Stakeholders' perspectives of a work-integrated learning program: The Chemical Engineering Practice School

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Structured abstract

BACKGROUND
The Chemical Engineering practice School (ChEPS) program at King Mongkut's University of Technology Thonburi (KMUTT) is a two-year Masters program that produces chemical engineering graduates who are equipped to learn on their own and possess high levels of the attributes required by industry. The program integrates chemical engineering courses and real-life experience through an industrial placement. The placement provides an opportunity for students to develop learning skills. Since its inception in 1997, ChEPS has received wide recognition from chemical engineering undergraduates and industry. The program has produced graduates who are known for their technical competency, English proficiency, and good communication skills. Despite ChEPS' reputation, stakeholders' perspectives of ChEPS are continually monitored and quantified to ensure continual improvement of the program.

PURPOSE
This study explores the expectations and satisfaction of stakeholders on the program with an emphasis on what works well and what needs improvement.

DESIGN/METHOD
Data were obtained initially from semi-structured individual interviews and group interviews with stakeholders, and subsequently through document analyses. The stakeholders are divided into four groups: student, institution, placement, and employer. The placement is defined as a company or an organisation that provides an opportunity for students to practice or to be trained and that hires ChEPS graduates while the employer is defined as a company or an organisation that has hired ChEPS graduates but has not yet provided placements for ChEPS students. A total of 51 program stakeholders were interviewed. The data were evaluated by thematic analyses.

RESULTS
All stakeholders agree that ChEPS is a successful model that helps develop student learning and produces graduates with attributes the industry needs. However, there is room for improvement. For instance, it was found that mentors' background can affect student learning so an effective tool is required to assess student learning development during placement. Another observation is that the ChEPS model may be suitable only for a small-sized class (less than 25 students) and may be difficult to implement when expanded to a bigger class. In addition, some employers argued that the success of ChEPS derives principally from the high quality of incoming students rather than the program itself.

CONCLUSIONS
The ChEPS program can assist students in developing learning through placement experience. Placement contexts such as mentors' background may affect student learning so a measure to ensure the quality of learning is needed. In addition ChEPS has so far been operating with 20-24 students a class, so it will be useful to further investigate the scalability of this practice-based model.

KEYWORDS
Chemical Engineering, Practice School Model, Stakeholder Perspectives, Work Integrated Learning

Introduction

The Chemical Engineering Practice School (ChEPS) program was initiated to address the problem of engineering students' weak aptitude in applying theories (Ku et al., 2005). King Mongkut's University of Technology Thonburi (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 & 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 & Kumer, 1997) and requires strong commitment from industry (Ku & 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, taking mostly chemical engineering graduates, whose curriculum structure is shown in Figure 1.

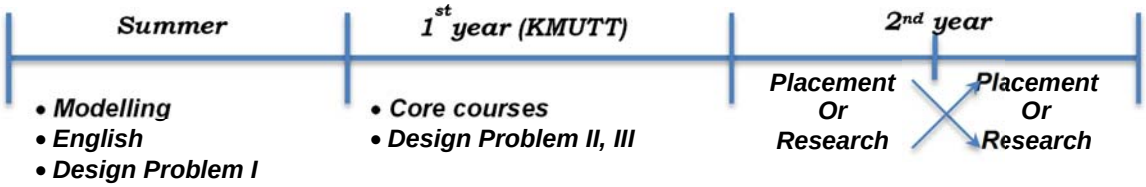

Figure 1: Curriculum structure of the ChEPS program (Ku et al., 2005)

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.

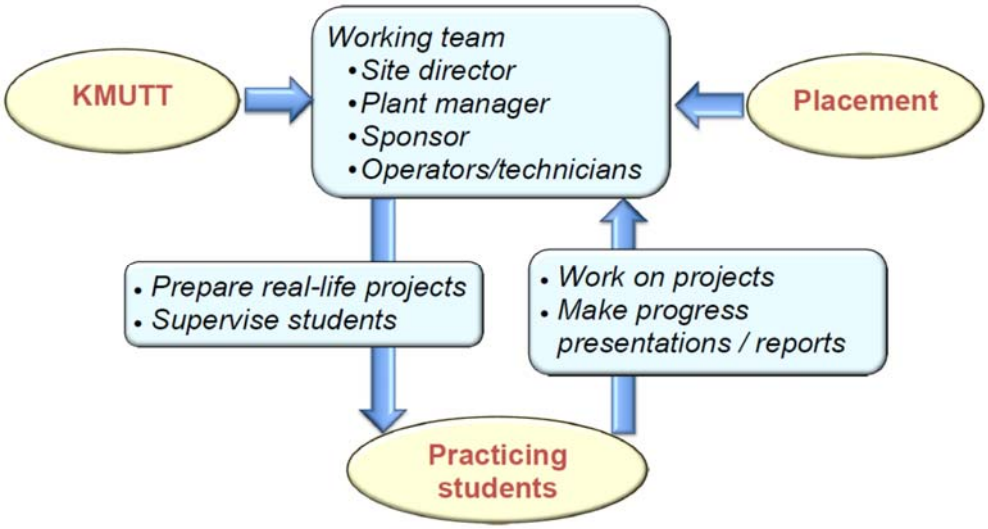

Figure 2: ChEPS' operation at placement (Adapted from Ku et al. (2007)).

