An Evaluation of Generic Skills
Outcomes in Engineering Education
In Hong Kong

Raymond Yin Kam Wong
EdD Thesis

The University of Technology, Sydney
2009
Certificate of Originality

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it reproduces no material previously published or written nor material which has been accepted for the award of any other degree or diploma, except where due acknowledgement has been made in the text.

(Signed)

Raymond Wong
(Name of student)
Acknowledgment

I would like to express my sincere appreciation and thanks to my Principal Supervisor, Associate Professor Robert Pithers, for his valuable guidance, support and encouragement. I am most grateful for the guidance he gave me on a chapter by chapter basis. His support and encouragement through these five years have inspired me to complete this thesis.

I would like to thank my wife, Theresa Wong, she spent her retirement time and stayed with me in Hong Kong instead of in Canada, supported and encouraged my study of the UTS EdD programme in Hong Kong. She even stayed alone by herself during the week-ends and holidays without a word of complaint. Her endless love and care are the essential key elements for the completion of this dissertation.

I would like to thank my Co-Principal Supervisor, Dr. Tony Holland, for his suggestion and advice to conduct study on generic skills research for graduate engineers in Hong Kong, Dr. Alison Lee, for her encouragement and support for conducting the study.

Last, but not least, I am grateful for my EdD (2004) classmates. The yearly get together dinner and lunch meeting functions do provide a forum for us to air our frustrations and our concerns. At the same time, our comforts and encouragements that make lots of differences for all of us to continue our study.
Abstract

A survey driven evaluation of the outcomes of generic skills in higher engineering education in Hong Kong was conducted. The survey techniques involved questionnaire and interviews with both recently graduated engineers and their work-related engineering managers as well as with a focus group of university academics. The results indicated that, overall, mostly the recently graduated engineers did possess adequate levels of generic-type skills to carry out their basic tasks in the workplace. However, the graduate engineers appeared to be insufficiently prepared in certain specific areas, especially for job-related problem-solving and communication skills. The study’s results also indicated that the majority of the graduate engineers and the engineering managers, viewed problem-solving and communication skills are most important priorities for the engineering profession. The majority of the engineering managers also rated the graduate engineers as generally satisfactory in performing their tasks in their organization.

The results of the self evaluation of the overall knowledge and skills, relevant to the generic-type skills learned at university by the graduate engineers, indicated that a significant percentage did not have adequate generic-type skills to carry out a range of tasks in their workplace setting. The findings from the surveyed employers were of a similar nature, although some interesting differences in perception emerged. Some of the recent graduates were also critical of certain subject material content, inadequately provided in some of their university subjects.

With the political change in Hong Kong society, the strategic improvement in communication in both English and Chinese (Putonghua) becomes more critical for the
Hong Kong university graduates, because Hong Kong is closely tied with China and the Western world. Other generic-type skills, such as problem-solving techniques, inter-personal skills, team building, creative thinking, work integrity and ethics are absolutely necessary for all engineering graduates to meet the new requirements of the workplace. The importance of the generic-type skills was validated by the study results and showed agreement in these areas across industry (engineering managers) between graduate engineers and academics.

Well educated citizens in Hong Kong will determine Hong Kong’s competitiveness and its future. The process applied to teaching and learning in university and will also significantly affect future graduate engineers. Strategic improvements such as stressing the importance of communications in both English and Chinese (Putonghua), in addition, the application of problem-based learning, work-integrated-learning and lifelong learning are recommended to be improved in teaching and learning in university education. Lifelong learning, self-motivation and sense of self-efficacy are a must for all graduates in order to meet the new challenges of this changing world.

Today, we live in an age when technology is advancing faster than at any other time in history. Educators should educate and provide graduates with generic-type skills to help them adapt intellectually to a changing world. Advances in technologies have also put engineering education at the forefront of innovation and creativity, two traits which have contributed to Hong Kong’s global status. The old misconception that engineers are only about technology, needs to be broken. Engineers who can communicate, have innovative mindset problem solving skills plus good people skills and leadership ability, as well as be technically competent and proficient are needed in the 21st century.
Table of Contents

Certificate of Originality i
Acknowledgment ii
Abstract iii
Table of Contents v
List of Figures viii
List of Tables x

