International Journal of Engineering Education Vol. 28, No. 5, pp. 1232–1242, 2012
Printed in Great Britain

0949-149X/91 $3.00+0.00

Mismatch between Higher Education and Employment in Malaysian Electronic Industry: An Analysis of the Acquired and Required Competencies*

ABDUL GHANI KANESAN ABDULLAH, SIM HOCK KEAT, AZIAH ISMAIL and MOHAMAD HANIF ABDULLAH
School of Educational Studies, Universiti Sains Malaysia, 11800 Penang, Malaysia. E-mail: agk@usm.my

MIDUK PURBA
Politeknik Negeri Medan, Indonesia

The relationship between tertiary education and employment is an important issue that concerns a number of interested parties that include education providers, national education policy makers, industry operators, the undergraduates and their families. In this study, the education and employment relationship were studied from the aspect of the mismatch of acquired (AC) and required (RC) competencies of the electronic engineers in the electronic industry. The competencies were studied from the generic and subject-specific aspects. Respondents from the Malaysian Penang Development Corporation Industrial Areas were involved in this research. The research samples comprised managers, human resource managers, production managers and test managers. Two sets of questionnaires were administered to the participants. The findings clearly showed that there is a common agreement among the managers (employers) on the existence of an AC–RC competencies mismatch. A paired sample t-test between the AC and RC competencies of the soft and hard skills showed they were significantly different. The size of the mismatch of the competencies in ascending order for the soft skills are: ICT skills, Personal qualities, Thinking skills, Interpersonal skills, Management skills, and Communication skills. In the hard skills categories, the size of the mismatch ascends in the order 'Practical usage of the software tools', 'Circuits construction', 'Operate, troubleshoots systems and equipment', 'Process, control and installation', 'Quality and reliability testing'. The overall mismatch of the soft skills was significantly greater than that of the hard skills. The findings of this study highlight the need for the Malaysian Higher Education system to take drastic action to close the gap between tertiary education and employment.

Keywords: graduate mismatch; higher education; acquired and required competencies; labour market

1. Introduction

Human resources are the key constituent of growth and the most important production factor in today's economies. Thus, in order to build a strong nation, an emphasis on developing individual skills is crucial; these skills are in strong demand and are important. However, Ramlee *et al.* [1] state that one of the most worrying concerns in Malaysia's economy is the absence of skilled human resources. In relation to this, the United Nations [2] pointed out that Malaysia ominously suffers from a growing shortage of skilled workforce, with a relatively weak human capital base that is increasingly out of line with its production and export structures. In response to this, the government of Malaysia has launched several efforts to correct and rectify the supply–demand shortfalls that have emerged in the labour market since the late 1980s. As part of the way to overcome the vacuum from the perspective of the quest for skilled personnel, a double-deduction taxation was introduced in 1988 to encourage in-house training in firms. Special directives and incentives were also introduced in the mid-1990s, intended to increase the supply of science and technology graduates. Training programmes and courses for low-level technical and vocational trades to engineering degrees were extended and the size of the intakes increased. In addition, The Private Universities Act of 1995 helped in opening the path for the growth of more universities, especially in the production of engineers in Malaysia.

Providentially, these efforts resulted in the production of more academically qualified personnel, who in return enhanced the quality of education in general. However, from the rising number of unemployed graduates each year, it can be seen that too many graduates are being fed into the job market, leading to a problem of oversupply. In contrast, many companies continuously complain about the shortage of skilled personnel; whereas many trained graduates remain jobless or unemployed or unattached to these workplaces, which are totally unrelated to their academic backgrounds. According to Kamal [3] the problem of being unable to secure a job is rising in Malaysia due to the lack of competencies of graduates who need to equip themselves

* Accepted 16 April 2012.

with the relevant generic skills and required technical skills. Nevertheless, it is not so much the issue of the mismatch of the number of graduates to the vacancies in the job market but rather the quality of the graduates that we should be worried about [4]. Thus, there is a real need to examine the fundamental issues of the qualities of the graduates, and focus on the possible mismatch of the graduates' competencies with the demands of the workplace. This issue of competency requirements for engineers has also been debated in the UK and in other parts of Europe and beyond in recent years. Many programmes have been criticized because of their inclination towards theory and the lack of application of engineering principles, which has led to a mismatch between the skills obtained by graduates during their higher education studies with the skills required by industry and commerce.

Hence, the focus of this study is primarily on assessing and examining the existence of a possible mismatch as well as investigating the prevailing gap between the 'acquired' and 'required' competencies that need to be addressed by the education provider. Furthermore, a failure to narrow the gap may lead to the employers incurring higher training costs and higher overheads for their employees. Inevitably, this will result in an unfavourable rise in production costs, thus reducing the competitiveness of the graduates. In Malaysia, employment [5] in the manufacturing sector contributed 29.3% of the total employment during the period of the 2005 mid–term Eighth Malaysia Plan review. The manufacturing sector contributed a major share of employment with 3 177 100 jobs, thus increasing its share of total employment to 29.3% in 2005 from 27.6% in 2000. Additionally, the upturn in the world demand for electrical and electronics products, coupled with Malaysia's competitiveness in this industry, contributed to the rise in employment openings in the manufacturing sector.

