPS, KMUTT)

Work Integrated Learning (WIL) can be defined as a learning process that occurs through the connection between theory and practice; a WIL program is a program providing an opportunity for students to practice or be trained at industry placements (Cooper, Orrell, & Bowden, 2010). Based on a report on graduate employability (Precision Consultancy, 2007), WIL has been proposed as a mechanism to develop graduate attributes and employability skills in students since it can provide an opportunity for them to experience working in industries. So far, WIL programs have been operating across many areas including medicine, engineering, and business (Patrick, Peach, & Pocknee, 2009).

The Chemical Engineering Practice School (ChEPS) program was established in 1997 at King Mongkut's University of Technology Thonburi (KMUTT), Thailand. It was developed based on the School of Chemical Engineering Practice, MIT, USA (Johnston, Meadowcroft, Franz, & Hatton, 1994) which has been operating successfully for over 90 years. A major objective of the 2-year Master's degree program is to produce professional chemical engineers possessing attributes in strong technical knowledge, theory application, problem solving, team working, effective communication, time management, and English proficiency (Ku & Thonglek, 2011). These attributes are developed through collaboration between KMUTT and industry. ChEPS students are provided with an opportunity to work at industry placements; therefore ChEPS can be categorised a WIL program.

Initially, ChEPS students spend one summer (10 weeks) revising undergraduate subjects. In the first year, they study advanced technical core courses (e.g. Mathematical Analysis for Chemical Engineering, Intermediate Chemical Engineering Thermodynamics, Chemical Reaction Engineering etc.) in a conventional classroom and also experience project-based learning. The projects are simplified real-life problems sponsored by industry. Through tackling the problems, students are expected to better understand theories and how the theories can be employed in the workplace, and to develop working skills that will be necessary during their placement.

In their 2nd year, the students spend one semester at the placement working in teams solving industry problems provided by placement engineers. Students work under the supervision of these engineers and a university staff member assigned to work full-time at the placement. Each placement accommodates 7-9 students; the academic significantly alleviates the engineers' workload by supervising the students for some technical issues. The academic also observes, reflects, and evaluates student learning. During the other semester, students conduct individual research either at a university or at the placement depending on research topics. To broaden the students' horizon, some students conduct their research overseas.

Ku and Thonglek (2011) reveal three key issues which ChEPS faces: student learning at placement, program effectiveness, and program sustainability. These issues are echoed in other literature. Kirby et al. (2003) focus on how to measure the learning outcomes developed in placements while Billett (2002) emphasises the importance of organisational context on student learning. However, even though Patrick et al. (2009) present various operational strategies for WIL programs, it seems that there is no documented evidence of a strategy that optimises effectiveness and sustainability.

Realistic evaluation

Traditionally, controlled experiments were conducted to identify and study the outcomes of educational programs. The differences between the experimental and control groups were attributed to the new teaching method (Campbell & Stanley, 1963). However, some limitations of this experimental approach have been found. Heywood (2005) demonstrates how the issue of unfairness could arise if the new teaching method has a positive effect on students. Practicality is another experimental problem. Heywood (2005) also explains difficulties in setting up experiments and interpreting data in fieldwork due to uncontrollable factors which then make evaluation difficult if not impossible.

In addition, the issue of research questions for the experimental design may also be problematic. Experiments are more likely to be designed to evaluate the program efficacy (Whether a program works or not.) than the program effectiveness (How a program work.) (Blackwood, O'Halloran, & Porter, 2010). Blamey and MacKenzie (2007) state that the evaluation of program effectiveness is difficult to achieve since the evaluation results not only reflect the program itself but also include the values and attitudes of the people involved in the program.

To overcome the above difficulties, a new approach for program evaluation called Realistic Evaluation (RE) was established (Pawson & Tilley, 1997). "*Ray Pawson and I are highly skeptical of this account of experimentation. We are doubtful of this as a method of finding out which programmes do and which do not produce intended and unintended consequences*" (Tilley, 2000). Shadish and Luellen (2004) also add that the experimental approach cannot fully address the issue of social program effectiveness which is highly contingent on people's value or attitude (Tilley, 2000). Rather than exploring whether the program works (the experimental approach), RE deeply investigates what (elements in the program) works for whom in which circumstances (Pawson & Tilley, 1997).

RE can be used to improve the program effectiveness (Pawson & Tilley, 1997). This framework reveals both expected and unexpected outcomes, and also the understanding of what in the program work or do not work for whom in which circumstances. As such, the understanding will provide us to be better able to adjust the program if the outcomes do not meet expectations.