Chapter 1 Literature Review

1.1 Introduction ................................................................. 1
1.2 Are graduate engineers equipped with the required generic skills? ..... 5
1.3 Generic skills requirements in the learning society ....................... 12
1.4 Conceptualization of generic skills ......................................... 18
1.5 Generic skill theory and model ............................................. 25
1.6 Changes in generic skill requirements ..................................... 30
1.7 Linking generic skills with education and industry ...................... 40
1.8 Employers’ perspectives on generic skills ............................... 48
1.9 New perceptions of generic skills and learning environment .......... 50

Chapter 2 Background

2.1 An economic overview .................................................. 59
2.2 New skill requirements in the 21st century ............................... 63
2.3 The Hong Kong Institution of Engineers (the HKIE) accreditation programme .................................................. 67
2.4 General concerns of generic skills of graduate engineers .......... 70
2.5 Current education system in Hong Kong ............................... 75
2.6 Motivation of this Research ............................................. 78
2.7 Research Questions ..................................................... 81
2.8 Research Objectives .................................................... 84
2.9 Research design ......................................................... 86

Chapter 3 Method

3.1 Introduction ................................................................. 89
3.2 Samples ........................................................................ 91
3.2.1 Sample sizes for the main study .................................... 92
3.2.2 Sample size for focus group discussion and interviews .......... 92
### Chapter 3

**Survey instruments**

- 3.3.1 Questionnaire for the graduate engineers ............................................ 94
- 3.3.2 Questionnaire for the engineering managers ....................................... 97
- 3.3.3 Pilot test of the instruments .................................................................. 98

**Procedures**

- 3.4 Main survey ......................................................................................... 101
- 3.4.1 Main survey ..................................................................................... 101
- 3.4.2 Focus group discussion and interview questions ............................... 101
- 3.5 Questionnaire survey procedures and results .................................... 105
- 3.5.1 Main study ....................................................................................... 105
- 3.5.2 Focus group discussions and interviews ........................................... 106

### Chapter 4

**Results**

- 4.1 Introduction ......................................................................................... 109
- 4.2 Quantitative results (from questionnaire) ........................................... 110
  - 4.2.1 The perceived importance of generic skills: A comparison between the graduate engineers and the engineering managers .......... 110
  - 4.2.2 Communication skills ................................................................... 112
  - 4.2.3 Problem-solving skills .................................................................. 117
  - 4.2.4 Management skills ........................................................................ 125
  - 4.2.5 Other ‘generic-type’ skills ........................................................... 137
  - 4.2.6 Evaluation by graduate engineers of the learned knowledge at university .......................................................... 144
- 4.3 Questionnaire open-ended questions ............................................... 147
  - 4.3.1 Graduate engineers’ responses on open-ended questions .............. 148
  - 4.3.2 Engineering managers’ responses to open-ended questions .......... 150
- 4.4 Qualitative results (from interviews and discussions) ...................... 151
  - 4.4.1 Findings on communication skills .................................................. 153
  - 4.4.2 Findings on problem-solving skills ............................................... 156
  - 4.4.3 Findings on Management skills ...................................................... 159
  - 4.4.4 Findings on other ‘generic-type’ skills .......................................... 162
- 4.5 Academic focus group discussion and interviews ............................ 165

### Chapter 5

**Conclusions and Discussion**

- 5.1 Introduction ......................................................................................... 173
- 5.2 Perception of the importance of generic skills categories ................ 174
- 5.3 Problem-solving skill ........................................................................ 175
- 5.4 Communication skill .......................................................................... 180
- 5.5 Management and the other generic-type skills categories ................ 185
5.6 The general adequacy of the generic skills of the graduate engineers ................................................................. 189
5.7 Perception of adequacy and usefulness of the learned knowledge and skills of the graduate engineers ....................... 192
5.8 Approaches to enhance the generic skills of the graduate engineers ................................................................. 198
5.9 Engineering education needs support from industry .................. 200
5.10 Concluding comments ................................................................................................................................. 201
5.11 Recommendations for further studies ........................................................................................................... 204

References ......................................................................................................................................................... 206

Appendix 1 Invitation letter and questionnaire for the graduate engineers ................................................................. 218
Appendix 2 Invitation letter and questionnaire for the graduate engineers ................................................................. 223
Appendix 3 Prepared interview questions for the managers .......................................................................................... 229
Appendix 4 Prepared focus group discussion questions for the graduate engineers ................................................................. 231
Appendix 5 Focus group discussion with the graduate engineers .................................................................................. 233
Appendix 6 Summary of the graduate engineers’ survey results .................................................................................. 234
Appendix 7 Summary of the engineering managers’ survey results .................................................................................. 237
Appendix 8 Comparison of the survey results between the graduate engineers and the engineering managers 239
Appendix 9 Comparison of the survey results of importance and performance of skills between graduate engineers and engineering managers 241
List of Figures