This study explores the various competencies that are acquired and required by electronics engineers, especially with the aim of understanding the core elements that constitute competencies and the actual elements that correlate the categories of competencies with the different demographic backgrounds of the engineers. Unfortunately, even though the correlating coefficient signifies a relationship and predictability, it does not imply any cause and effect. In other words, a limitation of this study is that it shows only relative variables without clearly indicating any possible contributing elements that influence them or if one causes the other. Thus, the findings of the study, the outcomes and the feedback would serve as a guide to integrating the required elements of competencies in the semiconductor and electronics industries into the curriculum and the activities planned in the higher institutions.

2. Literature review

The link between competency and performance has been much discussed and argued over in the educational literature. However, Hyland [6] choose to relate competency to knowledge and understanding. He reaffirms that knowledge and understanding cannot be separated from performance (through observable behaviour) just as much as competency itself. Many researchers suggested that experiences attained from higher education should prepare one to take on the mantle of career and life. However, many graduates embarking on their new career ventures discovered that the knowledge and ability acquired during their time in higher learning institutions were basically not enough. Something crucially significant was missing during this time of knowledge acquisition in the process of preparation that prevented them from translating what they had learned into effective performance. It was noted by Kumar and Kent Hsio [7] that currently engineers acquire and master leadership and management skills and soft skills when they are actually in the working environment. It was further pointed out that education or training could be transferred from the laboratories, seminar rooms or lecture theatres to the outside world, where skills could be transferred from one context to another in the place where they are to be applied. Bridges [8] further described transferable skills as the application of skills across different social contexts: skills in interpersonal communication, management skills and collaborative group working skills.

In relation to this, the manufacturing sector in Malaysia created 270 700 new jobs as a result of the expansion in domestic-oriented industries, which had benefited from the positive effects of the fiscal stimulus programme. Consequently, employment in the manufacturing sector expanded at an average rate of 3.40% per annum, thus increasing its share to 27.9% in 2003 in total. The technicians and associate professionals category registered an average growth of 4.8% per annum, accounting for the creation of 165 200 new jobs. Of these, 15.3% were engineering technicians in fields such as electrical and electronics as well as telecommunications. This was partly as a result of the expansion of telecommunications services in Malaysia as the telecommunications companies in Malaysia had upgraded their services to meet increasing demand, which increased from 11.9% in 2000 to 12.5% in 2003 of the total employment in this category. Comparatively, Malaysia's electronics industry grew steadily from a handful of companies with less than 600 workers in 1970 to an industry of world class capabilities, making it the largest contributor to the country's manufacturing output [9]. Thus, the electronics industry plays a major role in pivoting the industry by providing 360 048 jobs with the export value reaching RM 183.2 billion in 2003.

Meanwhile, a survey conducted by the National Bank in 2002 on Employability of Graduates discussed the issue of the skills mismatch [10]. The survey covered 312 companies, 187 of which responded to the survey. The result showed that 77.6% indicated that graduates did not have the necessary skills required by the organizations, which, in return, resulted in an understanding that the quality of the graduates produced was not as required. This apparently coincides with a study carried out by Ahmad [11] on technical graduates; the findings show these graduates were unemployed due their lack of generic skills. It was further deliberated that apart from the lack of soft skills and generic skills, these technical graduates were found to be lacking in the employability skills required by the industry. The employers, therefore, were inclined to employ competent workers from abroad. Similar studies concerning the quality of graduates were discussed in a separate study, Abuelma'atti1 [12], as the need to recruit better qualified people into the industry and to upgrade the skills of existing employees showed that the higher education institutions have an important contributing role to play in Saudi Arabia. A more positive reaction and response are required when the chorus of complaints from industrial recruiters was heard, pertaining to the questions about the types and quality of degrees being offered. The demand for graduates possessing a broader based and more application-orientated degree was increasing [13]. This showed that companies are not ready to compromise quality for quantity. Hence, one of the reasons for the non-recruitment of graduates was the lack of required skills of the applicants [5]. In general, certain key qualities needed by employable graduates are: communication skills (competency in written and spoken English), a passion for learning and re-learning (skills to keep pace with advances in the market and technology), and the drive to achieve quality excellence, market orientation, and creative thinking in expressing ideas. Ramlee [14] claims that in general the employers in Malaysian industry says that even though the local technical graduates have adequate technical skills, they are not satisfied with the communication, interpersonal, critical thinking, problem solving and entrepreneurial skills that these graduates possess.

3. Competencies

There are many ways of describing competencies. Behaviourist tends to see competencies as the characteristics that employees have inherited from their progenitors. The behaviourists' perspectives on competencies were widely accepted, particularly in the USA in the 1960s. On the other hand, a functional analysis approach expressed competencies as: that which is to be achieved and enables performance to be measured in a fairly objective manner. It allows the break-down of competencies into increasingly specific functions until the original broad functions have been reduced to the elements of competency. Such a break-down of competency ensures that performance vs. competencies can be measured reasonably objectively. However, it cannot be assumed that a mastery of the elements of competency will automatically lead to the attainment of more complex competencies in the higher tasks. This is because performance in the more complex tasks depends on factors other than the elements identified by functional analysis.

3.1 Types of competencies

The final outcome of higher education is that the student should acquire enough competencies to be transferred into work efficiencies. Education contributes a large portion of the acquirement of competencies. In order to realize the objective of higher education from the perspective of the Human Capital Theory, one has to acquire the competencies needed in the workplace. These competencies may cover the cognitive, psychomotor and even affective domains. However, these competencies can be categorized by the ways in which the competencies have been acquired: the generic competencies and subject-specific competencies.