Contexts are also to be considered as important factors of any evaluation including educational programs (Saunders, 1995). Thus, this paper employs the RE framework to investigate what happens to students at placements and how the placement context affects student outcomes. A framework of Realistic Evaluation (Pawson & Tilley, 1997) can be presented as follows:

Context (C) + Mechanism (M) = Outcome (O)

Where in this study:

Context (C): program procedure, stakeholder's background and attitude

Mechanism (M): what students do or decide to do which leads to outcomes in a given context

Outcome (O): results of what students do

Data Collection Methods

Pawson and Tilley (1997) argue that RE emphasises quality of data not quantity. The framework investigates a set of ideas or patterns of outcomes embedded across groups of interests. In this investigation, 50 stakeholders of the ChEPS program were interviewed. The participant distribution including the interview timetable is presented in Table 1.

Table 1: Participant distribution and interview timetable

No. of Stakeholder		**Interview Schedule**													
		January 2011					**February 2011**								
Stakeholder	Total	25	26	27	30	31	1	2	3	8	11	14	15	16	22
University executive	2				1						1				
Academic Supervisor	9	4	2								2		1		
Current student	3									1	2				
Alumni	15			2		4	2	3	1				3		
Mentor	2						2								
Mentor (also alumni)	9			5		2		1	1						
Employer	5							3				1	1		
Employer at placement	4						1						1	1	1
Employer (also alumni)	1					1									

Open-ended interviews were conducted. The interviews can be either individual or in small groups agreed upon by the participant and the researcher. The duration of interview was 30 - 90 minutes. The questions were categorised into 3 themes: student learning outcomes, program operation, and program sustainability. Patterns of outcomes across different groups of stakeholders were explored. This paper presents how program stakeholders (university, placement, and student) perceive student outcomes and how the placement contexts (placement policy and industry mentors) affect such outcomes. The understanding of the effects of contexts may lead to a better understanding between the university and the placement, and the awareness of mentor teaching strategies.

Results

How program stakeholders perceive student outcomes

The student benefits are the underpinning drivers of the ChEPS program. At the beginning, the benefits which the stakeholders anticipated were investigated. Data were derived from the ChEPS operational procedure and stakeholder interviews. The data were analysed and presented in the form of context-mechanism-outcome configuration in Table 2.

Table 2: The CMO configuration of how program stakeholders perceive student outcomes

Context	Mechanism	Outcome
At university Academics organise teaching activities and material including the assessment (C1) to prepare students prior to placement. *At placement* Academics (C2) work with mentors (C3) to prepare problems for students. Students (C4) tackle the problems under the supervision of academics and engineers.	Mechanisms are the ways students decided to do at placement. For examples, students used different strategies to tackle problems such as: reading textbooks (M1), discussing with their friends (M2), academic advisors (M3), and mentors (M4).	*Expected learning outcomes (O1):* - strong technical knowledge (O11), - theory application (O12), - problem solving (O13), - team working (O14), - effective communication (O15), - time management (O16), and - English proficiency (O17) *Unexpected learning outcomes (O2):* - knowledge acquisition (O21) such as from colleague discussion and observation, - self-understanding (O22), and - managing work under pressure (O23) *Expected employment benefits (O3):* - early job offer (O31) *Unexpected employment benefits (O4):* - confidence in job interviews (O41), - understanding of organisational structure in workplace (O42), and - appropriate job selection (O43)

In Table 2, the context (C1-C4) is the ChEPS procedure, the mechanism (M1-M4) is what students do, and the outcome (O1-O4) is what students gain. Student outcomes can be divided into 2 categories: learning outcomes, and employment benefits. The details of the outcomes are illustrated in Table 2. Table 2 shows both expected and unexpected outcomes. The expected outcomes (O1,O3) can be drawn from the ChEPS handbook and stakeholder interviews, whereas unexpected outcomes (O2,O4) are revealed through in-depth student interviews. A student said "*At (company), I observed how (name of his mentor) presented his work in a formal meeting and how he explained it (the work) to his colleague and operators. It's the same story but in different ways. I don't know how he could do that but I know this skill is very important"*. Another student added *"I talked to people in (company) but not technical stuff (smile). I need to know what a company wants from a graduate because I thought I had a problem with job interviews. Finally, I found out that job interviews might not be a big issue for me but I applied for the position not suited me.* (Prior to ChEPS, this student had a good academic performance in the undergraduate level but she tended to be declined after job interviews.) Both students agreed that they could not gain these invaluable experiences in the university.

According to Table 2, the unexpected outcomes lead to positive results to students which reinforce the concept of work integrated learning. However, it is generally accepted that what students will face at placements is unpredictable and organisational contexts also affect student learning (Billett, 2002). And thus, the next step, the study focuses on how the placement context has impacts on the student outcomes.

How placement contexts affect student outcomes

Based on the interviews, two components at placement have impacts on students: the placement policy, and the mentor attitude. The CMO configuration of the impacts of placement policy and the mentor attitude are illustrated in Tables 3 and 4.

The placement policy context

The policy of the ChEPS placements can be classified into 3 categories: supporting learning environment (C5), searching for early recruitment (C6), and expecting project outputs (C7). How these different policies influence students is presented in Table 3.

