

Collaborative Efforts in Developing the PhD in Engineering Education Program in Universiti Teknologi Malaysia

*Khairiyah Mohd Yusof, Fatin Aliah Phang, Syed Ahmad Helmi Syed Hassan, Rose Alinda Alias
Centre for Engineering Education, Universiti Teknologi Malaysia*

Abstract

The PhD in Engineering Education program in Universiti Teknologi Malaysia (UTM) was first offered in late 2008. Since the program is multidisciplinary in nature, with very few reference points to benchmark against as well as scarce expertise in the area, collaboration with institutions from other parts of the world with a similar program was established. When the program was first designed, a link with the School of Engineering Education, Purdue University was formed. Until now, academic staff from Purdue University are regularly invited to provide feedback on the curricula structure and the research conducted by the first cohort of students, as well as conduct short courses on different topics on rigorous research in engineering education. As word about the PhD program spread, links with other institutions offering similar programs are also formed. In 2011, a Memorandum of Understanding and Cooperation Agreement between UTM and Aalborg University, Denmark, was signed to offer a joint PhD in Engineering Education program. There are also efforts to start off collaboration to have joint supervision and research in engineering education with other universities. Since the pool of experts conducting rigorous research in engineering education is rather limited, some of the experts in the area were invited to provide research consultation and short courses to students. For example, Dr. Elliot Douglas from the University of Florida were invited to talk about qualitative research methods. Although there are experts in qualitative methods in UTM from the Faculty of Education who also assisted students in the program, having someone who has conducted research and published specifically in engineering education motivates students to conduct their research to a similar high level of rigor. When the time came for students from the first cohort to submit their theses and go through the oral defense, external examiners were purposely appointed from universities with similar programs, mainly from Purdue University and Aalborg University. This does not only ensure that students are able to have an expert in engineering education as their examiner, but also provide assurance that the quality of the graduates are at par with other programs at the international level. Through collaborative efforts with partner universities, the PhD in Engineering Education in UTM program managed to generate capacity in engineering education research not only among the PhD students/graduates, but also among academic staff who supervise them. With this capability, further collaborative efforts can be made, especially in helping the community of practice grow in Asia.

Keywords: Experience sharing, engineering education

Introduction

The call for more competitive, marketable and global engineers today (NAE, 2004) has resulted in many engineering departments to revise and review their curriculum and the way of teaching and learning engineering. The grand challenges in the 21st Century, requires the input of engineers who can work in a multidisciplinary environment to solve novel problems of the future, that is essential to the well-being of mankind and the earth. The pressure is heightened as the accreditation boards (EAC, 2007) demanded that the engineering programs at universities must equip the engineering students with skills that could not be instilled by just giving lectures such as the graduate attributes outlined by the Washington Accord (IEA, 2009).

In order to improve engineering education, rigorous and in-depth research in engineering education is crucial in helping the engineering departments to carry out the reform. There is overwhelming realization that engineering education needs to be improved through evidence-based practices, through the virtuous cycle of research. Some of the organizations and universities around the

world have started research in engineering education (such as ASEE and SEFI) and offer doctoral program in engineering education such as Purdue University, Utah State University, Virginia Polytechnic Institute and State University, Aalborg University and so on.

Universiti Teknologi Malaysia

In Malaysia, a similar development can be seen. Universiti Teknologi Malaysia (UTM) is one of the five research universities in Malaysia. There are six engineering faculties in UTM, which enable UTM to offer numerous engineering programs at various levels of study and record the highest enrolment of engineering students in the country (www.utm.my). The need to obtain the accreditation for its engineering programs from the Engineering Accreditation Council (EAC) under the Board of Engineers, Malaysia (BEM) has also pushed UTM to look into its engineering programs, as BEM is one of the signatories of the Washington Accord starting 2009 (IEA, 2012).

However, there are no specifically trained experts in engineering education in Malaysia that can take up the task to research and recommend the best practice for engineering educators and UTM to meet the requirements of EAC. This calls for UTM to form a

team of experienced engineering educators and counterparts in the Faculty of Education to design a doctoral program in Engineering Education in order to produce its own experts in research in engineering education. The task was given to the Centre for Teaching and Learning (CTL), UTM in 2007.