3.2 SCANS' competencies

In 1990, the Secretary's Commission on Achieving Necessary Skills (SCAN) assembled labour, education and business leaders of the United States in order to identify the common skills associated with high skills and high wage jobs [10]. The intention was to raise the awareness of education systems to the broad skills needed by graduates on the job. The commission highlighted the competencies needed by higher educated personnel to work with budgets, evaluate data, to interpret and disseminate information, to use technology and to make judgments and demonstrate leadership in the workplace. 'Basic Skills' deals with the abilities to read, write, perform arithmetic and mathematical operations, listening skills and speaking skills. 'Thinking Skills' basically involves creative thinking, making decisions, problem solving, visualizing, knowing how to learn and reasoning. The 'Personal Qualities' listed are responsibility, self-esteem, self-management, integrity and honesty as sub-categories of the required competencies.

3.3 Required competencies

The required competencies related to workplace demands are divided into two large components: generic competencies and subject-specific competencies. There are six groups of skills and competencies recommended in the model. In this research, the generic competencies component takes into account the Global and Strategic, Industrial, Humanistic skills and competencies.

3.4 Generic competencies

Teichler and Kehm [15], referred to generic competencies as general competencies. Thus, in establishing the relationship between higher education and the world of work, they revealed the importance of generic competencies with social skills and personality. In many professions, specialized professional knowledge is less emphasized than generic competencies. One of the reasons is that a growing number of professions and positions within enterprises and public agencies are not clearly demarcated but are based rather on knowledge derived from different disciplines. Another reason for the emphasis on the generic competencies is the demand for flexibility and more adaptability to dynamic changes in the economy. To others, generic competencies mean transferable skills, core skills as well as cross-curricula skills, although some attempts are made to differentiate them [8].

4. Categorization of competencies

The competencies of electronics engineers are initially divided into two large components: generic competencies and subject-specific competencies. The generic competencies were then further categorized into four categories namely:

1. Personal qualities
2. ICT skills
3. Management skills
4. Thinking skills.

Likewise, the subject-specific competencies are divided into two categories:

1. Subject knowledge
2. Technological skills and knowledge.

4.1 Personal qualities

SCANS' competencies include responsibility, self-esteem, sociability, self-management, integrity and honesty as the personal qualities needed. There are some similarities of competencies between SCANS' competencies and the 'values education' proposed in the report by the ASEAN regional seminar on Values Education. The overlapping personal qualities are: integrity, self-esteem, honesty, tolerance and perseverance. Loyalty and commitment were stressed in the ASEAN seminar as the oriental culture may consider these as the values that a worker should uphold. In this category of competency, some of the characteristics and qualities of the workforce are expected. The qualities that are expected to be observed include: the willingness to compete, an inquisitive mind to drive constant and continuous learning. The quality of high self-esteem would mean thinking positively about one's own self-worth. In addition, the personal qualities should include sociability, such as: understanding, friendliness, adaptability, empathy and politeness in a group setting. Employers are also keen to see that the workers are working towards 'results' or show achievement orientated attitudes.

4.2 ICT Skills

Increasing globalization and dynamic changes in Information and Communication Technology (ICT) has changed the demand for technology skills in the workplace. For example, the International Computer Driving Licence (ICDL) was the computer skills testing model that was widely accepted by some 75 countries worldwide. Its IT competencies standards provide a benchmark of computer knowledge and skills to employment recruitment. The universality of the ICDL is important, as it is independent of any specific software provider. The standard model of ICT competencies highlighted some important elements of ICT competencies. Among the competencies needed are the ability: to use spreadsheets for data computation, to make an effective presentation using computer software such as PowerPoint, to use word-processing software, to make effective using of database software and use file management for daily tasks; to be able to communicate, to search, and to have the ability to transfer information with search engines and to use e-mails. It also includes the basic concepts of IT and their applications.

4.3 Management skills

Resources in an organization need to be managed so that the organization can implement plans smoothly to attain its objectives. Management skills are needed to allocate and coordinate resources to accomplish many tasks in the organization or department. This includes delegating personnel in order to use the organization's resources for carrying out tasks successful [16]. Management skills are particularly required in the areas of project management and quality management. In the literature review, there are four main components of management skills identified: (1) planning; (2) organizing; (3) motivation and (4) control.

4.4 Thinking skills

Engineers are considered to be professionals. Collins [17] describes an irony involved in the type of duties and responsibilities typically carried out by the professional. Professionals are involved in intervention with uncertain outcomes, which also means that there is no standard, routine way of dealing with a particular problem. However, Hoachlander [18] argued that professionals must also be able to carry out specific tasks. It is sensible that certification systems alone will not be adequate if specific tasks could not be accomplished. For the professionals, technical skills and basic competencies are the foundation of general functions, such as problem solving, reasoning and the exercise of judgment. Thus, thinking skills become an important category of competency. Creative thinking is the required ability to generate new ideas and it is also important for decision making where the risk factor should be balanced against specific goals and constraints. Creative thinking helps one to generate alternatives to solve problems and tackle situations. For professionals such as engineers, Wolfson *et al.* [19] consider the professionals' need to have quite a different framework of skill components because the professionals are usually expected to perform actions that are autonomous, proactive, and quite often non-routine. Therefore, problem solving that involves recognizing problems, devising and implement plans of action, will be an important subcategory competency. In the area of problem solving, the ability to visualize is necessary; this is done through the recognition and processing of symbols.