Table 3: The CMO configuration of how the placement policy affects student outcomes

Context	Mechanism	Outcome
Placement policy encourages a learning environment (C5) or focuses on recruitment benefits (C6).	Students feel free to learn both technical knowledge and people skills (M5).	Students have a good impression on the placement (O5) leading to good program reputation (O6).
Placement policy focuses on project outputs (C7)	Students feel more under pressure (M6) and tend to focus on technical things to meet industry expectation (M7).	Students may have a bad impression on the placement (O5-) and lead to the issue of program reputation (O6-).

One student said *"I think I was lucky since I worked in different placements. The first company, my mentor told me that, if possible, he wanted my project succeed but unless I could do that he was also fine at least we (my mentor and I) could learn something from it. He let me propose my thoughts (M5) and tried it, definitely, under his supervision. I was happy about that (O5) and finally, I could achieve the project goals. It differed* *from the second place; I was assigned to develop a simulation program that the company intended to use it with a plant unit. I was quite stressful that time. Again finally, I could make it. However, I had no idea what would happen if I couldn't achieve it."*

The mentor context

The strategies which engineers work with the ChEPS students can be classified into 3 types: facilitation (C31), action (C32), and instruction (C33). How the strategies affect student outcomes is presented in Table 4.

Table 4: The CMO configuration of how the industry mentor affects student outcomes

Context	Mechanism	Outcome
Mentors facilitate students as academics do (C31).	Students are provoked to tackle problems (M8) as the program expected.	O1-O6 can be expected
Mentors use the strategy of "leading by examples" (C32).	Students find the reasons of what mentor do and develop their own strategy (M9).	O1-O6 can be expected
Mentors tend to instruct students (C33).	Students imitate what mentors do regardless any reason (M10). Students follow mentors' instruction (M11).	Some O1-O4 may not be developed and O5--O6- may be occurred

A student said *"my mentor was so nice, when I needed his advice. After regular working hours; he always spent time discussing (C31) about our problems. He never directly told me an answer but most of the time I learnt from his questions (M8)"*. While another student said *"my mentor never explained (C32) what and why he did. I had to observe it and try to find answers by myself (M9)"*. The interviewer asked, *"How could you make sure your answer was right or wrong?"* He said *"some were not right or wrong answers. However, if I really needed an answer, I would ask him then"*.

Another type of mentor strategy was mentioned by an academic supervisor. He observed that some students could not fully understand what they were doing since they just follow the mentor instruction (M11) or some students just imitated what mentor did (M10). *"Personally, I'm concerned whether these students could develop their learning as we expected"*, added the advisor.

Discussion

RE was employed for this investigation since this framework considers the importance of contexts. The data analysis shows that even though students could gain benefits from ChEPS as the program stakeholders expected (Table 2), there still are some possible mechanisms that cause unwanted outcomes at placement (Table 3,4). The CMO configurations lead to a better understanding between the university and the placement, and the awareness of mentor teaching strategies.

Better understanding between the university and the placement

To operate WIL programs successfully, common understandings among program stakeholders are necessary (Cooper, et al., 2010). The ChEPS operation handbook which the program stakeholders are supposed to read includes roles and responsibilities of stakeholders, and expected student learning outcomes. However, the expectations of the placement are excluded in the handbook. Thus, it should be better if the clear objectives of the placement participation are firstly agreed and, significantly, the participation objectives should be specified in the document.

The awareness of mentor teaching strategies

How a mentor works with a student is uncontrollable. However, the mentor approach to teaching (C31, C32, C33) should be discussed in formal and informal meetings. In addition, expected mentor strategies should be specified in the handbook. An academic advisor should maintain communication with students in case they need help. For instance, an advisor may ask a student about their reasons for the approach to problem solving if he/she is working with an action mentor (C32). Moreover, a formal meeting between an academic and a mentor is required if the mentor just focuses on project outcomes (C33) instead of supporting the student learning.

Conclusion

RE is employed by this research due to the difficulties of experimental approach, and the contextual impacts in educational program. In this study, RE uncovers the possibilities of how placement policy and mentor attitude influence student outcomes. In the end, a deeper understanding of the contextual influences on the student outcomes can lead to a better understanding between the university and the placement, and the awareness of mentor teaching strategies.

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Appendix C: Coding descriptions and examples

This appendix contains coding descriptions and examples of coded excerpts from the data are also provided.

