Identifying core competencies for students of a Vocational Education and Training (VET) Programme in Electrical and Mechanical Engineering in Hong Kong

by

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STATEMENT OF ORIGINALITY

I, KWAN Wai Wing, hereby declare that I am the sole author of the thesis and the material presented in this thesis in my original work except those indicated in the acknowledgement. I further declare that I have followed the Institute's policies and regulations on Academic Honesty, Copy Right and Plagiarism in writing the thesis and no material in this thesis has been published or submitted for a degree in this or other universities.

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August 2016

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ABSTRACT

The rapid development of technology and globalization are the two driving forces of 21st century society; this development has greatly impacted upon the educational system because the significance of vocational education and training (VET) has a pendulum effect on the academic system. It swings from the end of the academic system towards the VET; the key attribute of VET education is to equip students with the capability for their future career development. In order to prepare electrical and mechanical (E&M) engineering graduates with the competencies they require to work in the 21st century, a holistic and deep understanding of the development of core competencies for students working in the E&M industry is crucial because it enables the maintenance of the quality of the VET system to make it more appropriate and effective.

The objective of this study was to identify the core competencies for students who will work in the E&M industry in Hong Kong and also to determine the adequacy of the programme in delivering core competencies from the students' perspective. A mixed methods research design that included a quantitative approach and a qualitative approach was applied. In this study, the quantitative design was the dominant method used. A self-report

questionnaire of 35 Likert-type items was distributed to collect data from 353 students in a final year cohort of higher diploma (HD) students studying Electrical Engineering at three different campuses. The questionnaire included two sub-scales that assessed the importance of as well as the adequacy in delivering core competencies. A qualitative approach was used as a supplement to the quantitative results and included three focus group interviews of seven to nine students from the campuses of Chai Wan, Haking Wong and Tsing Yi. A Rasch rating scale model revealed that both subscales fit the model well; the reliability of the scales was good and no differential item functioning was detected by students from three different campuses.

The results highlighted the importance of core competencies for students who will work in the E&M industry in the 21st century and the adequacy of the HD programme at delivering these core competencies. The findings suggested that almost all core competencies listed in the questionnaire were important and indicated that the HD programme had properly delivered most of the core competencies being explored in this study. Discussions based on these findings were conducted to determine the relationship between core competencies and adequacy in delivering the HD programme to develop short-term implications for how the programme administrator should address the core competencies and strategically deliver them to students. In the end, long-term suggestions regarding how to apply this study to improve the quality of the VET system were made.

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LIST OF ABBREVIATIONS

21CCCUE	21st Century Core Competencies for University Education
AHELO	The Assessment of Higher Education Learning Outcomes
APASO	The Affective and Social Outcomes
APEC	The Asia-Pacific Economic Cooperation
ATC21S	The Assessment and Teaching of 21st Century Skills
CC	Character Development and Citizenship
CO	Communication
CP	Creativity and Problem Solving
DeSeCo	The Definition and Selection of Competencies
DIF	Differential Item Functioning
E&M	Electrical and Mechanical
EE	Electrical Engineering
EU	The European Union
GPA	Grade Point Average
HKCAAVQ	Hong Kong Council for Accreditation for Academic and Vocational Qualification
HD	Higher Diploma
HKDSE	Hong Kong Diploma of Secondary Education
HKIE	Hong Kong Institution of Engineers
HKIEd	Hong Kong Institute of Education
HKIVE	Hong Kong Institute of Vocational Education
HKSAR	Hong Kong Special Administrative Region
ICAC	Independent Commission Against Corruption
ICSS	International Civic and Citizenship Education Study
ILO	International Labour Organization
IRT	Item Response Theory
IT	Information Technology Literacy
ITACs	Industry Training Advisory Committees
KSAVE	Knowledge, Skills, Attitudes, Values and Ethics
MCEETYA	The Melbourne Declaration and Education Goals for Young Australians
MDGs	Millennium Development Goals
MNSQ	The Mean Square Error
OECD	The Organization for Economic Cooperation and Development
PISA	Programme for International Student Assessment
PVE	Professional and Vocational Education

QF	Qualification Framework
RPL	Recognition of Prior Learning
RQ	Research Question
RSM	Rating Scale Model
SCS	Specification of Competency Standards
SD	Standard Deviation
SDGs	Sustainable Development Goals
SE	Standard Error
UNESCO	The United Nations Education Scientific, and Cultural Organization
VET	Vocational Education and Training
VTC	Vocational Training Council
WA	Working Attitude and Vocational Development
ZSTD	Standardized as a Z-score

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Chapter 1

RESEARCH BACKGROUND

Over the last 30 years, mathematics, science and languages have been the focus of academic modules in engineering programmes as the basic requirements for securing a good job with decent remuneration and associated benefits. In contrast, vocational courses have long been a burr under the saddle of stakeholders in society. According to Bok (2006), part of the explanation for this thinking is the tendency of vocational education programs to offer training that lacks intellectual depth; instead, the focus is mainly on capability and skills.

Globalization, one of the driving factors in today's changing world, is a current trend in the 21st century. Many old ways of thinking and working principles cannot solve modern problems. Changes in technology along with the impact of globalization have generated a great impact to the education system and the society; we recognize that change is required to adapt to this new environment. At the same time, the number of college and university graduates has increased significantly. With this inflation in diplomas and graduate certificates, secure jobs are no longer guaranteed. Graduates are deeply preoccupied with succeeding in their careers, especially in a world with increasing competition that is in constant flux. From

this perspective, it is not logical to ignore vocational education and training (VET) as a crucial element in career development for graduates.

1.1 Introduction

Abundant evidence (ADB, 2009; Martinez-Fernandex, 2014; McGrath, 2014; Kuchinke, 2013; Valiente, 2014) indicates that education is needed for economic expansion; a lack of adequately trained and educated workers presents a major bottleneck in growth and development. An expansion of university education has been seen in most countries over the past few decades. However, the size of the job market has not grown proportionally with the development of university education, which has produced a gap. Students choose a programme in preparation for a specific career, and they set an even higher priority for finding a good job in their fields once they graduate.

The demand for skills is increasing, and a significant growth in the participation rates for Vocational Education and Training (VET) programmes has also accompanied this rising demand. A shift is taking place from basic education to technical and vocational education and training. It is therefore a critical time for the development of a new strategy in the educational system to adapt to these new challenges and prepare for a better future. A number of core issues need to be addressed; for example, which kind of competencies should be

cultivated? What are the key competencies for working in the 21st century? How can students be equipped with the most suitable talents to face the combination of technological, structural and organizational changes of modern society?

There has been a shift to core competencies by many countries and organizations in the 21st century (Bok, 2006; Delors et al., 1996; European Association for the Education of Adults, 2011; Lyz, 2012; Miles & Wilson, 2004; Rychen & Salganik, 2002; Stein, 2000). In today's rapidly changing world, students should be well prepared with the most substantial competencies to meet new challenges and opportunities. The United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Organisation for Economic Co-operation and Development (OECD) have worked both directly and indirectly to develop competence frameworks for university education according to their respective considerations for economic, educational, political and cultural issues (OECD, 2010; Delorset al., 1996). Various competencies have been defined and selected according to different priorities and contents; one competency may be more important than others in a specific trade or in some regions or countries. Based on the importance of core competencies, both regional and trans-regional theoretical frameworks could be developed for future citizens (Rychen & Salganik, 2003).

A number of studies have presented theoretical frameworks and models for core competencies according to different purposes and different domains (Lin, Yu, & Lin, 2014;

OECD, 2010; Rychen & Salganik, 2003; Stein, 2000; Wiek, Withcombe, & Redman, 2011), and they are all good references for the development of education systems in different countries. Since there are significant and remarkable cultural differences between the East and the West (Heine, 2010; King & McInerney, 2014; Tabellini, 2008), the existing literature provides a good point of reference but cannot directly be applied to an Eastern city's culture in Hong Kong. The significant importance of VET in contrast with the traditional academic structure as addressed by many countries (as well as Hong Kong) is that it generates a gap to initialize local research, focuses specifically on the local educational system and is crucial to inspect the core competencies of engineering students to gain a holistic and precise perspective.

The current study focuses on the core competencies of students specifically in the Electrical and Mechanical (E&M) Industry in the 21st century. The main research aim was to identify the perceptions of core competencies of students who will work in the E&M industry in the 21st century from the students' perspectives. A mixed methods research design with both quantitative and qualitative approaches was applied. The study investigated E&M students using a survey to detect the overall perspective of students regarding the importance of the core competencies and how adequate the programme was at delivering them. The qualitative component focused on the same questions and supplemented them with complementary explanations to the findings from the quantitative section. The overall results

generated a holistic and in-depth profile of the topic being investigated.

The quantitative part of this study composed of a questionnaire survey with 35 Likert-type items. Rasch measurements were used in the data analysis in addition to using the raw scores. The Rasch model converted the original raw scores, which were in form of ordinal-level Likert-type responses, to interval-level measures, and this process enabled comparison of measures across items to be done validly. Rasch converted the ordinal scales into an interval scale with logit units (Bond & Fox, 2015; Fisher, 1999; Rasch, 1960). Due to their characteristics as measures on an interval scale, Rasch measurements have been widely applied in education, psychology and health sciences.

1.2 Background of the study

This section provides a general background of the VET system in Hong Kong and the specific higher diploma (HD) programme in electrical engineering (EE). In the 1980s, students found it difficult to gain admission to a university as there were only two universities in Hong Kong at the time: the University of Hong Kong (HKU) and the Chinese University of Hong Kong (CU). Students who were not admitted either went to work in the community or entered vocational courses to prepare for future careers.

The Vocational Training Council (VTC) was established in 1982; one of its main aims is to provide VET for students in Hong Kong. Under the VTC umbrella, the Hong Kong

Institute of Vocational Education (HKIVE) was set up to offer technician programmes for secondary school graduates to fill the gap of students not qualified to enter the universities. Since students working towards an HD in EE had a main role in this study, they were not only survey participants but also were the key stakeholders of the current research; its focus will now shift to the HD in the EE programme.

Under the HKIVE, there are nine disciplines; engineering was one of the nine disciplines developed to provide a variety of technician and craft courses to train skilled technicians and craftsmen for the engineering labour market in Hong Kong. This HD programme is one of the vocational programmes set up to train electrical technicians for the E&M industry in Hong Kong.

Under the new educational reform, the first cohort of the Hong Kong Diploma of Secondary Education (HKDSE) was accepted in 2012, while the new HD programme had its first intake in the 2012/2013 academic year. Under the new HD programme, the duration of study was changed from three years to two years. To adapt to a more condensed programme, a summer semester was added to produce a two-year, five-semester programme.

Since VTC is highly attentive to the quality assurance system, the new HD programme periodically goes through internal validation as well as external validation. The external validating organizations are the Hong Kong Council for Accreditation for Academic and Vocational Qualifications (HKCAAVQ) and the Hong Kong Institute of Engineers (HKIE).

The HD programmes were also matched to the Hong Kong Qualification Framework (QF) at Level Four, while all the curricula were revamped to suit the short time frames of the programmes as well as their QF levels.

Graduates of the HD programme in EE will be prepared for positions as technicians, technician trainees, supervisors, and assistance engineers in different roles within the E&M industry. They will be assistant engineers who carry out design work at E&M consultant firms, technicians who perform installations, maintenance, testing and commissioned workers within small- to medium-sized electrical companies or assistant project engineers who assist in managing projects at contracting firms.

The objective of the current study was to identify the core competencies of the E&M industry from the perspective of students from the HD in EE programme, and to take stock of the adequacy of programme delivery in order to ensure the quality of the end product so that our students can be equipped with the necessary knowledge and skills for their future career development within the E&M industry.

1.3 Purpose of the study

The Government of the Hong Kong Special Administrative Region (HKSAR) has recently been highly attentive to the area of VET. In the 2014 policy, Hong Kong's Chief Executive highlighted the importance of VET, and in June of that year, a task force was set up to

promote VET and change the mind-set of parents to consider options other than universities for their children. In July 2015, the task force submitted recommendations for several marketing strategies to strengthen VET's image within the community.

With this new level of VET awareness in the community, the number of students pursuing VET should increase; however, the number of graduates with an HKDSE is projected to drop significantly until the 2022–2023 academic year (Table 1.1).

Table 1.1 Number of Projected HKDSE graduates

Academic Year	Number of Projected HKDSE graduates in HK
2015-2016	61,773
2016-2017	60,762
2017-2018	58,893
2018-2019	59,928
2019-2020	55,692
2020-2021	53,330
2021-2022	44,368
2022-2023	43,634
2023-2024	44,800
2024-2025	46,676

Note: Adapted from the 2015/16 Report of Student Enrolment Statistics from the Education Bureau of the HKSAR.

This shift will generate a new challenge for VET providers since the first priority of students will be to further their study at a university, while the number of degrees offered to students will only gradually increase. In other words, the size of the cake is becoming smaller, but the number of customers who want the cake is increasing. Under these circumstances, the

best solution is to promote VET to raise the public's awareness of its importance. At the same time, the most effective way to strengthen HD programmes is to increase their quality.

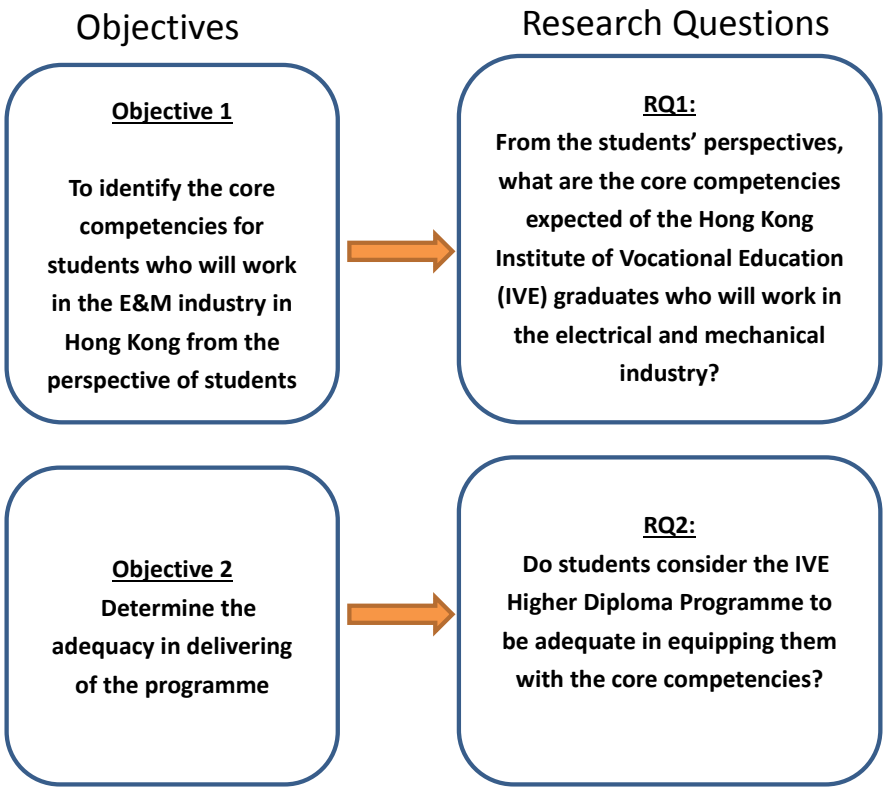


Figure 1.1 Relationship between the objectives and research questions

The overarching aim of the current study is to increase the quality of the VET programmes. In order to achieve this aim, this study has two objectives: (1) to identify the core competencies for students who will work in the E&M industry in Hong Kong from the perspective of students; and (2) to measure the adequacy in the delivery of the HD programme. Corresponding to these two objectives, two research questions were formulated, namely RQ1: "From the students' perspectives, what are the core competencies expected of

the Hong Kong Institute of Vocational Education (IVE) graduates who will work in the E&M industry?" and RQ2: "Do students consider the IVE Higher Diploma Programme adequate to equip them with the core competencies?" Figure 1.1 shows the relationship between the objectives of this study and the research questions. The current study will identify the core competencies of the E&M industry from the perspective of students who will work in the industry, and it will also measure the adequacy of the delivery of the HD programme. These crucial findings could assist the programme administrator with further improving the curriculum design and quality.

1.4 Significance of the study

In the past, the mode of delivery of modules within a programme typically included lectures, tutorials and laboratory sessions; continuous assessments were set, and end-of-module assessments given at the end of each semester helped equip students with strong technical knowledge and professional skills. However, opportunities to deliver core competencies outside a module are rare, although they are crucial for students' future career development. Today's employers need their employees to possess not only professional knowledge but also core competencies for the workplace.

This new paradigm shift calls for a new curriculum design; therefore, the current study is important as it aims to identify the core competencies that will adequately prepare students for the E&M industry in 21st century Hong Kong and assess the students' performance. A

newly developed instrument for improving the curriculum design will give VET institutes a valid tool for targeting the desired intended learning outcomes and use them to measure the effectiveness of the HD programme.

Students are one of the key stakeholders within educational systems, so investigating core competencies from the students' perspectives is intended to enhance the efficiency of the learning process. Increasing students' awareness of the core competencies will more easily align these competencies with the learning process and, therefore, improve learning. The current core competencies are adequate but have not been accepted by the students; therefore, the programme administrator should either determine the reason behind this rejection or simply remove them from the programme.

Since the programme administrator maintains the quality of the programme and ensures that the core competencies are properly delivered, students have been taught according to the programme intended learning outcome (PILO). The current study was developed using solid evidence whether the core competencies could be adequately delivered. In the event of delivery noncompliance, a strategic plan should be devised to increase the programme's quality level. The outcomes of the current study will be a crucial tool for the programme administrator to continually improve the quality of the programme.

1.5 Organization of the thesis

Figure 1.2 indicates the overall flow of this study interpreted by a flowchart of the research framework. This thesis is comprised of five chapters; the first chapter is the introduction and also contains some background information about the study. Chapter 2 reviews the literature on competence and indicators of core competencies in the 21st century. Chapter 3 reports the two pilot runs of the research design before the main study was conducted. The research method of the study, which adopted a mixed research design with both quantitative and qualitative approaches. Chapter 4 contains the research findings and results according to the research questions. Chapter 5, the concluding chapter, discusses the implication of the results together with the limitations of the study and possibilities for future research.

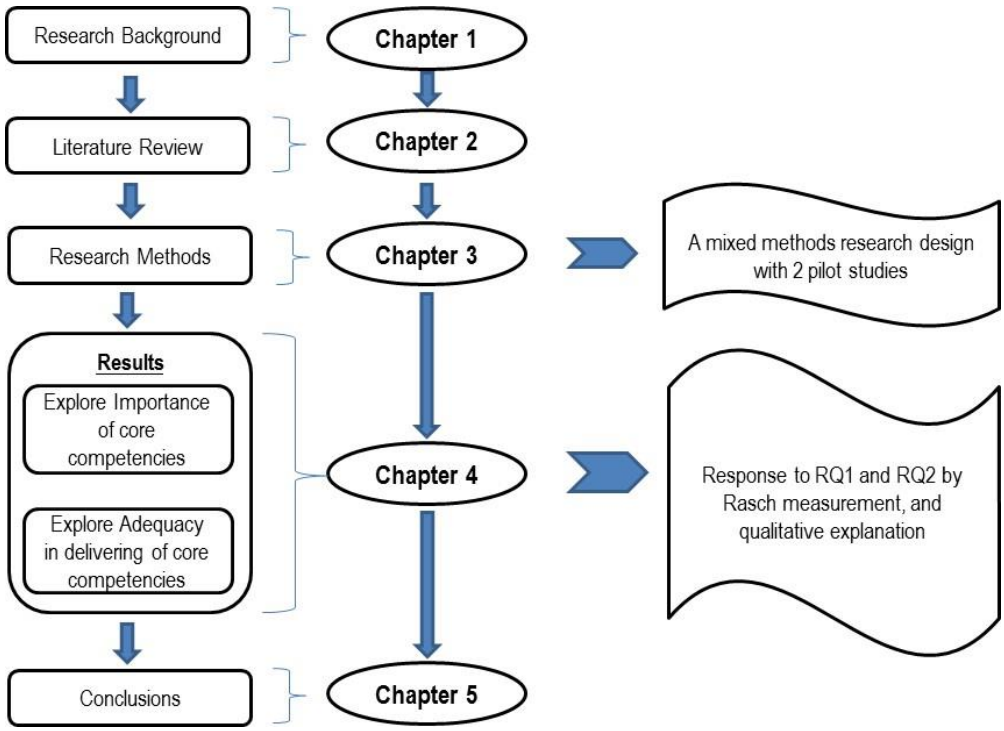


Figure 1.2 Flowchart of the research framework

Chapter 2

LITERATURE REVIEW

This chapter reviews the literature related to the current study. It contains 11 sections. The first section explains the concepts related to competence and core competencies. Section 2 describes competence, and Section 3 focuses on core competencies. Section 4 reviews the indicator of core competencies for the 21st century. The core competencies for engineering students working in the E&M industry are reviewed in Section 5. Section 6 addresses whether engineering students are equipped with those core competencies, while Section 7 examines the adequacy in delivering these core competencies to students. Section 8 reviews the Education 2030, and the limitations of the current literature are explored in Section 9. Section 10 contains the conceptual framework and research questions. The last section is the chapter summary.

2.1 Developing concepts on competence and core competence

The term “competence” has been widely used since the middle of the last century (Mulder, 2007). There are different interpretations from different scholars regarding its professional use in different domains (Tillema, Kessels, & Meijers, 2000; Verle et al., 2014). Similar terms, such as “ability”, “aptitude”, “capability”, “capacity”, and “skill” all reflect the complexity and versatility of the concept. The trend is extensively used for terms in the area of educational and development processes and outcomes in university education, replacing the traditional use of the words “ability” and “skill” (Boni & Lozano, 2007; Teixeira et al., 2016; Weinert et al., 2011). In addition, core competencies emphasise a certain extent of competencies that are commonly applied for different educational applications. With the increasing use of competencies and core competencies in the development of human resources and the productivity of a country, the concept has been popularly implemented in many industries.

2.2 Competence

Ever since a competence movement known as "competence-based education" was introduced in the United States (US) in the 1990s, "competence" has been described as a specific and concrete skill (Harris, Guthrie, Hobart, & Lundberg, 1995). The term "competence" denotes a person's characteristics in fulfilling a specific job or a person's ability to demonstrate performance according to given working standards (Mansfield & Mitchell, 1996; McLagan, 1989; Verle et al., 2014). As influenced by behaviour theories, competencies were analysed by definite knowledge and skills, with which people developed the enhanced competence profiles for teacher education and vocational education (Fletcher, 1991; McLagan, 1989; Sakhieva 2016).

In 1997, the OECD launched the Definition and Selection of Competencies (DeSeCo) project, which was chaired by the Swiss Federal Statistical Office and included more than 12 countries. DeSeCo aimed to provide "solid theoretical and conceptual foundations" for a wide variety of competencies to meet the challenges of the 21st century. DeSeCo stated that competencies indicate "the ability to successfully meet complex demands in a particular context through the mobilization of psychosocial prerequisites (including both cognitive and non-cognitive aspects)" (Rychen & Salganik, 2003). This definition was well accepted in European organizations as well as by Asia's educational researchers. Kim et al. (2007) stated four essential characteristics of competence based on the DeSeCo definition, including

wholeness (holistically involving cognitive, affective and behavioural aspects), mobilization (emphasizing the interconnected operation of those cognitive and noncognitive aspects), context-dependency (including a specific context necessary to demonstrate the competence), and learnability (competence which is learnable).

The definition of the term “competence” is elusive; however, it is gaining popularity and importance worldwide as indicated in documents of international organizations. It includes the International Labour Organization (ILO), the OECD, the European Union (EU) and the Asia-Pacific Economic Cooperation (APEC) (Winterton, 2009). In this study, the definition of competence will be applied in the context of education in the field of engineering based on the aforementioned literature.

2.3 Core competence

Core competence usually implies a competence that is very important or crucial. In a business environment, three criteria are set for the core competencies of a company: (1) be capable of building market share; (2) offer great value to customers by the end products; and (3) be hard for others (Yang, 2015). The core competencies from a business point of view provide insight to the area of VET.

In the field of education, people's interest in the term "competence" primarily facilitates vocational-technical education and the credit transfer system in university education (Mulder, 2007; Teixeira et al., 2016). Hence, key or core competencies are used as cluster indicators for various educational purposes. Koltz (2015) and Hanning (2012) state that each core competency is a combination of interrelated cognitive skills, attitudes, motivation and emotion, and other social components as defined in DeSeCo. Weinert (2001) associates the term key/core competencies with "multifunctional and transdisciplinary competencies that are useful for achieving many important goals, mastering different tasks, and acting in unfamiliar situations" (p. 52). Brockmann (2008) define that Competence is understood as the ability to deal with complex work situations, drawing on multiple resources that the employee brings to the workplace. Thus, competence is a holistic notion, relating to the whole person and including different dimensions (for instance, occupational, personal and inter-personal).

Discussions does not always focus on the context of core competencies to incorporate education and human development into its educational bodies and identify the criteria of core competencies. For example, Prahalad and Hamel (1990) propose three criteria that engineering students should possess: (1) survivability and sustainability; (2) contributions to human society; and (3) their own characteristics and unique values. It is observed that core competencies in a business environment are easier to construct and evaluate via the figures of turnover and market share, while it is complicated to assess the education field due to multiple educational objectives and considerations.

For the current study, core competencies for the 21st century will be considered to achieve multiple goals, master different tasks and meet complex demands for present learning activities and future sustainability. The review of the above literature is the main direction and explanation for the definition of core competencies.

2.4 Indicators of Core Competencies for the 21st Century

To nurture students with core competencies for the challenging environment in the 21st century, new frameworks for the educational systems have been developed by many countries and different organizations, including UNESCO, OECD, … etc. Examples of major projects are the DeSeCo Symposium hosted by the OECD, the 21st Century Learning Outcomes Project and the Assessment and Teaching of 21st Century Skills Project. The Melbourne Declaration was held in Australia, while the German Educational Panel Study took place in Germany. Other explorations on core competencies include Bok (2006) and his famous book, *A Candid Look at How Much Students Learn and Why They Should Be Learning More*, the APEC Education Reform Symposium (2008) and the Assessment of University Education Learning Outcomes (AHELO) by the OECD (2010).

2.4.1 The Delors Report by UNESCO

The Delors Report (Delors et al., 1996) was published by the UNESCO in 1996. The report expected universities to establish and act as centres for life-long learning for adults and students and also offer high-level vocational qualifications to facilitate the best teaching via international cooperation and exchanges.

The concept of learning is not to stop after graduation but to continue throughout life;

learning is “the heartbeat of society” (Delors et al., 1996, p. 22). This idea is in line with the driving force from HKIE to engineers that we should acquire knowledge and skills, seize learning opportunities and adapt to changing and complex situations throughout life. The core messages from the report are the four pillars of education, while the competencies listed in the report according to these pillars are summarized in Table 2.1.

Table 2.1 Competencies suggested by the Delors Report

Four Pillars	**Competencies**
Learning to live together	Collaboration Citizenship and mutual respect Communication skills Respect for diversity
Learning to know	Problem-solving skills Critical thinking Self-management skills Intellectual curiosity
Learning to do	Communication skills Managing and resolving conflicts Working with others Leadership skills
Learning to be	Character development Personal responsibility Aesthetic sense and spiritual values Imagination

Note: Adapted from *Learning: The Treasure Within–Report to UNESCO of the International Commission on Education for the 21st Century* (pp. 22-24), by Delors et al., 1996, Paris, France: United Nations Educational Science, and Cultural Organization.

2.4.2 DeSeCo and Three Core Qualities Required for a Healthy Society and Successful Life

The mission as described in the DeSeCo is "to contribute to broadening indicators by including competencies that are not directly related to economic productivity and competitiveness" (Rychen & Salganik, 2002, p. 3). It is intended to emphasise the participation in civic society and self-management, which may not be acquired through formal schooling. Rychen and Salganik (2002) state the three core qualities for a healthy society and successful life are to act autonomously, use tools interactively and join and function well in socially heterogeneous groups. Acting autonomously demands competencies in identifying one's resources, evaluating one's needs and limits, developing strategies, and analysing situations and relationships to enable a person to live a successful and initiative life. Using tools interactively requires competencies in gathering and analysing information, literacy and numeracy. Joining and functioning in socially heterogeneous groups takes up competencies in managing and resolving conflict, acting in synergy and cooperating to work as a team.

2.4.3 The 21st Century Learning Outcomes Project and "21st century skills"

The 21st Century Learning Project, hosted by the League for Innovation in the Community Colleges in America, developed a set of 21st century skills based on the research of 16 pioneering community and technical colleges (Miles & Wilson, 2004). The "21st century skills" are composed of soft and hard skills. Soft skills include teamwork, communication, problem solving and the ability to interact with diverse groups. Hard skills include literacy, numeracy and technical ability. Details of these competencies are listed in Table 2.2.

Table 2.2: Competencies suggested by the 21st century learning outcomes project

Competencies	**Components**
Communication skills	Reading, writing, speaking and listening
Community skills	Citizenship, appreciation of diversity and pluralism, local, community, global, and environmental awareness
Computation skills	Understanding and applying mathematical concepts and reasoning, analysing and using numerical data
Critical thinking and problem solving skills	Analysis, synthesis, evaluation, decision making, creative thinking
Information management skills	Collecting, analysing and organizing information from a variety of sources
Interpersonal skills	Conflict resolution, teamwork, relationship management, workplace skills
Personal skills	The ability to understand and manage oneself, management of change, learning to learn, personal responsibility, aesthetic responsiveness, wellness
Technology skills	Computer literacy, internet skills, retrieving and managing information via technology

Note: Adapted from "Learning outcomes for the 21st century: Cultivating student success for college and the knowledge economy", by Miles and Wilson, 2004, *New Directions for Community Colleges*, 126, pp. 89 – 90.

2.4.4 The Assessment and Teaching of 21st Century Skills Project (ATC21S) and the KSAVE model

The Assessment and Teaching of 21st century skills project (ATC21S) involved six countries (Australia, Finland, Portugal, Singapore, England and the US) and three founding corporations (Cisco, Intel and Microsoft) and was launched in 2009. The objective of the project was to offer insight into assessment and teaching in the future. Binkley and his colleagues (2012) analysed 12 relevant frameworks originated by countries and organizations and then grouped ten skills each into four categories to form the KSAVE model. The four categories included knowledge, skills, attitudes, values and ethics (Binkley et al., 2012), and the details are listed in Table 2.3.

Table 2.3: The 21st Century Skills Framework of the KSAVE Model

Categories	**Competencies**
Ways of thinking	Creativity and innovation Critical thinking, problem solving, decision making Learning to learn, metacognition
Tools for working	Information literacy ICT literacy
Methods of working	Communication Collaboration
Living in the world	Citizenship Life and career Personal and social responsibility

Note: Adapted from Assessment and Teaching of 21st Century Skills (pp. 18-19), by Binkley et al., 2012, Dordrecht: Springer.

2.4.5 The Melbourne Declaration of Educational Goals for Young Australians (MCEETYA)

The objective of the Melbourne Declaration is to provide a high quality of life for all Australians in the 21st century by innovating education and improving educational outcomes. In this Declaration, the goal of "all young Australians become successful learners, confident and creative individuals, and active and informed" was set up (MCEETYA, 2008, p. 8). The details of the three targets are illustrated in Table 2.4.

Table 2.4: Competencies suggested by the MCEETYA

Educational goals	**Competencies**
Successful learners	Capacity to learn, skills in literacy, numeracy and information technology, ability to think deeply and logically, innovative, ability to be creative, resourceful, and solve problems, ability to plan, collaborate, communicate, and work in teams, ability to make sense of the world, and ability to self-develop and self-motivate.
Creative and confident individuals	Ability to manage one's mental, emotional, spiritual and physical wellbeing, have a sense of optimism, be enterprising, take initiative and be creative, develop personal values and character, ability to pursue education and employment, ability to relate well with others, be ready and responsible for one's life roles.
Informed and active citizens	Ethical and moral integrity, ability to practice democracy and justice, ability to understand and appreciate indigenous and non-indigenous cultures, ability to work for the common good, be responsible global and local citizens.

Note: Adapted from the Melbourne Declaration on Educational Goals for Young Australians, 2008, pp. 8-9.

2.4.6 The Lifespan Competencies Framework of the German National Educational Panel Study (NEPS)

The German National Educational Panel conceptualized competencies for major educational-stage-comprehensive assessments using multi-cohort large-scale approaches (Artelt, Weinert, & Carstensen, 2013; Weinert et al., 2011). Competencies are functional, educational and relevant; they are acquired and developed over different educational stages across the lifespan and relevant for future educational and professional careers, general life satisfaction and well-functioning societies (Artelt et al., 2013). Individual abilities and competencies are grouped into four areas as listed in Table 2.5. Areas II and III are relevant educational competencies, while Area I and IV are general competencies and educational stage-specific outcomes.

Table 2.5 The Lifespan Competencies Framework of the NEPS

Areas	**Abilities and Competencies**
I	Domain-general cognitive abilities and capacities, such as indicators of nonverbal reasoning and information-processing speed
II	Domain-specific cognitive competencies, including German language competencies, mathematical competence and scientific literacy
III	Meta-competencies and social competencies, including indicators of procedural and declarative metacognition and self-regulation, information and communication technologies (ICT) literacy, and social competencies
IV	Educational stage-specific (curriculum or job-related) attainments, skills and outcome measures

Note: Adapted from "Assessing competencies across the lifespan within the German National Educational Panel Study (NEPS) – Editorial", by Artelt, Weinert, & Carstensen, 2013, Journal for Educational Research Online, 2, pp. 5-14.

2.4.7 Other Explorations on Core Competencies for the 21st Century

The OECD (2010) produced a feasibility study for the Assessment of University Education Learning Outcome (AHELO). The objective was to access if students in higher education can learn practically and scientifically upon graduation. The learning outcomes include generic skills, such as critical thinking, analytical reasoning, problem solving and written communication. These attributes are considered common abilities for all students and are also specific skills for economics and engineering students. Three volumes of the AHELO study that involved implementation, data analysis and future insights about the project have been published (Tremblay, Laiancette & Roseveare, 2012, 2013a, 2013b).