4.5 Subject-specific competencies

Subject-specific competencies form another important component of the required competencies in the workplace. Bailey and Merritt [20] made a fundamental distinction between technical and academic skills. The required skills and knowledge take on either a workplace or a classroom orientation with little overlap, thus separating the workers' and learners' roles in the organization. The skills represented in this context also tend to be narrowly defined. Technical skills define the explicit knowledge and abilities that are necessary to perform industry- or occupational-specific tasks (or set of tasks). Academic skills constitute an employee's foundation or basic knowledge components of competencies that an employee needs before gaining technical skills.

Bailey and Merritt [20] compartmentalized the skills into: technical skills, employability skills and related academic skills. E£xamples that distinguish the proposed technical and academic skills are:

- *Technical skills*—Safety identifies first aid supplies, personnel and emergency protection areas; keep work area free from clutter; use appropriate safety procedures and guidelines;
- *Academic skills*—Algebra interprets ratios; solve linear equations; determine equivalent forms of a formula; convert word problems to mathematical expressions.

Hence, in this study, subject-specific competencies are the skills and knowledge that are acquired through a particular course of study or programme. There is very little or no overlapping of the course content with other fields of study. This makes the competencies acquired through the electronics engineering course very discipline specific compared with others. In order to see the applicability and 'use value' of this specific academic knowledge and skills, these competencies have to be demonstrable in the form of the abilities to do and to perform in the job context. In this component of competencies, the subject-specific competencies are consolidated into: Subject knowledge, Technological skills, and Knowledge including related academic skills as suggested by [16].

4.6 Subject knowledge

Subject knowledge is learned prior to specific vocational/technical knowledge. Subject knowledge is considered to help workers master the required list of tasks; that is, the academic knowledge is supposed to enable the acquirement of competencies. Subject knowledge includes:

1. Basic sciences & mathematics
2. Analogue electronics
3. Digital electronics
4. Electronics circuit theory
5. Solid states theory
6. Industrial electronics
7. Elective courses (Fibre optics, Computer networking, Software engineering).

4.7 Technological skills and knowledge

The technological competencies of electronics engineering were examined and identified through analysing the duty/task profile of electronics graduates in Taiwan. In the report of Chen and Chang [21], the list of competencies required includes: the selection of electronics components; the operation of electronics instruments, construction of electronic circuits, and software design with the help of computer-aided drawings, projects, monitoring production management and the construction of technical services. Meanwhile, on consolidating the job specification in the local recruitment of electronics engineers, Chen and Chang [21] report that the technological skills and knowledge of electronics engineers can be summarized as follows:

1. Selection of electronics components
2. Operation of instruments
3. Construction of electronic circuits
4. Practical usage of software and hardware tools
5. Process and control
6. Maintenance and trouble shooting of equipments and systems
7. Quality & testing
8. Installation.

5. Aim of the study

This study intends to find the extent to which the electronic engineers employed meet the demands of the electronic industry and to find the areas of mismatch and the extent of the mismatch. In this paper, the mismatch was studied from two aspects (components): required competencies and the acquired competencies.

6. Methodology

The respondents for this research were electronics engineers, electrical engineers or physics graduates, immediate superiors or managers of the electronics engineers and the training department's managers or human resource managers randomly selected from the Malaysian Penang Development Corporation Industrial Areas based and employed in the electronics firms in the Penang Development Corporation Industrial Areas (Penang Free Trade Zone and Industrial Parks). The questionnaire was administered and completed by 472 electronics engineers who had a minimum of at least 3 months working experience, selected from fourteen companies as well as their technical superiors, training managers and other managers. The items for this research were taken from the sub-category competencies gathered from interviews, primarily with the production, testing and quality assurance engineers, their managers and the human resource or training managers. From these interviews, the sub-categories of the required competencies became a guide for formulating the items needed. The items for the questionnaires were subjected to modification based on the findings from the empirical data. Seventy-six items were identified of which 40 items were from the generic competencies category. Apart from that there were 36 items from the subject-specific category. Of the 36 items, 6 items were in the subject knowledge category while 30 items were formulated in the technological skills and knowledge category. There were two Ten Point Scales of 1–10 ('1' being the least needed and '10' being the most needed) on each side of the components of the competencies.

7. Findings

In this study, a large number of variables were used in exploring the required and acquired competencies of the electronic engineers. As a result of the triangulation, 40 variables were constructed to examine the soft skills (required competences) and 30 variables were used to explore the competencies required in the area of subject and technological knowledge (hard skills). These variables were summarized under their common underlying dimensions to determine whether they fitted into the categories of skills as conceptualized in the conceptual framework. Thus, the exploratory factor analysis was conducted for soft skills items and conceptually six factors were merged with eigenvalues above 0.3 and contributed 61.707 % of the variance with the KMO measure of sampling adequacy of 0.866 and Bartlett test of sphericity value of 2972.77 were significant at $p = 0.00$. These factors were: Interpersonal skills, Communication skills, Personal qualities, ICT skills, Management skills, and Thinking skills. While, for the hard skills, 30 items were analysed using exploratory factor analysis. The Kaiser–Meyer–Olkin measure of sampling adequacy was 0.893 and Bartlett's test of sphericity was significant ($p < 0.00$), showing that the data were useful for the factor analysis. Five factors merged with eigenvalues above 0.3: Process and control, Operates and troubleshooting instruments and systems, Construction of the electronic circuits, Quality and reliability testing, and Practical usage of software tools.