Coding descriptions and examples of learning development

Learning step	Description	Example
Identify a problem	Students clarify what the problem is, why the problem is important, and the goal they would like to achieve.	*'As a result of these [placement] experiences I started to get more details of operational issues. ... I attempted to investigate these issues in detail and relate them back to periods of process instability in the control charts I developed. This provided a comprehensive link between operational and process factors affecting the thickener underflow density.'*
Create a strategy to solve the problem	Students describe the methods or ideas to solve problems.	*'I decided that I will participate in some of the settling tests to understand how they work but will not participate in all the planning and analysis for the project.'*
Acquire knowledge	Students explain how they gain knowledge to solve the problems such as observation, discussion or other sources such as company report.	*'I obtained this information from the daily technical meetings, process and shift engineers, control room operators, shift controller logs and RMA logs.'*
Implement the strategy	Students describe the ways they tackle the problems.	*'A number of experiments were conducted to develop an appropriate settling test method. This was done to ensure the results were valid and applicable to the process at [the placement].'*
Evaluate the consequences of implementation	Students explain the outcomes of their action and what they have learnt from their experience	*'... I asked myself what I should do to tackle the problem. First, I changed my attitude not to dislike any subjects and then I managed my time ... I tried to relate new lessons to what I had already known... At present, I am getting more confident about exams, especially when I can offer my thoughts and make arguments with my friends.'*
Adjust the strategy	Students describe why and how they change their methods to solve problems after their implementation.	*'My group was assigned to design a unit in a chemical plant. I was first responsible for programming which I was good at... Half way through the project, I found that the strategy in allocating work was not effective…I decided to change how we managed work tasks. I asked my colleagues to share responsibility for programming and I also helped in other tasks. I found that this new strategy worked quite well.'*

Coding descriptions and examples of graduate attributes

Graduate attribute	Description	Example
Professional ethical skills	The ability to demonstrate trustworthy and ethical behaviours in societies and to conform to professional practices and standards.	*'I observed in action the unspoken rules of who may talk when, and gained an appreciation of how important it is to be punctual to particular types of meetings or event.'*
Technical knowledge competency	The ability to demonstrate in-depth technical knowledge and to apply the knowledge to real situations.	*'Industry placement has allowed me to see the action/reaction mechanisms at work within the device, which gave a much clearer understanding of the theories I had first learnt in class.'*
Critical and analytical thinking	The ability to identify or simplify a complex problem into manageable tasks and to evaluate the outcomes of the managed tasks.	*'…this would significantly impact my project as I had been collecting data on the conditions that were presently observed in the thickeners. It would mean that I would have to delay the trials I was planning as I would have to collect background data based on the new conditions. This was necessary in order to observe any improvement to the thickeners during the trials. I was also prepared to collect overflow samples as well as underflow samples in order to get an accurate measurement of the slurry pH in the feed-well.'*
Problem solving	The ability to create and develop strategies to tackle a problem.	*'I decided that I will participate in some of the settling tests to understand how they work but will not participate in all the planning and analysis for the project.'*
Knowledge acquisition	The ability to investigate process behaviours and identify causes of problems.	*'I obtained this information from the daily technical meetings, process and shift engineers, control room operators, shift controller logs and RMA logs.'*
Teamwork	The ability to solicit ideas and opinions to help form specific decisions or plans, keep people informed and up-to-date about the group process, and share all relevant or useful information	*'Since we needed to deal with the time constraint, my group decided to share responsibility according to preferences of each group members. For instance, I was good at modelling so I was responsible for programing part while one of my friends used to take an economic class so she was responsible for the economical part and the other one was responsible for writing a report.'*
Team leadership	The ability to motivate team members to achieve desired outcomes, demand high performance, give detailed directions to get a job done, and purposely give or withhold information to gain specific results.	*'Half way through the project, I found that the strategy in allocating work was not effective…I decided to change how we managed work tasks. I asked my colleagues to share responsibility for programming and I also helped in other tasks. I found that this new strategy worked quite well.'*
Technological literacy	The ability to use tools related to professions, such as engineering software.	*'I have learnt to use professional software called HYSIS to complete a required task in the project.'*

Graduate attribute	Description	Example
Communication	The ability to understand attitudes, interests, needs, and perceptions of others and respond appropriately, such as making persuasive arguments or explaining ideas, to make work-related and social contacts and build connections, and to make public presentations.	*'I have had the chance to work with a variety of disciplines of engineer,..., all of whom require a slightly different manner in which to interact.'*
Professional writing	The ability to make professional documents such as reports, minutes, memo or e-mail.	*'I was able to develop my technical report writing skills throughout the period through the submission of the report.'*
Organisational awareness	The ability to understand the organisation's structure, culture, and constraints and then align oneself accordingly.	*'The more I came into contact with personnel from other departments, the more I learnt about the company's workforce and core values.'*
Quality-oriented awareness	The ability to show concerns for order, check the accuracy of one's work, monitor work progress, and develop a system to organise and keep track of information	*'I realised that I haven't got a single place that I keep a track of all the things I do (I keep information in various places, email, my notebook etc). … I have decided to keep a daily log and record everything I do each day. It is much quicker to take 5 minutes at the end of the day to note what I have done as opposed to spending much longer going through lots of information (my notebook, emails, Inbox calendar etc) trying to figure out when I did something weeks after it happened.'*
Customer-oriented awareness	The ability to match the needs of clients to available products and services, and take responsibility for correcting customer problems if any.	*'I learnt that a [client] needs three things to work at [placement]…: It is [placement]'s responsibility to ensure the [client] has these things.'*
Mentoring	The ability to express positive expectations of others, even in "difficult" cases and give directions or demonstrations with reasons or rationale as well as providing training strategies.	*'When I realised that I could not finish a task [related to programing] in time, I started asking help from my friend. Then I realised that I needed to explain the knowledge related to the task first, next what I was doing and what I wanted them to help me.'*
Achievement	The ability to learn on his/her own and show internal motivations to learn new knowledge and reach a challenging goal for oneself.	*'The lack of significant guidance …ultimately develop an independent approach to solving issues and further developed my own effectiveness and decisiveness.'*
Adaptability	The ability to adapt his/her intentions to unexpected events.	*'I was a little confused when I found out that I would be sticking around and the other two would be leaving. I felt very anxious about being up here alone. Over the past few days I have been forced repeatedly to move outside of my comfort zone in both self management and also in interactions with people I do not know.'*