The second APEC Education Reform Symposium held in 2008 emphasised important knowledge, skills and attitudes as 21st century competencies in four priority areas: learning each other's languages, stimulating learning in mathematics and science, career and technical education (CTE), and information communication technology (ICT) and systemic reform (APEC Education Reform Symposium, 2008).

Derek Bok (2006) proposed eight educational goals for 21st century universities; he advocated cultivating graduates with competencies of communicating, thinking, building character, demonstrating citizenship, living with diversity, preparing for a global society, acquiring broader interests and preparing for a career. Bok (2006) suggested a reform for university curricula, teaching methods and research; he had a deep influence on the world by

advocating that university education should pay more attention to satisfy its stakeholders (Lyz, 2012; McClung & Werner, 2008).

2.5 Core Competencies for Engineering Students in 21st Century

Historically, vocational education and higher education emerged from opposing traditions, with universities producing systematic scientific knowledge and vocational education providing training for specific occupations (Maclean & Pavlova, 2013). The demand to enhance productivity and the employability of individuals through the development of work-related competencies has become more important than educational achievement (Pavlova 2013b). Policymakers and administrators who wish to strengthen their VET education systems must shift from curricula-based approaches to competency-based training (Martinez-Fernandex & Weyman, 2014). For engineering students working in the E&M industry, core competencies are important and beneficial to their future career development paths.

All the above literatures are useful as a reference to the current study, however, it won't be a one size fit all's situation. There is no specific literature in core competencies for students who are working in the E&M industry. As most of the researches and studies were carried out in the western countries, it cannot be directly applied to the situation in Hong

Kong, there exists a gap to find out the core competencies of students who are studying in Hong Kong and going to work in E&M industry.

According to the literature review based on the indicators of core competencies (Delors et al., 1996; OECD, 2010; Rychen & Salganik, 2003; Stein, 2000; Wiek et al., 2011), Cheng, Yeh, Liu, and Mok (2011), and Mok et al. (2011) proposed six domains of core competencies as the most important for the 21st century. These indicators are the foundation of the current study because the domain of core competencies are indicators for engineering students who are working in the E&M industry; the research gap needs to be bridged with competencies specific to VET students, the domain of core competencies has been revised to eight. The domains of working attitude and vocational development (WA) and information technology literacy (IT) were added, and the core competencies were trimmed down to five after the pilot study. Details are listed in Chapter 3.

2.5.1. Core Competencies for 21st Century University Education

The six proposed domains of core competencies that are arguably the most important for the 21st century (Cheng et al., 2011; Mok et al., 2011) are basic and professional knowledge, creativity and problem solving, interpersonal communication, character and civic literacy, global and international perspective and self-directed learning. Table 2.6 shows the indicators and related literature in which they are widely proposed.

Table 2.6 Six Domains of Core Competencies and Their References in the Literature

Indicators	UNESCO The Four Pillars of Education (Delors et al., 1996)×	OECD DeSeCo Key competencies for a successful life (Rychen&Salanlik,2003)	Derek Bok (2006) The purpose for undergraduate education	OECD The key competencies for lifelong learning (European Communities, 2007)	OECD The Assessment af Higher Education Learning Outcomes (OECD,2010)	MCEETVA (2008) The Melblourne Delaration on Educational Goals for Young Autralians	ATC21S KSAVE Model (Binkley et al.,2012)
1. Professtional and Basic Knowledge	✓	✓	✓	✓	✓	✓	✓
2.Creativity & problem Solving	✓	✓	✓	✓	✓	✓	✓
3.Interpersonal Communication	✓	✓	✓	✓	✓	✓	✓
4. Character &International Perspective	✓	✓	✓	✓	x	✓	✓
5.Global &International Perspective	✓	✓	✓	✓	x	✓	x
6.Self-directed learning	✓	✓	✓	✓	✓	✓	✓

Note: Adapted from “The development of indicators for the basic competencies of university students,” by Cheng, Y. Y., Yeh, L. J., Liu, K. S., & Mok, M. M. C. (2011), Psychological Testing, 58(3), p. 558.

2.5.2 Core Competencies for the 21st Century in VET

Globalization is the process of integrating the work of businesses and people from different countries to operate seamlessly throughout the world. As a result, jobs are now assigned to the smartest, cheapest and most productive workers regardless of their location in the world (Hafner, 2008). Widing (2006) states that business will go to where the "talent is", producing a relatively higher unemployment rate in developed countries. In the current era of globalization, the growing negative reaction to immigrants in the form of nativism is known as xenophobia, which is understood as the fear of foreigners and as ananti-immigrant animus (Galindo, 2011) in which people protect their own culture as well as their jobs. McGrath (2012) has observed a significant return of interest in VET amongst the international policy community in the current decade.

This change was due to the factors of technological change, reorganization of work, economic openness and competition, and capital deepening (ADB 2009). The skills that used to be offered by the skilled worker have been automated and off-loaded to machines; machines became complex, intelligent and sophisticated, while the skills to manage them became broader in scope and more refined in their application (Ajiampur & Prasad, 2015). Competencies became one of the key areas for development in VET.

In Hong Kong, there are many programmes available at the sub-degree level; however, professional and vocational education (PVE) is considered a less preferred route (Tam, 2013)

than a full degree. The reason behind this perception includes the more traditional mind-sets of parents and also the quality of the programme. The goal to change the mind-set of parents is not a short-term goal but instead is a long-term one that will require marketing and education. It may be easier simply to improve the quality of VET programmes. Tam (2014) mentioned that learning outcomes as measures of learning effectiveness and instructional quality can make an important contribution. In the current study, the first goal was the identification of core competencies for 21st century students working in the E&M industry. The second goal was to measure the adequacy of the programmes in delivering core competencies. With the proper tools in hand, the quality of the programme will be maintained and could also improve significantly. In the next sub-sections, the VET provider in Hong Kong (the Vocational Training Council) is reviewed and followed by relevant parties related to the quality of the HD programme. The five domains of core competencies are also discussed.

2.5.2.1 Vocational Training Council

In 1982, the Vocational Training Council (VTC) was established as a statutory body under the VTC Ordinance, Chapter 1130 of Hong Kong Laws. The VTC is the largest VET body within Hong Kong, and it provides development policies and manpower planning supports to the government.

The aim of the VTC is to improve the quality of all VET programmes via her member institute, the HKIVE, to operate efficiently and cost effectively on all campuses under the HKIVE. This organisation also objects to the formation of a strong team made up of highly capable academic and administrative staff who are also involved and adaptable to changes. Although VTC is the largest VET provider in Hong Kong, it has a well-structured and a well-developed system of governance; it is also committed to a high standard of corporate governance and continues to seek quality improvement and maintain a high quality level. Management has a clear line of responsibility and accountability to execute a strategic plan for bringing better quality to the VET education system.

The HD program in EE operates under the Engineering Discipline, which is one of the academic disciplines under the HKIVE, one branch that operates under the VTC. The New Senior Secondary (NSS) academic structure was launched in 2009/2010; with the recent development of the Hong Kong Qualifications Framework (QF), the HKIVE has revamped all HD programmes by checking and modifying the existing curriculum and transforming it

into a new HD programme for students from the first Hong Kong Diploma of Secondary Education (HKDSE) cohort in 2012. The new HD programme includes five semesters, and all programmes will undergo an internal programme validation under the VTC quality assurance system. The academic standards and quality of the programme were checked for their appropriateness for the HD award. At the same time, identifying the core competencies of students from the HD programme has become crucial in satisfying the quality standard of the VTC and should be clearly executed under the quality assurance policy in the delivery of the HD programme.

The objective of the programme is to equip students with the core competencies who will work in the electrical engineering industry. These core competencies include communication, which will be conducted through language discipline modules; information technology, which will be conducted by IT professionals and provides the opportunity to use the Internet to seek information; interpersonal skills, such as working in a positive manner; soft skills to prepare for employment; and character development to adapt to the community through active citizenship. The key issue is the desire for lifelong learning, as graduation from college or university is not the end of the learning journey. The HD programme in EE starts at a paraprofessional level, where the blending of professional knowledge and technical practice for application will allow students to seek a job within the industry. These jobs include the design work within a consulting firm, repair and maintenance work at an

electrical company and project administration work at a contracting firm.

The main objective of the HD in EE programme is to be operated under appropriate learning and teaching strategies, a well-designed curriculum structure, adequate assessment methods, comprehensive vocational training, and a variety of extra-curricular activities.

2.5.2.2 Hong Kong Institution of Engineers (HKIE)

The Hong Kong Institution of Engineers (HKIE) is a professional body responsible for maintaining and setting up the technical and professional standards for their members. The HKIE also aims at promoting the engineering profession and nurturing the young to sustain engineering excellence.

An engineering graduate from the HD programme accredited by the HKIE is an acceptable academic qualification for the Associate Membership of the HKIE. The process for HKIE in approving such programmes is called professional accreditation. The HKIE regards this accreditation of engineering HD and equivalent programmes as part of the working process with higher education institutions on a regular basis to support and advise, to provide help and to ensure that the quality of engineering HD and equivalent programmes is satisfactory and meets the needs of the Hong Kong society, employers and profession in general.

Graduates should be fulfilled with a set of attributes indicative of the graduate's

potential. It forms a set of outcomes that can be assessed, and the graduates' potential is all at an appropriate level. Graduates from an accredited programme should demonstrate the attributes as listed in Table 2.7.

Table 2.7 Summary of graduates' attributes of an accredited programme

Graduates' attributes	**Description of attributes**
Engineering knowledge	Depth and breadth of education, and both practical and theoretical knowledge
Complexity of analysis	Problem analysis
Design of solutions	Development of solutions, breadth and uniqueness of engineering problem
Investigation	Depth and breadth of investigation and experimentation
Modern tool usage	Level of appropriateness and understanding how to use the tool
Engineer and Society	Level of responsibility and knowledge
Sustainability and Environment	Type of solutions to maintain the environment
Ethics	Understanding and level of practice to follow
Team work and Individual	the role in the team and diversity
Communication	Level of communication with respect to the type of activities performed
Project Finance and Management	Level of management required for handling different types of activity
Life long learning	Preparation oneself and always keep continuing learning

Note: Adapted from the website of HKIE, (http://www.hkie.org.hk)

2.5.2.3 Hong Kong Council for Accreditation for Academic and Vocational Qualification (HKCAAVQ)

The HKCAAVQ was established as the Accreditation Authority under the QF. It is empowered under the Accreditation of Academic and Vocational Qualifications Ordinance (Cap 592) to conduct accreditation activities for vocational and academic operators and their associated education and training programmes.

Accreditation is the action of taking references and standards that have been benchmarked both locally and internationally and applying them through a process of peer review. The HKCAAVQ generates an accreditation report as the outcome of the accreditation activity. According to the guidelines, procedures and processes of the HKCAAVQ accreditation services, they are enclosed by a four-stage quality assurance process that includes (1) the initial evaluation; (2) learning programme accreditation; (3) programme area accreditation and (4) a periodic review.

The HKCAAVQ provides service to VET operators in accreditation and quality assurance services. VET operators include private education and training institutions, commercial corporations, non-government organisations and public organisations. All the accreditation exercises for VET institutes are strictly follow the four-stage quality assurance process undertaken by the HKCAAVQ.

In addition to providing accreditation services, the HKCAAVQ also supports the development of the QF via its participation in Industry Training Advisory Committees (ITACs), the moderation of Specification of Competency Standards (SCS) and accreditation of Recognition of Prior Learning (RPL) Assessment Agencies (www.hkcaavq.edu.hk/).

2.5.3 Five Domains of Core Competencies for 21st Century Engineering Students

Based on the framework of core competencies for 21st century university graduates with the input of element for VET, the instruments undergo pilot testing and finalize the domains of WA, IT, CC, CP, and CO.

2.5.3.1 Working Attitude and Vocational Development (WA)

The workforce in the community is always upgrading their skills through service providers of VET education. Employers continually seek short courses or VET diplomas for their employees to improve their knowledge and skills within the industry. With the impact of the new technology changes, working procedures or working tools are more computerized; the skills to operate new machines or gain up-to-date information from the industry are crucial. Therefore, the continuity of education and open access to industrial information are the foundations for public education. Based on these principles, it has become an obligation for employers to offer their employees all kinds of training opportunities, including a specific trade of in-service training to the employees or some financial support for attending vocational training institutes (Akbas, 2011).

Many vocational training providers overlook intellectual depth and have only concentrated on specific training in the form of practical skills. Although intellectual depth has been delivered, it is too vague and is often lacking in specific trades (Bok, 2006).

Even if intellectual depth has been delivered, it is out of focus of the intellectual depth specific in their trade (Bok, 2006). Employers trend to weight students' attitudes in comparison with their academic achievements, especially in the area of VET. The expectation has shifted from employers to students regarding a competent performance along with a good and positive attitude. Other attitudes include developing self-awareness and constructive self-criticism, exercising good judgement, pursuing a chosen field of study, reflecting upon personal performance and modifying it accordingly while taking responsibility, and working with confidence while accepting accountability.

Pepper (2011) mentions that regardless of whether an employee can successfully learn as planned, the area for concentration should not just be key competencies, skills and knowledge but should also include attitudes. Good attitudes can support the learning of professional knowledge and the application of professional skills. To develop a bit further, the context of lifelong learning is all a matter of attitudes. All factors interact with each other to support the learning process of professional knowledge, while professional skills provide a neutral interpretation of attitudes. Attitude can be interpreted as having affective, cognitive and motivational facets. Although there is no direct link between attitude and professional

skills and knowledge, some relationship does exist between gaining in attainment to the extent to measure attitude. High attainment takes place in the context of either a positive or a negative attitude.

To be successful in today's workplace, university and college graduates should learn more than just the basic academic and technical skills. Pavlova (2014) states that Technical and Vocational Education and Training (TVET) should pay more attention to the element of "green" economics to encourage the application of green knowledge and skills. The workers should possess an attitude to think and work in a professional manner and always remember environmental protection. In conclusion, one's working attitude and vocational development is one of the core competencies for students working in the 21st century.

2.5.3.2 Information Technology Literacy (IT)

Ezziane (2007) mentions that concepts, skills and capabilities imply the three key components in IT literacy under different approaches. Students usually learn how to use word processing software when they must complete an assignment or prepare an essay. They also learn to use spread sheets or create a database when handling a set of data and analysing the data to obtain results. These results can be presented with colourful plots and attractive bar charts, which are generated by the computer software. Many students start to develop their IT skills when they are in primary or secondary school, while other successful students who own IT literacy have strong motivation to learn. Other than learning through the normal teaching curricula, students learn IT from other channels, such as participating in extra-curricular activities, reading instruction manuals on a CD or on the internet, learning from peers, or joining a workshop or short course after school. The fundamental concept of IT literacy is difficult to include in a normal curriculum. Ritzhaupt (2013) states that boys have better IT skills than girls, perhaps because boys tend to spend more time on home computers. This preference goes to the engineering students as more than 95% of HD in EE students are boys, it may be possible for VET instructors to design some teaching plans that allow students to practice IT skills. This approach should increase the efficiency of raising IT literacy by applying fundamental concepts relevant to the programme and the discipline to all materials.

The approaches and models of IT literacy and computers have begun to mix together over the past 25 years. The development of the internet and its associated technology has acted as a catalyst to speed up this merger. Technology drives the changes, and the evaluation of information becomes both a need and an application of technology. During the past few years, computers and technology have had a great impact on the community. The advancement of computer applications with the environment along with low-cost equipment, such as sensors, smart devices and integrated circuits, have deeply penetrated into the community. There is no choice but to positively accept the impact of IT and learn as much as possible for the 21st century (Ezziane, 2007).

2.5.3.3 Character Development and Citizenship (CC)

Character education began in the 1960s and has experienced further development throughout the years. The fundamental component is to teach our students a sense of morals and a sense of right or wrong. CC started in Western countries and continued to develop. Nowadays, students are taught to sense if something is right or wrong based on the community moral context. With the new digital and network era, a new type of character education emerged to adapt to the new changes of cyber issues in the 21st century. Students must possess new competencies and skills to face the smart communities in the new digital style (Ohler, 2012).

To begin a new programme to teach character education, the value of the community is a good place to start. It requires a lot of open discussion in terms of the ethics of new cyber and digital actions; all discussion should be open and honest. Ohler (2012) suggested that students should be one key stakeholder in character education; the advantages of getting students involved is the stimulation of students' participation and buy-in as well as their valuable guidance for the types of activities.

One common phenomenon today is the downtrend of political participation by young citizens. A decrease in voting rates has been observed, which should caution those who are involved in the education of our students in the preparation for citizenship. According to Bok (2006), the voting rate is below 40% in the range of 18–24-year-old citizens. The current young generation votes less than the previous young generation, while their general

knowledge of public affairs is also weaker than the previous young generation or even their grandparents'. Scholars have concluded that well-designed institutes, which deliver professional knowledge and skills, must also include the character development. Bok (2006) pointed out that the best place to offer civic education is in the schools. Although there exists the problem that civic involvement is always being treated as the least or next to the least important reason for attending schools and institutes, this change will require a paradigm shift, and engineering students must be trained with good moral standards. They should work ethically in their workplace, incorporate "green" elements in their projects or product designs and think in an environmental friendly way. They should also always be aware of occupational health and safety, be respectful of others and participate more in the community.

2.5.3.4 Creativity and Problem Solving (CP)

The word "creativity" can be defined and explained broadly; more than 40 definitions have been laid out since the start of the 20th century. Trnova (2014) is one researcher who has defined "Creativity", and he states that "Creativity is process of motivation and cognition through the mental brain, under the process, it takes the role as intuition, inspiration and imagination. After the process, the outcome will be a new, unexpected, unusual and correct solution addressed to a specific problem" (p. 11).

Creativity is an important element in education; it is involved in different aspects, such as design, problem solving and even the ways in handling a project. Trnova (2014) mentioned that most educational systems have included creativity as one of the core competencies for the 21st century. Therefore, graduates of both universities and colleges should develop not only their competency of professional knowledge and skills but also the element of being "creative". The development of a teaching plan and the curriculum design must consider the element of "creativity" to deliver the material to students adequately. The learning and teaching package should be shifted from teacher-orientated to student-orientated to provide an environment for students to develop their innovative skills, to think out of the box and to connect what they are learning to real-life situations. New multimedia facilities should be integrated to apply the current technology for group discussion with open-ended questions and guide students to an outcome. Toner and Dalitz (2014) proposed that innovative policy

and consultative mechanisms should connect more deeply with the VET system.

According to the traditional curriculum, students apply their professional knowledge and skills to integrate and solve most of the problems they encounter in everyday situations. This process requires students to memorize information according to their industrial needs for professional knowledge. Most curriculum designs are major projects to access students' problem solving skills and allow students to apply their equipped professional knowledge and skills to dig out an answer to achieve the project goal. In the new century, the workforce is facing a frequently changing environment; the solution becomes complicated because it is not as trivial as the solution from their predecessors. Students facing a problem with adaptability, and they need to respond to problem without any explicit tools or methods to solve. Bagby and Sulak (2009) stated that even lecturers may not have a teachable solution and assessment tools on hand; as a result, they need to facilitate students to use their ability to find a solution, which is based on their existing knowledge and skills while also searching for more new information or new methods to solve a problem.

2.5.3.5 Communication (CO)

Although "Communication" is one of the core competencies to survive in the work place, university and college graduates are usually not aware of this stage, and they do not pay attention during this stage in learning. Communication was learnt secretly and quietly during their daily activities in the classroom or laboratory, such as group discussions, laboratory work or project presentations. Outside the schools, another way to train communication is in the workplace. Good workplace communication enhances an employee's working efficiency and may even get a person promoted if he or she has good communication skills. Another way to instil good communication in engineering students is to encourage them to join the student membership of some professional bodies, such as the Institution of Engineering and Technology (IET) and the Hong Kong Institution of Engineers (HKIE). Professional bodies not only convey professional knowledge but also ethics, codes of conduct and even communication between members. Wood (2010) stated that there are mentorship programmes for experienced engineers to lead and develop young engineering student in competencies during their stage of learning in institutes. It is in the form of telephones, e-mail and face-to-face discussion not limited to major projects but covers all modules in the programme.

Bok (2006) stated that everyone is aware of the importance of communication and the need to communicate effectively, including students, teachers, law partners, business

executives, and other employers. For a programme, the design of the curriculum should aim to nurture communication skills to build up students' capability to communicate with others and express themselves with style and clarity. Another view of communication composes skill in listening, writing, and speaking. It is not realistic to expect university and college graduates to be armed with good communication skills after completing just one subject or a module of a short course or a programme; the crux of good writing skills is to practice more and even repeat an exercise. Speaking skills are similar to writing skills because practice is the best way to improve them. Speaking persuasively and articulately are also good assets for students. Many large companies have pointed out communication was one core competency for work, and they were unsatisfied with the communication standards as well as the language skills of their employees who graduated from vocational institutions and even from universities. It is common for students to stand up in front of people and present a plan or a project, and they often feel stress and anxiety because they do not have adequate communication skills. The only way to overcome this situation is to practice this activity instead of avoiding it. The same can also be done to improve listening skills; people usually have little patience for listening to others, such as when an elderly person is describing a scenario. It is important to make use of a clear decoding process to ensure the correct message is received and therefore to provide an appropriate response or make the right decision.

2.6 Identifying Core Competencies for Engineering Students Working in the 21st Century

Only a few studies have investigated core competencies in the 21st century workplace. Even those who have proposed such competencies seldom consider whether their students possess 21st century core competencies. Although a number of studies (Coetzee, 2014; Lin et al., 2014) have developed a valid scale to measure students' core competencies, there still exists a gap in identifying core competencies for engineering students preparing to work in the 21st century.

Cheng and his associates (2011) developed and validated the Indicators of Undergraduate Students' Key Competences (IUSKC) for Taiwan university students to gauge their view on which core competencies are most important and to what extent students own those core competencies. Mok and her colleagues refined the scale and renamed it to the 21st Century Core Competencies for University Education (21CCCUE) and validated it with new data from Mainland China and Macau (Mok et al., 2011).

In conclusion, research into the preparedness of core competencies for students in the 21st century is not yet conclusive. Takayama (2013) found that key competencies define learning and teaching as a process where not only knowledge and skills are acquired but, more importantly, where particular values, attitudes, motivations and dispositions that are deemed necessary for continuous, reflective and autonomous learning are nurtured. However,

Takayama's (2013) study was not specific for engineering students or students working in the E&M industry. In this study, students studying HD in an EE programme were able to identify from their own perspectives the core competencies for 21st century work in the E&M industry.

2.7 Proper Delivery of Core Competencies by the Programme Administrator

A critique common to both vocational education and training is the view that a vocational emphasis decreases students' critical thinking and senses of moral, civic and social responsibility (Bok, 2006; Grubb & Lazerson, 2005). Bok (2006) also noted a tendency to drive universities into vocational training camps, in which priority is given to occupational needs instead of preparing graduates "to live a full life as widely informed, reflective human beings" (p. 3). It is inevitable that the rapid increase in vocationalism in recent years has suggested that reform of this market intends to make educational institutions responsive to market force without distinguishing between education and any commercial product (Tilak, 2006).

In Hong Kong, the Education and Manpower Bureau has conducted surveys on employers' opinions of graduates' performance to track the value-added output of the training system (Education Bureau, 2010). Legrand (2014) stated that competency based training relevant to working needs is industry led and is the main mechanism for industry engagement

to provide intelligence and advice to government and enterprises on workforce development. According to the feedback from employers, the overall performance of graduates was quite satisfactory (Education Bureau, 2010). Regarding the importance of the nine main aspects perceived by the employers, they rated "work attitude" as the most important. For the performance of graduates, the best was "information technology literacy". However, there has been no survey for a specific industry, such as the E&M field.

University education can develop 21st century core competencies for their students to a significant extent if they have the will to do so. The difficulty in today's VET environment is the lack of evidence to prove that the quality of the programme's delivery of core competencies is adequate. Although there are no reliable methods to ensure this type of performance, the current study fills a gap by measuring the adequacy of the programme at delivering core competencies and may contribute to the field of VET.

2.8 Education 2030

A global sustainable development agenda, the Sustainable Development Goals (SDGs), consisting of 17 goals and 169 targets, was adopted at the United Nations summit in New York to succeed the eight Millennium Development Goals (MDGs), which expire in 2015. It is the fourth SDG, and it has 10 targets concerned with improving the quality of education

(Ward, 2015) that together represent an ambitious and universal agenda to develop better skills for better lives.

McGrath (2012) set a timeline up to 2030 for promoting a life-long learning process that provides employable skills, especially to young men and women, and increases basic numeracy and adult literacy. The concept is an array of work-related educational endeavours in vocational knowledge. It includes vocational education, career and technical education, adult education, professional development, and human resource development (Kuchinke, 2013).

In Education 2030 in the Incheon Declaration and Framework for Action (Education 2030, 2015), there are two targets (Target 4.3 and 4.4) related to the quality development of VET. Target 4.3 stated that by 2030, all women and men will have equal access to affordable and quality technical, vocational and tertiary education, including university. VET, which is provided at different levels of education, plays a vital role in imparting job skills, stimulating critical and creative thinking, and generating and disseminating knowledge for social, cultural, ecological and economic development. Target 4.4 stated that by 2030, the number of youths and adults who have relevant skills, including VET skills, will substantially increase for employment, decent work and entrepreneurship.

2.9 Limitations of the Literature Review

Although there have been many studies on core competencies for the 21st century, most research has only examined these within the context of Western cultures. In comparison, there is a dearth of research on educational systems within Eastern cultures. While literature on the core competencies of students within mainstream university academic structures is abundant, research on students studying under a VET system are rare. Four limitations, or gaps, were identified in the current literature on core competencies.

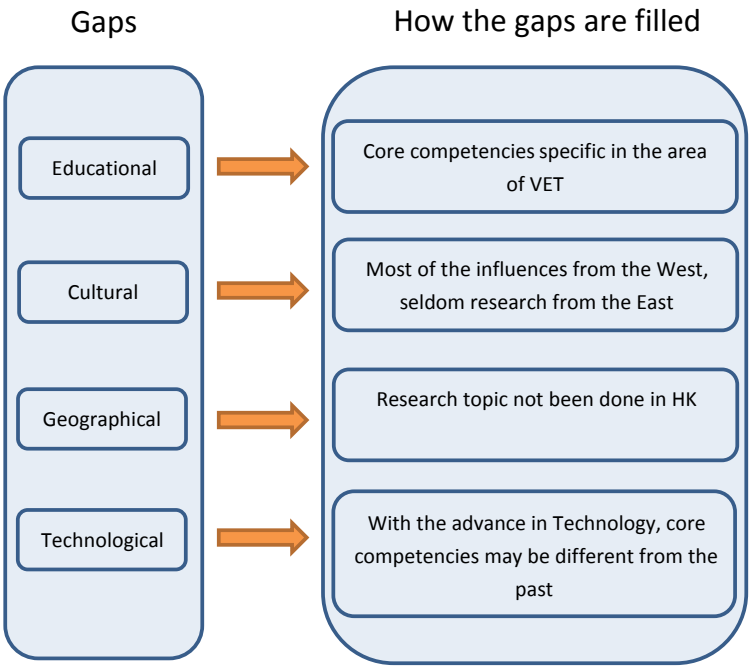


Figure 2.1 Conceptual framework on how the gaps are filled by the current study in different areas.

Figure 2.1 displays the gaps in the literature and how these will be filled by the current study. These gaps are in four different areas: (1) Education: existing literature on core

competencies are not specific to the area of VET; (2) Culture: most of the literature covers influences from Western cultural perspectives, with minimal research conducted from the Eastern cultural perspective; (3) Geography: this research topic has not yet been done in Hong Kong; (4) Technology: with technological advances, the core competencies may differ from those identified in the past.

This study was designed to address the limitations in the literature and fill the above gaps as follows: (1) In the educational area: the current study specifically targeted VET; (2) In the cultural area: the current study was conducted in an Eastern culture; (3) In the geographical area: the current study was undertaken in Hong Kong; (4) In the technological area: two domains were included in this study, namely (a) Information Technology Literacy – it may not have been important in the past, but it is gaining importance with technological advancements; and (b) Working Attitude and Vocational Development – Work ethics are important and must catch up with the trend towards VET.

Pavlova (2013a) emphasised that both our own reflections and assumptions and those of others are important because they are inter-related; the implementation of a technology education curriculum lets students realise and engage in collaborating and understanding others' meaning during the communication process during real-world learning opportunities. This distinction raises another limitation of the paradigm shift from a traditional teacher-centred method to a student-centred approach, where the emphasis is on what the

students are expected to be able to do after the learning experience (Tam, 2011). The current literature is mostly focused on experts' viewpoints, such as programme administrators or educators; only a few studies have investigated the perspective of the students. Valiente (2014) reported that educational and training systems are no longer passive recipients of the demands from employers and markets. In turn, Froy (2013) reminded us that learners are not just passive recipients of education and training but are active agents with specific aptitudes and interests. It is a pity not to take the students' perspectives into consideration as a policy because students will maximise their outputs, such as the efficiency of teaching (Shvidko, Evans & Hartshorn, 2015). This is why Tymon's (2013) "missing perspective" is one of the aims of this study.

It is also invaluable to get the views of the industry or professional managers on identifying the core competencies. Because I have been working in the E&M industry for more than 20 years, I have developed a strong network of professional managers. As a result, I have a good idea of the views within the industry through frequent discussions with them. The key unknown stakeholders to me are the "students" and this research focused on getting their perspectives. In conclusion, in the existing exploration of core competencies for 21st century students who will work in the E&M industry, very little attention has been given to identifying the core competencies, as well as the adequacy of their delivery to students. This information is crucial to the quality of VET programmes.

2.10 Conceptual Framework and Research Questions

A framework for 21st century learning was developed by the Partnership for 21st Century Skills (n.d.). Its main aim is for student success under the new global economy. With this framework, the Partnership includes the knowledge and skills that expert students must master to succeed in life and in work; it is a mixture of specific skills, content knowledge, literacies and expertise.

The P21 Framework can be mastered with the core knowledge and the context of (1) learning and innovation skills; (2) information, media and technology skills and (3) life and career skills (the Partnership for 21st Century Skills, n.d.). There is no doubt that a framework cannot only specifically identify the skills, knowledge, expertise and literacies; a supporting system must also work in context with the above skills in order for the successful execution of the framework. The Partnership (n.d.) has identified five critical support systems to foster 21st century skills: (1) standards; (2) assessments; (3) curriculum and instruction; (4) professional development and (5) learning environment.

2.10.1 Conceptual Framework of the Study

With reference to the indicators of core competencies for the 21st century (Binkley et al., 2012; Delors et al., 1996; OECD, 2010; Rychen & Salganik, 2003; Stein, 2000; Wiek et al., 2011) and the core competencies specific for VET, five domains of core competencies were identified as the most important core competencies for students working in the E&M industry in the 21st century.

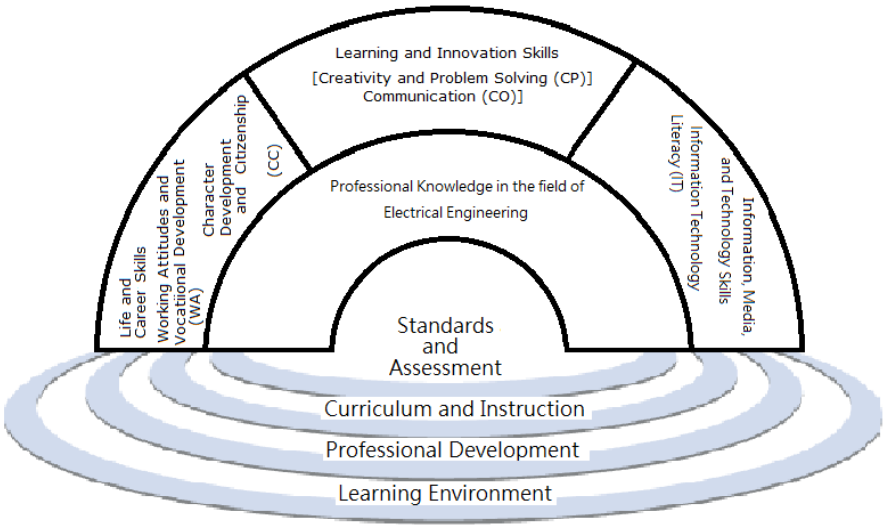


Figure 2.2 Conceptual framework of the current study (Adapted from "Partnership for 21st Century Skills", pp.1)

Figure 2.2 depicts the conceptual framework of the current study. The backdrop of the core knowledge is professional knowledge in the field of electrical engineering. The context includes the domain of "working attitude and vocational development" and the domain of

"character development and citizenship" within life and career skills; the domain of "creativity and problem solving" and the domain of "communication" within learning and innovation skills; and the domain of "information technology literacy" within information, media and technology skills. The framework is supported by assessments and standards, instruction and curriculum, learning environment and professional development.

2.10.2 Research Questions

To explore and gain a holistic understanding from the perspective of students on the core competencies required for them to work in the E&M industry, the first step was to focus on the importance of these core competencies in the 21st century. Hence, the first research question (RQ1) is: From the students' perspective, what are the core competencies expected of the Hong Kong Institution of Vocational Education (IVE) graduates who will work in the electrical and mechanical industry?

As the five domains of core competencies adapted in this study have best represented the core competencies for students working in the E&M industry according to the literature review in the previous chapter and the pilot study in Chapter 3, it is assumed that students perceive all these competencies to be important.

The next step is to check whether students have been properly equipped with these core competencies, which is directly related to the quality of the programme. The second research question (RQ2) is: Do students consider the IVE HD programme to be adequate in equipping them with the core competencies? The result is crucial for the programme administrator to improve the quality of the programme.