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.

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 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 (Benjamin & Meghan, 2004; Brown, 2010; Coll & Eames, 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.

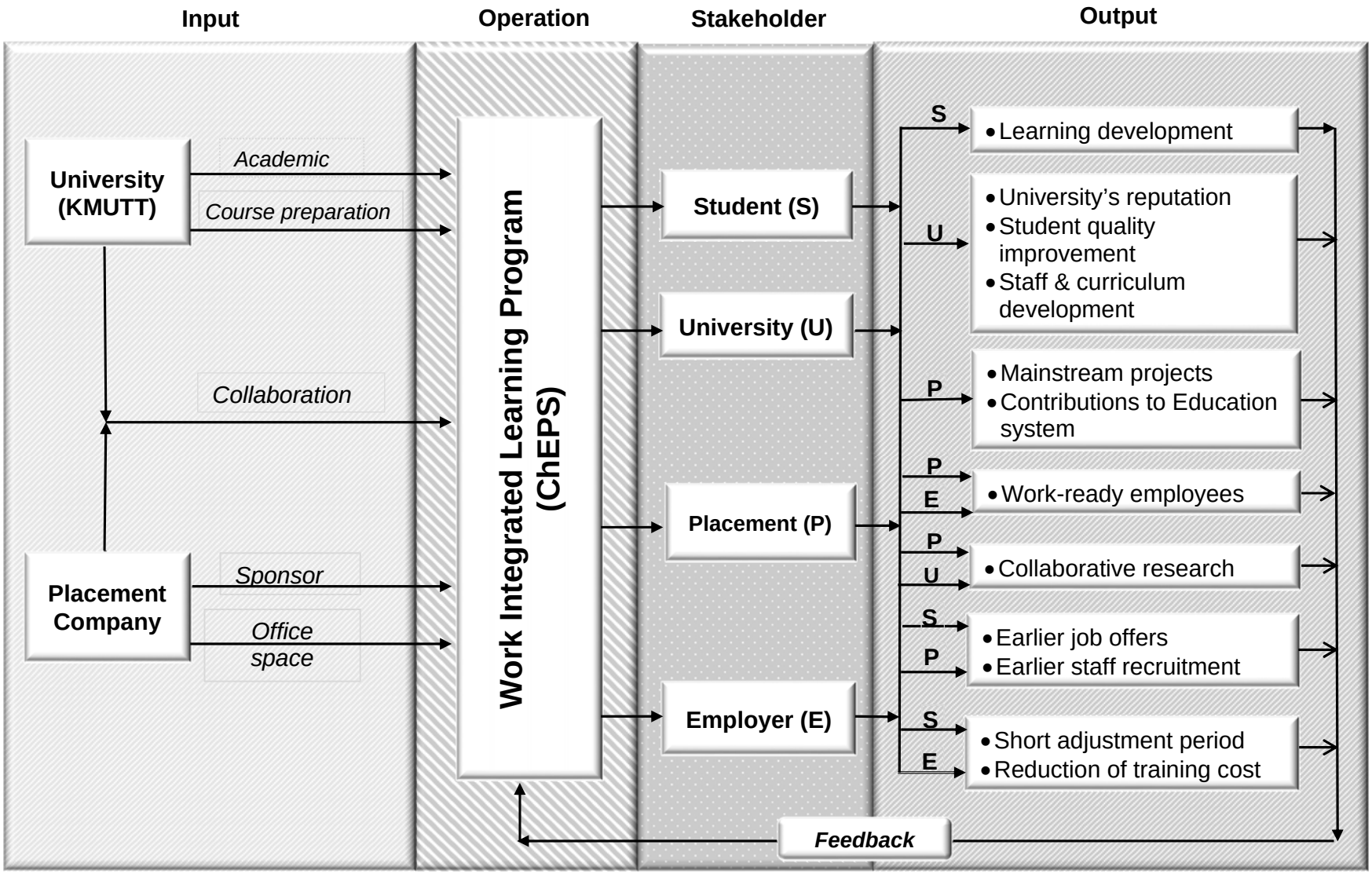

Figure 3: Framework of ChEPS Evaluation

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 select a method 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 & 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 & 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).

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 et al. (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 requirements. 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.(Doel, 2009; Moon, 1999; Schon, 1991) 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 & 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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