Graduate attribute	**Description**	**Example**
Self-management	The ability to effectively manage to complete oneself and group tasks within a time constraint.	*'…as I had not planned a lot of other work to continue with during this time. I had completed a project risk analysis for this scenario. The appropriate action was to reprioritise my workload.'*
Self-control	The ability to maintain performance under stressful or hostile conditions.	*'At first I was worried that this [an obstacle] would significantly impact my project as I had been collecting data on the conditions that were presently observed in the thickeners. It would mean that I would have to delay the trials …. Once I had made arrangements to consider the acid injection in my project I felt like I could handle this setback.'*
Self-confidence	The ability to maintain performance against discouraging circumstances and uncertainties.	'*...Once I got my head around the process data I felt a lot more confident in my understanding of the process.* ", *"...I also felt more confident talking to the different work groups about operational problems affecting the plant.*'

Appendix D: An example of data analysis

I've learnt many thing form design problem that I can use to improve myself. Surely, my English has been improved by preparing presentation presenting each work and writing the report and my technical knowledge has been integrated together. Moreover, I've learnt other things from those two design problem which are 4 main stories as fallow.

First story happened in 1st design problem. Everyone in my group was new friend and I didn't know them much. They chose me to be the group leader and I knew that I had to manage all works. The problem was he is a clever student from and he studied well in Aspen class. So I asked him to simulate the process with I expected he could do it very well. But every time that he couldn't converge the flow sheet or cannot solve the error, he didn't try to solve any problem and he would walk around, sit somewhere, say something like "This is wrong I cannot do anything" and stop working. I thought that was bad behavior because problem could take place every time and he must solve it. After 30 minutes, he still walked so I must leave my work and try to help him solve the problem. After I could solve the error and converge the flow sheet for him, he would get back to work again. However, my group loss 30 minutes of working because of his problem. From this happening, I've learnt that I had to help my group member for solving the problems because member's problems were group's problems and we would loss many time if the problem could not be solved. Finally, I helped him solving every problem and we saved the time because the problem could be solved before he started walking around.

Second story also happened in 1st design problem. We prepared the presentation and sent the power point file to our adviser. One day later, she sent it back to us and asked us to talk with her. She said that she couldn't understand what we wanted to communicate and other people couldn't understand too. Because we put everything in the slides and everything was disorder. So she made us rearrange it again. After that, we sit together and try to get some good ideas to rearrange the presentation. That time, we thought we must present our work as the story which may easier to understand for example we introduced the product and its importance first, linked with how to produce it chose the best method by reasons and described the chosen process after. After we rearranged the presentation, we presented our work in proposal presentation and everyone looked understand our presented slides. Our adviser said that you did well I could understand your work. From this happening, I've learnt that slides order is important and they should be presented as the story to keep people understand and pay attention on our presentation.

Third story happened in the proposal presentation of 2nd design problem. After we finished presentation Dr. asked us a lot of questions. He asked about the result and something that is not in our scopes of work for example I said that I evaluated carbon reduction by using LCA analysis and he asked me that what we did about LCA, he asked me for types of the reactor to be used gasification and how it operated, he asked me how dept that we studied about the reactor etc. We couldn't answer him many question, he looked upset and he used 45 minutes for asking questions. Firstly, I was angry and afraid what Dr. and I didn't know what he want from us. That was very bad moment for me, we worked hard but couldn't answer question. However, I got back to think why he asked those questions and why we couldn't answer. I thought positively that he might make us think a lot before presented something. So I tried to take note and answered his questions, I worked harder and went to see our advisor more for getting better presentation. In the next presentation, Dr. ill asked many questions but we could answer more and he wasn't upset. I thought questions are the way that he taught us to improve our self, I shouldn't angry him and I should look myself first to do the better work.

Appendix E: A Survey – WIL Programs in Chemical Engineering in Australia and Thailand

WIL program - University's operation and satisfaction

The Survey of WIL Programs across Schools of Chemical Engineering in Austra...