2.11 Summary

In this section, the concept of competence has been discussed, followed by core competence. The indicators of core competencies for the 21st century were referenced and the focus was shifted to the core competencies of VET, a conceptual framework was developed as the research context and conceptualization of the core competencies for students working in the E&M industry. The Education 2030 indicated the scope of the international agenda for education set by the education community. The limitations of the literature review were analysed, and the research questions were also introduced. A pilot study to cement the research method will be carried out and further elaborated upon in the next chapter.

Chapter 3

Research Methods

The current study applied a mixed methods research and combined the benefits of both quantitative and qualitative methods. First of all, the quantitative method was applied to research findings followed by the qualitative method to further investigate these findings. It is believed to be an appropriate method in many research domains for the new century.

In this study, quantitative methods were used to collect data from students of the HD in EE programme to explore the importance of core competencies for graduates who will work in the E&M industry and also the adequacy in delivering the HD programme. The qualitative method followed the quantitative survey because the qualitative process focuses on a descriptive and interpretative supplement to the findings of the quantitative method. It is a complementary explanation to the research questions via focus group discussions.

3.1 Mixed Methods Flow

The notation system of the mixed methods research was identified in this section. Figure 3.1 graphically depicts a partial mixed sequential dominant status design (Leech & Onwuegbuzie, 2009). The word "partial" implies that the two research approaches of quantitative and qualitative were partly mixed, while "sequential" suggests the two research approaches were conducted in tandem; "dominant status" implies the quantitative approach was dominant in the current study.

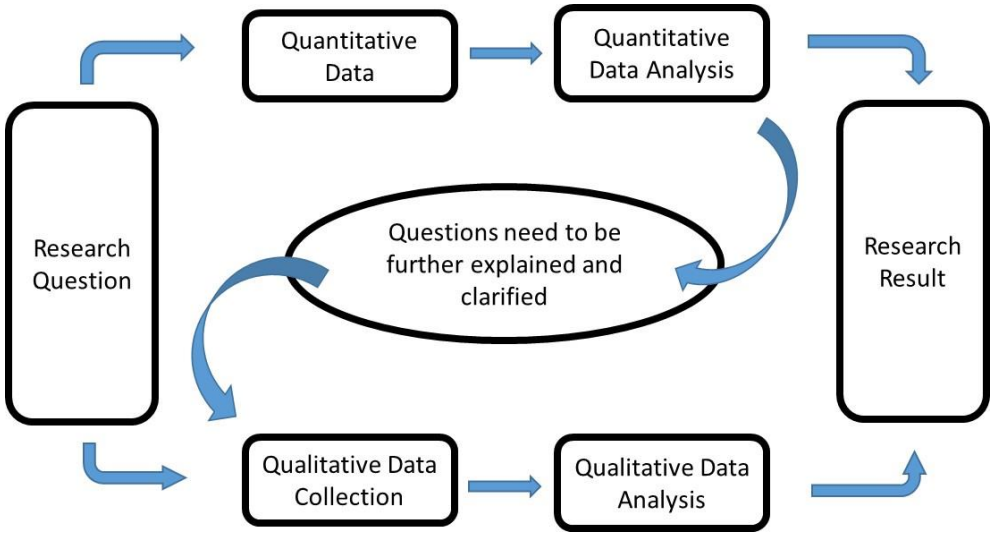


Figure 3.1: The current study with a partial mixed sequential dominant status design

3.1.1 Mixed Methods Research

A study combining wholly or partially qualitative and quantitative investigative approaches of the same underlying phenomenon can be considered mixed method research (Leech & Onwuegbuzie, 2009). It is a type of research that applies research methods, data collection, data analysis and interpretation by quantitative and qualitative approaches (Tashakkori & Teddlie, 2003).

Quantitative research holds a post-positivist worldview and emphasises numerical analysis, while qualitative research maintains a constructivist worldview and employs narrative data. Mixed methods research takes a pragmatic position and is interested in both types of data (Tashakkori & Teddlie, 2003). Different research studies have combined both quantitative and qualitative research; therefore, it is recommended that a mixed methods approach be used in the current study.

It must be emphasised here that the quantitative-qualitative approaches used in this study were not a one-way flow. Instead, the quantitative data provided a broad perspective to the research questions, but the qualitative data added depth to the interpretation of the quantitative findings. In this study, after analysing the quantitative data from Pilot study one, focus group interviews were conducted to interpret the responses to the survey questions. On the basis of the students' responses from the focus group interviews, the quantitative survey questionnaire was refined and quantitative data were collected again using the refined

questionnaire in Pilot study two. After analysing the quantitative data from Pilot study two, more focus group interviews were conducted, from which the qualitative responses were used to inform the survey questionnaire. That is why the mixed methods used here comprised a two-way flow between the quantitative and qualitative methods, leading to better quality of the research instrument and data.

3.1.2 Research Design and Notation System

There is an increasing trend of applying mixed method research in various publications (Burch & Heinrich, 2016; Newman, 2013; Tashakkori & Teddlie, 2003). Leech and Onwuegbuzie (2009) proposed a three-dimensional typology of mixed methods designs based on content analysis. The three dimensions are level of mixing (which includes a partially mixed versus a fully mixed type); time orientation (which contains concurrent versus sequential time); and emphasis of approach (which includes equal status versus dominant status). With the mixing of all combinations between these three dimensions, there were eight types of mixed research designs. Leech and Onwuegbuzie (2009) modified the work by Newman (2013) and developed a notation system for the eight-design framework.

Based on the three-dimensional typology of a mixed methods design, the current study used a partial mixed sequential dominant status design. It mixed quantitative and qualitative portions, which played complimentary role to each other. In this study, quantitative data were

collected using self-administered questionnaire in the first stage, while qualitative data were collected using in-depth interviews during the second stage for more informational interpretation to the quantitative results. At last, findings from the qualitative analysis was used to supplements findings from the quantitative analysis, while the quantitative portion was given the dominant status.

Before the survey for the main study, it is crucial to guarantee the validity of the instrument. The quantitative data of the study were collected using a survey questionnaire comprising six domains of core competencies proposed by Cheng, Yeh, Liu, and Mok (2011), and by Mok et al. (2011) together with the core competencies specific for engineering students who are working in the E&M industry. Two pilot studies were carried out to ensure the validity of the survey before the main study. The first pilot study refined the instrument by replacing the original items with well-structured and clear descriptions for each items within the questionnaire. The second pilot study verified the fitness of the data to the Rasch Model. Both pilot investigations improved the quality of the instrument, which guarantees the data collected in the coming main study will be reliable and valid. The main study will be specifically addressed to the research questions of (1) From the students' perspective, what are the core competencies expected of HKIVE graduates who are going to work in the E&M industry? And (2) Do students consider the IVE HD programme to be adequate for teaching them the core competencies?

3.2 Rasch Model

The one-parameter IRT model is also called the Rasch Model (Rasch, 1960; Smith & Smith, 2007; Wright & Masters, 1982), and it is one of the mathematical models under the IRT family. These models may be used to compute the probability of a specific response given the characteristics of an item and also to determine whether it will be more favourable than other items. The characteristics refer to the amount of latent traits of a person and also the difficulties of an item. The outcomes from the Rasch Model are values in logit units, an interval-level scale that measures each item and person and calibrates a common score using the same scale for the person's ability and the item's difficulty. One of the features of the model is that the item's difficulty and a person's ability can be separated from each other; it is a sample free measurement, and a person's latent construct estimation should be independent of the distribution of individual items. At the same time, item difficulty estimation is independent from the distribution of the person from the sample. The Rasch measurement is useful in measuring a person's ability, characteristics, attitudes, and personal traits. It has been widely applied in educational settings, psychological and large-scale assessment, such as the Programme for International Student Assessment (PISA) and the International Civic and Citizenship Education Study (ICCS).

The classic Rasch Model for dichotomous responses is the probability of a specified response is modelling as a logistic function of person and item parameters (Rasch, 1960):

$$\text{Log}\,(P_{ni1}/P_{ni0}) = \theta_n - \delta_i$$

When θ_n is the proficiency level of person n; δ_i is the difficulty of item i: P_{ni1} is the probability of scoring 1, namely a correct answer, on item i for person n; and P_{ni0} denotes a wrong answer. In the context of the current study, a person is represented by an HD student who responded to the questionnaire. The "proficiency level of a person" or the "ability of a person" represents the students' attitude to endorse the measured latent trait (i.e. the importance and adequacy in delivering of core competencies). The difficulty of an item implies to what extent a questionnaire's item is endorsed by the students. A more difficult item means an item in the questionnaire is more difficult to be endorsed, while a less difficult item refers to a questionnaire item that is less difficult for the students to endorse.

When polytomous data are collected, the Rasch Rating Scale Model (RSM) will be used. A threshold value in the item estimation is also included when accommodating ordinal data during the process.

A threshold is a value that creates a line in separating categories within a Likert scale; it is equal to the number of scale categories (k) minus one. When the level of difficulty to endorse an item and the student's level of the construct are given, the RSM can calculate the probability that a student will be observed in a specific category of the rating scale; the formula can be expressed as follows:

$$\text{Log}\,(P_{nik}/P_{ni(k-1)}) = B_n - D_i - F_k$$

where P_{nik} is the probability that student n would be observed in category k on encountering item i. $P_{ni(k-1)}$ is the probability that student n would be in category k-1, B_n is the latent ability level of student n, D_i is the difficulty for a student to endorse of item i, and F_k is the probability of being observed in category k relative to category k-1. In the current study, a four-point Likert scale with polytomous scores was used, and RSM was applied.

A number of useful indices could be obtained from the Rasch measurement. The infit statistics, outfit statistics and Rasch reliability indicate the quality of a scale. The infit and outfit statistics measure the mean square error (MNSQ), whereby the figure indicates the difference between the observed data and the expected score. The range of the value lies between 0 and infinity, with the expectation value equal to one. The infit includes information-weighted estimates of the pattern of responses to items targeted at the person. The outfit is unweighted and is, therefore, more sensitive to participants' unexpected responses to items. The acceptable range of MNSQ is 0.5–1.5 (Linacre, 2014).

As recommended in the literature (e.g., Bond & Fox, 2015), for low-stake research, this criterion is adequate for judging model-data fit. The current research was about programme evaluation and, thus, could be considered low stake. Further, the programme's improvement did not rely totally on the statistical results. Instead, the programme administrator used the

results as evidence to inform the discussion and deliberate on areas of enhancement. Consequently, the 0.5–1.5 criterion was used in this study.

The reliability of a scale is defined as the proportion of true variance to observed variance. Cronbach's alpha is also a popular reliability statistic used in social science research (Cronbach, 1951). It provides the internal consistency or the average correlation of items on a scale. In the Rasch model, the true variance is the adjusted observed variance by measurement error, while the error variance is the mean-square error inflated by the misfit of the data to the model (Wright, 1996). Rasch practitioners developed the separation index instead of using conventional internal consistency coefficients (Linacre, 2014; Wright, 1996). The person/item separation index represents the "reproducibility of a relative measure location"; a high person/item reliability indicates a high probability of estimating the person/item with high measures rather than with low measures (Linacre, 2014).

As the aforementioned studies on core competencies have successfully used the Rasch model to assess their data and take advantage of interval measurement (Cheng et al., 2011; Mok et al., 2011), raw scores in classical test theory are usually adopted as respondent measures. However, subsequent parametric statistical analyses, such as computing mean, variance, correlation coefficient and Cronbach's alpha, would be incorrect because raw scores are not on an additive interval scale. To overcome this obstacle, the IRT-based Rasch model, a probabilistic relationship between a person's level of a latent trait (commonly referred to as

ability or measure) and an item's property (difficulty or threshold) was developed. Both person ability and item difficulty (calibrated in terms of log odds or logits) are located along the same continuum (Chien et al., 2011).

The current study took advantage of the interval measurement enabled by the Rasch model over raw scores used in classical test theory. Further, the Rasch model allowed for testing the Differential Item Functioning (DIF) on students from three different campuses, thereby providing evidence based on the validity of the measured data. Handling missing data was another advantage of applying the Rasch model over the use of raw scores in classical test theory. The current study will follow the Rasch model approach in its data analysis.

3.3 Pilot Study One

The conceptual framework of the study was defined following the trend of literature reviews. Eight domains of core competencies with 54 Likert-type items were developed and piloted in August 2014. The questionnaire was based on a self-report of the 21CCCUE scale involving 40 Likert-type items with six domains (Cheng et al., 2001) along with the two extra domains of "information technology literacy" and "working attitude and vocational development" involving 14 Likert-type items specific for students who worked in the E&M industry.

3.3.1 Sample for Pilot Study One

The sample comprised 27 students who belonged to a mixture of first- and second-year students of the 2014/15 cohort studying for the HD in EE programme at the Haking Wong campus. The sample was purposively selected, and the genders of the participants were 26 males and 1 female. The unbalanced gender distribution was a reflection of the student distributions in the population of different year cohorts in the HD in EE programme. However, given the unbalanced gender, no gender comparison was involved in the current study.

3.3.2 Assessment Instrument for Pilot Study One

The assessment instrument was composed of 54 Likert-type items with eight domains: basic and professional competence; communication; creativity and problem solving; character and civil literacy; international perspective; information technology literacy; working attitude and vocational development; and independent study. There were six items in the domain of international perspective, while the other domains each contained seven items. The assessment instrument was divided into four sections; in the first three sections for each of the 54 items, three questions were asked in each section correspondingly: (1) Which of the following are the core competencies that university and college graduates should have mastered? The response scale comprised four options with increasing levels; 0 was coded for "indifference", 1 for "better to be equipped", 2 for "should be equipped" and 3 for "must be equipped"; (2) Do you think that you are equipped with these core competencies? The response scale included four options: 0 was for "not equipped", 1 for "a little bit equipped", 2 for "equipped" and 3 for "well equipped"; (3) Do students consider the IVE HD programme to be adequate at providing them with the core competencies? The response scale comprised four options according to level of adequacy; it was coded as 0 for "not equipped at all", 1 for "slightly equipped", 2 for "equipped" and 3 for "well equipped". The fourth section contained the background information of the participants.

3.3.3 Procedures for Pilot Study One

The questionnaires were distributed to one class of 27 students. Due to the small sample size, the intention was not to test the reliability and validity of the quantitative part of the survey by using Rasch analysis. Instead, it was to rationalize the structure of the questionnaires for the future main study. A focus group discussion with all participants was conducted immediately following the qualitative part of the survey; the results will be further analysed to improve the quality of the questionnaires.

3.3.4 Variables for Pilot study 1

The variables include the importance of the core competencies from the perspective of students, the self-rating of personal possession of the core competencies and the adequacy in delivering the HD programme. Each variable contained 54 Likert-type items according to eight domains and the content of each items were listed in Table 3.1.

Table 3.1 The Content of 54 Likert-type items with 8 domains for Pilot Study 1

1. Basic and professional competence
a. Professional knowledge
b. Capacity expressed in words
c. Empirical Reasoning Ability
d. Ability of Information Technology
e. Ability of logical analysis
f. Critical thinking ability
g. Ability of decision making

2. Creativity and Problem Solving
a. Creativity
b. Develop their potential
c. Imagination
d. Keen awareness force
e. Innovation and change attitudes
f. The spirit of adventure challenge
g. Problem-solving ability

3. Interpersonal communication
a. Attitude of respect and acceptance
b. Ability of oral expression
c. Ability to listen
d. Ability to manage emotions
e. Ability of teamwork
f. Ability to lead and coordination
g. Ability of human interaction

4. Character and civic literacy
a. Positive personality traits
b. Humanities and art appreciation
c. Empathy and morality
d. Respect for human rights and freedoms
e. Practice of democracy and justice
f. The ability to participate in society
g. The ability of value judgment

5. Global & International Perspective
a. Foreign language ability
b. Open horizons
c. Respect for cultural diversity
d. Familiar with international affairs
e.The concept of the global village

6. Self-directed learning
a. The ability to independently research
b. Set learning objectives and strategies
c. Control of the learning process adjustment
d. Manage learning environment
e.The use of learning resources
f. Reflections on learning effectiveness
g. Assessing learning outcomes

7. Positive attitude and vocational development
a. Attribut of Punctuality
b. Ability to follow instruction
c. Attribute of Discipline
d. Responsible attitudes
e. Motivation to strive upstream
f. Work independently and adaptability
g. Mission and vision with the company unanimously

8. Application of information technology
a. Ability to create multimedia reporting
b. Capability in application of software
c. Capability to grasp information
d. Capability to create and integrate information
e. Ability to analyze data
f. Use of data in compliance
g. Safety use of data

The content of the 54 Likert-type items for Pilot Study 1 composed of eight domains. The first to sixth domains was according to the 21CCCUE scale which is a self-report questionnaire involving 40 Likert-type items (Cheng et al., 2011). The domains are: Basic and Professional Competence; Creativity and Problem Solving; Interpersonal Communication; Character and Civic Literacy; Global and International Perspective; and Self-directed Learning. The seventh and eighth domains were specific competencies for students studying in the area of TVET involving 14 Likert-type items, the domains are: Positive attitude and Vocational Development; and Application of Information Technology.

Each domain has seven items except the domain of Global & International Perspective, which has five items. A total number of eight domains end up with a total number of 54 Likert-type items as the main component of the first Pilot Study.

3.3.5 Findings and Implications for the Pilot Study One

A discussion with 27 students, who agreed voluntarily to participate at the discussion, was conducted immediately after the survey, and students expressed their views about the questionnaire and the process of responding to the items. They felt that it was clumsy to repeat the same items in approaching three different aspects of questions. They lost patience when asked to answer the second half of the questionnaires. Students also gave feedback that some items seemed too superficial and simplistic as professional knowledge is a must in the Electrical and Mechanical field, so it was redundant to keep it in the questionnaire. Some item descriptions were also too vague; students expected complementary items with further description to be present to allow a better understanding of the content of the item.

Grounded on the feedback from students, the length of the questionnaires was shortened but still stay in line with the main themes of this study. The entire section involving students' self-rating of personal possession of the competencies was deleted. The quantitative part of this survey thus focused on the importance of core competencies and the adequacy of the institute in delivering the programme, which was the main purpose of this study.

It was also noted that some core competencies, such as the domain of basic and professional competence, should not be included in the questionnaire, as recommended by the students at the discussion. The professionalism of the programme is maintained by the professional body in Hong Kong; the programme is accredited by the Hong Kong Institute of

Engineers (HKIE), and the delivery of professional competence is guaranteed. To make the questionnaire more effective, a restructuring of the eight domains and a fine tuning of all items was deemed necessary. Some extra descriptions were included to further elaborate on the meaning of each item and the domains in order to avoid terms that are too vague to be understood by the participants.

The first pilot refined the instrument with well-structured and clear descriptions for each item. It made the questionnaire for this research study more focused.

3.4 Pilot Study Two

The structure of the questionnaire has been improved, and the participants should have an easier experience filling in the questionnaire. However, the fitness of this instrument to the overall model still needs to be further tested. Therefore, the second pilot study was based on the improved questionnaire and was carried out in January 2015.

3.4.1 Sample for Pilot Study Two

The sample comprised 273 students. They belonged to the cohort of second-year students studying in the HD in EE. The sample included 128 students from the Haking Wong campus; 63 students from the Chai Wan campus and 82 students from the Tsing Yi campus. The sample included the entire population of the 2014/15 cohort except those students who were absent from class while the survey was administered.

3.4.2 Assessment Instrument for Pilot Study Two

The assessment instrument is composed of 35 Likert-type items organised into five domains: working attitude and vocational development; character development and citizenship; creativity and problem solving; information technology literacy and communication. Each of the domains contained seven items. The assessment instrument was divided into two sections, with each section containing 35 items each. Two questions were asked in each section: (1) Which of the following are the core competencies that university and college graduates should display? The response scale included four options: 0 was coded for “indifference”, 1 for “better to be equipped”, 2 for “should be equipped” and 3 for “must be equipped”; and (2) Do students consider the IVE HD programme to be adequate in equipping them with these core competencies? The response scale comprised four options with differing levels of adequacy: 0 was coded for “not equipped at all”, 1 for “slightly equipped”, 2 for “equipped” and 3 for “well equipped”.

3.4.3 Procedures for Pilot Study Two

The questionnaires were distributed to students studying the HD programme in EE at three campuses. A total of 273 participants and data were collected and analysed using Winstep software. The flow of Winstep begins with an estimate for each student followed by the response and item structure calibration if there are no pre-determined values provided by the analyst. The results will be displayed in different formats that include tables, graphs and plots after the iteration is completed (Linacre, 2014).

A focus group discussion with purposively selected participants immediately following the qualitative part of the survey at each campus. The results will help further the analysis to determine the feasibility to begin the main study.

3.4.4 Variables for Pilot Study Two

The variables for the current study were the importance of the core competencies from the students' perspectives and the adequacy of the institute in delivering the HD programme. The variables were changed from three to two (i.e. the variable on students' self-ratings was deleted) in order to focus on the objective of this study. For each variable, the eight domains from the first pilot study were trimmed down to five domains. The domain of basic professional competency is a must for the HD in EE, so it was redundant to be included in the questionnaire. The international perspective domain was not appropriate for students working in the E&M industry. In contrast with commercial businesses that have a backdrop of internationalization, most employees in the E&M industry work locally. At the focus group interview, students explained that since most E&M graduates worked locally, and unlikely the electronic industry which had moved their production sites to Mainland China, E&M companies could not move outside Hong Kong. Consequently, the students did not perceive great important on international perspective. Of course this perspective reflected the students' immaturity, most likely due to their young age and lack of work experience. Nevertheless, the domain of international perspective was removed from the questionnaire. Finally, the independent study domain involves personality characteristics, such as motivation and self-control. It is similar to the attributes in the domain of positive attitude, so both domains were combined to simplify the structure of the questionnaire.

After the questionnaire was re-structured, it contained 35 Likert-type items with five domains for each variable with the details shown in Table 3.2:

Table 3.2 The Content of 35 Likert-type items with 5 domains for Pilot Study 2

A.	**Work Attitude and Vocational Development** **Full of enthusiasm for the work, with good and positive attitudes**
1	**Attribute of Punctuality** **Be punctual to work, attend any meeting and banquet**
2	**Ability to follow instructions** **For any instructions issued by supervisors, can follow and execute flawlessly and correctly**
3	**Attribute of Discipline** **Can strictly abide by the company's codes of conduct and discipline**
4	**Responsible attitudes** **Attitude to work with seriously and professionally manner**
5	**Strive to power himself/herself upstream** **Not just stay in the comfort zone, always keep on learning and training**
6	**Work independently and adaptability** **Can work Independently and able to adapt to new environment**
7	**Mission and vision with the company unanimously** **Consistent with the company's mission and vision and work hard for the future**
B.	**Information Technology Literacy** **Able to master IT , apply technology to assist in working and learning**
1	**Making multimedia for reporting** **Able to apply multimedia and software in order to make presentation and reporting**
2	**Capability in application of software** **Able to apply general (Word, Excel) and Professional software (Acad, BIM) for daily work**
3	**Capbility to grasp information** **Able to gather a wide range of information, consolidate and apply accurately**
4	**Capability to create and integrate information** **Able to create and integrate useful information**
5	**Ability to analyze data** **Able to analyze a large amount of data for further application**
6	**Use of data in compliance** **To use personal and company data in comply with the law**
7	**Safely use of the data** **Can distinguish the legitimacy of data, apply and protect them safely**

C.	**Character Development and Citizenship** **Professional Character with Civic Responsibility, eager to make contribution to the society**
1	**Awareness of environmental protection** **With environmental awareness, always apply in daily life and future work**
2	**Identification and awareness of Occupational safety** **Keep safety in first priority, can strictly follow and well perform**
3	**Respect to Intellectal Property** **Well understand of intellectual property and not to carry out any copyright infringement**
4	**Attitude to prevention corruption** **Understand the harmful of corruption, without bribery or bribery behavior**
5	**Ability to participate in society** **Care for the community, actively participate in community activities**
6	**Respect to human rights and freedom** **Able to respect others and accept different point of views, respect to human rights and freedom**
7	**Ethics and Social Responsibility** **With high moral values, make contribution to the community whenever possible**
D.	**Creativity and Problem Solving** **Work Creatively and able to solve problem in the workplace**
1	**Ability to integrate resources in innovation** **To integrate resources to create new design**
2	**Independent research and development capacity** **Independent research and invention of new products or new services**
3	**Lenovo and imagination** **To connect and integrate of data , imagine new problems and provide solutions**
4	**A keen awareness force** **Always keep awareness for timely and appropriate action**
5	**Attitude in innovation and change** **Always think in an innovative way to react and to solve problem**
6	**The spirit of adventure challenge** **Do not stay in a comfort zone, keep facing challenge to enhance the quality of work**
7	**Ability in problem-solving** **Able to apply professional knowledge to solve a problem**

E.	**Communication** **Get along well with others, able to express himself/herself and understand of each other**
1	**Oral Expression** **Able to use English and Mandarin for communication**
2	**The capability in listening** **Can listen properly in English and Mandarin**
3	**Use of language** **Able to use Chinese and English to write**
4	**The ability to manage emotions** **Able to maintain a high EQ with good relation with others**
5	**Teamwork spirit** **Can be a good team member, cooperate well with other team members**
6	**Ability to lead and to coordinate** **Apply good communication skill, to lead and coordinate with other team members**
7	**The synergy through human interaction** **Through communication and interpersonal relationships, collaborate with others for the best outcomes**

The content of the 35 Likert-type items for Pilot Study 2 composed of five domains. The domains are: Work Attitude and Vocational Development; Information Technology Literacy; Character Development and Citizenship; Creativity and Problem Solving; and Communication. Each domain has seven items to end up with a total number of 35 Likert-type items as the main component of the second Pilot Study.

3.4.4.1 Importance of Core Competencies (Variable 1)

The variable for the importance of core competencies implied that the students' perceptions on importance ranged from 0–3 for each item (competence) using the importance subscale of the questionnaire. The numbers from 0–3 represent four levels of importance, with 0 for "indifference", 1 for "better to be equipped", 2 for "should be equipped" and 3 for "must be equipped". An item with a higher score indicates that the competency is perceived as being relatively important than one with a lower score; the item difficulty is higher and more difficult to achieve. Rasch analysis was applied to validate the assessment of the importance of core competencies. The person and item reliabilities, item difficulty and item fit were verified in the following section.

3.4.4.1.1 Reliability of Item and Person Measures (Variable 1)

Table 3.3 shows detailed figures regarding the reliability of the instrument; both the item reliability (0.98) and the person reliability (0.92) were statistically high, which implied that the assessment tool had an excellent reliability. An item separation index of 6.35 suggested that the items can be separated into at least six groups according to the responses from students, while a person separation index of 3.42 implies that at least three student groups can be separated by items. The internal consistency index of Cronbach's alpha was 0.94, which shows that the scale has a high degree of internal consistency.

Table 3.3 Cronbach's Alpha and Rasch Reliabilities of the Scale of Importance (35 items)

Cronbach's Alpha	Rasch Separation		Rasch Reliability	
	Person	Item	Person	Item
0.94	3.42	6.35	0.92	0.98

3.4.4.1.2 Item Fit and Difficulty (Variable 1)

Besides the reliability of the scale, the Rasch analysis also provides other indices to check the fitness of the data to the model. Columns 4 (Infit) and 6 (Outfit) of Table 3.4 are the goodness of fit of the data to the Rasch model. Columns 5 and 7 of Table 3.4 are the corresponding standard errors of the goodness of fit statistics. These statistics indicates that most of the items had a goodness of fit (Infit and Outfit) within the range from 0.5–1.5 except "attribute of punctuality" (item 1), which has a poor Outfit, and "attitude to prevent corruption" (item 18), which had poor Infit and Outfit. These items had been addressed by enhancing the item description for better understanding by the participants. Other than the mentioned items, the results which indicates that the data fitted the Rasch Model well.

In Table 3.4, the second column shows the item difficulty estimated values. The item difficulties ranged from -1.17 logit for item 7, "mission and vision with the company unanimously" (the least important item) to 1.38 logit for item 1, "attribute of punctuality" (the most important item). The range from -1.17 logit to 1.38 logit covers a wide array of attitudes and indicates the level of importance of the core competencies.

Table 3.4: Item Parameter Estimates (in logit) and Fit Statitstics for the Scale of Importance

			Infit		Outfit	
	Measure	SE	MNSQ	ZSTD	MNSQ	ZSTD
Working attitude and Vocational Development (WA)						
1. Punctuality	1.38	0.11	1.10	1.2	1.65	5.5
2. Ability to follow insstructions	0.64	0.10	0.84	-2.0	0.92	-0.9
3. Discipline	0.67	0.10	0.99	0.0	1.01	0.1
4. Responsible attitudes	1.10	0.10	0.93	-0.9	0.88	-1.2
5. Strive to power upstream	-0.31	0.10	1.19	2.2	1.17	1.9
6. Work independently and strain	0.13	0.10	1.01	0.2	1.04	0.5
7. Mission and Vision with the company unanimously	-1.17	0.09	1.19	2.2	1.20	2.3
Information Technology Literacy (IT)						
8. Making multimedia for reporting	-0.55	0.10	0.82	-2.3	0.82	-2.3
9. Application of software	-0.13	0.10	0.84	-2.0	0.84	-2.0
10. Grasp information	-0.38	0.10	0.76	-3.1	0.76	-3.1
11. Create and integrate information	-0.03	0.10	0.81	-2.5	0.81	-2.4
12. Ability to analyze data	-0.05	0.10	0.68	-4.3	0.68	-4.3
13. Use of data in compliance	0.46	0.10	1.28	3.2	1.29	3.1
14. Safely use of data	0.45	0.10	0.99	-0.1	0.98	-0.2
Character Development and Citizenship (CC)						
15. Awareness of environmental protection	-1.06	0.09	1.11	1.3	1.12	1.4
16. Identification and awareness of Occupational Safety	0.85	0.10	1.27	3.1	1.24	2.5
17. Respect for Intellectal Property	0.45	0.10	1.22	2.5	1.27	2.9
18. Prevention of corruption attitude	0.65	0.10	1.71	7.2	1.73	6.8
19. Ability to participate in society	-0.84	0.09	1.19	2.3	1.19	2.1
20. Respect for human rights and freedom	0.21	0.10	1.11	1.3	1.09	1.0
21. Ethics and Social Responsibility	0.05	0.10	1.19	2.2	1.17	1.9
Creativity and Problem Solving (CP)						
22. Ability to use resources to innovation	-0.73	0.09	0.71	-3.9	0.71	-3.9
23. Independent research and development capacity	-1.09	0.09	0.88	-1.5	0.88	-1.4
24. Lenovo and imagination	-0.72	0.10	0.84	-2.0	0.84	-2.0
25. A keen awareness force	-0.28	0.10	0.75	-3.3	0.76	-3.1
26. Innovation and change in attitude	-0.79	0.09	0.92	-1.0	0.91	-1.0
27. The spirit of adventure challenge	-1.07	0.09	1.30	3.4	1.29	3.2
28. Ability to problem-solving	0.27	0.10	0.84	-2.0	0.83	-2.0
Communication (CO)						
29. Oral Expression	0.10	0.10	0.90	-1.2	0.91	-1.0
30. The ability to listen	0.27	0.10	0.88	-1.5	0.86	-1.6
31. The ability to use of language	0.20	0.10	0.73	-3.6	0.73	-3.4
32. The ability to manage emotions	0.65	0.10	1.06	0.7	1.08	0.9
33. The ability of teamwork	0.72	0.10	0.92	-0.9	0.90	-1.2
34. Ability to lead the coordination	-0.34	0.10	0.90	-1.2	0.90	-1.2
35. The ability to human interaction	0.30	0.10	1.05	0.6	1.02	0.3

3.4.4.2 Adequacy in Delivering Core Competencies (Variable 2)

The variable for the adequacy in delivering core competencies implies students' perceptions of adequacy range from 0–3 for each item (competence) using the adequacy subscale of the questionnaire. Numbers from 0–3 represent four levels of importance, with 0 for "not equipped at all", 1 for "slightly equipped", 2 for "equipped" and 3 for "well equipped". An item with a higher score indicated that the competency is perceived as being relatively more adequate than one with a lower score, so the item difficulty is higher and therefore more difficult to be equipped. Rasch analysis was applied to validate the assessment of the adequacy in delivering core competencies. The person and item reliabilities, item difficulty and item fit were checked in the following section.

3.4.4.2.1 Reliability of Item and Person Measures (Variable 2)

Table 3.5 shows the detailed figures for the reliability of the instrument; both the item reliability (0.94) and the person reliability (0.93) were statistically high, which implies that the reliability of the assessment tool is excellent. An item separation index of 3.87 indicates that the items can be separated into at least three groups according to the responses from students, while a person separation index of 3.78 implies that groups of at least three students can be separated by items. The internal consistency index of Cronbach's alpha was 0.96,

which shows that the scale has a high degree of internal consistency.

Table 3.5 Cronbach's Alpha and Rasch Reliabilities of the Scale of Adequacy (35 items)

Cronbach's Alpha	Rasch Separation		Rasch Reliability	
	Person	Item	Person	Item
0.96	3.78	3.87	0.93	0.94

3.4.4.2.2 Item Fit and Difficulty (Variable 2)

In addition to the reliability of the scale, the Rasch analysis also provides other indices to check the fitness of the model. Table 3.6 indicates that all of the items' goodness of fit (Infit and Outfit) assessments ranged from 0.65–1.47. As all the figures fall between the range from 0.5–1.5, it indicates a good fit with the Rasch Model.

In Table 3.6, the first column shows the item difficulty estimated values, with a range from -0.86 logit for "mission and vision with the company unanimously" (item 7) to 0.79 logit for "identification and awareness of occupational safety" (item 16). The range from -0.86 logit to 0.79 logit covers a wide number of attitudes and also indicates the level of adequacy in delivering the core competencies.