7.1 Is there a mismatch between the acquired and required competencies of the graduates in the electronic industry?

A paired sample t-test was carried out to investigate whether there is a significant difference between the score mean of acquired competency (AC) and the required competencies (RC) of the engineers. The differences between AC and RC were computed for both soft and hard skills from the perspectives of the managers, followed by the engineers. The results are presented in Tables 1 and 2 respectively.

The findings from Table 1 indicate that there were significant differences between the acquired and required skills for engineers, In other words, there exist mismatches or gaps between the acquired and required competencies among engineers. This finding also displays the largest mismatch for soft skills, occurring in the communication and management categories.

Table 1. Mean scores of AC and RC (soft skills)

		Mean	SD	Mean differences	Std error mean	t-value
Pair 1	Mean of AC Interpersonal skills	5.18	1.77	–2.26	0.18	–12.14*
	Mean of RC Interpersonal skills	7.44	1.22			
Pair 2	Mean of AC Communication skills	5.03	1.88	–2.56	0.21	–11.70*
	Mean of RC Communication skills	7.59	1.47			
Pair 3	Mean of AC Personal qualities	6.42	1.81	–1.78	0.18	–9.70*
	Mean of RC Personal qualities	8.21	1.23			
Pair 4	Mean of AC ICT skills	5.64	2.07	–1.52	0.19	–7.76*
	Mean of RC ICT skills	7.16	1.58			
Pair 5	Mean of AC Management skills	5.01	2.07	–2.54	0.24	–10.24*
	Mean of RC Management skills	7.54	1.48			
Pair 6	Mean of AC Thinking skills	5.86	1.84	–2.23	0.23	–9.70*
	Mean of RC Thinking skills	8.09	1.39			

Notes: * sig. at $p < 0.01$

Table 2. Mean scores of AC and RC (hard skills)

		Mean	SD	Mean difference	Std error	t-value
Pair 1	AC – Process, control & installation	4.62	2.21	–2.69	0.26	–10.23*
	RC – Process, control & installation	7.31	2.01			
Pair 2	AC – Operates and troubleshoots instrument & systems	4.33	2.23	–2.07	0.25	–8.22*
	RC – Operates and troubleshoots instrument & systems	6.41	2.15			
Pair 3	AC – Construction of circuits	4.95	2.12	–0.93	0.25	–3.73*
	RC – Construction of circuits	5.89	2.27			
Pair 4	AC – Quality, reliability and testing	4.10	2.39	–3.05	0.26	–11.33*
	RC – Quality, reliability and testing	7.16	1.89			
Pair 5	AC – Usage of software tools	4.91	2.06	–0.8569	0.19	–4.42*
	RC – Usage of software tools	5.77	1.89			

Notes: * sig. at $p < 0.01$

Meanwhile, the finding presented in Table 2 show that there was a significant difference between the AC and RC of the engineers. In other words, mismatches or gaps of competencies exist. Table 2 shows that 'Process, control and installation' and 'Quality, reliability and testing' were the two largest mismatch hard skills categories.

7.2 Standardized the magnitude and classification of the mismatch

In order to determine the extent of the gap or mismatch, a standardization of the magnitude of the gap for both soft and hard skills was done. The standard z score (Table 3) is a derived score that expresses how far a given raw score (in this case the magnitude of gap) is from some reference point that is the mean, in terms of standard deviation units. The extent of the mismatch was classified by dividing and defining the magnitude of the mismatch in a five z score scale. The extent of the mismatch is defined as σ = standard deviation = 0.707. According to this definition, score $z < -1.5$ is then categorized as a negligible size of mismatch; –1.5 to < –0.5 as tolerable; –0.5 to < +0.5 as medium; + 0.5 to < +1.5 as serious; and $\geq$ +1.5 as critical. The findings are shown in Table 3.

The findings from Table 3 showed that soft skills, Communicative skills and Management experienced a serious mismatch compared with Interpersonal skills, while Thinking is classified only as a medium mismatch. ICT skills, on the other hand, experienced only a tolerable mismatch. Meanwhile, in terms of hard skills, the research's findings show that Quality skills, Reliability and Testing experienced a critical mismatch. Process and control skills, on the other hand, are at a serious level, while the Operates and Troubleshooting category is at a medium level; Construction skills and Practical usage experience mismatch is negligible.

8. Discussion and recommendations

The only category of competencies that has a critical mismatch is the hard skills category, where the components are 'quality, reliability and testing'. This is the hard skills category that was among the most required (RC mean scores = 7.16) in hard skills competencies, but it was the least acquired. Quality