Work integrated learning (WIL) has been shown to enhance student learning by providing an opportunity for students to integrate and apply their technical knowledge to practical work in an authentic environment strong supervision from both academia and industry.

This survey focuses on WIL programs designed for chemical engineering students both in Australia and in Thailand. It's anticipated that identifying organisational and administrative issues as well as learning outcomes will allow for evaluation of best practice and recommendations for improvement of the program.

The information gathered will be kept strictly confidential and methods comply with UQ ethical procedures. A copy of the findings will be sent to all participants.

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Institution: University of Queensland

Glossary

1. WIL program = Work integrated learning (WIL) program is a part of an undergraduate or postgraduate degree program providing an opportunity for students to learn professional skills such as communication skills, management skills etc. in an authentic environment.

Features of WIL programs
1. Well-prepared program
To operate WIL programs, collaboration between university and company is required. In some universities, a coursework schedule may be reorganised to accommodate WIL students. Placements (an organisation or a company providing facilities for students to practice / be trained) needs to prepare well-defined projects including student mentors. Then well-organised administration of WIL programs is necessary.

2. University – industry interaction
To ensure that WIL graduates can obtain professional skills during working at placements, academic staff and engineers need to work closely in several procedures such as finding appropriate projects, assessing student performances etc.

3. Quality of projects
Projects for WIL students should provide an opportunity for students to improve their professional skills such as theory appreciation, theory application, engineering problem solving etc.

4. Student assessment
In WIL programs, students learning outcomes will be assessed by universities and industries.

5. Working period
Students should practice at placements at least 1 semester.

WIL program - University's operation and satisfaction

Background and organisation

1. What was the motivation to set up the WIL Program at your institution? (Tick all that apply)

- [ ] Industry collaboration
- [ ] Accreditation requirements
- [ ] Improving the student experience
- [ ] School initiative
- [ ] University policy
- [ ] Other (please specify)

2. What is the accreditation standard for this WIL program? (Tick all that apply)

- [ ] None
- [ ] Accreditation Board for Engineering and Technology
- [ ] Engineers Australia
- [ ] Institute of Chemical Engineering
- [ ] Other (please specify)

3. Approximately what year was the WIL program established in?

4. Which level of organisation operates and administers the WIL program?

- ◯ Program (e.g. it is run by the coordinator of the Chemical / Metallurgical program which sits in the School of Chemical Engineering)
- ◯ School (e.g. it is run by the School of Chemical Engineering.)
- ◯ Faculty (e.g. it is run across many schools of engineering.)
- ◯ University (e.g. it is run by a university-wide office for many different disciplines)
- ◯ Other (please specify)

WIL program - University's operation and satisfaction

5. Are there WIL programs in other engineering disciplines?

- No
- Yes – but they are essentially the same
- Yes – and they are different (Please specify differences)

6. How many academics are involved in the coordination and administration of the WIL program? [For total% full time add all contributions. e.g. 2 academics each working 20% of the WIL program = 40%]

6.1 The number of academics in teaching and supervising in WIL and relevant courses

6.2 Total % Full Time (est) of academics in teaching and supervising in WIL and relevant courses

6.3 The number of academics in the coordination and administration in WIL program

6.4 Total % Full Time (est) of academics in the coordination and administration in WIL program

6.5 The number of general staff in the coordination and administration in WIL program

6.6 Total % Full Time (est) of university staff in the coordination and administration in WIL program

WIL program - University's operation and satisfaction

7. How many people from industry are involved in the coordination and administration of the WIL program? [For total% full time add all inputs]

The number of people from industry in supervising students at the placements	
• Total % Full Time (est) of people from industry in supervising students at the placements	
The number of people from industry in the coordination and administration at the placements	
Total % Full Time (est) of people from industry in the coordination and administration at the placements	

WIL program - University's operation and satisfaction

Program curriculum

8. What year students are supported by your WIL program? (Tick all that apply)

- [ ] Undergraduate - 1st year
- [ ] Undergraduate - 2nd year
- [ ] Undergraduate - 3rd year
- [ ] Undergraduate - 4th year
- [ ] Graduate

9. Is the WIL program compulsory?

- ○ Yes
- ○ No

10. If not, how is the WIL subject incoperated into the curriculum?

(WIL Subject = A subject in the WIL program providing an opportunity for students to work in an organisation including preparation subject (if any)).