Table 3.6 Item Parameter Estimates (in logit) and Fit Statistics for the Scale of Adequacy

			Infit		Outfit	
	Measure	SE	MNSQ	ZSTD	MNSQ	ZSTD
Working attitude and Vocational Development (WA)						
1. Punctuality	0.02	0.10	1.29	3.1	1.47	4.7
2. Ability to follow insstructions	0.31	0.10	0.97	-0.3	1.04	0.5
3. Discipline	0.09	0.10	1.05	0.6	1.06	0.8
4. Responsible attitudes	0.72	0.11	0.83	-2.1	0.80	-2.4
5. Strive to power upstream	-0.10	0.10	1.20	2.2	1.22	2.3
6. Work independently and strain	0.21	0.10	0.91	-1.1	0.91	-1.0
7. Mission and Vision with the company unanimously	-0.86	0.10	1.21	2.4	1.21	2.4
Information Technology Literacy (IT)						
8. Making multimedia for reporting	0.16	0.10	1.07	0.8	1.04	0.5
9. Application of software	0.64	0.10	1.26	2.8	1.24	2.6
10. Grasp information	0.23	0.10	0.89	-1.3	0.86	-1.6
11. Create and integrate information	0.30	0.10	0.97	-0.4	0.92	-0.9
12. Ability to analyze data	0.34	0.10	0.83	-2.0	0.83	-2.0
13. Use of data in compliance	-0.3	0.10	0.93	-0.9	0.92	-0.9
14. Safely use of data	-0.30	0.10	0.97	-0.4	0.97	-0.3
Character Development and Citizenship (CC)						
15. Awareness of environmental protection	-0.66	0.10	1.16	1.8	1.15	1.7
16. Identification and awareness of Occupational Safety	0.79	0.11	1.28	2.9	1.25	2.6
17. Respect for Intellectal Property	-0.21	0.10	1.08	0.9	1.08	1.0
18. Prevention of corruption attitude	-0.33	0.10	1.39	4.1	1.42	4.3
19. Ability to participate in society	-0.68	0.10	0.97	-0.4	1.00	0.0
20. Respect for human rights and freedom	-0.26	0.10	0.95	-0.5	0.97	-0.3
21. Ethics and Social Responsibility	-0.36	0.10	0.94	-0.7	0.96	-0.4
Creativity and Problem Solving (CP)						
22. Ability to use resources to innovation	-0.27	0.10	0.65	-4.7	0.65	-4.5
23. Independent research and development capacity	-0.35	0.10	0.80	-2.6	0.80	-2.5
24. Lenovo and imagination	-0.29	0.10	0.78	-2.8	0.77	-2.9
25. A keen awareness force	-0.12	0.10	0.86	-1.7	0.83	-2.0
26. Innovation and change in attitude	-0.42	0.10	1.00	0.1	1.00	0.1
27. The spirit of adventure challenge	-0.65	0.10	0.93	-0.8	0.94	-0.7
28. Ability to problem-solving	0.40	0.10	0.89	-1.3	0.87	-1.5
Communication (CO)						
29. Oral Expression	0.35	0.10	0.92	-0.8	0.89	-1.2
30. The ability to listen	0.19	0.10	0.94	-0.7	0.93	-0.7
31. The ability to use of language	0.35	0.10	0.79	-2.5	0.79	-2.5
32. The ability to manage emotions	-0.11	0.10	1.39	4.1	1.36	3.8
33. The ability of teamwork	0.56	0.10	0.85	-1.8	0.84	-1.9
34. Ability to lead the coordination	0.12	0.10	0.91	-1.0	0.91	-1.1
35. The ability to human interaction	0.47	0.10	0.94	-0.7	0.91	-1.0

3.4.5 Findings and Implications of Pilot study 2

The second pilot study included a larger sample size of 273 in contrast with the 27 participants who took part in the first pilot study. This sample size allows for further testing on the modified instrument in regards to the fitness of the Rasch Model. The reliability and validity to the two sub-scales indicated the following: 1. the importance of core competencies from the perspective of students and 2. the adequacy in delivering these core competencies to students was verified.

3.5 Main Study

After the process of two pilot studies, the instrument was justified to be adequate and ready to be applied in the main study. The main study composed of quantitative research and qualitative research, the details of the research designs will be followed in the next sessions.

3.5.1 Quantitative Research Design

As a quantitative research method is dominant in the current research design, an important component is required to fulfil the aim of this study: to respond to the research questions of (1) From the students' perspective, what are the core competencies expected of HKIVE graduates who are going to work in the E&M industry? And (2) Do students consider the IVE HD programme to be adequate for teaching them the core competencies?

The quantitative data were collected using a self-report survey questionnaire of all HD in Engineering students. The data were analysed by the Rasch analysis under the Rasch RSM to enable the creation of interval scales in logit units from ordinal level responses (Bond & Fox, 2015). Winsteps computer software (Version 3.70.0.2) was applied for the data analysis, and the calibration of the responses was based on the Rasch Model.

3.5.1.1 Sample

The sample for the survey comprised 353 students who participated in the survey. The survey of students who completed the questionnaires included 61 students from Chai Wan Campus; 120 students from Haking Wong Campus and 179 students from Tsing Yi Campus of the 2015/16 cohort. The participants were second-year students studying in the HD in EE from the Hong Kong Institute of Vocational Education (HKIVE) located at three different campuses: the Chai Wan campus, the Haking Wong campus and the Tsing Yi campus. The age of students in the sample was between 17 and 20, and their gender was 99% male. The samples comprised the entire 2015/16 cohort of students studying in the HD in EE programme except those students who were absent from class while the survey was administered.

3.5.1.2 Instruments

After the success of pilot study two, the instrument was determined to be adequate, and a very fine adjustment was carried out in the main study. The final assessment instrument was composed of 35 Likert-type items according to five domains: working attitude and vocational development; character development and citizenship; creativity and problem solving; information technology literacy and communication. Each of the domains contains seven items. The assessment instrument was divided into two sections, with one section for each of the 35 items; two questions were asked in each section correspondingly: (1) Which of the following are core competencies that university and college graduates should display? The response scale comprised four options: 0 was coded for “indifference”, 1 for “better to be equipped”, 2 for “should be equipped” and 3 for “must be equipped”; (2) Do students consider the IVE HD programme to be adequate at preparing them with these core competencies? The response scale included four options: “not equipped at all” coded as 0, “slightly equipped” coded as 1, “equipped” coded as 2 and “well equipped” coded as 3.

3.5.1.3 Procedures

Questionnaires were distributed to students in the HD in EE programmes at three campuses. The survey of students at the Chai Wan campus was conducted on 29 September 2015 while the survey of students at Haking Wong campus and Tsing Yi campus was conducted on 2 October 2015. A total of 353 participants and their data were collected and analysed using Winstep software. The results were displayed in different formats, including tables, graphs and plots, after the iteration is completed (Linacre, 2014).

In the current study, the Rasch analysis was conducted separately to address the two research questions. The analysis consisted of an assessment of each subscale's validity. Indices of item reliabilities, item fit, test characteristic curve (ICC) and differential item functioning (DIF) between campuses were included and checked (Linacre, 2014). Section 3.4.4.1 and Section 3.4.4.2 justified the reliability and validity of the research instrument, details of the indices provided evidence to implement this research instrument for the main study. Descriptive statistics were included to describe the perspective of students on each subscale. They revealed the importance of core competencies for students who work in the E&M industry and also the adequacy of the HD programme in EE at delivering these competencies to students.

3.5.1.4 Variables

The current study focused on the core competencies for students working in the E&M industry for the 21st century. The variables include the importance of the core competencies from the perspective of students, the self-rating of personal possession of the core competencies and the adequacy in delivering the HD programme. The variables were trimmed down to two after the pilot study 1, the variable for the current study was confined to the important of core competencies from the students' perspective and the adequacy in delivering the HD programme.

Each variable contained 54 Likert-type items according to eight domains were trimmed down to 35 Likert-type items for better focusing of the current study. The details of the changes were related to the findings and implementations from the pilot studies.

3.5.2 Rasch Method

The current study was a mixed methods approach and the quantitative research is dominant in the current research, Rasch method will be applied to analysis the quantitative data collected from the survey. Before the research results were finalized, a number of indices will be examined to validate the quality of the important scale and the adequacy scale.

The infit and outfit statistics measure the mean square error (MNSQ), the acceptable range should be fall between 0.5 – 1.5. The reliability of the scale which is defined by the proportion of true variance to observed variance, the Cronbach's alpha will be examined. The higher the number, the more confidence we can maintain the replicability. The separation coefficients and reliability index will be informative for the reliability of item and person measures. All the above figures will be started to evaluate from the pilot study stage as well as the main study to ensure the validity.

The test characteristic curve for each item will be plotted to ensure the quality of the scales, it shows the difference between the theoretical and the empirical for each item. The fitness of each item to the Rasch Model can be analysis microscopically. Another index will be examined is the Differential Item Functioning (DIF), the participants of the survey were coming from three different campuses. When an item's difficulty estimate varies to a certain extend from samples across different campuses, it is evidence as DIF exists. The contrast of the DIF between campuses reflects on the DIF measured value, a contrast values higher than 0.5 is assumed to be an existence of DIF between samples from different campuses.

3.5.3 Research Question 1: Importance of Core Competencies (Variable 1)

The important variable for the core competencies implies students' perceptions regarding their importance range from 1–4 for each item using the importance subscale of the survey. The numbers 0, 1, 2 and 3 represent four levels of importance, with 0 for "indifference", 1 for "better to be equipped", 2 for "should be equipped" and 3 for "must be equipped". An item with a higher score indicates that the item is more difficult and the competency is perceived as relatively important than items with a lower score. Rasch analysis was conducted to validate the assessment of importance of core competencies. Indices including person and item reliabilities, item difficulty, item fit and Differential Item Functioning (DIF) between campuses will be reported in the following sections.

3.5.3.1 Reliability of the Item and Person Measures (Variable 1)

Table 3.7 shows detailed figures for the reliability of the instrument; both the item reliability (0.96) and the person reliability (0.91) were statistically high, which implies that the reliability of the assessment tool is excellent. An item separation index of 5.12 suggests that the items could be separated into at least five groups according to the responses from students, while a person separation index of 3.23 implies that at least three student groups could be separated by the items. The internal consistency index of the Cronbach's alpha was 0.93, which shows that the scale has a high degree of internal consistency.

Table 3.7: Cronbach's Alpha and Rasch Reliabilities of the Importance Subscale (35 items)

Cronbach's Alpha	Rasch Separation		Rasch Reliability	
	Person	Item	Person	Item
0.93	3.23	5.12	0.91	0.96

3.5.3.2 Item Fit and Difficulty (Variable 1)

Table 3.8 shows the item measures as listed in column two, which ranged from -1.04–0.87 and therefore covered a wide array of students' attitudes. The results showed that a range from -1.04 logit for "Mission and Vision with the company unanimously" (item 7) to 0.87 logit for "Responsible attitudes" (item 4), it indicates the level of importance of the core competencies.

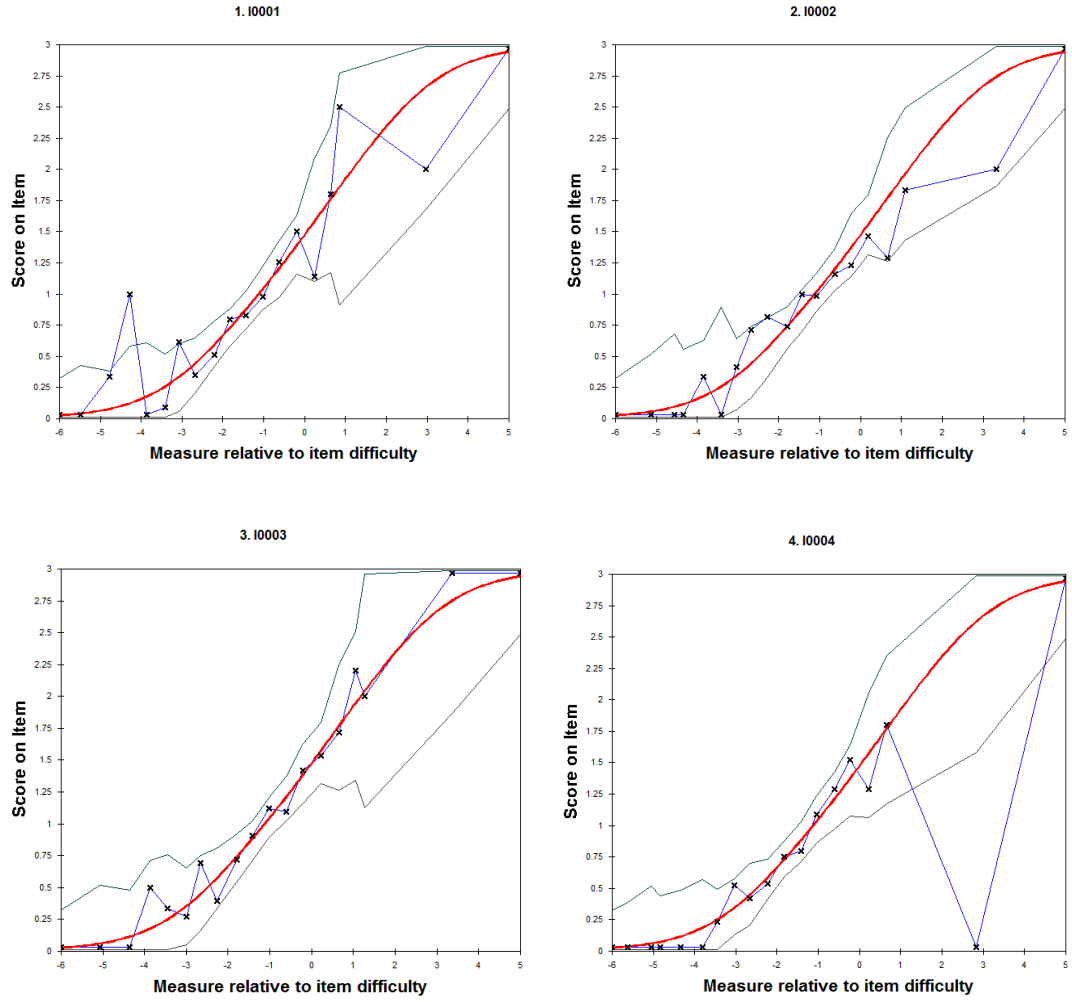
According to Linacre (2014), Infit and Outfit Mean Square Error (MNSQ) values between 0.5–1.5 indicates a good data-model fit. The fit statistics as listed in Table 3.8 ranged from 0.72–1.5, which suggested that all items well fit into the Rasch Model. The item, "attitude to prevent corruption" (item 18) was on the border of the results with an Infit MNSQ of 1.5 and an acceptable Outfit MNSQ of 1.47.

Table 3.8: Item Parameter Estimates (in logit) and Fit Statistics for the Importance Subscale

			Infit		Outfit	
	Measure	SE	MNSQ	ZSTD	MNSQ	ZSTD
Working attitude and Vocational Development (WA)						
1. Punctuality	0.74	0.09	1.34	4.2	1.41	4.9
2. Ability to follow insstructions	0.37	0.09	1.01	0.1	1.01	0.2
3. Discipline	0.32	0.09	1.00	0.0	1.00	0.0
4. Responsible attitudes	0.87	0.09	1.19	2.5	1.17	2.2
5. Strive to power upstream	-0.31	0.08	1.21	2.7	1.20	2.6
6. Work independently and strain	0.21	0.09	0.86	-2.0	0.89	-1.6
7. Mission and Vision with the company unanimously	-1.04	0.08	1.25	3.3	1.25	3.3
Information Technology Literacy (IT)						
8. Making multimedia for reporting	-0.55	0.10	0.82	-2.3	0.82	-2.3
9. Application of software	-0.13	0.10	0.84	-2.0	0.84	-2.0
10. Grasp information	-0.38	0.10	0.76	-3.1	0.76	-3.1
11. Create and integrate information	-0.03	0.10	0.81	-2.5	0.81	-2.4
12. Ability to analyze data	-0.05	0.10	0.68	-4.3	0.68	-4.3
13. Use of data in compliance	0.46	0.10	1.28	3.2	1.29	3.1
14. Safely use of data	0.45	0.10	0.99	-0.1	0.98	-0.2
Character Development and Citizenship (CC)						
15. Awareness of environmental protection	-0.50	0.08	1.10	1.4	1.09	1.2
16. Identification and awareness of Occupational Safety	0.76	0.09	1.00	0.0	0.97	-0.3
17. Respect for Intellectal Property	0.11	0.08	1.17	2.3	1.16	2.1
18. Prevention of corruption attitude	0.34	0.09	1.50	5.9	1.47	5.6
19. Ability to participate in society	-0.62	0.08	1.20	2.7	1.21	2.7
20. Respect for human rights and freedom	0.38	0.09	1.01	0.1	0.99	-0.2
21. Ethics and Social Responsibility	0.14	0.09	1.19	2.5	1.18	2.4
Creativity and Problem Solving (CP)						
22. Ability to use resources to innovation	-0.59	0.08	0.78	-3.2	0.78	-3.3
23. Independent research and development capacity	-0.73	0.08	0.96	-0.5	0.96	-0.6
24. Lenovo and imagination	-0.50	0.08	0.86	-2.0	0.85	-2.1
25. A keen awareness force	-0.18	0.08	0.80	-2.8	0.80	-2.9
26. Innovation and change in attitude	-0.49	0.08	0.86	-2.0	0.86	-2.0
27. The spirit of adventure challenge	-0.73	0.08	1.06	0.9	1.05	0.8
28. Ability to problem-solving	0.28	0.09	0.96	-0.5	0.95	-0.6
Communication (CO)						
29. Oral Expression	0.20	0.09	1.05	0.7	1.21	2.7
30. The ability to listen	0.25	0.09	0.84	-2.3	0.84	-2.3
31. The ability to use of language	0.12	0.08	0.86	-1.9	1.00	0.0
32. The ability to manage emotions	0.39	0.09	1.08	1.0	1.07	1.0
33. The ability of teamwork	0.40	0.09	0.85	-2.1	0.84	-2.3
34. Ability to lead the coordination	-0.21	0.08	0.94	-0.8	0.98	-0.3
35. The ability to human interaction	0.34	0.09	0.96	-0.5	1.17	2.2

3.5.3.3 Test characteristic curve (Variable 1)

Figures 3.2a – 3.2e show the test characteristic curve of the 35 core competencies corresponding to the 35 items classified by the five domains, which revealed the fitness between the theoretical and the empirical for each item.



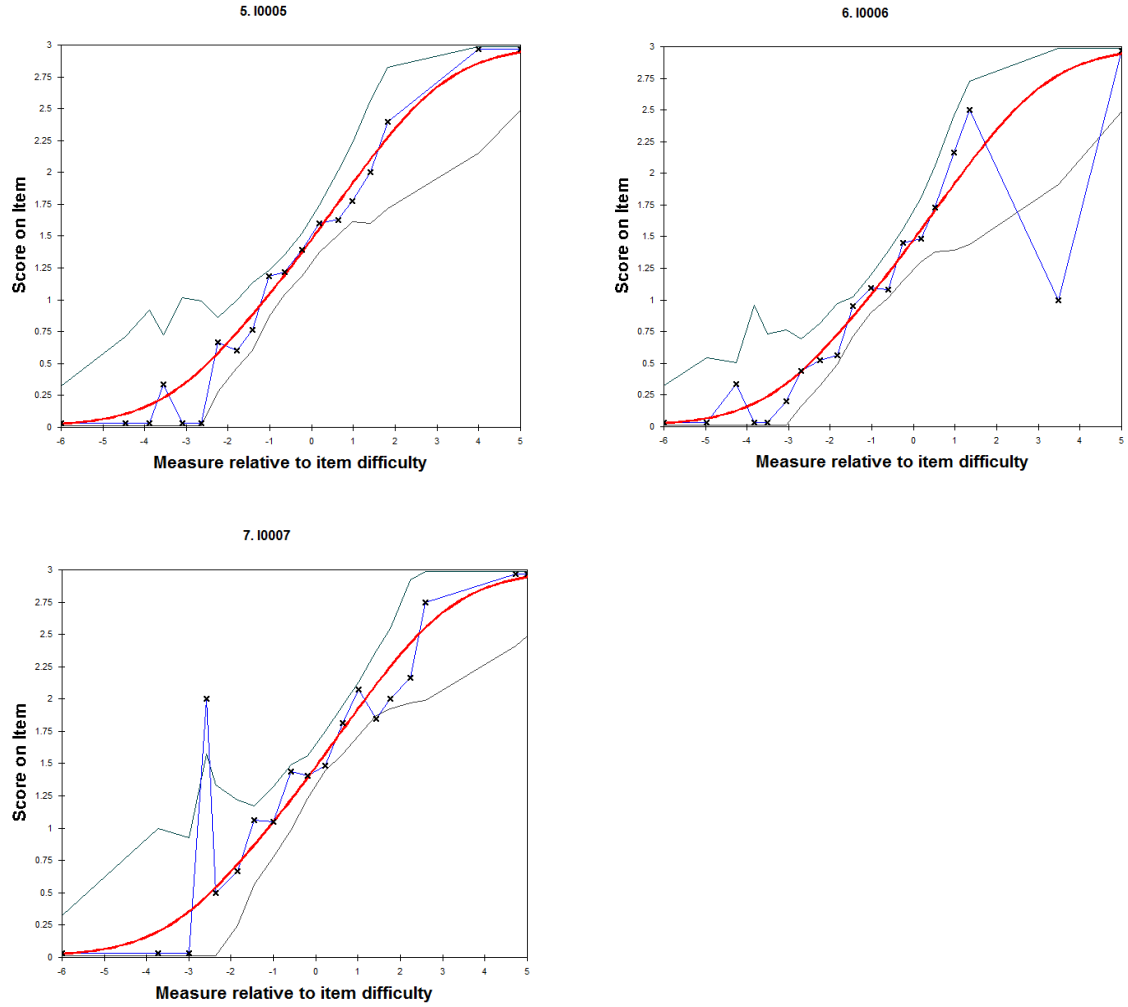
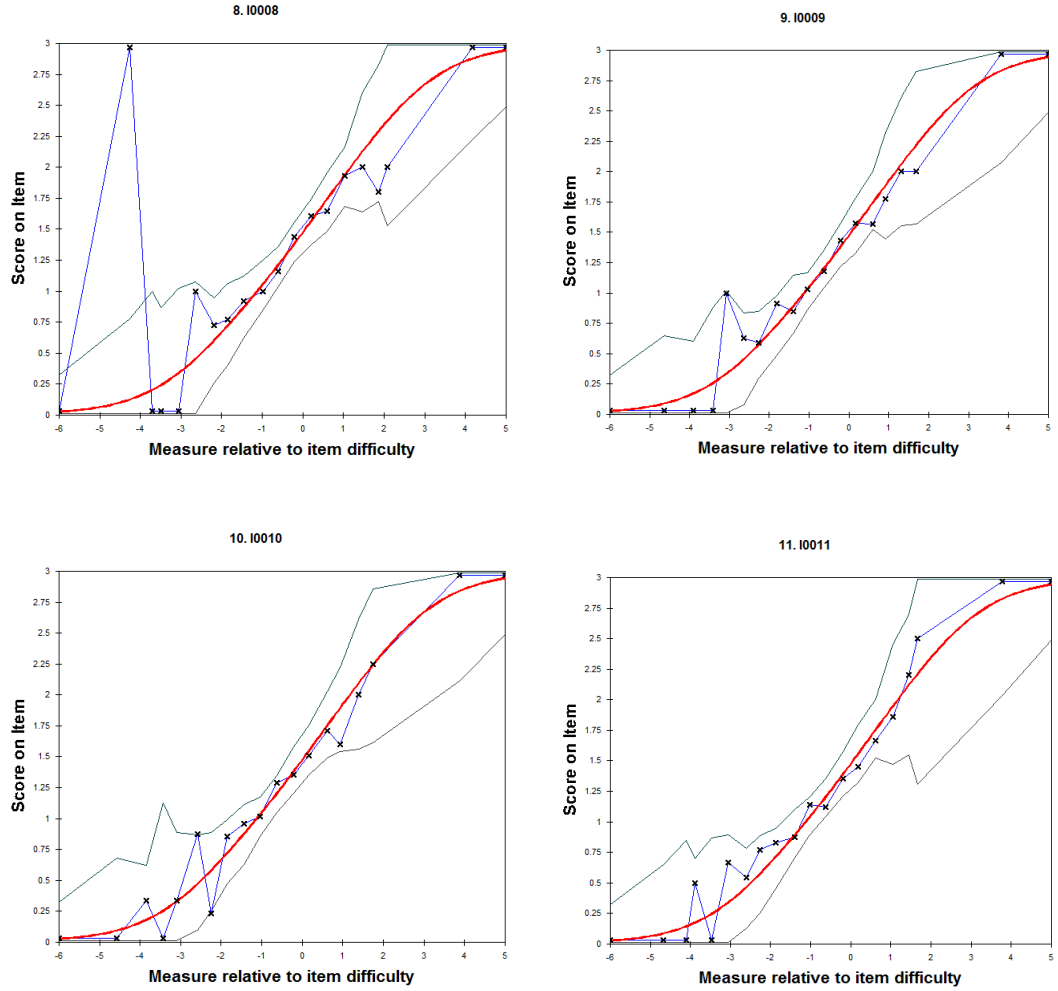


Figure 3.2a: Characteristic Curve of the Theoretical vs. the Empirical for Each Item Regarding the Importance of Core Competencies in the Working Attitude (WA) domain

The results showed that in the domain of "Work Attitude and Vocational Development", all seven figures representing items (item 1 – item 7) demonstrated the actual performance of 353 students fit to the Rasch Model. Most of the items within the WA domain fit the test characteristic curve except for "responsible attitudes" (item 4) and "work independently and adaptability" (item 6), which were unfit at a high score for item difficulty. There was also one

unfit low score for the item difficulty of "mission and vision with the company unanimously" (item 7) and one for the "attribute of punctuality" (item 1). Except the mentioned areas, most of the performance closed to the smooth Rasch modelled expectation.



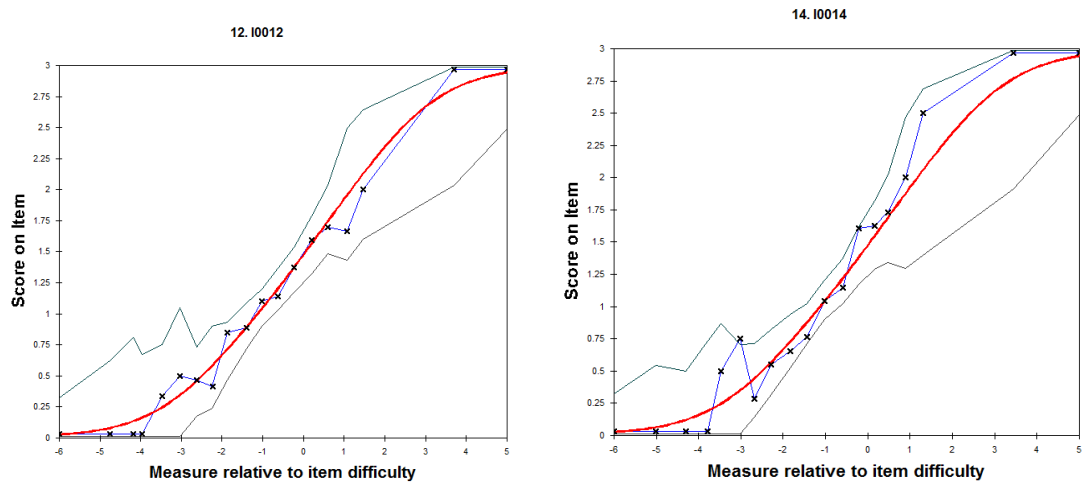
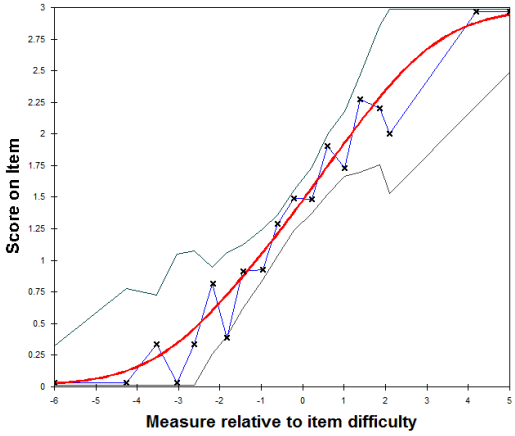


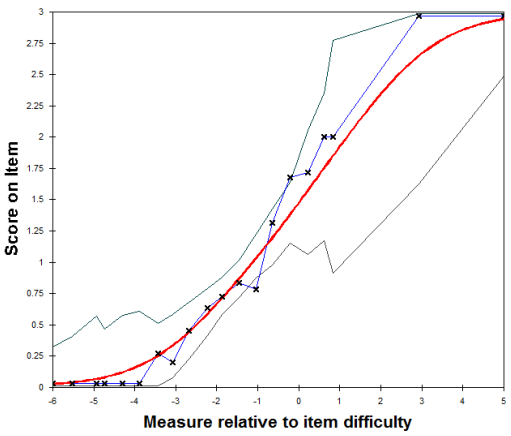
Figure 3.2b: Characteristic Curve of the Theoretical vs. the Empirical for Each Item on the Importance of Core Competencies in the Information Technology Literacy (IT) domain

The results showed that in the domain of "Information Technology Literacy", all seven figures representing items (item 8 – item 14) demonstrated the actual performance of 353 students fit to the Rasch Model. Most of the items within the domain of IT fit the test characteristic curve except for "making multimedia for reporting" (item 8), which showed an extremely unfit low score for item difficulty. Except the mentioned area, most of the performance closed to the smooth Rasch modelled expectation.

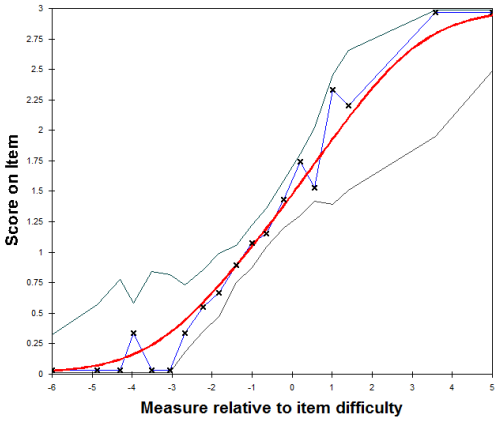
15. I0015



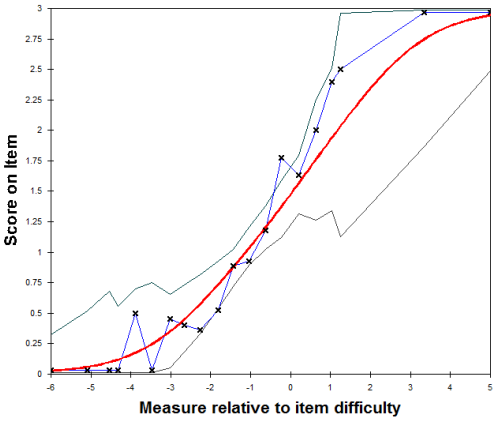
16. I0016



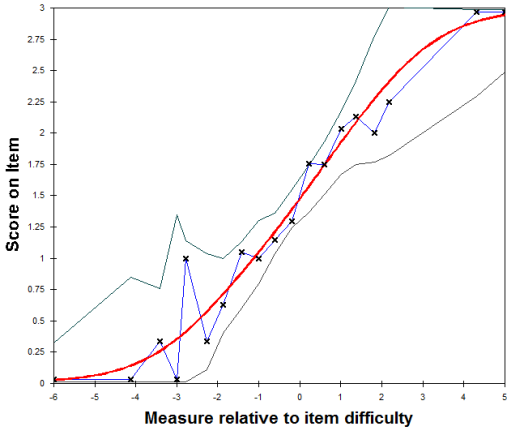
17. I0017



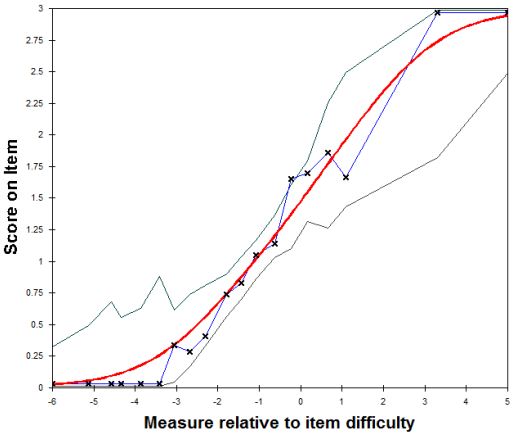
18. I0018



19. I0019



20. I0020



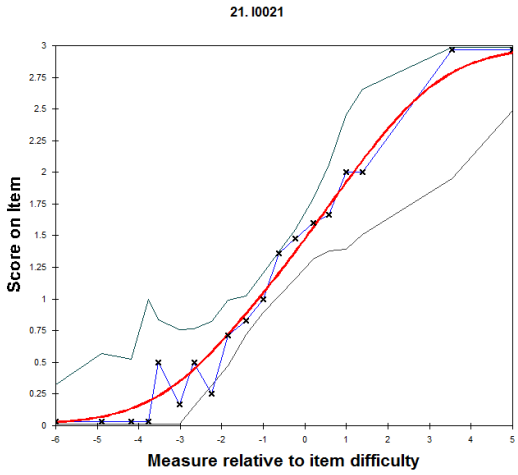
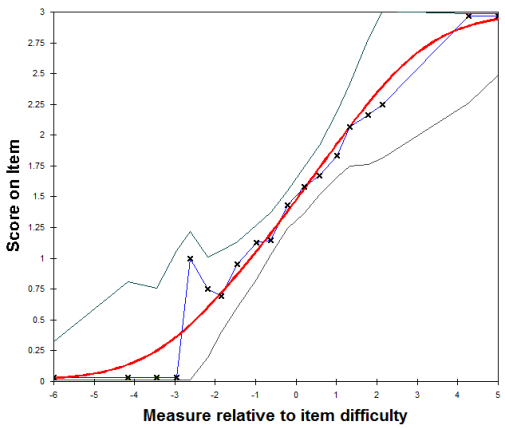


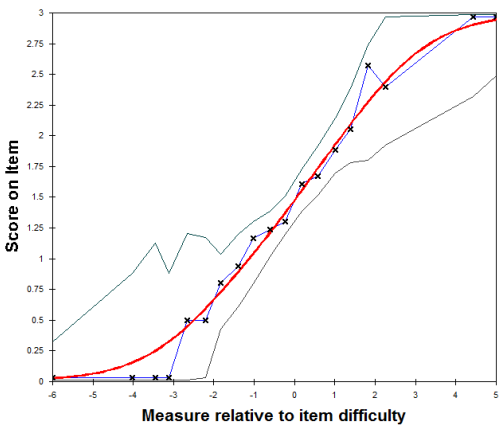
Figure 3.2c: The Characteristic Curve of the Theoretical vs. the Empirical for Each Item on the Importance of Core Competencies in the Character Development and Citizenship (CC) domain

The results showed that in the domain of "Character Development and Citizenship", all seven figures representing items (item 15 – item 21) demonstrated the actual performance of 353 students fit to the Rasch Model. Almost all of the items within the CC domain fit the test characteristic curve except "attitude to prevent corruption" (item 18). The "identification and awareness of occupational safety" (item 20) also showed a very slight unfit with a medium score and item difficulty. Except that slight unfit areas, most of the performance closed to the smooth Rasch modelled expectation.