Table 3. Standardization of magnitude and classification of mismatch by skills

	Soft/Hard skills	Magnitude of gap	z scores	Classification of mismatch
Interpersonal	Soft skills	–2.26	0.30	Medium
Communications	Soft skills	–2.56	0.72	Serious
Personal qualities	Soft skills	–1.79	–0.36	Medium
ICT	Soft skills	–1.52	–0.74	Tolerable
Management	Soft skills	–2.54	0.69	Serious
Thinking skills	Soft skills	–2.24	0.27	Medium
Process and control	Hard skills	–2.69	0.91	Serious
Operates and troubleshooting	Hard skills	–2.07	0.03	Medium
Construction of electronic	Hard skills	–0.94	–1.56	Negligible
Reliability and testing	Hard skills	–3.05	1.51	Critical
Practical usage	Hard skills	–0.86	–1.68	Negligible

and reliability issues are closely related to the customer's satisfaction. Business environment factors greatly influence the required competencies of the engineers; therefore, enhancement in this area of hard skills is necessary and urgent. 'Quality, reliability and testing' has to be emphasized in the design of the curriculum for the electronics engineering course content. Courses that deal with ISOs, such as ISO 9000 and ISO 14000, were strongly recommended in the engineering programme. This is seen as an important measure to strengthen the undergraduates' concepts of quality and systems. The mismatches that were rated as 'serious' include one hard skills category and two soft skills categories. 'Process, control and installation' is the hard skill that was rated as seriously mismatched. This was followed by two soft skills: Communication skills and Management skills. 'Process, control and installation' includes identifying and solving equipment problems, controlling production time to reduce cycle times, and improving yields by using failure analysis skills. Installation skills and knowledge are required in this category as engineers in this department are expected to set up new equipment, instruments and systems, and to test run them for the proper functioning of new equipment, instruments and systems. In this hard skill category, the ability to read and write technical reports is the most important skill to provide the necessary and precise information for decision making.

Two soft skills that were rated seriously mismatched were Communication skills and Management skills. Communication skills include directing discussion and good presentation. These skills are necessary for securing successful negotiations. The skills are particularly important as the roles of engineers have been extended to business-focused activities. Examples of business environment factors include: knowledge of costing, product end life management and justification to purchase. As business environmental factors become prominent in the job specification of engineers, the mismatch in the soft skills category becomes increasingly important and serious attention is needed to be paid to it. The second mismatch of soft skills that was rated 'serious' was the category of Management skills. Generally, electronics engineering courses emphasize the hard skills categories. Very often soft skills were self-acquired skills and were left to the undergraduates. Since the mismatch in management skills is relatively serious, it is beneficial to understand its composition from the point of view of employers and the engineers themselves. Principally, the elements of management skills require one to coordinate the workforce and plan the achievement short and long-term goals. One needs to master the skills of dedicated jobs so that each unit can carry out the specific tasks allocated to them. The elements of management skills also include the monitoring and gearing of operation units (cell). The management skills needed include providing positive comments and expectations. The competitiveness of the undergraduates will be increased if management and communication skills training are included in the electronics engineering course contents. Mastery of communication skills and management skills in tertiary education itself will facilitate the process of turning the engineers into productive and independent workers in the field. This will shorten the learning curve and retraining time required in industry.

Three soft skills categories fell into the medium mismatch range: Interpersonal skills, Thinking skills, and Personal qualities. Though Thinking skills and the Personal qualities were the two most required soft skills, the magnitude of the mismatch was comparatively moderate. This was mainly due to the contribution of the relatively higher acquired competencies in the respective soft skills. The range of mismatch for these two skills is not alarming. Nevertheless, the increasing emphasis and demand for the Thinking skills and Personal qualities may result in a further widening of the gap in the future. Further enhancements in these two soft skills categories are necessary. The requirements in the Personal qualities have two aspects: Implicit and Explicit aspects. Explicit aspects include having a pleasant personality and the ability to converse fluently in English. Implicit aspects involve honesty and moral principles, positive attitudes and the willingness to learn new things. The willingness to learn new things is the most required element in this soft skills category. The ability to be motivated to achieve results is highly appreciated. Another very much needed soft skill is Thinking skills. Thinking skills includes recognizing and understanding underlying problems. Problems identified may arise from statistical and numerical aspects. Thinking skills provides logical analysis of the root of the problem and they allow one to devise plans and alternatives to solving problems. In the electronics industry, problem solving is a day-to-day activity and therefore thinking skills are particularly important. As the need for the soft skills is greater than the need for the hard skills, the education providers or the coordinators of the electronic engineering programme or schools, need to seriously consider incorporating soft skills courses and training in line with the training for the hard skills. Tertiary education providers who leave undergraduates to acquire the soft skills themselves, may need to employ structured, properly planned soft skills training activities. The programme run by corporate bodies may serve as a guide for the types of soft skills content and activities required. However, the six categories of soft skills will serve as an important guideline and also demonstrate a degree of urgency for incorporating the required soft skills. In the electronics industry, where business becomes the main concern, operational procedures, modifications and technological requirements change accordingly. This scenario greatly affects the roles of engineers. Continuous life-long learning is a must for all graduates. The concept of life-long learning needs to be instilled in the undergraduates through some structured activities.