- ○ The WIL program replaces some courses
- ○ The WIL program is extra curricular
- ○ Other (please specify)

11. If the WIL subject replaces some subjects, how many subjects are replaced?

12. What is the approximate average cohort size in chemical engineering at your institution? (i.e. the number of students in each year)

13. Approximately how many students apply for the WIL program each year?

14. Approximately how many students are accepted into the WIL program each year?

15. What are the selection criteria for acceptance into the WIL program(if any)?

WIL program - University's operation and satisfaction

16. How long do the students in the WIL program spend in industry?

- ◯ 1 semester
- ◯ 2 semesters
- ◯ 1 semester + summer vacation
- ◯ summer vacation
- ◯ Other (please specify)

17. Is the WIL program full time (i.e. Students take no other courses while in the program)?

- ◯ Yes
- ◯ No

18. How are the students prepared for the program? (Tick all that apply)

- ☐ No preparation
- ☐ Special courses
- ☐ Workshops
- ☐ Introductory session
- ☐ Intermediate session
- ☐ Other (please specify)

19. How long does the preparations take?

20. What are learning objectives of the preparations?

21. What are learning outcomes for the WIL program? (Tick all that apply)

- ☐ Students demonstrate knowledge of fundamental engineering theory
- ☐ Students demonstrate ability to apply theoretical knowledge to real-life problems
- ☐ Students demonstrate professional engineering practice
- ☐ Students demonstrate ability to work in team
- ☐ Students demonstrate ability to communicate effectively
- ☐ Other (please specify)

WIL program - University's operation and satisfaction

22. What assessment is used? (Tick all that apply)

- ☐ Project report
- ☐ Oral presentation
- ☐ Attendance
- ☐ Weekly journal
- ☐ Other (please specify)

23. How are the students placed?(Tick all that apply)

- ☐ Individually (A chemical engineering student that is responsible for his or her own project.)
- ☐ Multidisciplinary student team (A group of students, which consists of at least one chemical engineering student and students from various disciplines.)
- ☐ Chemical Engineering student team (A group of only chemical engineering students)
- ☐ Industry team (A group with engineers from the working industries and chemical engineering students)
- ☐ Other (please specify)

WIL program - University's operation and satisfaction

Industry

24. Where are the industries located? (Tick all that apply)

- [ ] Locally to the university
- [ ] At a distance from the university that requires the student to relocate
- [ ] Overseas

25. What kinds of industries are typically involved in the WIL program? [Tick all that have participated?

	Large (>500 employees on site)	Medium (500-50 employees on site)	Small (<50 employees on site)
Oil / Gas platform	☐	☐	☐
Petrochemical industry	☐	☐	☐
Food manufacture	☐	☐	☐
Chemical manufacture	☐	☐	☐
Breweries / Distilleries	☐	☐	☐
Pharmaceuticals	☐	☐	☐
Consulting firms	☐	☐	☐
Mineral processing	☐	☐	☐
Water companies	☐	☐	☐
Research	☐	☐	☐

Other (please specify)

WIL program - University's operation and satisfaction

Program outputs and evaluation

26. Approximately how many students have completed the WIL program since its inception?

27. Who has evaluated the program? (Tick all that apply)

- ☐ No Evaluation
- ☐ University / Academics
- ☐ Industry
- ☐ Current students
- ☐ Alumni
- ☐ Employers
- ☐ Other (please specify)

28. How the WIL program has been evaluated?

29. In your opinion, the WIL program has a positive effect on

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Promoting university's and /or schools reputation	○	○	○	○	○
Increasing the number of students enrolling the school	○	○	○	○	○
Developing curriculum	○	○	○	○	○
Building staff's expertise	○	○	○	○	○
Attracting more funding	○	○	○	○	○
Initiating university – industry research	○	○	○	○	○

WIL program - University's operation and satisfaction

Financial support

30. Where does the funding that supports administrative and academic staff and associated costs come from? (Tick all that apply)

- [ ] University
- [ ] Industry
- [ ] Student
- [ ] Government
- [ ] Other (please specify)

31. Does the student receive a "scholarship"?

- [ ] No
- [ ] Yes, from industry
- [ ] Yes, from the university
- [ ] Yes, from other (please specify)

32. Does the student pay tuition expenses?

- ( ) Yes
- ( ) No

WIL program - University's operation and satisfaction

Challenges

33. How often do the following problems occur in the operation of WIL program?

	Always a problem	Often	Occasionally	Rarely	Not a problem
Lack of university funding	◯	◯	◯	◯	◯
Lack of university administration	◯	◯	◯	◯	◯
Low student demand	◯	◯	◯	◯	◯
Finding suitable industry	◯	◯	◯	◯	◯
Finding sufficient placements for the student demand	◯	◯	◯	◯	◯
Soliciting appropriate projects from industry	◯	◯	◯	◯	◯
Finding academic supervisors	◯	◯	◯	◯	◯
Mismatch of university and industry expectations	◯	◯	◯	◯	◯
Industry not committed to program objectives	◯	◯	◯	◯	◯
Ability to embed WIL program in degree curriculum	◯	◯	◯	◯	◯

34. Are there any proposed changes to address the above issues?

◯ No

◯ Yes (please specify)

Appendix F: Participant information sheet and Participant consent form

PARTICIPANT INFORMATION SHEET

Interviewer
Ms Saranya Thonglek
School of Engineering
The University of Queensland
Mobile: 0412 805 910
s.thonglek@uq.edu.au

Title

Chemical Engineering Work Integrated Learning Programs in Australia and Thailand

Purpose of study

This research aims to compare Work Integrated Learning (WIL) programs in the Schools of Chemical Engineering in Australia and Thailand with respect to organisational and administrative issues, satisfaction of stakeholders, program outcomes and program stability. It is anticipated that the results from this research lead to more understanding in the operation of WIL programs and that best practice will be identified. Furthermore, the benefits from being part of the program, apart from producing prospective engineers, will be explored and analysed. Finally, possible strategies for program stability will be proposed.