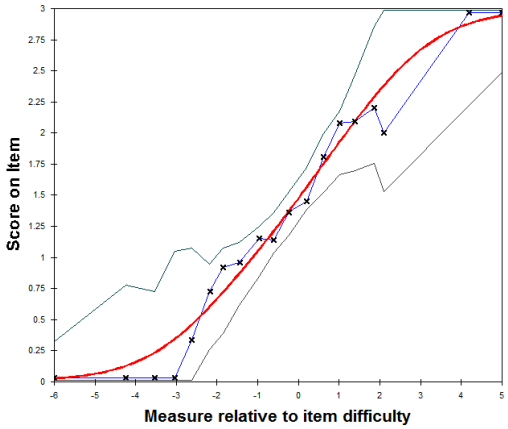
22. I0022



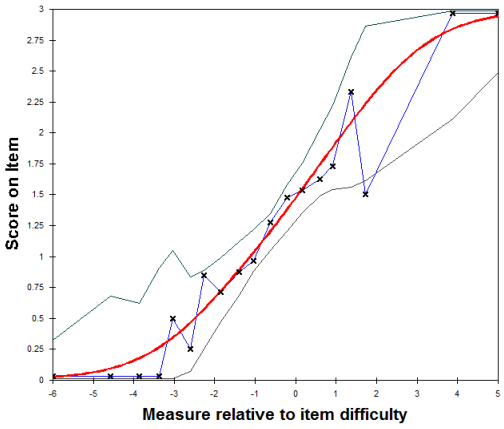
23. I0023



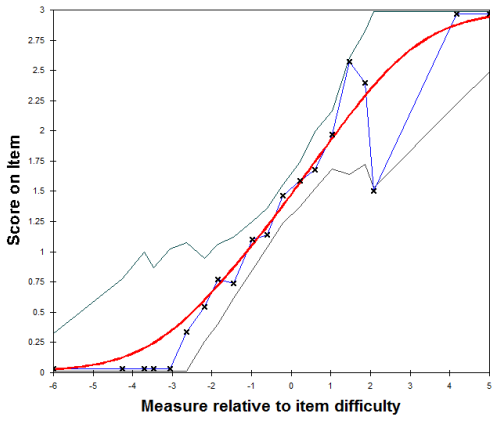
24. I0024



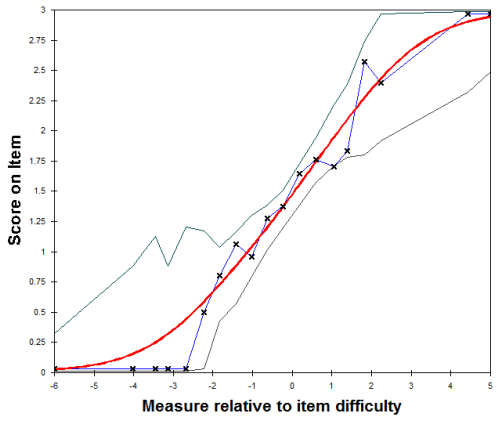
25. I0025



26. I0026



27. I0027



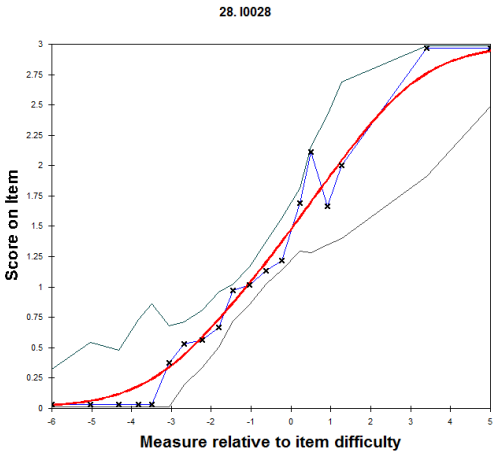
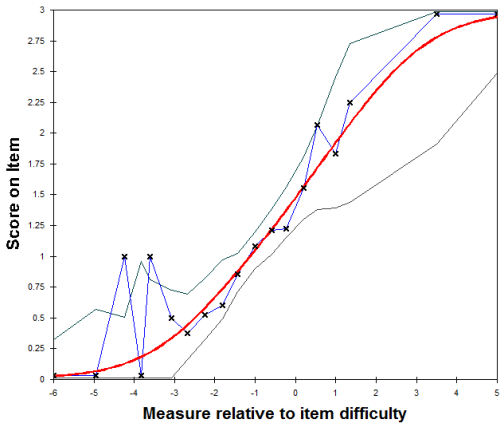


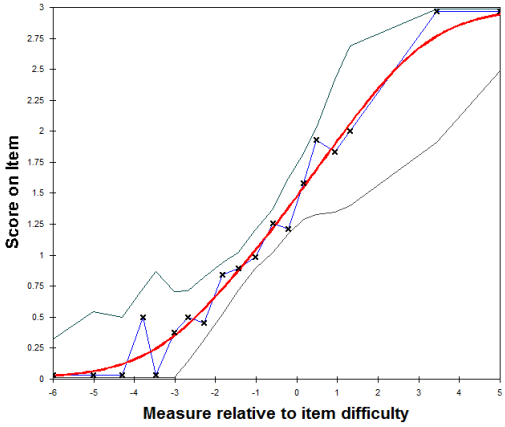
Figure 3.2d: A Characteristic Curve of the Theoretical vs. the Empirical for Each Item on the Importance of Core Competencies in the Creativity and Problem Solving (CP) domain.

The results showed that in the domain of "Creativity and Problem Solving", all seven figures representing items (item 22 – item 28) demonstrated the actual performance of 353 students fit to the Rasch Model. Most of the items within the CP domain fit the test characteristic curve except "a keen awareness force" (item 25), which showed a slightly unfit at high score for item difficulty. Except that slightly unfit area, most of the performance closed to the smooth Rasch modelled expectation.

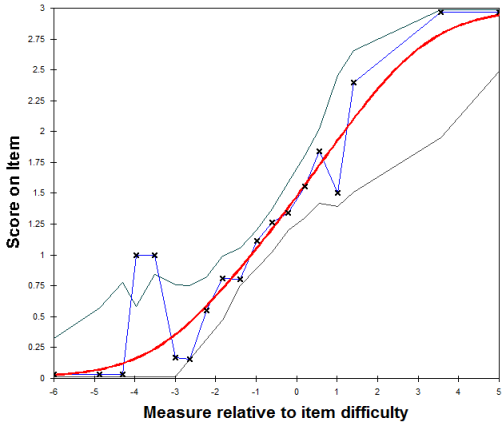
29. I0029



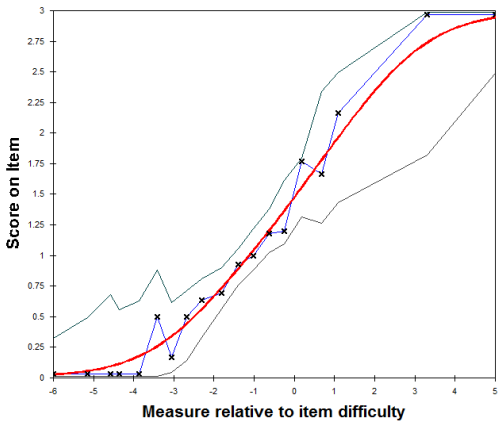
30. I0030



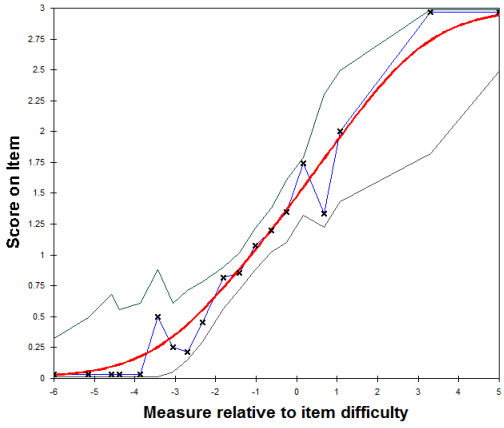
31. I0031



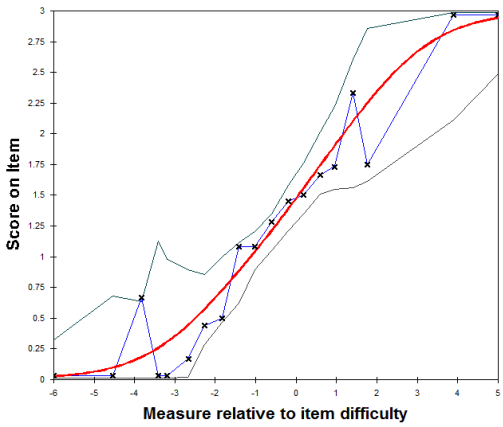
32. I0032



33. I0033



34. I0034



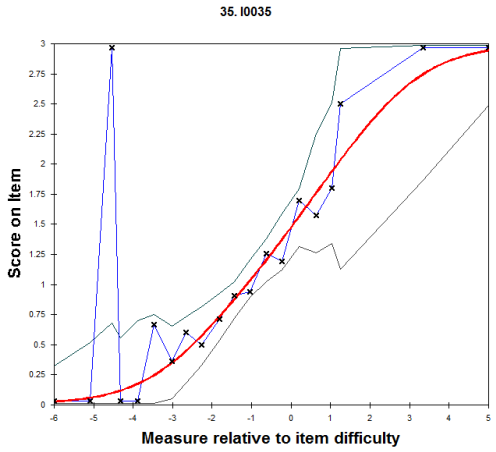


Figure 3.2e: A Characteristic Curve of the Theoretical vs. the Empirical for Each Item on the Importance of Core Competencies in the Communication (CO) domain.

The results showed that in the domain of "Communication", all seven figures representing items (item 29 – item 35) demonstrated the actual performance of 353 students fit to the Rasch Model. Most of the items within the CP domain fit the test characteristic curve except "oral expression" (item 29) and "use of language" (item 31), which had a slightly unfit at low score for item difficulty. "The synergy through human interaction" (item 35) showed an extremely unfit low score for item difficulty. Except the mentioned areas, most of the performance closed to the smooth Rasch modelled expectation.

In conclusion, all 35 items plotted points representing the sample of the actual 353 students' performance demonstrated a good fit to the Rasch Model, which is a smooth and ideal curve close to an impossible expectation.

3.5.3.4 Differential Item Functioning (Variable 1)

The results indicated the differential item functioning (DIF) between samples from three different campuses, which reveals the validity of the scale and the results extracted from this survey. Table 3.9 shows the DIF result between groups regarding students' perspectives of the importance of the 35 core competencies that correspond to 35 items. The difference in the DIF measures between campuses with values higher than 0.5 was classified as DIF exists. Column one of the table showed the content of each item; column two indicated the name of the campuses; column three were the DIF measure in the unit of logit for each campus; column five showed the name of two campuses for comparison while the last column demonstrated the difference of the DIF measure between these two campuses.

Table 3.9: DIF Between Students from Different Campuses Regarding the Importance of Core Competencies.

	Campus	DIF Measure (Logit)	DIF S.E. (Logit)	Campus vs Campus	Difference between Measure (Logit)
Working attitude and Vocational Development (WA)					
1. Punctuality	Chai Wan	0.58	0.21	CW vs HW	-0.18
	Haking	0.76	0.15	HW vs TY	-0.02
	Tsing Yi	0.78	0.13	TY vs CW	0.20
2. Ability to follow insstructions	Chai Wan	0.32	0.21	CW vs HW	-0.28
	Haking	0.60	0.15	HW vs TY	0.36
	Tsing Yi	0.24	0.12	TY vs CW	-0.08
3. Discipline	Chai Wan	0.45	0.21	CW vs HW	0.26
	Haking	0.19	0.15	HW vs TY	-0.19
	Tsing Yi	0.38	0.12	TY vs CW	-0.07
4. Responsible attitudes	Chai Wan	0.54	0.21	CW vs HW	-0.48
	Haking	1.02	0.15	HW vs TY	0.15
	Tsing Yi	0.87	0.13	TY vs CW	0.33
5. Strive to power upstream	Chai Wan	-0.11	0.2	CW vs HW	0.20
	Haking	-0.31	0.14	HW vs TY	0.05
	Tsing Yi	-0.36	0.12	TY vs CW	-0.25
6. Work independently and strain	Chai Wan	0.19	0.21	CW vs HW	-0.15
	Haking	0.34	0.15	HW vs TY	0.21
	Tsing Yi	0.13	0.12	TY vs CW	-0.06
7. Mission and Vision with the company unanimously	Chai Wan	-0.79	0.2	CW vs HW	-0.03
	Haking	-0.76	0.14	HW vs TY	**0.56**
	Tsing Yi	-1.32	0.12	TY vs CW	**-0.53**

	Campus	DIF Measure (Logit)	DIF S.E. (Logit)	Campus vs Campus	Difference between Measure (Logit)
Information Technology Literacy (IT)					
8. Making multimedia for reporting	Chai Wan	-0.35	0.2	CW vs HW	0.33
	Haking	-0.68	0.14	HW vs TY	-0.29
	Tsing Yi	-0.39	0.12	TY vs CW	-0.04
9. Application of software	Chai Wan	-0.20	0.2	CW vs HW	0.08
	Haking	-0.28	0.14	HW vs TY	-0.23
	Tsing Yi	-0.05	0.12	TY vs CW	0.15
10. Grasp information	Chai Wan	-0.40	0.2	CW vs HW	-0.21
	Haking	-0.19	0.14	HW vs TY	0.01
	Tsing Yi	-0.20	0.12	TY vs CW	0.20
11. Create and integrate information	Chai Wan	-0.23	0.2	CW vs HW	-0.15
	Haking	-0.08	0.14	HW vs TY	-0.06
	Tsing Yi	-0.02	0.12	TY vs CW	0.21
12. Ability to analyze data	Chai Wan	-0.02	0.2	CW vs HW	0.14
	Haking	-0.16	0.14	HW vs TY	-0.29
	Tsing Yi	0.13	0.12	TY vs CW	0.15
13. Use of data in compliance	Chai Wan	-0.11	0.2	CW vs HW	**-0.54**
	Haking	0.43	0.15	HW vs TY	0.08
	Tsing Yi	0.35	0.12	TY vs CW	0.46
14. Safely use of data	Chai Wan	0.14	0.21	CW vs HW	-0.21
	Haking	0.35	0.15	HW vs TY	0.12
	Tsing Yi	0.23	0.12	TY vs CW	0.09
Characteri Development and Citizenship (CC)					
15. Awareness of environmental protection	Chai Wan	-0.59	0.2	CW vs HW	0.09
	Haking	-0.68	0.14	HW vs TY	-0.34
	Tsing Yi	-0.34	0.12	TY vs CW	0.25
16. Identification and awareness of Occupational Safety	Chai Wan	0.52	0.21	CW vs HW	-0.34
	Haking	0.86	0.15	HW vs TY	0.10
	Tsing Yi	0.76	0.13	TY vs CW	0.24
17. Respect for Intellectal Property	Chai Wan	-0.07	0.2	CW vs HW	-0.22
	Haking	0.15	0.15	HW vs TY	0.00
	Tsing Yi	0.15	0.12	TY vs CW	0.22
18. Prevention of corruption attitude	Chai Wan	0.02	0.2	CW vs HW	**-0.58**
	Haking	0.60	0.15	HW vs TY	0.31
	Tsing Yi	0.29	0.12	TY vs CW	0.27
19. Ability to participate in society	Chai Wan	-0.47	0.2	CW vs HW	0.15
	Haking	-0.62	0.14	HW vs TY	0.04
	Tsing Yi	-0.66	0.12	TY vs CW	-0.19
20.Respect for human rights and freedom	Chai Wan	0.49	0.21	CW vs HW	0.17
	Haking	0.32	0.145	HW vs TY	-0.06
	Tsing Yi	0.38	0.12	TY vs CW	-0.11
21. Ethics and Social Responsibility	Chai Wan	0.36	0.21	CW vs HW	0.35
	Haking	0.01	0.14	HW vs TY	-0.13
	Tsing Yi	0.14	0.12	TY vs CW	-0.22

	Campus	DIF Measure (Logit)	DIF S.E. (Logit)	Campus vs Campus	Difference between Measure (Logit)
Creativity and Problem Solving (CP)					
22. Ability to use resources to innovation	Chai Wan	-0.47	0.2	CW vs HW	0.07
	Haking	-0.54	0.14	HW vs TY	0.12
	Tsing Yi	-0.66	0.12	TY vs CW	-0.19
23. Independent research and development capacity	Chai Wan	-0.79	0.2	CW vs HW	-0.11
	Haking	-0.68	0.14	HW vs TY	0.05
	Tsing Yi	-0.73	0.12	TY vs CW	0.06
24. Lenovo and imagination	Chai Wan	-0.50	0.2	CW vs HW	0.03
	Haking	-0.53	0.14	HW vs TY	-0.05
	Tsing Yi	-0.48	0.12	TY vs CW	0.02
25. A keen awareness force	Chai Wan	0.10	0.21	CW vs HW	0.28
	Haking	-0.18	0.14	HW vs TY	0.10
	Tsing Yi	-0.28	0.12	TY vs CW	-0.38
26. Innovation and change in attitude	Chai Wan	-0.27	0.2	CW vs HW	0.16
	Haking	-0.43	0.14	HW vs TY	0.18
	Tsing Yi	-0.61	0.12	TY vs CW	-0.34
27. The spirit of adventure challenge	Chai Wan	-0.75	0.2	CW vs HW	-0.13
	Haking	-0.62	0.14	HW vs TY	0.17
	Tsing Yi	-0.79	0.12	TY vs CW	-0.04
28. Ability to problem-solving	Chai Wan	0.36	0.21	CW vs HW	-0.07
	Haking	0.43	0.15	HW vs TY	0.27
	Tsing Yi	0.16	0.12	TY vs CW	-0.20
Communication (CO)					
29. Oral Expression	Chai Wan	0.45	0.21	CW vs HW	0.47
	Haking	-0.02	0.14	HW vs TY	-0.29
	Tsing Yi	0.27	0.12	TY vs CW	-0.18
30. The ability to listen	Chai Wan	0.27	0.21	CW vs HW	0.10
	Haking	0.17	0.15	HW vs TY	-0.13
	Tsing Yi	0.30	0.12	TY vs CW	0.03
31. The ability to use of language	Chai Wan	0.19	0.21	CW vs HW	0.02
	Haking	0.17	0.15	HW vs TY	0.11
	Tsing Yi	0.06	0.12	TY vs CW	-0.13
32. The ability to manage emotions	Chai Wan	0.36	0.21	CW vs HW	0.00
	Haking	0.36	0.15	HW vs TY	-0.06
	Tsing Yi	0.42	0.12	TY vs CW	0.06
33. The ability of teamwork	Chai Wan	0.27	0.21	CW vs HW	-0.01
	Haking	0.28	0.15	HW vs TY	-0.25
	Tsing Yi	0.53	0.12	TY vs CW	0.26
34. Ability to lead the coordination	Chai Wan	0.03	0.21	CW vs HW	0.33
	Haking	-0.30	0.14	HW vs TY	-0.09
	Tsing Yi	-0.21	0.12	TY vs CW	-0.24
35. The ability to human interaction	Chai Wan	0.27	0.21	CW vs HW	0.10
	Haking	0.17	0.15	HW vs TY	-0.33
	Tsing Yi	0.50	0.12	TY vs CW	0.23

The results indicated that most of the items were found to have no DIF when different students from the Chai Wan, Haking Wong and Tsing Yi Campuses were compared. There were a few exceptional cases, such as “mission and vision with the company unanimously” (item 7) and a difference of measure from the Tsing Yi campus at 0.56 and 0.53 to the Haking Wong campus and the Chai Wan campus, respectively. There was also a measurement discrepancy of 0.54 and 0.58 between the Haking Wong campus and the Chai Wan Campus for “use of data in compliance” (item 13) and “attitude to prevent corruption” (item 18), respectively. Since there were only 3.8% of items between campus that were observed with DIF, there was a less than 5% confident level. It was therefore concluded that there was no DIF for students from different campuses to the items regarding the importance of core competencies.

3.5.4 Research Question 2: Adequacy in Delivering Core Competencies (Variable 2)

The adequacy variable of core competencies implies students' perceptions on the adequacy range in delivering the HD programme from 1–4 for each item using the adequacy subscale of the survey. The numbers 0, 1, 2, and 3 represent four levels of adequacy: 0 for "not equipped at all", 1 for "slightly equipped", 2 for "equipped" and 3 for "well equipped". An item with a higher score is more difficult, and its associated competency is perceived as being relatively adequate than those items with a lower score. A Rasch analysis was conducted to validate the assessment of adequacy of core competencies. Indices including person and item reliabilities, item difficulty, item fit and DIF between campuses will be reported in the following sections.

3.5.4.1 Reliability of Item and Person Measures (Variable 2)

Table 3.10 shows detailed figures regarding the reliability of the instrument; both the item reliability (0.95) and the person reliability (0.95) were statistically high, which implies the reliability of the assessment tool is excellent. An item separation index of 4.46 suggests that the items can be separated into at least four groups according to the responses from students, while a person separation index of 4.19 implies at least four student groups can be separated by items. The internal consistency index of Cronbach's alpha was 0.96, which shows that the

scale has a high degree of internal consistency.

Table 3.10 Cronbach's Alpha and Rasch Reliabilities of the Adequacy Subscale (35 items)

Cronbach's Alpha	Rasch Separation		Rasch Reliability	
	Person	Item	Person	Item
0.96	4.19	4.46	0.95	0.95

3.5.4.2 Item Fit and Item Difficulty (Variable 2)

Table 3.11 shows the item measure of adequacy in delivering of the programme as listed in column two, which ranged from -0.72–0.96, and covered a wide array of students' attitudes. The results showed that a range from -0.72 logit for "Ability to participate in society" (item 19) to 0.96 logit for "Identification and awareness of Occupational Safety" (item 16), it indicates the level of adequacy in delivering of the core competencies by the programme.

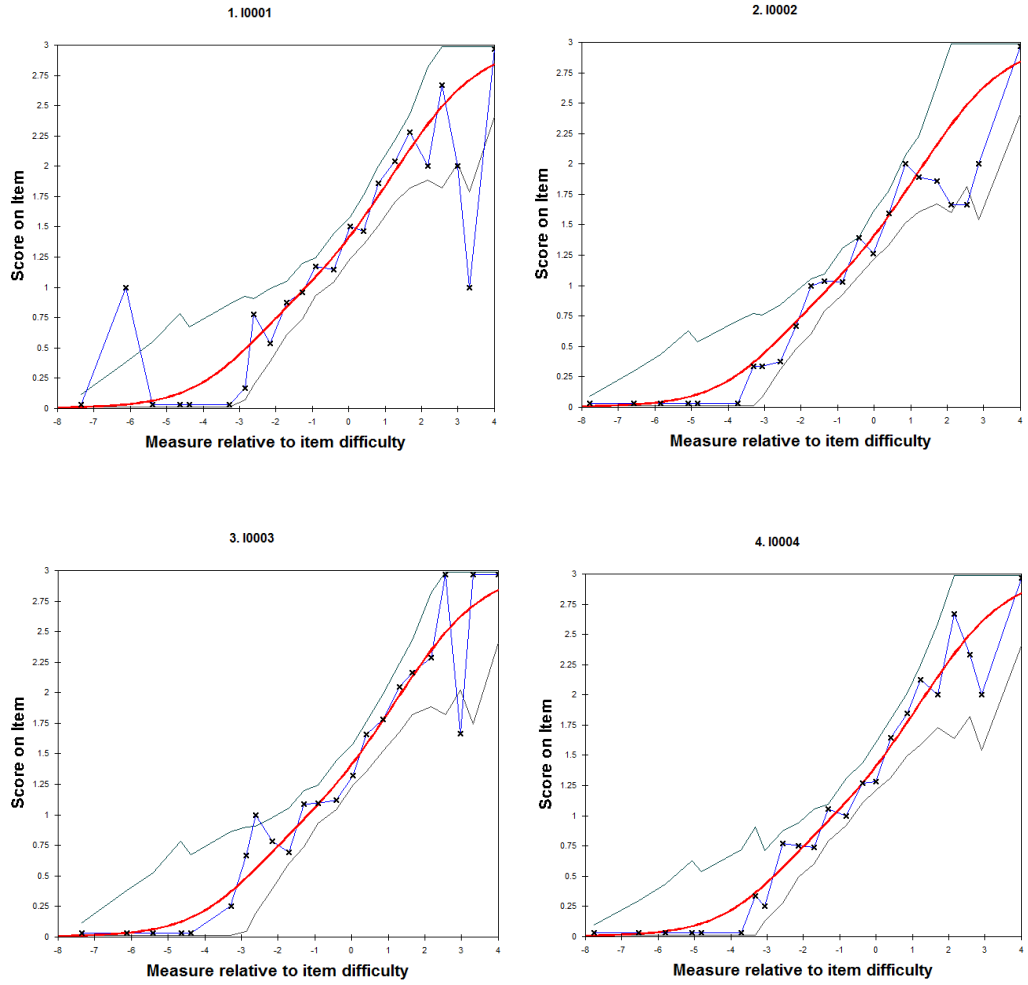
According to Linacre (2014), Infit and Outfit Mean Square Error (MNSQ) values between 0.5-1.5 indicates a good data-model fit. The fit statistics as listed in Table 3.11 ranged from 0.74–1.47 and the results showed that all items were well fit to the Rasch Model.

Table 3.11: Item Parameter Estimates (in logit) and Fit Statistics for the Adequacy Subscale

			Infit		Outfit	
	Measure	SE	MNSQ	ZSTD	MNSQ	ZSTD
Working attitude and Vocational Development (WA)						
1. Punctuality	-0.17	0.09	1.38	4.6	1.47	5.3
2. Ability to follow insstructions	0.28	0.09	0.95	-0.7	0.94	-0.7
3. Discipline	-0.16	0.09	0.90	-1.3	0.90	-1.3
4. Responsible attitudes	0.24	0.09	1.00	0.0	0.99	-0.1
5. Strive to power upstream	-0.28	0.09	1.14	1.9	1.12	1.5
6. Work independently and strain	0.35	0.09	0.89	-1.5	0.87	-1.7
7. Mission and Vision with the company unanimously	-0.64	0.09	1.18	2.4	1.17	2.1
Information Technology Literacy (IT)						
8. Making multimedia for reporting	0.54	0.09	0.98	-0.3	0.95	-0.5
9. Application of software	0.91	0.09	1.20	2.5	1.17	2.0
10. Grasp information	0.26	0.09	0.93	-0.8	0.92	-1.1
11. Create and integrate information	0.32	0.09	0.89	-1.4	0.87	-1.7
12. Ability to analyze data	0.37	0.09	0.77	-3.3	0.77	-3.0
13. Use of data in compliance	0.05	0.09	1.01	0.1	0.98	-0.2
14. Safely use of data	0.03	0.09	1.07	1.0	1.07	0.8
Character Development and Citizenship (CC)						
15. Awareness of environmental protection	-0.50	0.09	1.09	1.2	1.07	0.9
16. Identification and awareness of Occupational Safety	0.96	0.09	1.32	3.8	1.28	3.0
17. Respect for Intellectal Property	-0.29	0.09	1.20	2.5	1.22	2.7
18. Prevention of corruption attitude	-0.63	0.09	1.32	4.1	1.29	3.6
19. Ability to participate in society	-0.72	0.09	1.03	0.4	0.98	-0.2
20. Respect for human rights and freedom	-0.51	0.09	1.01	0.2	1.02	0.3
21. Ethics and Social Responsibility	-0.49	0.09	1.00	0.0	0.97	-0.4
Creativity and Problem Solving (CP)						
22. Ability to use resources to innovation	-0.35	0.09	0.76	-3.5	0.74	-3.7
23. Independent research and development capacity	-0.44	0.09	0.83	-2.5	0.82	-2.5
24. Lenovo and imagination	-0.14	0.09	0.91	-1.2	0.92	-1.1
25. A keen awareness force	-0.14	0.09	0.81	-2.7	0.81	-2.6
26. Innovation and change in attitude	-0.36	0.09	0.85	-2.2	0.86	-1.9
27. The spirit of adventure challenge	-0.28	0.09	0.92	-1.1	0.91	-1.1
28. Ability to problem-solving	0.33	0.09	0.90	-1.4	0.90	-1.3
Communication (CO)						
29. Oral Expression	0.23	0.09	0.90	-1.3	0.91	-1.1
30. The ability to listen	0.12	0.09	0.93	-0.9	1.10	1.2
31. The ability to use of language	0.30	0.09	0.84	-2.2	0.87	-1.7
32. The ability to manage emotions	-0.13	0.09	1.11	1.5	1.12	1.5
33. The ability of teamwork	0.44	0.09	0.89	-1.5	0.87	-1.7
34. Ability to lead the coordination	-0.02	0.09	0.83	-2.3	0.81	-2.5
35. The ability to human interaction	0.53	0.09	0.92	-1.0	0.91	-1.1

3.5.4.3 Test Characteristic Curve (Variable 2)

Figures 3.3a – 3.3e show the test characteristic curves of the adequacy in delivering the 35 core competencies that correspond to 35 items classified by the five domains. They also show the fitness between the theoretical and the empirical for each item.



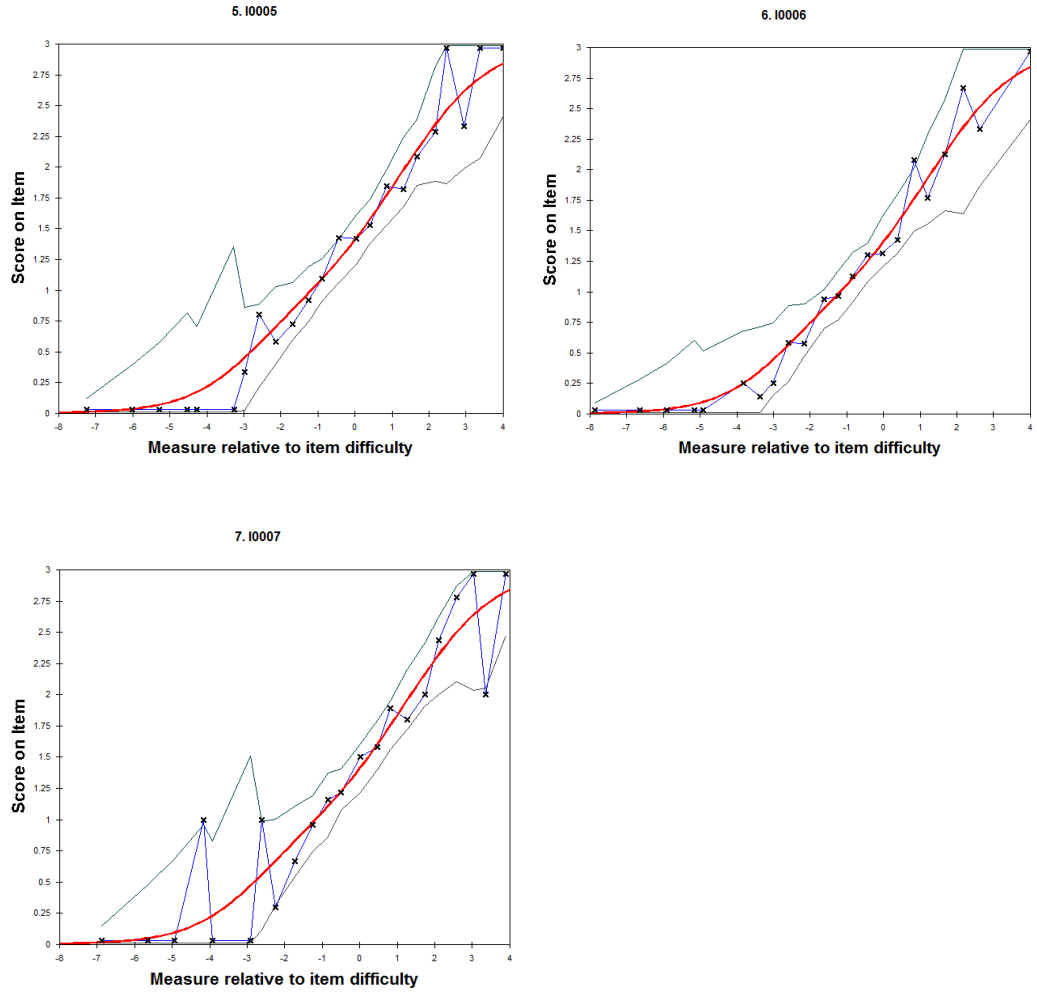
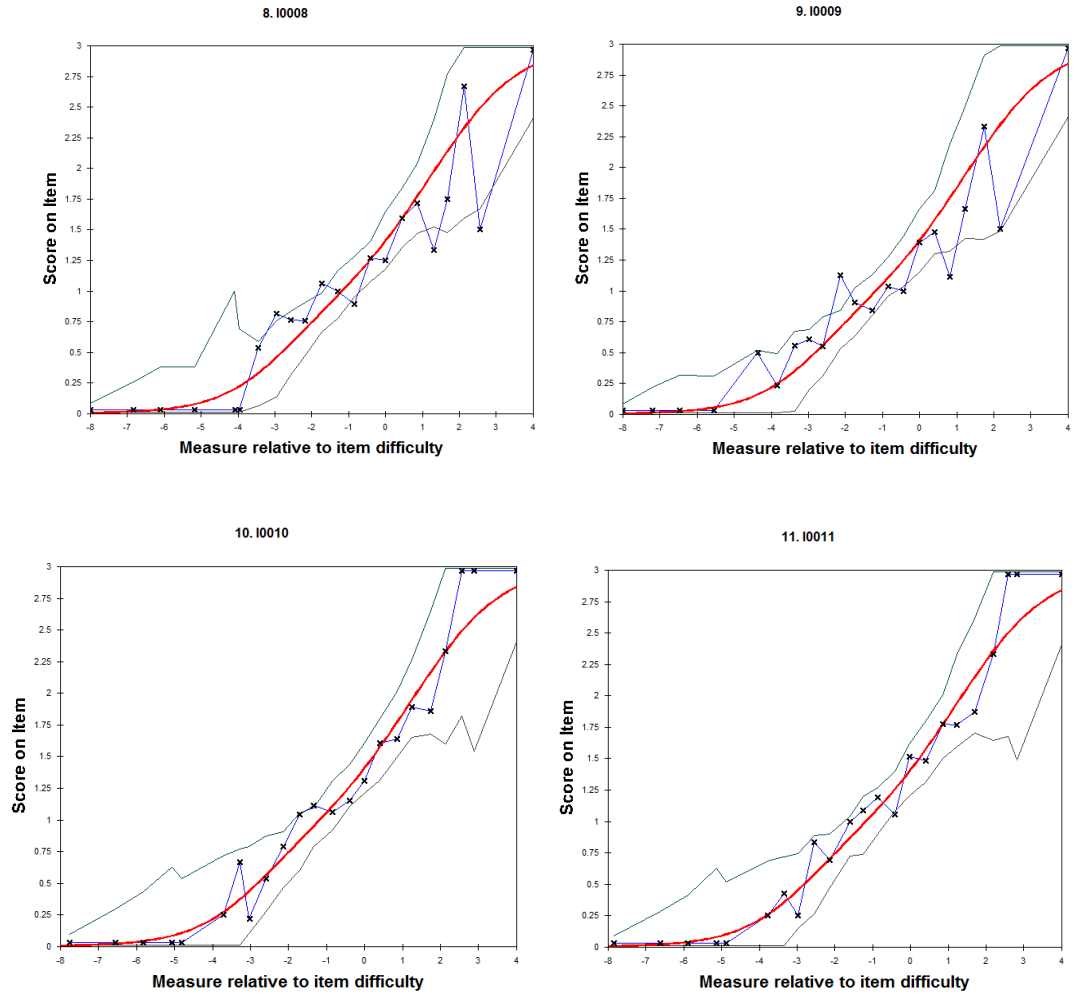


Figure 3.3a: Characteristic Curve of the Theoretical vs. the Empirical for Each Item on the Adequacy of Core Competencies in the Working Attitude (WA) domain

The results showed that in the domain of "Work Attitude and Vocational Development", all seven figures representing items (item 1 – item 7) demonstrated the actual performance of 353 students fit to the Rasch Model. Most of the items within the WA domain fit the test characteristic curve except for "attribute of punctuality" (item 1), which showed a score that was unfit at low and high to determine the item difficulty; "attribute of discipline" (item 3)

indicated a slightly unfit at medium and high score compared with the item difficulty; "mission and vision with the company unanimously" (item 7) revealed a very slightly unfit at low score compared to the item difficulty. Except the mentioned areas, most of the performance closed to the smooth Rasch modelled expectation.