Figure 1.1 Individual and collective goals and competencies (OECD, 2005)........ 4
Figure 1.2 Skills in higher education (Barnet 1994)................................. 27
Figure 1.3 A ‘new’ proposed model of generic skills in higher education........ 28
Figure 1.4 Engineering curricula in the new century (McMaster 2003)......... 43
Figure 1.5 Engineering is practised in a ‘System’ (McMaster, 2003).......... 44
Figure 1.6 Hong Kong students’ perspective of education.......................... 54
Figure 1.7 The puzzle for engineering disciplines....................................... 54
Figure 2.1 Orienting decisions...................................................................... 87
Figure 4.1 Overall comparison of the ranking of priorities of generic skills:
graduate engineers and engineering managers................................. 111
Figure 4.2 Comparison of the importance and the adequacy of communication
skills: graduate engineers and engineering managers...................... 113
Figure 4.3 Comparison of the overall adequacy of communication skills perceived
by graduate engineers and engineering managers......................... 116
Figure 4.4 Comparison of the importance and the adequacy of problem-solving
skills: graduate engineers and engineering managers...................... 119
Figure 4.5 Comparison of the overall adequacy of problem-solving skills
perceived by graduate engineers and engineering managers............. 123
Figure 4.6 Comparison of the importance and the adequacy of management skills:
graduate engineers and engineering managers.............................. 127
Figure 4.7 Comparison of the overall adequacy of management skills perceived
by graduate engineers and engineering managers......................... 135
Figure 4.8  Comparison of the importance and the adequacy of other 'generic-type' skills category: graduate engineers and engineering managers.................................................. 138

Figure 4.9  Comparison of the overall adequacy of other 'generic-type' skills perceived by graduate engineers and engineering managers.............. 142

Figure 4.10  Percentage distribution of the perceived relevance and usefulness of the learned university knowledge................................................. 145
List of Tables

| Table 1.1 | Generic skills descriptions in various countries (ANTA, 2003) .......... 19 |
| Table 1.2 | Boeing's list of engineering attributes ................................................. 49 |
| Table 2.1 | Future structure of corporations (Byrne, 2000) ..................................... 61 |
| Table 2.2 | Attributes for assessment of new engineers (Magee, 2003) .................. 71 |
| Table 3.1 | Response rates for the pilot test of graduate engineers' and engineering managers' questionnaires ................................................................. 99 |
| Table 3.2 | Response rates (with follow-ups) of the in the main study of graduate engineers' and engineering managers' questionnaires .................. 106 |
| Table 4.1 | Summary of comparison of the importance and the adequacy of communication skills category: graduate engineers and engineering managers ................................................................. 112 |
| Table 4.2 | Graduate engineers' and engineering managers' summaries of the importance and the performance of communication skills category .... 115 |
| Table 4.3 | Raw summary comparison of data used for a Chi-square test of the overall adequacy of communication skills perceived by graduate engineers and engineering managers ................................................................. 117 |
| Table 4.4 | Summary of comparison of the importance and the adequacy of problem-solving skills: graduate engineers and engineering managers 118 |
| Table 4.5 | Percentage differences between graduate engineers and engineering managers of three statements rated as 'High Importance' ................. 120 |
| Table 4.6 | Summary of comparison of the importance and the performance of problem-solving skills: graduate engineers and engineering managers 122 |
Table 4.7  Raw summary comparison of data used for a Chi-square test of the overall adequacy of problem-solving skills perceived by graduate engineers and engineering managers ........................................ 124

Table 4.8  Summary of comparison of the importance and the adequacy of management skills: graduate engineers and engineering managers .... 125

Table 4.9  Major ranked difference between graduate engineers and engineering managers on their ratings of statements as of ‘High Importance’ .... 130

Table 4.10 Summary of comparison of the importance and the performance of management skills: graduate engineers and engineering managers .... 133

Table 4.11 Raw summary comparison of data used for a Chi-square test of the overall adequacy of management skills perceived by the graduate engineers and the engineering managers ........................................ 136

Table 4.13 Summary of comparison of the importance and the performance of the other ‘generic-type’ skills: graduate engineers and engineering managers ............................................................................ 141

Table 4.14 Raw summary comparison of data used for a Chi-square test of the overall adequacy of other ‘generic-type’ skills perceived by graduate engineers and engineering managers ........................................ 143