The Birth of Doctoral Program in Engineering Education

Designing the doctoral program is not an easy task especially when there is no expert at the time in UTM. International experts in engineering education were sought, such as Prof. Karl Smith, Prof. Kamyar Haghighi, Prof. David Radcliffe, and several others to help UTM's team in planning the curriculum of the doctoral program and identifying areas as well as depth of the research carried out. Most of the efforts to design the program were taken up by a task force consisting of academics from engineering and education faculties who are passionate about engineering education. One of those in the task force, Dr. Khairiyah Mohd Yusof, visited the School of Engineering Education in Purdue, had the opportunity to discuss and learn about the PhD program with the founding head, the late Prof. Kamyar Haghighi. Following the visit, several academic staff, especially Prof Karl Smith, was invited to come to UTM as a visiting Professor, where he shared Purdue University's experience in conducting the PhD program, gave ideas and feedback on the program in UTM as well as the PhD students' research.

The ownership of the program was an issue at the time as there are six engineering faculties and one education faculty in UTM. As a multidisciplinary program, it is difficult to put the program under one of the faculties. Finally, the university decided to put it under the School of Graduate Studies, UTM, which is able to host multidisciplinary programs.

In late 2008, UTM first offered the program to its own engineering lecturers as a strategy to build a pool of experts in engineering education in UTM and also as the future supervisors for this program. The intake to the program was temporarily frozen for two years afterwards to ensure encouraging progress by the first cohort of students. Up to today, more than twenty students enrolled in this program, with 8 students having passed their viva-voce, which were examined by at least one external examiner who is an international expert in engineering education. In 2010, the doctoral program is managed by the Centre for Engineering Education (CEE).

The following strategy was put in place to ensure the success of the PhD in Engineering Education program:

1. Development stage - program and operational structure, benchmarking with other similar programs, and incentives needed to attract UTM academic staff to enroll in this new program. Dr. Khairiyah visited Purdue University during this stage.

2. Initial implementation stage - strengthening syllabus of courses offered, invite visiting professors to assist in giving workshops related to engineering and engineering education research, and provide feedback on overall program and research. Signed LOI with Purdue University.
3. Quality establishment stage - ensure quality research and graduates by increasing interaction with internationally renowned experts, and expand networking to learn about engineering education from different parts of the world. Students were also regularly given support to present at internal seminars, and to present their research at international conferences. Experts in engineering education were identified to be external examiners for the pioneering cohort of students.
4. Expansion and dissemination stage - since 2011, the program is open for admission to the public. MOU and joint PhD program with Aalborg University was established at this stage. Student and staff exchange with departments and schools in other universities with similar programs are planned.

The Program Structure

Establishment of the program structure spans over stages 1 and 2 of the strategy described in the previous section. The doctoral program is research based, with 12 credit hours of courses to be taken during the study. The courses are designed to support students who are mostly from engineering background to learn about fundamental principles in education, design of educational research, and the current needs and overall scenario in engineering education.

The doctoral research projects are selected based on the five key areas of engineering education research as outlined by The Steering Committee of the National Engineering Education Research Colloquies Reports (Colloquies, 2009), which are:

1. Engineering Epistemologies: Research on what constitutes engineering thinking and knowledge within social contexts now and into the future
2. Engineering Learning Mechanisms: Research on engineering learners' developing knowledge and competencies in context.
3. Engineering Learning Systems: Research on the instructional culture, institutional infrastructure, and epistemology of engineering educators.
4. Engineering Diversity and Inclusiveness: Research on how diverse human talents contribute solutions to the social and global challenges and relevance of our [the engineering] profession.
5. Engineering Assessment: Research on, and the development of, assessment methods, instruments, and metrics to inform engineering education practice and learning.

The supervisors for each student are one from the engineering faculty and one from the education faculty. This is because there is no one expert who are well versed in engineering education as a discipline. CTL and CEE were actively inviting international experts to advice and assist both the students and supervisors in conducting the doctoral research projects. Among the them are:

1. Prof. Dr. Karl Smith, Purdue University
2. Prof. Dr. Ruth Streveler, Purdue University
3. Assoc. Prof. Dr. Elliot Douglas, University of Florida
4. Prof. Dr. Anette Kolmos, Aalborg University
5. Assoc. Prof. Dr. Johannes Strobel, Purdue University
6. Assoc. Prof. Dr. Heidi Deifus-Dux, Purdue University
7. Prof. Dr. Kurt Becker, Utah State University

Workshops and courses in various aspects of engineering education innovations and research were organized by for supervisors and students have helped shape the doctoral program. Among the seminars, workshops and courses are Importance of Engineering Education Research, Rigorous Research in Engineering Education (RREE), Qualitative Research in Engineering Education, Cooperative Learning, Problem Based Learning, POGIL, Project Oriented Problem Based Learning, Current Scenario of Engineering Education in Europe, etc.