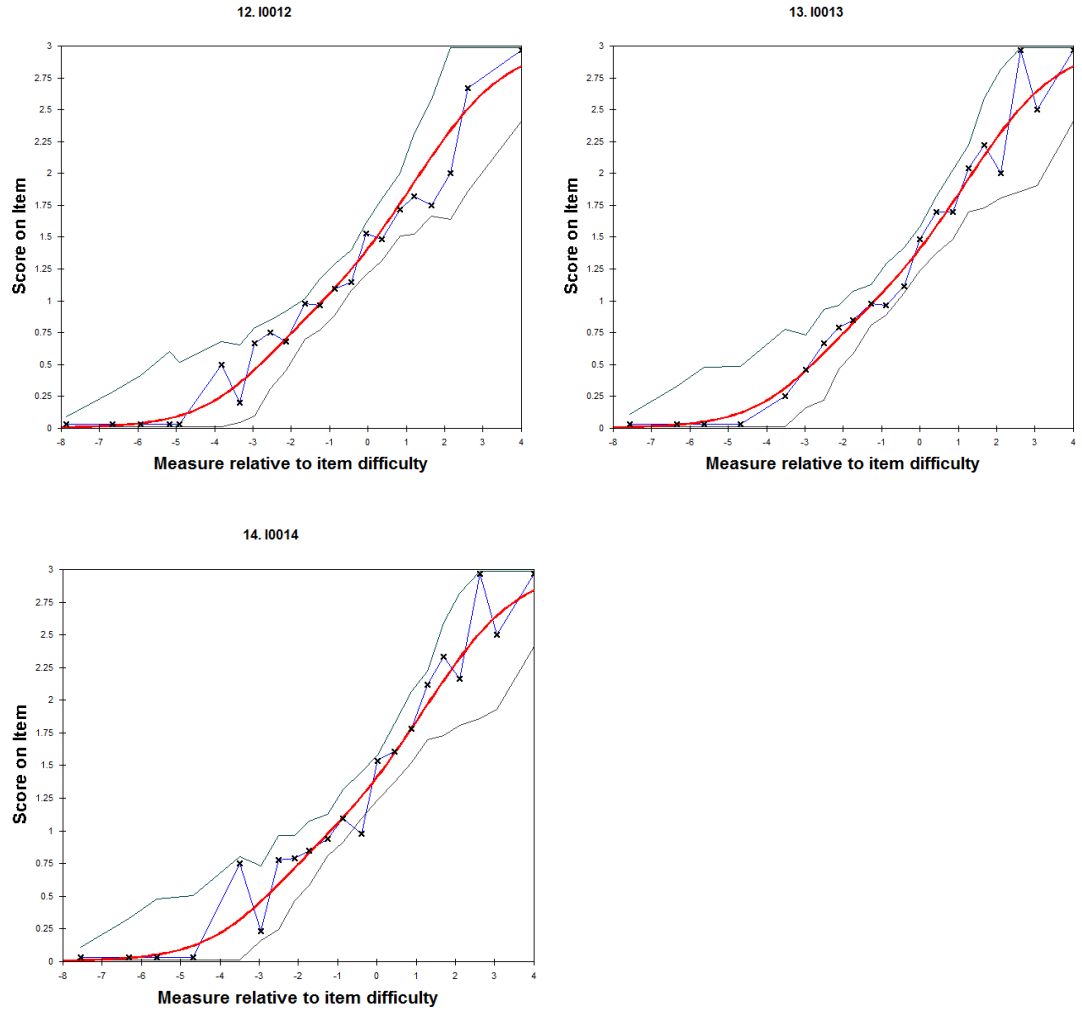
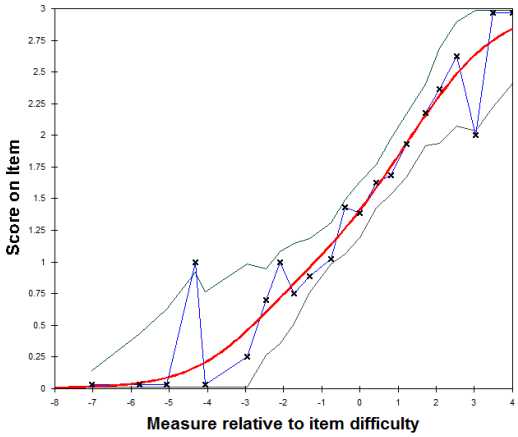


Figure 3.3b: Characteristic Curve of the Theoretical vs. the Empirical for Each Item on the Adequacy of Core Competencies in the Application of Information Technology (IT) domain

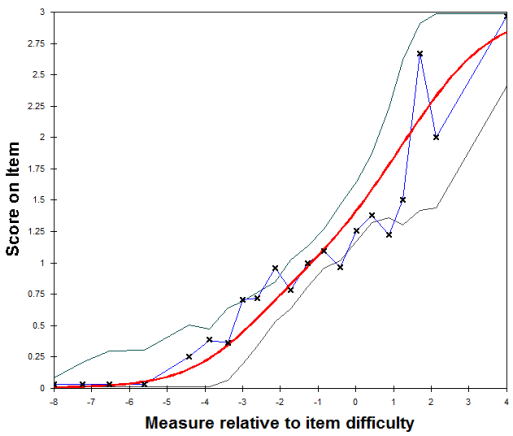
The results showed that in the domain of "Information Technology Literacy", all seven figures representing items (item 8 – item 14) demonstrated the actual performance of 353 students fit to the Rasch Model. Most items within the domain of IT fit the test characteristic curve except for "making multimedia for reporting" (item 8) and "capability in application of software" (item 14), which showed slightly unfit scores for item difficulty. "Safely use data"

(item 9) also produced a very slightly unfit at medium score for item difficulty. Except that slightly unfit areas, most of the performance closed to the smooth Rasch modelled expectation.

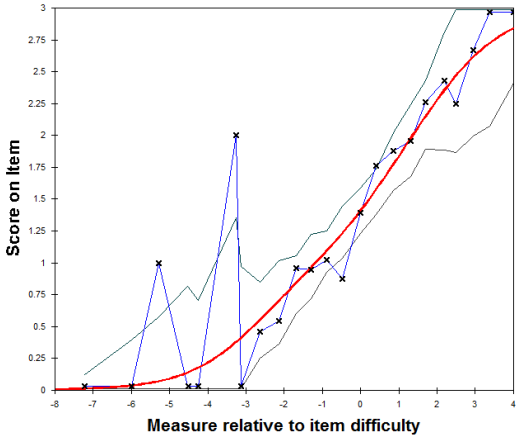
15. I0015



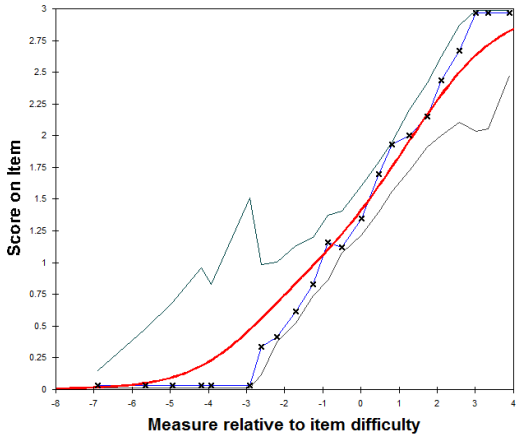
16. I0016



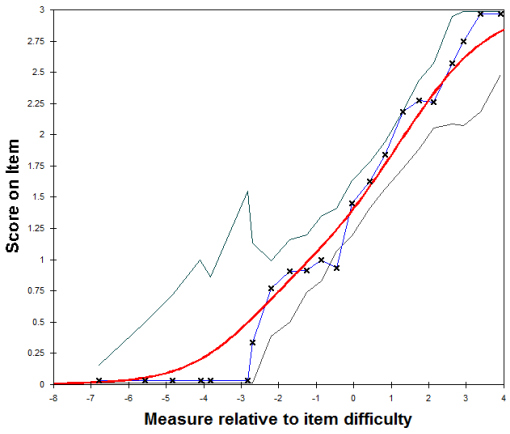
17. I0017



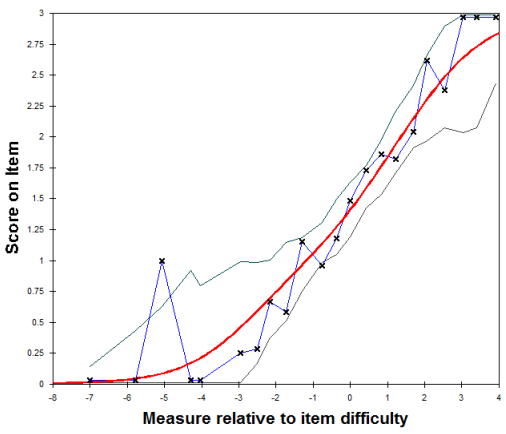
18. I0018



19. I0019



20. I0020



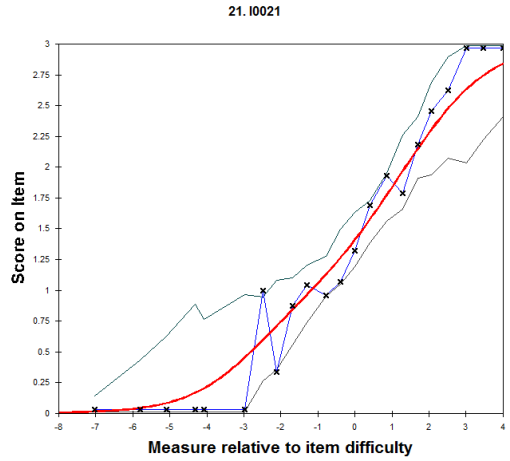
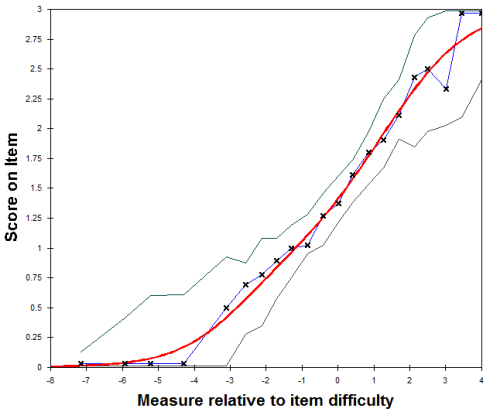


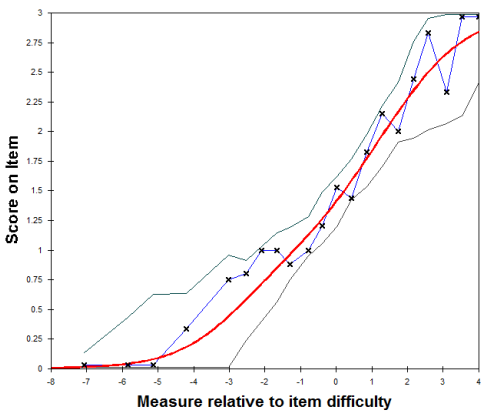
Figure 3.3c: Characteristic Curve of the Theoretical vs. the Empirical for Each Item on the Adequacy of Core Competencies in the Character Development and Citizenship (CC) domain

The results showed that in the domain of "Character Development and Citizenship", all seven figures representing items (item 15 – item 21) demonstrated the actual performance of 353 students fit to the Rasch Model. Most of the items within the CC domain fit the test characteristic curve except "respect to intellectual property" (item 17), which was unfit at low to medium score for item difficulty; "awareness of environmental protection" (item 15), "identification and awareness of occupational safety" (item 16) and "respect to human rights and freedom" (item 20) dimensions showed slightly unfit at low score compared to the item difficulty. Except the mentioned areas, most of the performance closed to the smooth Rasch modelled expectation.

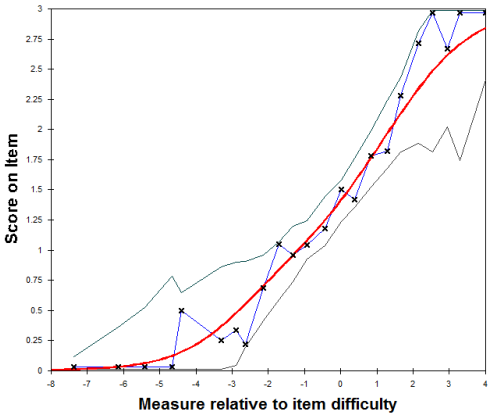
22. I0022



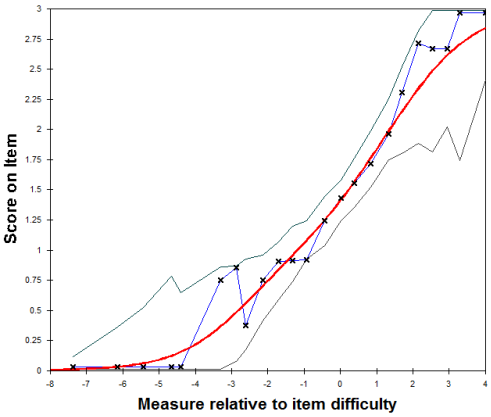
23. I0023



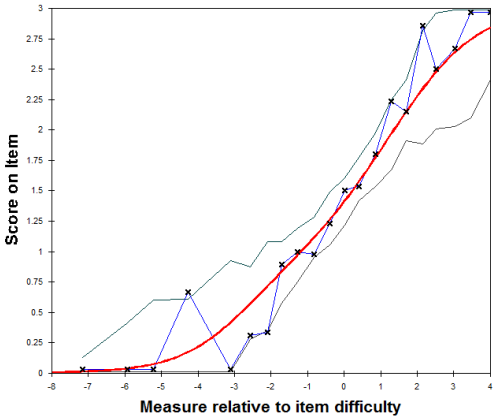
24. I0024



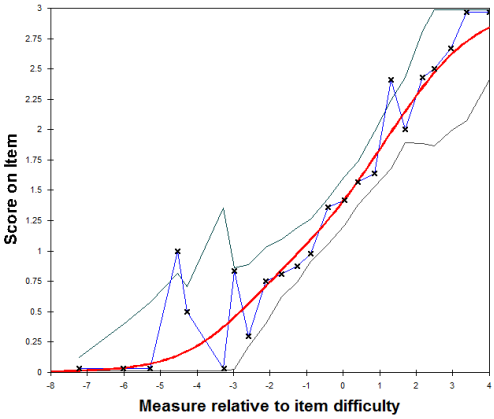
25. I0025



26. I0026



27. I0027



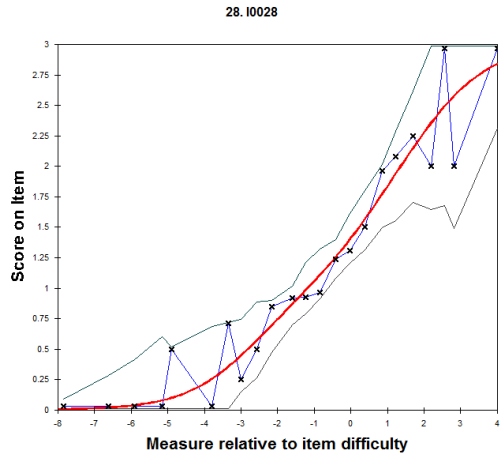
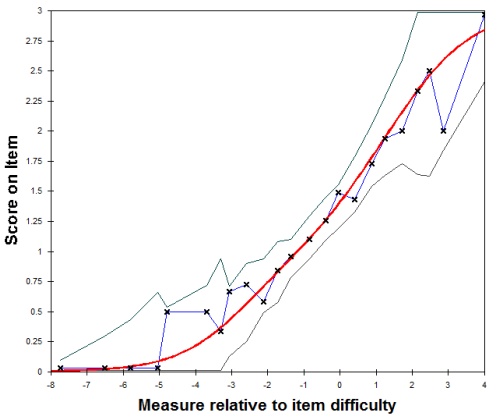


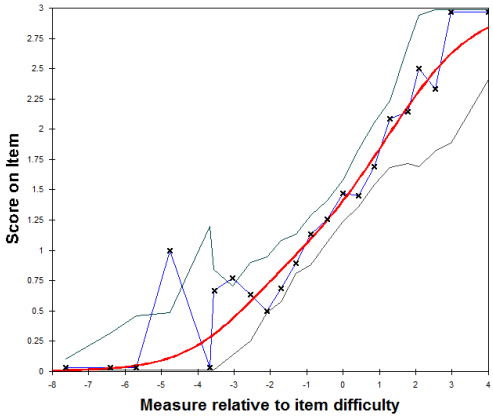
Figure 3.3d: Characteristic Curve of the Theoretical vs. the Empirical for Each Item on the Adequacy of Core Competencies in the Creativity and Problem Solving (CP) domain

The results showed that in the domain of "Creativity and Problem Solving", all seven figures representing items (item 22 – item 28) demonstrated the actual performance of 353 students fit to the Rasch Model. Most items within the CP domain fit the test characteristic curve except "attitude in innovation and change" (item 26) and "the spirit of adventure and challenge" (item 27), which show a very slight unfit low and high score for the item difficulty. Except that slightly unfit areas, most of the performance closed to the smooth Rasch modelled expectation.

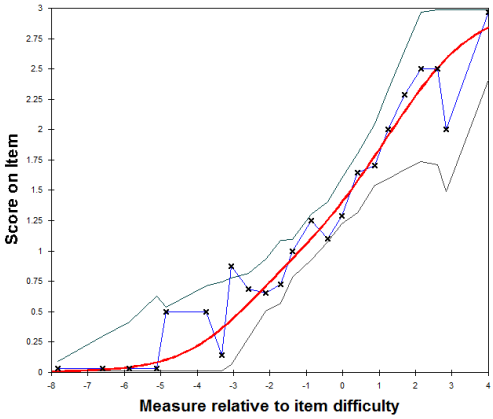
29. I0029



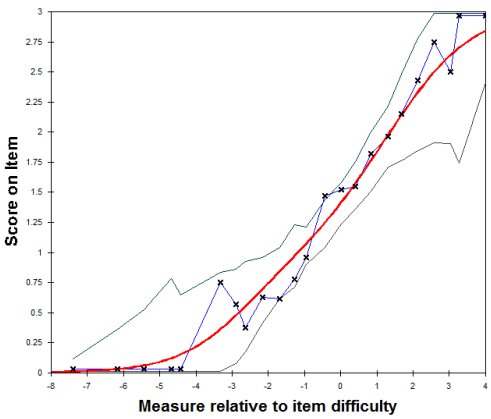
30. I0030



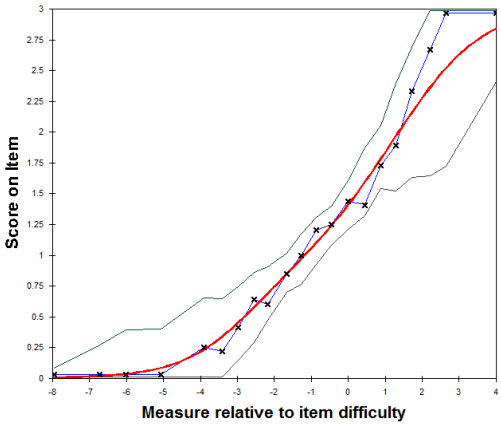
31. I0031



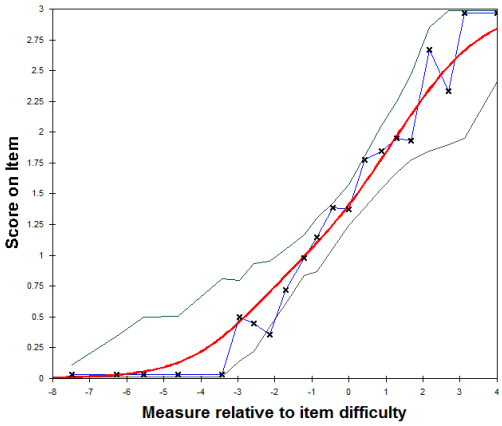
32. I0032



33. I0033



34. I0034



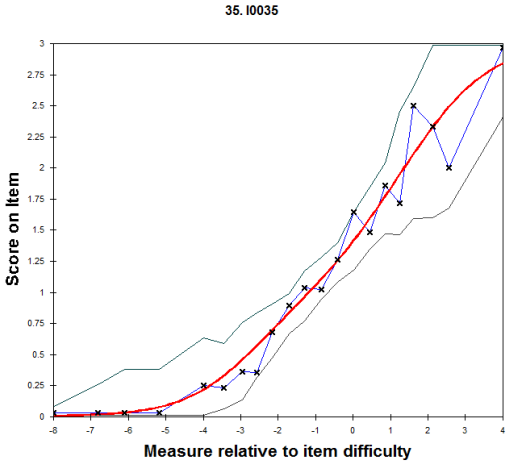


Figure 3.3e: Characteristic Curve of the Theoretical vs. the Empirical for Each Item on the Adequacy of Core Competencies in the Communication (CO) domain

The results showed that in the domain of "Communication", all seven figures representing items (item 29 – item 35) demonstrated the actual performance of 353 students fit to the Rasch Model. Most of the items within the CP domain fit the test characteristic curve except "the capability in listening" (item 30) and "use of language" (item 31), which showed a slight unfit at low score for the item difficulty. Except that slightly unfit areas, most of the performance closed to the smooth Rasch modelled expectation.

In conclusion, all 35 items plotted points representing the sample of the actual 353 students' performance demonstrated a good fit to the Rasch Model, which is a smooth and ideal curve close to an impossible expectation.

3.5.4.4 Differential Item Functioning (Variable 2)

The results indicated the DIF between samples for the three different campuses, which reveals the validity of the scale and the results extracted from this survey. Table 3.12 shows the DIF result between groups regarding students' perspectives of the importance of the 35 core competencies that correspond to 35 items. The difference in the DIF measures between campuses with values higher than 0.5 was classified as DIF exists. Column one of the table showed the content of each item; column two indicated the name of the campuses; column three were the DIF measure in the unit of logit for each campus; column five showed the name of two campuses for comparison while the last column demonstrated the difference of the DIF measure between these two campuses.

Table 3.12: DIF Between Students from Different Campuses Regarding the Adequacy in Delivering Core Competencies.

	Campus	DIF Measure (Logit)	DIF S.E. (Logit)	Campus vs Campus	Difference between Measure (Logit)
Working attitude and Vocational Development (WA)					
1. Punctuality	Chai Wan	-0.32	0.21	CW vs HW	-0.22
	Haking	-0.10	0.15	HW vs TY	0.07
	Tsing Yi	-0.17	0.13	TY vs CW	0.15
2. Ability to follow insstructions	Chai Wan	0.35	0.22	CW vs HW	0.02
	Haking	0.33	0.16	HW vs TY	0.11
	Tsing Yi	0.22	0.13	TY vs CW	-0.13
3. Discipline	Chai Wan	0.10	0.22	CW vs HW	0.39
	Haking	-0.29	0.15	HW vs TY	-0.13
	Tsing Yi	-0.16	0.13	TY vs CW	-0.26
4. Responsible attitudes	Chai Wan	0.30	0.22	CW vs HW	-0.03
	Haking	0.33	0.16	HW vs TY	0.16
	Tsing Yi	0.17	0.13	TY vs CW	-0.13
5. Strive to power upstream	Chai Wan	-0.32	0.21	CW vs HW	-0.04
	Haking	-0.28	0.15	HW vs TY	0.00
	Tsing Yi	-0.28	0.13	TY vs CW	0.04
6. Work independently and strain	Chai Wan	0.35	0.22	CW vs HW	-0.06
	Haking	0.41	0.16	HW vs TY	0.09
	Tsing Yi	0.32	0.13	TY vs CW	-0.03
7. Mission and Vision with the company unanimously	Chai Wan	-0.17	0.22	CW vs HW	0.35
	Haking	-0.52	0.15	HW vs TY	0.36
	Tsing Yi	-0.88	0.12	TY vs CW	**-0.71**

	Campus	DIF Measure (Logit)	DIF S.E. (Logit)	Campus vs Campus	Difference between Measure (Logit)
Information Technology Literacy (IT)					
8. Making multimedia for reporting	Chai Wan	0.54	0.23	CW vs HW	0.21
	Haking	0.33	0.16	HW vs TY	-0.34
	Tsing Yi	0.67	0.13	TY vs CW	0.13
9. Application of software	Chai Wan	0.96	0.23	CW vs HW	0.21
	Haking	0.75	0.16	HW vs TY	-0.25
	Tsing Yi	1.00	0.13	TY vs CW	0.04
10. Grasp information	Chai Wan	0.45	0.22	CW vs HW	0.39
	Haking	0.06	0.16	HW vs TY	-0.26
	Tsing Yi	0.32	0.13	TY vs CW	-0.13
11. Create and integrate information	Chai Wan	0.40	0.22	CW vs HW	0.17
	Haking	0.23	0.16	HW vs TY	-0.13
	Tsing Yi	0.36	0.13	TY vs CW	-0.04
12. Ability to analyze data	Chai Wan	0.25	0.22	CW vs HW	0.05
	Haking	0.20	0.16	HW vs TY	-0.32
	Tsing Yi	0.52	0.13	TY vs CW	0.27
13. Use of data in compliance	Chai Wan	0.25	0.22	CW vs HW	0.50
	Haking	-0.25	0.15	HW vs TY	-0.44
	Tsing Yi	0.19	0.13	TY vs CW	-0.06
14. Safely use of data	Chai Wan	0.30	0.22	CW vs HW	0.42
	Haking	-0.12	0.15	HW vs TY	-0.15
	Tsing Yi	0.03	0.13	TY vs CW	-0.27
Characteri Development and Citizenship (CC)					
15. Awareness of environmental protection	Chai Wan	-0.58	0.21	CW vs HW	-0.17
	Haking	-0.41	0.15	HW vs TY	0.13
	Tsing Yi	-0.54	0.12	TY vs CW	0.04
16. Identification and awareness of Occupational Safety	Chai Wan	0.80	0.23	CW vs HW	0.08
	Haking	0.72	0.16	HW vs TY	-0.47
	Tsing Yi	1.19	0.14	TY vs CW	0.39
17. Respect for Intellectal Property	Chai Wan	-0.43	0.21	CW vs HW	-0.16
	Haking	-0.27	0.15	HW vs TY	-0.01
	Tsing Yi	-0.26	0.13	TY vs CW	0.17
18. Prevention of corruption attitude	Chai Wan	-0.54	0.21	CW vs HW	0.07
	Haking	-0.61	0.15	HW vs TY	0.07
	Tsing Yi	-0.68	0.13	TY vs CW	-0.14
19. Ability to participate in society	Chai Wan	-0.66	0.21	CW vs HW	-0.02
	Haking	-0.64	0.15	HW vs TY	0.16
	Tsing Yi	-0.80	0.12	TY vs CW	-0.14
20.Respect for human rights and freedom	Chai Wan	-0.09	0.22	CW vs HW	**0.54**
	Haking	-0.63	0.15	HW vs TY	-0.06
	Tsing Yi	-0.57	0.12	TY vs CW	-0.48
21. Ethics and Social Responsibility	Chai Wan	-0.04	0.22	CW vs HW	0.45
	Haking	-0.49	0.15	HW vs TY	0.15
	Tsing Yi	-0.64	0.12	TY vs CW	**-0.60**

	Campus	DIF Measure (Logit)	DIF S.E. (Logit)	Campus vs Campus	Difference between Measure (Logit)
Creativity and Problem Solving (CP)					
22. Ability to use resources to innovation	Chai Wan	-0.50	0.21	CW vs HW	-0.18
	Haking	-0.32	0.15	HW vs TY	0.00
	Tsing Yi	-0.32	0.13	TY vs CW	0.18
23. Independent research and development capacity	Chai Wan	-0.54	0.21	CW vs HW	-0.17
	Haking	-0.37	0.15	HW vs TY	0.07
	Tsing Yi	-0.44	0.12	TY vs CW	0.10
24. Lenovo and imagination	Chai Wan	-0.18	0.21	CW vs HW	0.07
	Haking	-0.25	0.15	HW vs TY	-0.19
	Tsing Yi	-0.06	0.13	TY vs CW	0.12
25. A keen awareness force	Chai Wan	-0.36	0.21	CW vs HW	-0.25
	Haking	-0.11	0.15	HW vs TY	-0.02
	Tsing Yi	-0.09	0.13	TY vs CW	0.27
26. Innovation and change in attitude	Chai Wan	-0.36	0.21	CW vs HW	-0.06
	Haking	-0.30	0.15	HW vs TY	0.10
	Tsing Yi	-0.40	0.13	TY vs CW	-0.04
27. The spirit of adventure challenge	Chai Wan	-0.71	0.21	CW vs HW	**-0.63**
	Haking	-0.08	0.16	HW vs TY	0.20
	Tsing Yi	-0.28	0.13	TY vs CW	0.43
28. Ability to problem-solving	Chai Wan	0.25	0.22	CW vs HW	-0.26
	Haking	0.51	0.16	HW vs TY	0.26
	Tsing Yi	0.25	0.13	TY vs CW	0.00
Communication (CO)					
29. Oral Expression	Chai Wan	-0.04	0.22	CW vs HW	-0.27
	Haking	0.23	0.16	HW vs TY	-0.10
	Tsing Yi	0.33	0.13	TY vs CW	0.37
30. The ability to listen	Chai Wan	-0.04	0.22	CW vs HW	-0.24
	Haking	0.20	0.16	HW vs TY	0.08
	Tsing Yi	0.12	0.13	TY vs CW	0.16
31. The ability to use of language	Chai Wan	-0.09	0.22	CW vs HW	-0.45
	Haking	0.36	0.16	HW vs TY	-0.04
	Tsing Yi	0.40	0.13	TY vs CW	0.49
32. The ability to manage emotions	Chai Wan	-0.13	0.22	CW vs HW	-0.14
	Haking	0.01	0.16	HW vs TY	0.22
	Tsing Yi	-0.21	0.13	TY vs CW	-0.08
33. The ability of teamwork	Chai Wan	0.33	0.22	CW vs HW	-0.29
	Haking	0.62	0.16	HW vs TY	0.26
	Tsing Yi	0.36	0.13	TY vs CW	0.03
34. Ability to lead the coordination	Chai Wan	-0.22	0.21	CW vs HW	-0.28
	Haking	0.06	0.16	HW vs TY	0.08
	Tsing Yi	-0.02	0.13	TY vs CW	0.20
35. The ability to human interaction	Chai Wan	0.75	0.23	CW vs HW	0.03
	Haking	0.72	0.16	HW vs TY	0.38
	Tsing Yi	0.34	0.13	TY vs CW	-0.41

The results showed that most of the items were found to have no DIF when they were compared with different students from the Chai Wan, Haking Wong and Tsing Yi campuses. There were a few exceptional cases, such as “mission and vision with the company unanimously” (item 7), which had a difference of measure of 0.71 between the Tsing Yi campus and the Chai Wan campus; “respect to human rights and freedom” (item 20), a difference of measure of 0.54 from the Haking Wong campus to the Chai Wan campus; “ethics and social responsibility” (item 21), a difference of measure of 0.60 from the Tsing Yi campus to the Chai Wan campus, and “the spirit of adventure and challenge” (item 27), a difference of measure of 0.63 from the Haking Wong campus to the Chai Wan campus. Since there were only 3.8% of items between campuses observed with DIF, the confidence level was less than 5%. Therefore, it was concluded that no DIF existed for students from different campuses to the items regarding the adequacy of delivering core competencies.