Procedures of involvement

Participants will be contacted via e-mail to gain assent to be interviewed. A participant consent form will be sent prior to the interview, based upon the University of Queensland Guidelines for Ethical Review's examples of informed consent. The interview will take approximately one hour. The recorded data will be de-identified and stored in a locked filing cabinet located in a secure office premises.

Location for participation

The interviews will be conducted at a location agreed upon by the participant and the researcher.

Risks

No foreseeable risks have been identified for the participants of this study.

Benefits to participants
There will be no monetary payment for participants of the study. It is the researcher's responsibility to seek a balance between new knowledge and practical research. With this in mind, it is recognised that often participants can identify urgent research needs more clearly than the researcher. In this way, the participants have the ability to influence the direction of the research questions. The researcher will also provide project progress updates. Final reports will be made available.

Freedom to withdraw without penalty
The participant is free to stop the interview at any time without any judgement or prejudice being made by the researcher. The participant is also free to withdraw their contribution to the study at any later point in time. In this case, the data pertaining to the participant would be destroyed and a letter sent to the participant informing them that this has occurred.

Assurance of confidentiality
Participation is voluntary and individuals will not be identified in any reports of the study. The interviews are confidential and will be conducted in private, with only the participant and the researcher present. Subject to the participant's approval, the interview will be audio recorded then transcribed. The transcripts will be stored in de-identified form. Only the researcher and supervisors (A/Prof. Tony Howes and A/Prof. Lydia Kavanagh) will have access to the primary data. The data will be kept in a locked filing cabinet on a secure business premises for a period of five years, with no other person able to use or access the data obtained.

Contact details for further questions

Interviewer	**PhD Advisors**	
Ms Saranya Thonglek	A/Prof. Tony Howes	A/Prof. Lydia Kavanagh
School of Engineering	School of Engineering	School of Engineering
The University of Queensland	The University of Queensland	The University of Queensland
Phone: 0412 805 910	Phone: 33654262	Phone: 33654264
s.thonglek@uq.edu.au	t.howes@eng.uq.edu.au	l.kavanagh@uq.edu.au

The University of Queensland's Ethical Paragraph
This study adheres to the Guidelines of the ethical review process of The University of Queensland. Whilst you are free to discuss your participation in this study with project staff (contactable on 0412 805 910), if you would like to speak to an officer of the University not involved in the study, you may contact the Ethics Officer on 3365 3924.

Participant Consent Form

Interviewer	**PhD Advisors**	
Ms Saranya Thonglek	A/Prof. Tony Howes	A/Prof. Lydia Kavanagh
School of Engineering	School of Engineering	School of Engineering
The University of Queensland	The University of Queensland	The University of Queensland
Phone:	Phone: 33654262	Phone: 33654264
Mobile: 0412 805 910		
s.thonglek@uq.edu.au	t.howes@eng.uq.edu.au	l.kavanagh@uq.edu.au

Title
Chemical Engineering Work Integrated Learning Programs in Australia and Thailand

Freedom to withdraw without penalty
The participant is free to stop the interview at any time without any judgement or prejudice being made by the researcher. The participant is also free to withdraw their contribution to the study at any later point in time. In this case, the data pertaining to the participant would be destroyed and a letter sent to the participant informing them that this has occurred.

Assurance of confidentiality
Participants will not be identified in any reports of the study. The interviews are confidential and will be conducted in private, with only the participant and the researcher present. Subject to the participant's approval, the interview will be audio recorded then transcribed. The transcripts will be stored in de-identified form. Only the researcher and her PhD advisors (A/Prof. Tony Howes and A/Prof. Lydia Kavanagh) will have access to the primary data. The data will be kept in a locked filing cabinet on a secure business premises for a period of five years, with no other person able to use or access the data obtained. All reports will be made available to participants prior to distribution for their consent.

Risks
No foreseeable risks have been identified for the participants of this study.

Benefits to participants
There will be no monetary payment for participants of the study. It is the researcher's responsibility to seek a balance between new knowledge and practical research. With this in mind, it is recognised that often participants can identify urgent research needs more clearly than the researcher. In this way, the participants have the ability to influence the direction of the research questions. The researcher will also provide project progress updates. Final reports will be made available.

The University of Queensland's Ethical Paragraph
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I have read and understood the above information and I agree with the terms of the study.
I give my consent for the investigator to contact me again at a later stage of the study (optional)
I, ________________________________ give my informed consent to being part of this study.

____ ______ / ______ / ______
Signature Date