During the study, the students were required to present their work to a panel consisting of all the supervisors involved in the doctoral program so that the supervisors can help each other in improving the students' research projects.

Regional Conference in Engineering Education

UTM first held the Conference on Engineering Education in 2004. The following year, realizing the importance of engineering education in the region, the conference was upgraded to become the Regional Conference in Engineering Education (RCEE) in 2005. Five series of conference from 2004 to 2012 have been held. Through the conferences, many experts from different countries visited Malaysia and UTM has made close contacts with them for many years since the conference started in 2005. Since the inception of the PhD in Engineering Education program in 2008, the conference became part of the strategy taken to establish quality in the program (Stage 3).

The experts were invited to network sessions and the possibilities to collaborate were explored while the doctoral students from various countries took the opportunity to learn from each other in improving their research projects. UTM's doctoral students who took this inexpensive opportunity to present their research at RCEE have benefited from the feedback, ideas and network obtained at the conference.

In order to provide wider perspectives and more experience for the engineering education students, they are required to submit papers and present at

international conferences around the world, especially the (RCEE) which is organized by CTL and CEE biannually. Through international conferences, UTM has introduced the doctoral program to the world and this has attracted the interest from various universities from Korea, Australia, the US, Denmark, etc to visit UTM and discuss the possibilities to collaborate in training, research and the doctoral program.

Joint PhD Program in Engineering Education

UTM's doctoral program in Engineering Education has attracted the interest of Aalborg University (AAU), Denmark to organize a Joint PhD program in Engineering Education. This is part of the expansion and dissemination stage of the PhD program strategy. A Memorandum of Understanding between UTM and AAU was signed in 22 August 2011 to path the way of making the Joint PhD program (The Star, 2012). Following that, Prof. Dr. Anette Kolmos from AAU visited UTM in February 2012 to work out the details of the Cooperation Agreement and PhD Student Agreement for the Joint PhD program. With differences in the universities' rules and regulations as well as the structure of the programs, it was a challenging task to produce final agreement which will see UTM and AAU to offer this program in the Autumn intake of 2012.

The program will incorporate the joint supervision framework with at least one supervisor from one of the institutions and taking at least 9 ECTS or 6 credits of relevant courses in one of the institutions (amounting to at least 30 ECTS or 20 credits for graduation). The program will also form a panel of assessors consisting of members from UTM and AAU.

Viva-voce Examination

For UTM's doctoral program, the students are required to submit a thesis of their research project at the end of the study where they will be assessed through a viva-voce examination by at least an internal examiner and an external examiner in the area of their research project. In order to ensure the quality of the doctoral program, the external examiners for the eight viva-voce examinations thus far are international experts in engineering education. This is part of the quality establishment stage. Professors who had been appointed as external examiners thus far are:

1. Prof. Dr. Karl Smith, Purdue University
2. Prof. Dr. Anette Kolmos, Aalborg University
3. Assoc. Prof. Dr. Johannes Strobel, Purdue University
4. Assoc. Prof. Dr. Heidi Deifus-Dux, Purdue University

Into the Future

As eight of the graduates (and more to come this year) from this doctoral program are UTM's staff, they

will become the teaching force to drive the doctoral program into a bigger scale. They will serve as the supervisors for future students and conduct courses as the local experts. Today, the enrolment of the students to this program is no longer the UTM's academic staff. Many are lecturers from other universities and colleges who join the program as well as an international student. The intake of new students for 2012 (until June) stands at 23.

As the first university in the Asia region to offer such program, it is crucial to market the program to engineering educators in other Asian countries. Nevertheless, there is still skepticism in the needs for engineering education research, although interest is definitely growing. The example of UTM has been followed by another university in Malaysia which is looking to offer a doctoral program in engineering education in the coming academic year of 2012/2013. It is anticipated that with higher enrolment in engineering education program, the engineering programs at universities, colleges and polytechnics in Malaysia will be improved based on the rigorous research conducted by the local experts in engineering education.

Conclusion

The collaboration with various institutions and organization around the world has immensely helped

UTM to shape its own doctoral program in engineering education. The effort undertook in years of collaboration, discussion and planning with international experts proved to be fruitful when UTM has produced eight PhD graduates in engineering education up to today and more are coming in the future. As more and more universities from different countries make contacts with CEE for possible collaborations, this will only strengthen the doctoral program and provide the students as well as the supervisors rich experience to success in this field.

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