3.5.5 Data Analysis Methods

According to the last section, the data collected were reliable and valid. The DIF across campuses was less than 5% confident level. The data will be analysed using Rasch rating scale analysis to enable the creation of interval scales in logit units from ordinal level responses (Bond & Fox, 2015). It aligned with the research question of the aim to determine the importance of the core competencies and the adequacy of the programme in delivering the core competencies to students from the students' perspective. The important subscale and the adequacy subscale of core competencies will be arranged in descending order to further analysis the core competencies related to corresponding domains with respect to the important aspects and the adequacy aspects. Two scales will be displayed of the Rasch Scale at the left hand side with the unit of logit; the right hand side shows the average raw scores. The expected raw scores on the test ranged from 0-105 for 35 items was referenced to Rasch Scale by the conversion table as listed in Appendix. Appendix I shows the Important sub-scale conversion table and Appendix II shows the Adequacy sub-scale conversion table, both tables facilitate interpretation of the Rasch Scale in term of the Average Raw Scores Scale. The relative importance of 5 domains will be ranked by the average of within-domain difficulty measures as well as the relative adequacy in delivering of 5 domains under the Rasch scale and Average Raw Scores scale. Some findings of the ranking of the five domains will be further explored during the focus group discussion of the qualitative part of this

research.

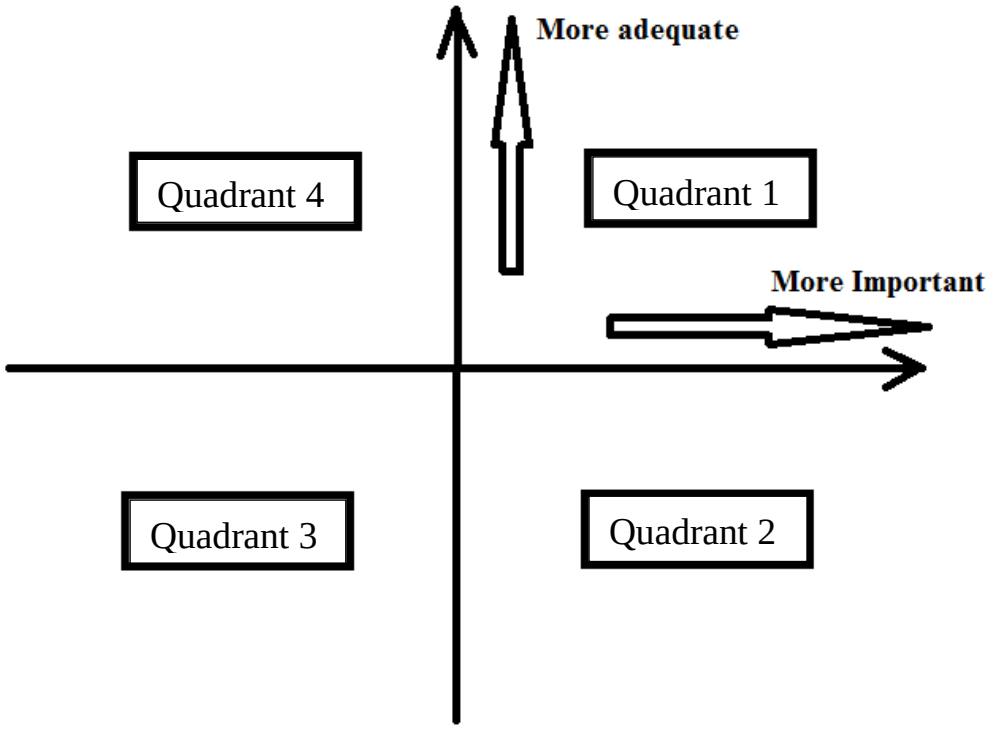


Figure 3.4 The Relationship between the importance and the adequacy of the HD Programme at Delivering Core Competencies

The ranked important subscale and the ranked adequacy subscale of core competencies will be related by a scatter diagram. Figure 3.4 shows the relationship between the importance subscale and the adequacy subscale in delivering core competencies. Thirty-five core competencies for 35 items will be scattered within the 4 quadrants which implies different scenario for the programme administrator to evaluate the quality of the HD in EE programme. For the core competencies falls within the first quadrant, it implies the core competencies are

important and adequately delivered from the perspective of students; the core competencies falls within the second quadrant implies the core competencies are important but have not been adequately delivered; the core competencies falls within the third quadrant implies the core competencies are not important and also have not adequately been delivered; and the core competencies falls within the fourth quadrant implies the core competencies are not importance but have been adequately delivered.

For those competencies of items with logit higher than 0.5 or lower than -0.5 will be highlighted for further investigation during the qualitative part of the study. Specific findings from the quantitative part of the study will be addressed during the focus group discussion with students to investigate deeper of the result findings.

3.5.6 Qualitative Research Design

This research is a partial quantitative and qualitative mixed sequential dominant status design. The qualitative approach is also important in the study as it is complementary to the quantitative approach. The qualitative component comprised focus group interviews conducted with the students after the analysis of the quantitative data. Interviews were used to investigate perceptions on the importance of core competencies and also the perceived adequacy of the HD programme in EE in delivering core competencies.

Focus group interviews were applied in consideration of the following benefits: (1) Qualitative data generated from focus group interviews could help the interpretation of quantitative data, such as asking the students "why" they do not consider some competencies important; (2) The researcher can interact with the participants, pose follow-up questions or probe further into a specific aspect; (3) The researcher can get information from non-verbal responses, such as facial expressions or body language; (4) Group dynamics encourage the generation of more responses; and (5) It is more efficient than individual interviews. However, there may be a drawback while participants feel less comfortable to speaking against the programme.

In the following sections, research participants, research instruments, procedures and the variables used in the data collection will be described.

3.5.6.1 Sample

The participants in the sample comprised students from the HD programme in EE. Three focus groups from three campuses (Chai Wan, Haking Wong and Tsing Yi) were created that contained seven students from the Chai Wan campus, eight students from the Haking Wong campus and nine students from the Tsing Yi campus. The sample selection was purposively chosen for the entire sample from each campus; all of the participants were male. All 24 students who took part in this qualitative survey also participated in the quantitative part of the survey.

Students were purposively sampled based on representation and articulation. For representation, the students came from three different campuses, resulting in one focus group per each campus; students with high, medium and low cumulative grade point averages (GPA) were invited in order to have representation from all achievement groups. For articulation, students who were articulate, outgoing and sociable were invited.

3.5.6.2 Instruments

The qualitative survey is a supplement to the quantitative survey. The results extracted from the quantitative survey need to be further clarified from the students' responses. A semi-structured focus group interview was therefore employed on each of the three campuses.

The questions focused on (1) What core competencies do you think are important to students working in the E&M industry today? (2) How adequate is the HD programme in EE at delivering the core competencies that will properly cultivate or equip students?

During the focus group interviews, students were specifically asked about the core competencies above +0.5 logit or -0.5 logit that fell within the four quadrants: (1) Quadrant one contained the core competencies that were both important and properly delivered; (2) Quadrant two had core competencies that were important but had not been properly delivered; (3) Quadrant three included core competencies that were not important and also not properly delivered; and (4) Quadrant four contained core competencies that were not important but were properly delivered. Questions that used the words “how” and “why” were asked for further clarification and interpretation of the responses and information.

3.5.6.3 Procedures

Three focus group interviews were conducted with 24 students from the HD programme in EE. Seven student participants from Chai Wan were interviewed at the Chai Wan campus on December 4, 2015; eight student participants from the Haking Wong campus and nine student participants from the Tsing Yi campus were interviewed on December 8, 2015.

The interview questions included the following: (1) What core competencies do you think are important for students working in the E&M industry today? (2) How adequate is the HD programme in EE in delivering those core competencies to students? All of the questions aided in understanding the students' perspectives with respect to the research questions. Further, the qualitative results plotted within four quadrants were shared with students. Questions of "how" and "why" for those core competencies specifically outside the range of -0.5 logit to 0.5 logit were asked. Each interview lasted approximately one hour and was recorded with the participants' consent.

The qualitative data collected was analysed. Firstly, purposive sampling was employed. Secondly, a semi-structured interview protocol was used to elicit important core competencies and the adequacy in delivering them; follow-up probes to establish why those core competencies were important were then executed. Thirdly, the coding process involved reading and re-reading to identify emergent themes. Lastly, the interpreted conclusions of the qualitative study, a mixed method research, were combined with the quantitative method to

contribute to this research study. This technique increases the "internal validity and contextual understanding and is particularly useful in revealing the processes that led to specific outcomes" (Maxwell, 2005).

The transcribed interviews, which were tape-recorded, were given to a second coder. After the second coder had coded the interview transcriptions, the two sets of codes were compared. In the case of a discrepancy, the two coders discussed the rationale used for the coding until they arrived at a consensus. In the end, the coding from the two independent coders were in 100% agreement. The final set of codes was used in this study. An example of the working process in the coding is the recorded message, "Electrical engineers have been more concerned with the environmental domain in recent years". Coder 1 interpreted this as: "Engineers have been more concerned with the environmental domain in recent years", while coder 2 interpreted this as: "Electronic engineers have been more concerned with the environmental domain in recent years". Finally, they agreed that "Engineers" specifically referred to "Electrical Engineers".

3.5.6.4 Variables

The variables for the qualitative part of this research study included (1) the importance of core competencies for students working in the E&M industry and (2) the adequacy in delivering core competencies by the HD programme in EE. The linkage between the first and second variables provides further information on the descriptions and interpretation of the research questions. This qualitative part of the study is focused on similar variables as the quantitative part of the study. However, the results in the qualitative research served to complement the results in the quantitative research.

3.6 Ethics and Confidentiality

The data used in the quantitative part of this research were a survey of all second-year students of the HD in EE programme. Before the survey, the application form regarding the issue for ethical review was submitted to the Human Research Ethics Committee (HREC). Approval was granted for this research on July 29, 2014. Two pilot studies were carried out in August 2014 and January 2015 before the main study took place between September and October in 2015.

As for the qualitative part of this research, all the interviews were in accordance to the HKIED's guidelines on ethics in research. In this study, all students were well-informed about the objective and method of the study; they were recruited without any coercion and had the right to exit the study at any time. All information related to the participants would be kept in confidence; any information collected contains no sensitive aspects that could be identifying to students. Participants were further informed that no physical or psychological risks could be raised during the process of this study.

3.7 Summary

This chapter focused on the research method of the current study. It introduced the mixed methods research approach that was applied. Details of the quantitative and qualitative research method designs have been addressed with the notation of systems that was adopted in this study. The structure of the questionnaire was adjusted after the first pilot study, while the fitness of the data to the Rasch Model was verified during the second pilot study. For the quantitative research design of the main study, the sample, assessment instruments, research procedures and variables were well presented. For the qualitative research design of the main study, the sample, research instruments, detail procedures and variables were also clearly presented. Ethics and confidentiality were introduced at the end of this chapter to determine the ethical issues involved with this study. The next chapter will present the research results based on this study and then the conclusion.

Chapter 4

Results

This chapter displays the results corresponding to the two research questions of this study. The first two sections provide the quantitative results: the importance subscale and the adequacy subscale of core competencies for students working in the E&M industry in the 21st century. The third section shows the results in the relationship between an important subscale and an adequate subscale to interpret the important and adequate delivery of core competencies by the HD programme. The fourth section contains the qualitative results of the study; it involved focus group interviews to investigate the two research questions and provides supplementary information from the students' perspective regarding the quantitative results of the current study. The last section is an overall summary to conclude the results for this study.

4.1 Students' Perspectives on the Importance of Core Competencies for the HD in EE Programme

As discussed in Chapter 3, there are two variables in this study. The first variable addressed the first research question, which was to investigate the core competencies expected of the HD in EE programme graduates who plan to work in the E&M industry.

4.1.1 The Importance of Core Competencies for the HD Programme

In the first half of the survey, students were asked to identify the importance of 35 core competencies for the HD in EE programme that corresponded to 35 items. The results were analysed using Rasch measurements to provide an estimate of the item difficulty. The 35 items of competencies with the corresponding domain were listed in descending order of different levels of importance in Table 4.1.

Table 4.1: Students' Perception on the Importance of Core Competencies with the Corresponding Domain for HD Programmes by Item Difficulty Measures in Descending Order.

Domain	Item	Core Competencies	Measure	SD
			More Importance	
WA	4	Responsible attitudes	0.87	0.09
CC	16	Identification and awareness of occupational safety	0.76	0.09
WA	1	Attribute of punctuality	0.74	0.09
CO	33	Teamwork spirit	0.40	0.09
CO	32	The ability to manage emotions	0.39	0.09
CC	20	Respect to human rights and freedom	0.38	0.09
WA	2	Ability to follow instructions	0.37	0.09
CC	18	Attitude to prevent corruption	0.34	0.09
CO	35	The synergy through human interaction	0.34	0.09
WA	3	Attribute of discipline	0.32	0.09
IT	13	Use of data in compliance	0.29	0.09
CP	28	Ability in problem-solving	0.28	0.09
IT	14	Safely use of data	0.25	0.09
CO	30	The capability in listening	0.25	0.09
WA	6	Work independently and adaptability	0.21	0.09
CO	29	Oral Expression	0.20	0.09
CC	21	Ethics and social responsibility	0.14	0.09
CO	31	Use of language	0.12	0.08
CC	17	Respect of intellectual property	0.11	0.08
IT	12	Ability to analyse data	0.00	0.08
IT	11	Capable of creating and integrating information	-0.08	0.08
IT	9	Capability in the application of software	-0.13	0.08
CP	25	A keen awareness force	-0.18	0.08
IT	10	Capability to grasp information	-0.19	0.08
CO	34	Ability to lead and to coordinate	-0.21	0.08
WA	5	Strive to power himself/herself upstream	-0.31	0.08
IT	8	Making multimedia for reporting	-0.49	0.08
CP	26	Attitude in innovation and change	-0.49	0.08
CC	15	Awareness of environmental protection	-0.50	0.08

CP	24	Lenovo and imagination	-0.50	0.08
CP	22	Ability to integrate resources in innovation	-0.59	0.08
CC	19	Ability to participate in society	-0.62	0.08
CP	27	The spirit of adventure and challenge	-0.73	0.08
CP	23	Independent research and development capacity	-0.73	0.08
WA	7	Mission and vision with the company unanimously	-1.04	0.08
			Less Importance	

In Table 4.1, the item measures ranged from -1.04 logits (for the item "mission and vision with the company unanimously") to 0.87 logits (for the item "resposible attitudes"). Since the Rasch analysis reference items at zero for a common ground on the same measurement scale, items with negative measures are hard to endorse as important by students, while items with positive measures are easy for students to recognise as important. Table 4.1 shows that the most important aspect was "responsible attitudes" (item 4), and the least important aspect was "mission and vision with the company unanimously" (item 7) from the perspective of students. Further, the five domains (WA, IT, CC, CP, and CO) show signs of differences in their order of importance. In other words, the top ten most important aspects were all from the WA, CC and CO domains, and the least ten important aspects were all from the CP domain. The IT domain falls within the range of less important aspects but not the least; this phenomenon will be further investigated in the qualitative section of this research.

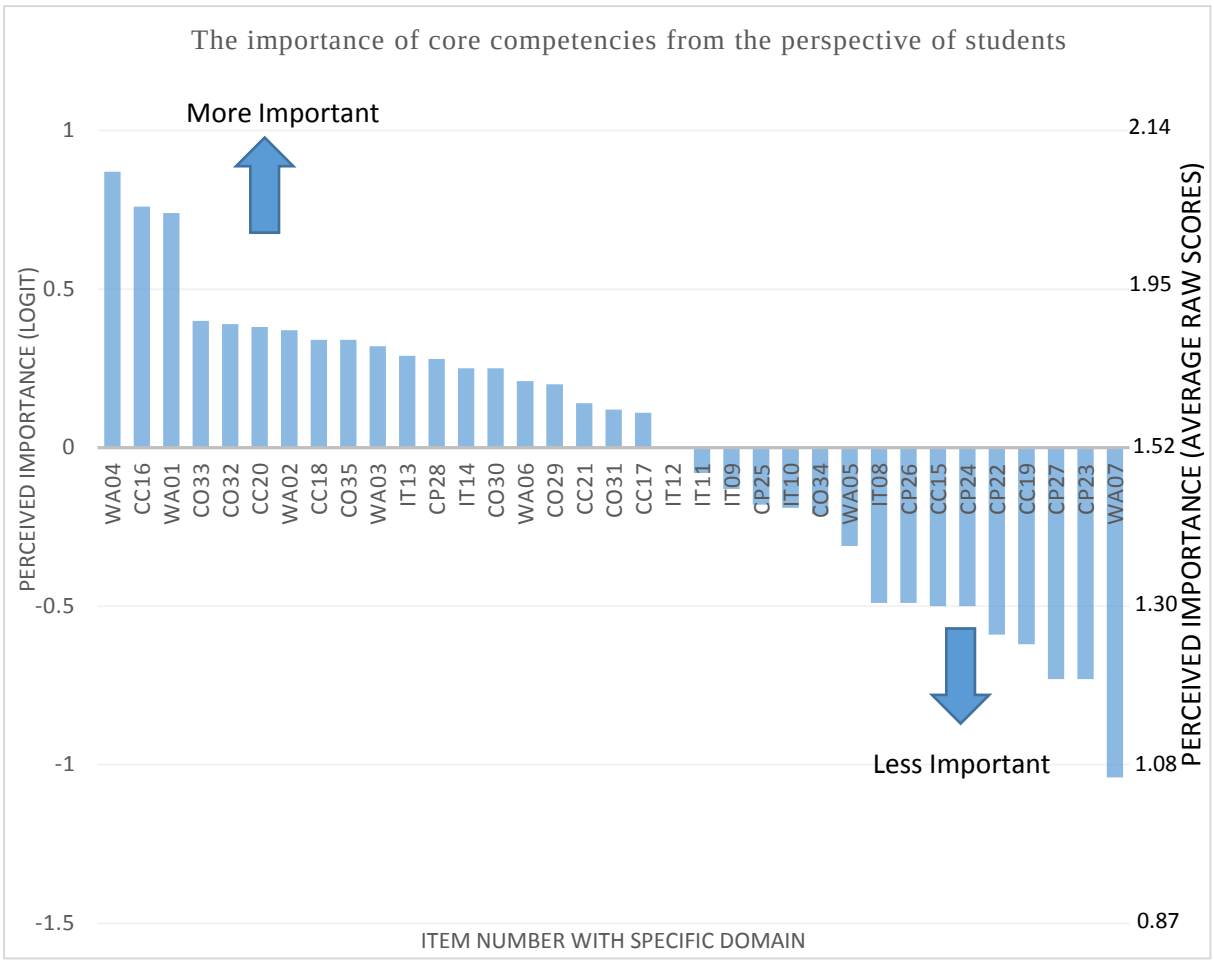


Figure 4.1: Students' Perceptions on the Importance of Core Competencies in Descending Order with Respect to the logit Scale and the Raw Scale.

Note: Raw Score Scale was coded as: 0 = Strongly Disagree; 1 = Disagree; 2 = Agree; 3 = Strongly Agree.

Figure 4.1 shows the perception of students on the importance of core competencies for the HD programme. There are two scales with the Rasch scale at the left hand side that use the unit of logit; the right hand side shows the average raw scale. Appendix I shows the Rasch-Raw scores conversion table to facilitate interpretation of the logit scale in term of the

raw-score scale. The expected item score ranged from 0-3 and the expected item mean score was 1.5. The reference of 0 logit corresponding to an average raw scale of 1.52 indicates a slight upshift that reflects most of the core competencies are important from the perspective of students. Under these scales, the most important core competency is "responsible attitudes" (item 4), followed by "Identification and awareness of occupational safety" (item 16) and "attribute of punctuality" (item 1). There was a drastic drop of 2.6 logits to "Teamwork spirit" (item 33) and a gradual decrease afterwards until the least important core competency of "Mission and vision with the company unanimously" (item 7).

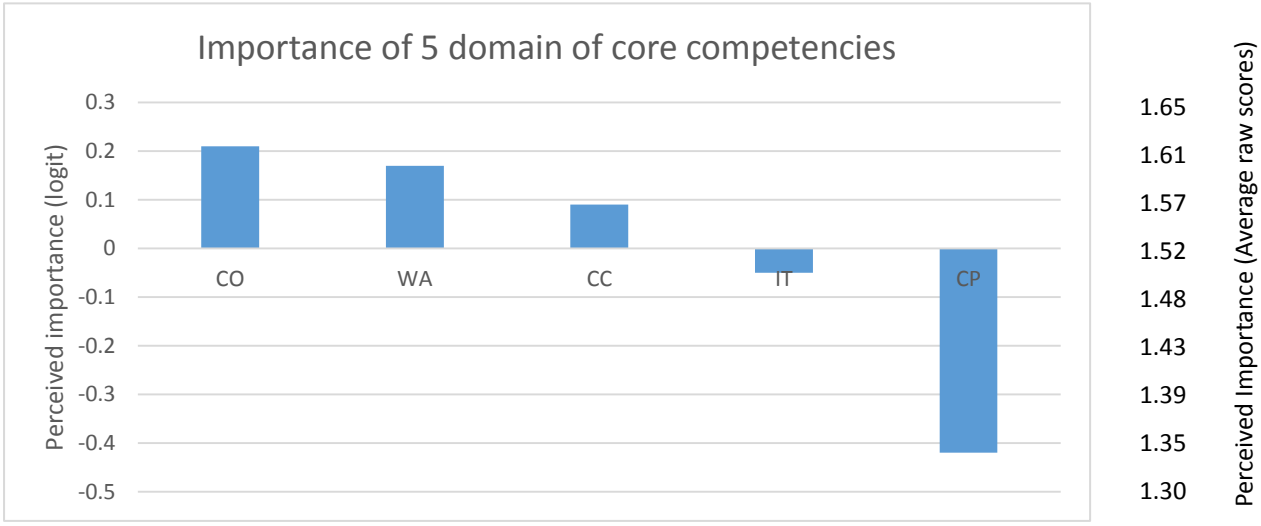


Figure 4.2: Perceived Importance (average) of the Core Competencies of the Five Domains.

Note: Raw Score Scale was coded as: 0 = Strongly Disagree; 1 = Disagree; 2 = Agree; 3 = Strongly Agree.

Figure 4.2 shows the five domains of the core competencies for HD in EE graduates to work in the E&M industry. The relative importance was ranked by the average of within-domain

difficulty measures. In descending order, the five domains are CO, WA, CC, IT, and CP. The importance of core competencies in the CP domain was extremely low; this phenomenon is explained in the qualitative section of this study during the focus group discussion with students at the end of this report.

4.2 Adequacy in delivering of core competencies by the HD in the EE programme

The second variable was the adequacy in delivering core competencies, which addressed the second research question and investigated the adequacy in equipping students with those core competencies as expected in HD in EE programme graduates who will work in the electrical and mechanical industries.

4.2.1 The adequacy in Delivering Core Competencies for the HD Programme

In the second half of the survey, students were asked to identify the adequacy in equipping them with 35 core competencies for the HD in EE programme that corresponded to 35 items, respectively. The results were analysed by Rasch despite difficulties in estimating the item's item difficulty. The 35 items of competencies with respect to the five domains are listed in descending order of different levels of adequacy in Table 4.2.

Table 4.2 The adequacy in delivering of core competencies for HD programme by item difficulty measures in descending order

Domain	Item	Core Competencies	Measure	SD
			More Adequate	
CC	16	Identification and awareness of occupational safety	0.96	0.09
IT	9	Capability in application of software	0.91	0.09
IT	8	Making multimedia for reporting	0.54	0.09
CO	35	The synergy through human interaction	0.53	0.09
CO	33	Teamwork spirit	0.44	0.09
IT	12	Ability to analyse data	0.37	0.09
WA	6	Work independently and adaptability	0.35	0.09
CP	28	Ability in problem-solving	0.33	0.09
IT	11	Capable to create and integrate information	0.32	0.09
CO	31	Use of language	0.30	0.09
WA	2	Ability to follow instructions	0.28	0.09
IT	10	Capability to grasp information	0.26	0.09
WA	4	Responsible attitudes	0.24	0.09
CO	29	Oral Expression	0.23	0.09
CO	30	The capability in listening	0.12	0.09
IT	13	Use of data in compliance	0.05	0.09
IT	14	Safely use of data	0.03	0.09
CO	34	Ability to lead and to coordinate	-0.02	0.09
CO	32	The ability to manage emotions	-0.13	0.09
CP	25	A keen awareness force	-0.14	0.09
CP	24	Lenovo and imagination	-0.14	0.09
WA	3	Attribute of discipline	-0.16	0.09
WA	1	Attribute of punctuality	-0.17	0.09
WA	5	Strive to power himself/herself upstream	-0.28	0.09
CP	27	The spirit of adventure and challenge	-0.28	0.09
CC	17	Respect to intellectual property	-0.29	0.09
CP	22	Ability to integrate resources in innovation	-0.35	0.09
CP	26	Attitude in innovation and change	-0.36	0.09
CP	23	Independent research and development capacity	-0.44	0.09

CC	21	Ethics and social responsibility	-0.49	0.09
CC	15	Awareness of environmental protection	-0.50	0.09
CC	20	Respect to human rights and freedom	-0.51	0.09
CC	18	Attitude to prevent corruption	-0.63	0.09
WA	7	Mission and vision with the company unanimously	-0.64	0.09
CC	19	Ability to participate in society	-0.72	0.09
			Less Adequate	

In Table 4.2, the item measures ranged from -0.72 logits (for "ability to participate in society") to 0.96 logits (for "identification and awareness of occupational safety"). Since the Rasch analysis referenced items at zero for a common ground on the same measurement scale, any items with negative measures are hard to endorsed as adequate when delivered by students, while an item with positive measures is easy to endorse as adequate in delivering by students. Table 4.2 shows that the most adequate in delivering aspects were "identification and awareness of occupational safety" (item 16), and the least important aspect was "ability to participate in society" (item 19) from the perspective of students. Further, it can be seen from Table 4.2 that five domains (WA, IT, CC, CP, and CO), show signs of differences in their order of importance. In other words, the top ten most important aspects were all from the domains of IT and CO, while the least ten were from the domain of CP and CC domains.

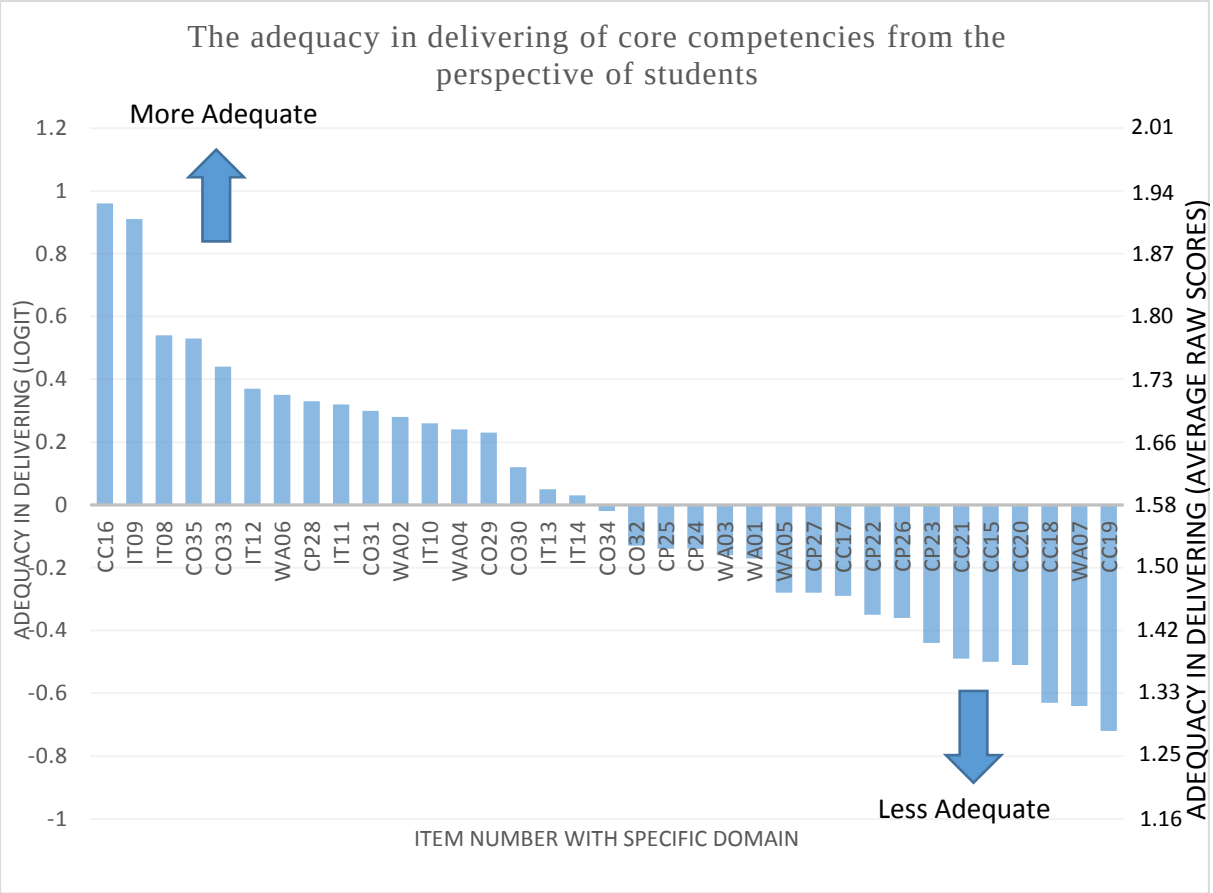


Figure 4.3: Students' Perceptions on the Adequacy in Delivering Core Competencies in Descending Order with Respect to the logit Scale and the Raw Scale.

Note: Raw Score Scale was coded as: 0 = Strongly Disagree; 1 = Disagree; 2 = Agree; 3 = Strongly Agree.

Figure 4.3 shows the perception of students on the adequacy of delivering core competencies for the HD programme. There are two scales with the Rasch scale on the left hand side that use the unit of logit; the right hand side shows the average raw scale. Appendix II shows the Rasch-Raw scores conversion table to facilitate interpretation of the logit scale in term of the raw-score scale. The expected item score ranged from 0-3 and the expected item mean score

was 1.5. The reference of 0 logit corresponding to an average raw scale of 1.58 indicates a slight upshift that suggests most of the core competencies are being adequately delivered from the perspective of students. Out of these scales, the most effective at delivering core competency is "identification and awareness of occupational safety" (item 16) followed by "capability in application of software" (item 9). There was also a drastic drop of 3.7 logits for "making multimedia for reporting" (item 8) and also a gradual decrease afterwards until the least adequacy in delivering of core competency of "ability to participate in society" (item 19).

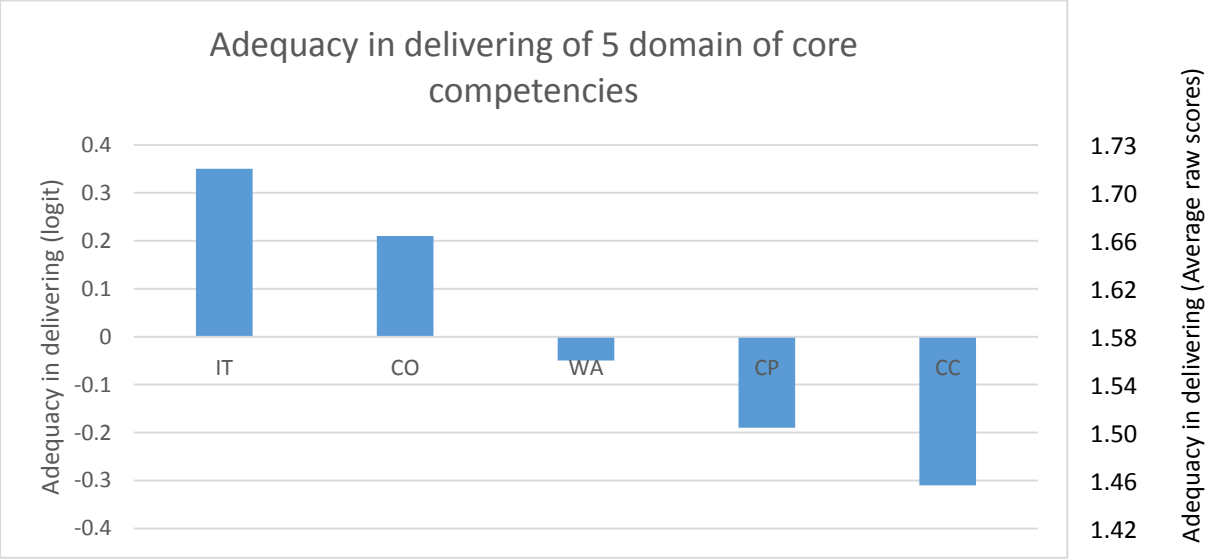


Figure 4.4: Perceived Adequacy in Delivering (average) Core Competencies of the Five Domains.

Note: Raw Score Scale was coded as: 0 = Strongly Disagree; 1 = Disagree; 2 = Agree; 3 = Strongly Agree.