Joint efforts between the industry operators and education providers have been made from time to time. These include: dialogues between the industry operators and the public universities, the setting up of laboratories in universities by the industry operators, and the offering of scholarships to undergraduates. The industry also absorbs undergraduates into industrial training, while dialogues between students and industry are being undertaken by universities for the undergraduates. These efforts produced certain bridging effects to narrow the gaps. However, industry operators are not satisfied with the rate of progress of the gap-bridging efforts. More questions are being raised concerning the precise timing and length of time that should be given. Students undergoing industrial training should be given a longer training period to complete their projects. Industrial training needs to be brought forward and not take place towards the end of the degree course. This is to ensure that time is allowed for corrective measures and a retraining process to take place after certain industrial training experiences have been undergone. Lecturers handling the technological courses should posses some industrial experience. They should be constantly exposed to contemporary technology through constant contact, dialogue, and by visiting factories. This will keep the lecturers constantly aware of the technological and organizational changes that are continuously taking place in the industry. In this way, lecturers will be able to understand how the complete industry system works. They will be able to understand the links between various functional units in the industry and the roles of the engineers. When this knowledge and experience is relayed to the undergraduates, the students will be well prepared to perform their roles or meet job specifications with respect to future industrial needs. The importance of the soft skills competencies needs to be realized by the undergraduates even during their first year of study. Constant dialogues between the students and industry operators on the required soft skills in the first year are necessary. The early awareness of the required soft skills allows undergraduates to sharpen and perfect these soft skills. These suggestions are market-driven human resource development strategies and they are aimed at enhancing the employability of electronic engineers. Apart from that, the result of the study shows that it coherently supports past findings and results: that there is a vacuum in the Malaysian graduates where they lack the generic skills [3, 23–25]. Hence, in conclusion, tertiary institutions should intensify their efforts to incorporate the development of soft skills into the curriculum and the assessment system, as well as in co-curricular activities.

Thus, in general, from the analysis it can be seen that the AC and RC exhibit a supply and demand relationship. Positive correlations exist for both soft and hard skills. How is the gap or extent of mismatch related to the supply curve of AC to RC? What happens to the supply curve and how is it related to the magnitude of the mismatch (gap) when the acquired competency from tertiary education remains the same, while there is greater demand in the required competency driven by market forces? Keeping the AC constant (no change in the amount of credits and course structure) when there is an increase in the demand for required competency (employment needs) will naturally shift the supply curve upwards. This is a very real life situation as there is an urgent need to equip graduates with the necessary skills so that they are ready at the point of graduation. Companies in Malaysia have often criticized the existing university curriculum (including the engineering curriculum) for falling short of tackling the practical issues in the industry. This is coherently parallel to the findings found in the study that was conducted by Kaur and Sharma [26], which also points to the perception of employers that there are preferences for graduates from local universities. However, unfortunately the real emphasis, especially among young employers, is the focus on employability factors, whereby generic skills stand as a pillar that is considered important by these employers, apart from the technical knowledge. Hence, this study basically confirms that similar matchings are found to be in existence as to the importance given by employers in the area of competencies required from the graduates, particularly relating to generic skills.

Therefore, with this in mind, tertiary education should find a convincing mechanism or chemistry to incorporate the acquisition of technical knowledge and generic competencies into their academic programmes in a more significant manner for graduates, both during their years of knowledge acquisition in the higher institution and when they are out in the job market. Apart from that, higher education should be aware of its social obligation of producing human resources to match what is required by the global world and industry demand. In other words, higher education should function as a dynamic evolving institution in accordance with the evolving development of the world to ensure that the graduates that it produces are employable. Nevertheless, higher education institutions may be aware of the requirements of industry, but they have their own constraints as tertiary education deals with academic learning whereas industry (employment) deals with profits. Tertiary education has to deal with the fundamentals of science and engineering, while industry operators are interested in the latest technology. On the other hand, technological advancement driven by a competitive environment has adopted a fast and ever changing pace. This make the progress of tertiary education curriculum development lag behind technological development, therefore demand leads supply. Concomitantly, Wye and Liew [27] agree with the above as their studies show that there seems to be a high level of mismatch between employers' and undergraduates' perceptions of their importance and development at university.

No doubt current Malaysian universities' curricula show the development and progress of curricula design in taking market demand into account. Soft skills (humanistic, management, communications, ethics) are being emphasized and more credit hours allocated to them. Emphasis has been made in the area demanded by the market (employment). Among the areas of concentration are: personality, effective communication, a high standard of ethical conduct, life-long learning and teamwork. Industrial training is also given high priority, so that graduates can be competent for employment in the industry. So these efforts should be given relevant importance, with evolving sustainability nature, to ensure that what is aspired to is what transpires, and what is aimed at, is what is substantially achieved. Apart from that, undergraduates are urged to include innovation in the knowledge construction. They are driven to be leaders and to be dynamic in their activities. These are the pressures applied to closen the gap between tertiary education and employment.

9. Conclusions

In conclusion, the results of this study indicates some similar facets to previously conducted research, that there exists a worrying level of mismatch between higher education and employment in the Malaysian electronics industry from the aspect of acquired and required competencies among the engineering graduates, especially in aspects relating to generic or soft skill. The relevant authorities in tertiary education and higher education institutions should enhance the employability commodities of their students not only from the aspect of incorporation of these skills into their academic programmes (curriculum and co-curriculum) but they should also continuously implement professional development for the lecturers.

References

1. M. Ramlee, K.Faridah, M. Y. Ruhizan, A. Norzaini, Y. A. Hamidah, M. Wahab and T. Sobri, *K-Economy and globalization—are our students ready? Jurnal Personalia Pelajar*, **1**(1), 2008, pp. 1–23.
2. United Nations, *Technology for Development Series, investment and technology policies for* competitiveness: Review of successful country experiences, 2003, http://www.unctad.org/en/docs/iteipc20032_en.pdf, Accessed Sept. 2009
3. K. Kamal, Training approach for the employability of graduates: critical graduates competencies in the changing world, paper presented at *National Conference on Continuing Technical Education and Training 2006, Challenges in Technical Education and Training Enhancing Employability among Graduates*, 28–9 July 2006, The Katerina Hotel, Batu Pahat, Johor.
4. A. Pandian, *University Curriculum: An Evaluation on Preparing Graduates for Employment*, National Higher Education Research Institute, Universiti Sains Malaysia, Penang, 2005.
5. Malaysia *Economic Planning Unit. Prime Minister's Department, Eighth Economy Plan*, 2005, fromhttp://www.epu.jpm.my/New%20Folder/development%20. Accessed at 29 Jan. 2008.