Figure 4.4 shows the five domains of the core competencies in delivering HD in EE graduates to work at the E&M industry. The relative adequacy in delivering was ranked by the average of within-domain difficulty measures. In descending order, the five domains are IT, CO, WA, CP, and CC. Further, it can be seen that the IT and CO domains were delivered adequately by the programme, while the CP and CC domains were not. This phenomenon is explained by the qualitative part of this study during the focus group discussion with students in a later part of this report.

4.3 Relationship between the Importance of Core Competencies and the Adequacy in the Delivery of the Programme

The results from Section 4.1 showed the importance of core competencies from the perspective of students for them to work in the E&M industry, while Section 4.2 described the HD in EE programme's adequacy in delivery of these competencies. An integration of these two research questions could be linked up by an X-Y plot became a scatter diagram, the x-axis represented by the "importance" of the core competencies, while the y-axis was represented by the "adequacy" in delivering the HD programme as shown in Figure 4.5. The relationship between these two research questions generate four scenarios and the outcomes provided a better understanding of the quality of the HD in EE programme.

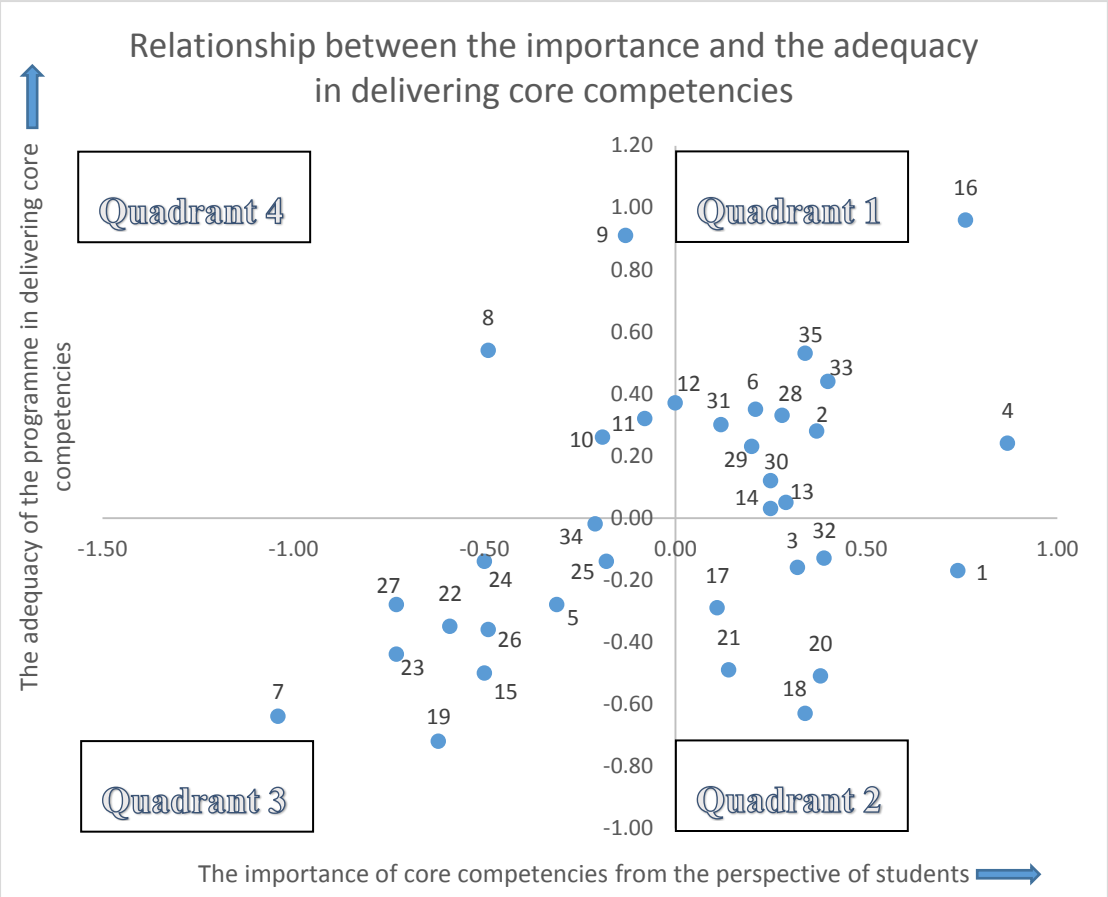


Figure 4.5: The Relationship Between the Importance and the Adequacy of the HD Programme at Delivering Core Competencies.

Thirty-five core competencies for 35 items were scattered onto four quadrants (Figure 4.5). They were also grouped into four groups (Table 4.3); items with logits higher than 0.5 or lower than -0.5 are highlighted in bold for easier reference. Figure 4.5 provides a geographical sense of the particular core competencies, while Table 4.3 offers a quantitative sense of particular core competencies within that specific group (Quadrant).

Table 4.3: Four Groups of Core Competencies Related to the "Importance" Subscale vs. the "Adequacy" Subscale.

Quadrant 4				
Domain	Item	Quadrant 2 - Not important but Adequate	Importance (Logit)	Adequacy (Logit)
IT	**9**	**Capability in application of software**	-0.13	**0.91**
IT	**8**	**Making multimedia for reporting**	-0.49	**0.54**
IT	10	Capbility to grasp information	-0.19	0.26
IT	11	Capability to create and integrate information	-0.08	0.32

Quadrant 1				
Domain	Item	Quadrant 1 - Important and Adequate	Importance (Logit)	Adequacy (Logit)
CC	**16**	**Identification and awareness of Occupational safety**	**0.76**	**0.96**
WA	**4**	**Responsible attitudes**	**0.87**	0.24
CO	**35**	**The synergy through human interaction**	0.34	**0.53**
CO	33	Teamwork spirit	0.40	0.44
WA	2	Ability to follow instructions	0.37	0.28
IT	12	Ability to analyze data	0.00	0.37
WA	6	Work independently and adaptability	0.21	0.35
CP	28	Ability in problem-solving	0.28	0.33
CO	31	Use of language	0.12	0.30
IT	13	Use of data in compliance	0.29	0.05
CO	30	The capability in listening	0.25	0.12
IT	14	Safely use of the data	0.25	0.03
CO	29	Oral Expression	0.20	0.23

Quadrant 3				
Domain	Item	Quadrant 3 - Not important and not Adequate	Importance (Logit)	Adequacy (Logit)
WA	**7**	**Mission and vision with the company unanimously**	**-1.04**	**-0.64**
CP	**23**	**Independent research and development capacity**	**-0.73**	-0.44
CP	**27**	**The spirit of adventure challenge**	**-0.73**	-0.28
CC	**19**	**Ability to participate in society**	**-0.62**	**-0.72**
CP	**22**	**Ability to integrate resources in innovation**	**-0.59**	-0.35
CC	**15**	**Awareness of environmental protection**	**-0.50**	**-0.50**
CP	**24**	**Lenovo and imagination**	**-0.50**	-0.14
CP	26	Attitude in innovation and change	-0.49	-0.36
WA	5	Strive to power himself/herself upstream	-0.31	-0.28
CO	34	Ability to lead and to coordinate	-0.21	-0.02
CP	25	A keen awareness force	-0.18	-0.14

Quadrant 2				
Domain	Item	Quadrant 4 - Important but not Adequate	Importance (Logit)	Adequacy (Logit)
WA	**1**	**Attribute of Punctuality**	**0.74**	-0.17
CC	**18**	**Attitude to prevention corruption**	0.34	**-0.63**
CC	**20**	**Respect for human rights and freedom**	0.38	**-0.51**
CC	21	Ethics and Social Responsibility	0.14	-0.49
CO	32	The ability to manage emotions	0.39	-0.13
WA	3	Attribute of Discipline	0.32	-0.16
CC	17	Respect to Intellectal Property	0.11	-0.29

The first quadrant was the group of core competencies, which are important and adequately delivered, included "identification and awareness of occupational safety" (item 16). This was the best scenario; students found it important, and the programme delivered the skills properly to students. The other core competencies within this quadrant included "responsible attitudes" (item 4); "the synergy through human interaction" (item 35); "teamwork spirit" (item 33); "ability to follow instructions" (item 2); "ability in problem-solving" (item 28); "use of data in compliance" (item 13); "safely use data" (item 14); "the capability in listening" (item 30); "oral expression" (item 29); "work independently and adaptability" (item 6); "use of language" (item 31) and "ability to analyse data" (item 12). As the above core

competencies were important and also properly delivered, the programme administrator should reinforce and maintain the good quality of delivering the programme in this area.

The second quadrant with the group of core competencies that are important but have not been adequately delivered included item 1 (“attribute of punctuality”). It was the worst scenario because students found it important but the programme could not deliver the idea properly to the students. The other core competencies within this quadrant included item 18 (“attitude to prevent corruption”); item 20 (“respect to human rights and freedom”); item 21 (“ethics and social responsibility”); item 32 (“The ability to manage emotions”); item 3 (“attribute of discipline”) and item 17 (“respect for intellectual property”). As the above core competencies were important yet not satisfactory delivered, the programme administrator should pay great attention to the items within this group. As item 1 (“attribute of punctuality”) and item 3 (“attribute of discipline”) were not delivered properly; it may be that when students are given freedom, they may override their right and challenge their boundaries. However, it is difficult if they receive too much freedom, as students will never grow up if they are left in their comfort zone. An optimum position therefore needs to be determined and applied.

The third quadrant contained the group of core competencies that were not important and also have not adequately been delivered, including item 7 (“mission and vision with the company unanimously”). It was an extreme scenario; students found item 7 less important,

and the programme was still unable to properly deliver item 7 to the students. The other core competencies within this quadrant included item 23 (“independent research and development capacity”); item 27 (“the spirit of adventure and challenge”); item 19 (“ability to participate in society”); item 22 (“ability to integrate resources in innovation”); item 15 (“awareness of environmental protection”); item 24 (“Lenovo and imagination”); item 26 (“attitude in innovation and change”); item 5 (“strive to power himself/herself upstream”); item 34 (“ability to lead and to coordinate”) and item 25 (“A keen awareness force”). As the above core competencies were not important and not satisfactory delivered, it was strange that item 15 (“awareness of environmental protection”) fell into this group, and the programme administrator should work further on this important concept. For item 7 (“mission and vision with the company unanimously”), item 23 (“independent research and development capacity”) and item 27 (“the spirit of adventure and challenge”), students may not realize their importance at this time. However, we should plant the seed for their future career development so that students will realize their importance when they are older.

The fourth quadrant contains the group of core competencies that are not important but have been adequately delivered, including item 9 (“capability in application of software”). This was an extreme scenario; students found it less important, but the programme still delivered properly to the students. The other core competencies within this quadrant included item 8 (“making multimedia for reporting”); item 10 (“capability to grasp information”) and

item 11 (“capable to create and integrate information”). As the above core competencies were not important but were properly delivered, there may be a gap between the perspectives of the programme administrator and the students. This is another area that needs to be addressed by the programme administrator to transfer this group of core competencies to students.

4.4 Focus Group Discussion

Since the current study is a mixed methods research, the focus group discussion is the qualitative part of the study that provides descriptive and interpretative supplementary information from the perspective of students regarding the research questions. Responses to questions regarding the importance of core competencies and the adequacy in delivering them were further investigated to identify the reasons behind the locations of these core competencies listed in Figure 4.5 and Table 4.3.

4.4.1 Perspectives of Student Interviewees on Core Competencies, Which Were Important and Properly Delivered (Quadrant One)

Students learned from recalling part of a message and drew a conclusion based on "identification and awareness of occupational safety" (item 16). "Electricity" is very dangerous if we do not handle it properly. It is invisible and odourless, so the students are all aware of its safety issues. They studied a module named "Occupational Safety and Health" to obtain a Construction Industry Safety Training Certificate before they could legally work on a construction site. There were also other modules within the programmes, such as the "Practical Training Workshop" previously mentioned about occupational safety, which contained a bit of "brainwashing" and hence was adequately delivered.

Students working in the E&M field should be aware of the importance of following instruction and taking responsibilities with a positive attitude. Students raised an example of a laboratory session in which they needed to follow instruction with a good, positive attitude to complete the task. It can be extremely dangerous if they do not follow the procedures for handling electrical and mechanical instruments, especially in some high-voltage working environments. This is the reason that it is important for students to display a responsible attitude and the ability to follow instructions of high importance.

The students appreciated working in teams, and they found that in a lot of circumstances, they needed to work in a team, such as laboratory work and group projects. They needed to prepare presentation materials and reports together and learn from each other, which explains why the teamwork spirit and the synergy through human interaction fall within Quadrant one.

4.4.2 Perspective of Student Interviewees on Core Competencies Were Important but Not Properly Delivered (Quadrant two)

Students are aware of the harmful "corruption" of society that they have seen in the media, such as on a TV programme. However, the core competencies for working against corruption have not been properly delivered to these students. Some students thought that the issue of "corruption" was a matter that they would not have to concern themselves with until they entered their future workplace; it was seldom involved in the school environment. Therefore, it is crucial to plant a seed of reality before the transition from school to the workplace.

Students all know about the importance of being punctual and disciplined. The transition from secondary school to the institute provides a free environment; they became weak in punctuality, and there is temptation not to follow discipline. They know how to approach their work with a good attitude, but they choose not to comply. No one is there to force them to do it. It is purely a matter of maturity, and the situation could be changed if they felt interest in the matter. Students mentioned that they follow discipline only in certain

environments; they will be punctual if they feel the activity is important or if they are very interested in a seminar or workshop. This indicates the importance of arousing interest for students to learn.

The ability to manage emotions was easy to understand but difficult to put into practice. Students thought that they needed other channels to release pressure, such as talking to a social worker or striking a sand bag. While it had not been learned in the EE programme, they mentioned attending a short course to supplement their coping skills in this area. Another core competence of paying respect for human rights and freedom was endorsed by students as important, but they thought that it was not easy to learn it from the programme.

Intellectual property (IP), ethics and social responsibility were all important to students; they found it difficult to learn these concepts from the programme, but sometimes the topics were conveyed during a lecture. It all depended on the experience of the lecturer; when he/she possessed important or specific knowledge on these topics, he/she might mention more to the student. Students used an example of quoting references at the end of a report to show that they respected IP. They mentioned that they might learn more about ethics and social responsibility when they went from their school to a workplace and gained more experience as well as a better understanding of this topic.

4.4.3 Perspective of Student Interviewees on Core Competencies Were Not Important and Were Not Properly Delivered (Quadrant three)

Students stated that engineer emphasis on calculation and cost effectiveness rather than environmental protection. This is a deviation from the HKIE, a professional body that strongly drives their members towards environmental protection. Students thought that an increase in efficiency would save energy and be positive to our environment. This explains why the lower amount of environment awareness from the perspective of students initiated another gap, which required the programme administrator to follow up on it.

Students felt negative towards the core competencies of independent research, the spirit of adventure and challenge. They may be too young to go on an adventure and also may be too far away from taking on independent research work as a HD student. This finding also explained that they feel they were too green to participate in the society. They thought that they should not take any risks at this age; only in the future when they had gained more experience in the industry, had more knowledge and experience to start their own independent research and would be wealthy would they be prepared to participate more in society. Because engineers contribute their professional knowledge to society, they often do not think they need to participate further. It is also too far away for these students to think of the vision and mission of their future companies. However, training an E&M person to simply follow instructions seems to contradict their potential for creative and innovative

works and also makes it difficult for them to integrate their resources in an innovative way. This also explains the phenomenon of a low average of within-domain difficulty measures for the CP domain.

4.4.4 Perspective of Student Interviewees on Core Competencies Were Not Important but Properly Delivered (Quadrant four)

Students thought that IT literacy was not important as they equipped them properly and even in secondary school. They thought numerical skills were more important than IT literacy and the E&M industry should not closely relate to IT literacy. It may be that a misconception is occurring here, as some students think that they are technical people equipped with technical skills, while IT literacy belongs to clerical persons. Students need to be educated regarding the importance of IT literacy in all trades. The gap between students' perspectives and the importance of IT skills in the domain of IT needs to be followed up by the programme administrator.

4.4.5 The Perspective of Students on the Core Competencies of Five Domains

Students were asked the results of the quantitative part of the survey as shown in Figure 4.2 and why they thought the domain of "creativity and problem solving" (CP) was not important. They responded that they have a latent trait to follow instruction and be less creative. It is difficult for them to work like an artist or designer because they can solve problems logically but not creatively.

The students also mentioned that the IT and CO domains were endorsed by students as being delivered adequately compared with the other domains (WA, CP, and CC); the main reason is that the modules that specifically covered IT and Language were included in the curriculum, while other domains of competencies were not taught in any specific modules. This variation raised an issue for the programme administrator to enforce those domains of core competencies and integrate them into the curriculum.

4.5 Summary of Key Findings

In this chapter, the importance of core competencies for the IVE graduates who will work in the E&M industry in Hong Kong has been identified. The item measures ranged from -1.04 logits (for the item "mission and vision with the company unanimously") to 0.87 logits (for the item "responsible attitudes"). Further, the adequacy in delivering the HD programme to the IVE graduates was explored. The item measures ranged from -0.72 logits (for "ability to participate in society") to 0.96 logits (for the item "identification and awareness of occupational safety"). From a domains point of view, the most important aspects were "Working Attitude and Vocational Development" (WA) and "Communication" (CO), while the least important aspect was the domain of "Creativity and Problem Solving" (CP), which was written by engineering students with the traits that allows them to follow instructions and be less creative. To adequately deliver the HD programme, the IT and CO domains were delivered adequately, however, the CP and "Character Development and Citizenship" CC were not delivered adequately. There are specific IT modules and language modules within the HD programme, but they are not the same as the core competencies of the other domains. Nevertheless, there were no substantial differences between students from different campuses from the students' perspective on the importance and adequacy of the programme at delivering core competencies. In the last chapter, a discussion and conclusions will be presented.

Chapter 5

Discussion and Conclusions

The study aimed to identify the core competencies in the 21st century for students who plan to work in the E&M industry in Hong Kong and to evaluate the performance of the existing HD Programme in EE. Valiente (2014) stated that education and training systems are no longer passive recipients of the demands from employers and markets; instead, we need to be active and broaden our channels to hear from different stakeholders. Tymon (2013) mentioned that the students' perspective is the "missing perspective" to which the public is not paying attention but is a good supplement to education and training systems. In view of this, the first research question aimed at identifying the core competencies for the E&M industry from the students' perspective. It filled the gap between the values of school management and students. The delivery of core competencies would be much more efficient if the programme leader could align prospective students and school management to minimise the gap between them. A mutual understanding between student and management is crucial, as better communication on the topic of "core competencies" results in a superior and more qualified delivery of the programme. Tam (2013) observed that many of the programmes available at the sub-degree level are in professional and vocational education (PVE), which is preferred less than the

traditional route from secondary schooling to university education for those who graduate from school. To change this paradigm, the PVE providers in Hong Kong should aim to provide high quality programmes for secondary school leavers. Tam (2014) also mentioned that instructional quality and learning effectiveness can be measured by setting up learning outcomes, an important contribution that can improve the quality of the programme by allowing for better curricula and instruction for students. The second research question aimed to assess the performance of the HD programme. The adequacy in delivering each core competency was measured. The current study used a mixed method approach comprising a survey followed by focus group interviews in order to drill into the data to extract more findings. These findings from the current study could be further analysed by the programme leader to improve the quality of the programme.

5.1 Core Competencies of an Electrical and Mechanical Graduate from the Perspective of Students

The competencies in the domain of (IT) were expected to be more important to students. According to the Bronfenbrenner Ecological Framework for Human Development (1994), students place stronger importance on competencies closer to the "self" (e.g. IT application ability) than to macro competencies further away (e.g. citizenship). The result from the current study with respect to a group of E&M students showed that it was not as important as expected because students started to learn IT skills in secondary school; they thought that they owned that skill properly, while IT literacy is increasingly being classified as the skill of clerical works within their mind. They preferred to own the professional skills in the Electrical and Mechanical industry. However, students did not realize that IT literacy is important in today's workplace. They could not work efficiently without a proper degree of IT literacy in parallel with the professional skills for a specific trade. This was an area we should communicate further with students to get the right track throughout their learning.

Some students also do not recognize the importance of a few core competencies, such as the understanding of the mission and vision with the company unanimously; the capacity to carry out independent research and development; and the spirit of taking adventure and challenge. It was found that the main cause was their "age" or immaturity because of young age; they were too young to realize the importance of those core competencies until they

walked through the path of their seniors, which took time. However, we could speed it up by planting the seed at the right time when they are in the process of learning.

It was good to observe that students realized the importance of the core competencies such as responsible attitudes; identification and awareness of occupational safety and the attribute of punctuality; however, it was alarming to observe the relatively low importance of the awareness in environmental protection. Students concluded that engineering improved the efficiency of electrical machines and domestic appliances, an increase in efficiency which implied a reduction in consumption and being more environmental friendly. However, they were missing the concept of considering environmental protection in different aspects, and the awareness became low. A similar case happened with the phrase of the ability to participate in society; students thought that an engineer/a technician contribute to the community with their technical knowledge, and they did not expect these technicians to participate further to serve the community in depth.

5.2 The adequacy in delivering the core competencies by programme

It was encouraging to observe that students learned it properly in their identification and awareness of occupational safety, which is a crucial competency needed to work in the E&M industry; the capability in making multimedia for reporting and the capability in the application of software, were the core competencies expected to be important. Students did not realize that these core competencies were delivered adequately by the program; the teamwork spirit and the synergy through human interaction arrived at their destinations delivered properly through a lot of group work in laboratory sessions or presentation projects.

It was alarming to observe that the awareness of environmental protection, respect to intellectual property, attitude to prevent corruption and the ability to participate in society were not being delivered adequately in the programme. Those topics were not properly addressed within the programme, and they were not specifically included in the curriculum design. Similar cases have occurred in the core competencies of creativity, including the following: the ability to integrate resources in innovation; the capacity in independent research and development; Lenovo and imagination; a keen awareness force and the attitude in innovation and change, the programme administrator need to pay more to afford to improve the situation.

5.3 Relationship Between Core Competencies and Adequacy of Delivery

A useful piece of information was observed when research question 1 and research question 2 was integrated together. Four scenarios were identified resulted in a better understanding of the quality of the existing programme.

The first scenario, core competencies were important and properly delivered. It was found that students realize the importance of the core competencies, which will motivate them to learn; therefore, the efficiency in delivering the core competencies was higher. However, the programme leader still needs to re-inforce and keep up the high quality in delivering of those competencies.

The second scenario, core competencies were important but not adequately delivered. The programme administrator could improve the situation promptly, as these core competencies were accepted by the students as important. This is the aim of the study to identify the deficiencies of the programme and get improvement to enhance the quality of the programme efficiently.

In the third scenario, core competencies were not treated as important, and the delivery were not adequate. It involves a two-stage of remedial works and takes a long time to improve. The first-stage is simply the communication between programme administrator and students. The second-stage is the revision of the programme curriculum to enforce those core competencies and adequately deliver them to students.

In the fourth scenario, core competencies, was not treated as importance but they were still delivered adequately. The programme administrator needs to communicate with students and keep them in line on the view of core competencies. It is not only important for students who are going to work in the industry but it will also assist in the efficiency in delivering those core competencies.

The core competencies fell within the four scenarios to assist the programme administrator to set up a strategic plan in two-stages. In the short term, scenarios two and four should be addressed - Remedial work to address the curriculum design and set up some remedial actions for scenario two; better communication through different channels with students for scenario four. In long term, scenario one and three should be addressed - Remedial work includes both curriculum design and communicating with students to improve the quality of the programme for scenario three; maintain a high quality with adequately in delivering of important core competencies to students for scenario one.

5.4 Short-term Implication to Identify and Deliver Core Competencies to the Graduates to Work in the E&M Industry

Students need to be reminded from time to time to seek out challenging learning experiences. This result was developed from the core competencies of identification and awareness of occupational safety; the students mentioned that they also learned this core competence through the media, such as on TV and radio programmes. Their programme administrator should arrange more chances to attend seminars by professionals to expose students to these core competencies. This effort was aimed to remind them frequently and to arouse their interest because learning is most efficient when they feel interested in a certain area.

In addition to the adequate delivery of core competencies in scenario one, students should be able to communicate well those core competencies which they feel unimportant, such as Information Technology Literacy. Lecturers should remind students of this fact during the IT lessons.

The programme administrator should plant the seed for students' creativity, although it may not be a crucial competency for students working in the E&M industry. Students should also be reminded to remain punctual and maintain a responsible attitude even though they feel freedom during the transition from secondary school to college; they should be aware that they need to be responsible to their quality of work and behaviour during the transition from adolescent to adult. Core competencies in scenario two need to be addressed promptly,

while the core competencies in scenario three take time to proceed except for awareness of environmental protection, which should be immediately addressed as it is an important competency for working in the E&M industry.

The deficiency of some crucial core competencies may occur during the transition of education reform; for example, a new two-year HD programme was substituted for the three-year old HD programme. It was recommended that a comprehensive section be added on the topic of character development and citizenship during the industry-based student project workshop. This workshop initialized student projects that they had executed in the E&M industry and has the best timing to cultivate students with these core competencies. During normal lessons, lecturers should also share their working experiences from time to time during the lessons, through the interaction between persons, students could learn more in the domain of character development and citizenship.

In conclusion, this research developed an excellent assessment tool for our HD programme administrator to monitor the quality of the programme and help policymakers for a betterment in setting up a strategic plan. In order to line up the mission of my organization, which is to be the leading provider of vocational and professional education and training in the region, we need an efficient instrument to improve the programme we offer. The data gathered in this study should help the programme administrator to consider new ways of thinking about students and may also clear the way to a strategic plan to improve the quality

of the programme. This is the way to fulfil our mission, which is to provide a valued choice to school leavers, working adults and secondary school graduates to acquire skills, values and knowledge for lifelong learning and to enhance them with higher employability. Without a proper tool from this research, we cannot provide adequate supports to industries specific in the area of manpower supporting.

5.5 Long-term Implications to identify and deliver core competencies of the engineering graduate to work in the engineering field

"Nativism" is also known as xenophobia, which is understood as anti-immigrant animus and the fear of foreigners (Galindo, 2011). Nativism was a way of living in the past until the advance of technology, a better infrastructure with strong road/railway network, or the popularity of using aircraft for travel. Nativism leads to a great benefit to the economy with mass communication, and it reduces the border between countries. The rapid globalization of the past decade has influenced us in all aspects as the pendulum is swinging from one end to the other. People begin to think that when the move from Nativism to Globalization occurs, side effects will follow. The young generation is losing its jobs, and the large numbers of job vacancies have shifted from developed countries to underdeveloped nations. Some technology countries are already being sent overseas or replaced by technology (Hafner & Owens , 2008). Businesses always go where the "talent is" while life-time employment rates have been replaced by life-time employability (Widing, 2006).

Recently, political trends on Nativism have strongly been divided in Hong Kong and supported by groups of young people. The government has paid more attention to the affairs of youth, and the focus has shifted to professional and vocational education to enhance the employability of young people. However, the unemployment rate of university graduates continues to rise, and a degree or certificate cannot guarantee a secure job. Education to

enhance students' employability is crucial, but the assessment of vocational education is not as straightforward as academic programmes. In this study, core competencies for students working in the E&M industry were identified and the accuracy in delivering the programme to students was measured to provide a microscopic view of the programme and aid in the continuous improvement of the programme.

The instruments used in this study could also be applied to the programmes in the engineering disciplines and further applied to all programmes in professional and vocational education. This practice offers a great benefit to the professional and vocational education system, as this assessment will improve the quality of the programme. Quality is the keystone in determining the success of the programme. The current study on the E&M industry could be fine-tuned to other industries and exercise great improvement in the quality of the labour market. It fills the gap while the pendulum is swinging from one extent of academia to another extent of vocational education.

5.6 Conclusions

The objectives of the study were achieved, which were to identify the core competencies in the 21st century for students who will work in the E&M industry and to evaluate the performance of the existing HD programme in EE. Based on these two objectives, two research questions were proposed, which were adequately and thoroughly addressed. The core competencies for students who will work in the E&M industry were identified, and the adequacy in delivering those core competencies was evaluated.

The results indicated that less importance was placed on competencies such as "creativity", while more importance was placed on competencies such as "work ethics". These findings are in alignment with organisational structures in the East, which are often top-down and hierarchical, while those in the West are often bottom-up and people are more equal. The perception of equality between people is induced from the cultural differences between the East and West and the environment the students were in growing up.

In addition, the differences between the students' expectations and those of the industry are probably due to the students' immaturity and their lack of work experience. Students thought that participating in society and possessing a spirit of adventure and challenge were unimportant. More mature students are more confident about taking up adventure and challenge; they are in a better position to participate and contribute to the society. Immature students do not understand that they can contribute and participate in another way.

The takeaways of the thesis confirm that the VTC design and teaching curriculum are on the right track. It is pleasing to know that students list work ethics (e.g., responsible attitudes, safety awareness) as the most important competencies for the E&M field. This study identified the need to reform the curriculum and promote "creativity" element within the programme. An immediate remedial action was taken to include the environmental protection element and the Independent Commission Against Corruption (ICAC) talks during the workshop and before students are attached to companies and begin working in the E&M industry.

In conclusion, this study established a set of procedures as well as a measurement tool and interview protocols to consult the key stakeholders, who are the students in this research. The research aim of improving the quality of the programme was accomplished. Finally, an excellent tool was developed to assess the programme and to improve its quality for better student learning and curriculum design.

5.7 Limitation of the Study

A limitation of the study was the timing of the survey collection. In this study, the survey was conducted during semester four, which is the last semester when students must go out into the industry to begin their industry-based student project. An optimum result can be achieved if the timing of the survey is close to the end of the last semester. Another limitation of the study is only taking students' perspectives into account; other stakeholders' perspectives could make this study more comprehensive.

5.8 Future Research

This study was limited to the students of the HD in the EE programme. However, it could be further applied to other programmes within the engineering discipline. The assessment tools could also be used in other disciplines within the Hong Kong Institute of Vocational Education and other organisations within the branch of the Vocational Training Council. Other stakeholders worth following up are VTC lecturers, industry leaders, employers, parents and the Government.

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Appendix I: Rasch – Raw Score Conversion Table (Importance Sub-scale)

TABLE OF MEASURES ON TEST OF 35 ITEMS									
Raw Score	Rasch	Raw Score	Rasch	Raw Score	Rasch	Raw Score	Rasch	Raw Score	Rasch
0	-7.02E	22	-2.10	44	-0.60	66	0.85	88	2.57
1	-5.80	23	-2.03	45	-0.53	67	0.92	89	2.66
2	-5.08	24	-1.95	46	-0.47	68	0.99	90	2.76
3	-4.65	25	-1.88	47	-0.41	69	1.06	91	2.87
4	-4.34	26	-1.80	48	-0.34	70	1.13	92	2.98
5	-4.09	27	-1.73	49	-0.28	71	1.20	93	3.09
6	-3.88	28	-1.66	50	-0.21	72	1.28	94	3.21
7	-3.70	29	-1.59	51	-0.15	73	1.35	95	3.34
8	-3.54	30	-1.52	52	-0.08	74	1.42	96	3.48
9	-3.39	31	-1.45	53	-0.02	75	1.50	97	3.63
10	-3.26	32	-1.38	54	0.05	76	1.57	98	3.79
11	-3.13	33	-1.32	55	0.11	77	1.65	99	3.98
12	-3.02	34	-1.25	56	0.18	78	1.73	100	4.19
13	-2.91	35	-1.18	57	0.24	79	1.80	101	4.44
14	-2.80	36	-1.12	58	0.31	80	1.88	102	4.76
15	-2.70	37	-1.05	59	0.38	81	1.96	103	5.20
16	-2.61	38	-0.99	60	0.44	82	2.04	104	5.92
17	-2.52	39	-0.92	61	0.51	83	2.13	105	7.14E
18	-2.43	40	-0.86	62	0.58	84	2.21		
19	-2.35	41	-0.79	63	0.64	85	2.30		
20	-2.26	42	-0.73	64	0.71	86	2.38		
21	-2.18	43	-0.66	65	0.78	87	2.47		

Appendix II: Rasch – Raw Score Conversion Table (Adequacy Sub-scale)

TABLE OF MEASURES ON TEST OF 35 ITEMS									
Raw Score	Rasch	Raw Score	Rasch	Raw Score	Rasch	Raw Score	Rasch	Raw Score	Rasch
0	-7.14E	22	-2.26	44	-0.78	66	0.84	88	2.87
1	-5.92	23	-2.18	45	-0.72	67	0.92	89	2.98
2	-5.20	24	-2.11	46	-0.65	68	1.01	90	3.09
3	-4.77	25	-2.04	47	-0.58	69	1.10	91	3.20
4	-4.46	26	-1.97	48	-0.52	70	1.18	92	3.31
5	-4.21	27	-1.90	49	-0.45	71	1.27	93	3.43
6	-4.00	28	-1.83	50	-0.38	72	1.36	94	3.56
7	-3.82	29	-1.76	51	-0.31	73	1.45	95	3.69
8	-3.66	30	-1.69	52	-0.24	74	1.54	96	3.83
9	-3.52	31	-1.63	53	-0.17	75	1.64	97	3.99
10	-3.39	32	-1.56	54	-0.10	76	1.73	98	4.15
11	-3.26	33	-1.50	55	-0.03	77	1.82	99	4.34
12	-3.15	34	-1.43	56	0.04	78	1.91	100	4.56
13	-3.04	35	-1.36	57	0.12	79	2.01	101	4.82
14	-2.94	36	-1.30	58	0.19	80	2.10	102	5.14
15	-2.85	37	-1.23	59	0.27	81	2.19	103	5.57
16	-2.75	38	-1.17	60	0.35	82	2.29	104	6.30
17	-2.66	39	-1.11	61	0.43	83	2.38	105	7.52E
18	-2.58	40	-1.04	62	0.51	84	2.48		
19	-2.50	41	-0.98	63	0.59	85	2.57		
20	-2.41	42	-0.91	64	0.67	86	2.67		
21	-2.34	43	-0.85	65	0.75	87	2.77		