6. T. D. Hyland, Vocational reconstruction and Dewey's instrumentalism, *Oxford Review of Education,* **19**(1), 1993, pp. 89–90.
7. S. Kumar and J. Kent Hsio, Engineers learn soft skills the hard way: planting a seed of leadership in engineeringclasses, *Leadership Manage. Eng.,* **7**(1), 2007, pp. 18–23.
8. D. Bridges, Transferable skills: a philosophical perspective, *Studies in Higher Education,* **18**(1), 1993, pp. 43–51.
9. MIDA, ICT & Electrical Industries Division, 2004. Accessed June 2004.
10. Malaysia. *Bank Negara Report: Employability of Graduates*, National Pub. K.L, 2002, pp. 39.
11. Z. Ahmad, Students and employers as customers of multimedia college, *Proceedings of National Seminar the Development of Technology and Technical—Vocational Education and Training in an Era of Globalization: Trend and Issues*, 19–18 August, 2005, Kuala Lumpur.
12. M. T. Abuelma'atti, Higher engineering education: Which type is really needed? Engineering science or engineering technology, *The 6th Saudi Engineering Conference*, KFUPM, Dhahran, **1**, 2002, pp. 211–234.
13. J. Arnold and D. K. Mackenzie, Self-ratings and supervisor-ratings of graduate employees' competences during early career, *Journal of Occupational and Organizational Psychology*, **65**, 1999, pp. 235–250.
14. M. Ramlee, The role of vocational and technical education in the industrialization of Malaysia as perceived by educators and employers. Unpublished Ph.D. thesis, Purdue University, Indiana, 1999.
15. SCANS, *What Work Requires of Schools,* 1991, The Secretary's Commission on Achieving Necessary Skills, U. S. Department of Labor, http://www.uni.edu/darrow/frames/scans.html#three. Accessed August 2008.
16. U.T.Teichler and B.M. Kehm, Towards a new understanding of the relationships between higher education and employment, *European Journal of Education,* **30**(2), 1995, pp. 45–53.
17. M. H. Mescon, M. K. Albert and K. Franklin, *Management,* Harper & Row, New York,1988.
18. R. T. Collins, *Conflict Sociology*, Academic Press, New York, 1976.
19. G. W. Hoachlander, *Making Pilots: An Inquiry into Standards*, American Educational Research Association, San Francisco, 1995.
20. A. D. Wolfson, J. T. Michael and J. T. Carolyn, Regulating the professions: A theoretical framework. In Simon Rottenberg (Ed.), *Occupational Licensure and Regulation,* American Enterprise Institute for Public Policy Research, Washington, DC, 1980, pp. 67–85.
21. T. Bailey and D. Merritt, Industry skill standards and education reform, *American Journal of Education,* **105**, 1997, pp. 401–436.
22. W. K. Chen and L. T. Chang, A study of entry-level employment technological competencies for the junior college graduates majoring in electronics engineering, *Proceeding World Conference on Engineering Education*, *Career Education*, 1995, pp. 56–61.
23. B. A. Rahim and I .Hanafi, *Assessing employability skills of technical vocational students in Malaysia, Journal of Social Sciences*, **3**(4), 2007, pp. 202–207.
24. K. Firtrisehara, K. Ramlah and B. A. Rahim, Employability skills among the students of technical and vocational training centres in Malaysia, *European Journal of Social Science*, **9**(1), 2009, pp. 128–136.
25. M. T. Kamaruddin, Penilaian Pembangunan Kemahiran Generik Dalam Kalangan Pelajar Tahun Akhir Kolej Komuniti Kementerian Pengajian Tinggi. Unpublished Ph.D. thesis, Universiti Kebangsaan Malaysia, 2010.
26. N. Kaur and R. Sharma, Skills development among undergraduates at the Malaysian University, UNIMAP, 2008.
27. C. K. Wye and C. S. Liew, Perception differential between employers and undergraduates on the importance of employability skills, *International Education Studies*, **29**(1), 2009, Economic Planning Unit, Ninth Malaysia Plan, pp. 451–469.

Abdul Ghani Kanesan Abdullah, Ph.D., is associate professor at School of Educational Studies in Universiti Sains Malaysia, Penang, and chairperson of the Educational Doctorate Program. His research interests include human resource management, educational leadership and management, and higher education.

Sim Hock Kiat, Ph.D., is a senior high school teacher in the state of Penang, Malaysia. His research interest is the field of human resource education, staff development and innovation engineering education.

Aziah Ismail, Ph.D., is senior lecturer at the School of Educational Studies in Universiti Sains Malaysia, Penang. Her research interests include educational planning and policy and higher education.

Mohamad Hanif Abdullah, M.Ed, is currently pursing his Ph.D. in the School of Educational Studies, Universiti Sains Malaysia, Penang. His research interest is TESOL.

MidukPurba, Ph.D., is director of Politeknik Negri Medan, Indonesia. His research interest is in technical and vocational education and engineering education.