SKILL STANDARDS FOR BIOTECHNOLOGY GRADUATES IN MALAYSIA : AN INDUSTRIAL PERSPECTIVE

LOKE CHOY YEAN

PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

PERPUSTAKAAN UTHM
30000002418528

PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

BORANG PENGESAHAN STATUS DISERTASI♦

JUDUL: **Skill Standards for Biotechnology Graduates in Malaysia: An Industrial Perspective**

SESI PENGAJIAN: **2007/2008**

Saya **LOKE CHOY YEAN**

(HURUF BESAR)

Mengaku membenarkan tesis (~~PSM~~/Sarjana/~~Doktor Falsafah~~)* ini disimpan di perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hak milik Universiti Tun Hussein onn Malaysia.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (√)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972).
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
√	TIDAK TERHAD	

Disahkan oleh

(TANDATANGAN PENULIS) (TANDATANGAN PENYELIA)

Alamat Tetap:

130, TAMAN BINTANG SATU,
34900 PANTAI REMIS,
PERAK.

ENCIK TAN KING HIYANG
Nama Penyelia

Tarikh: 16/4/2008 Tarikh: 16-4-2008

CATATAN: * Potong yang tidak berkenaan.
** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.
♦ Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana secara penyelidikan, atau disertasi bagi pengajian secara kerja kursus dan penyelidikan, atau Laporan Projek Sarjana Muda (PSM).

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Universiti Tun Hussein Onn Malaysia

86400 Parit Raja, Batu Pahat, Johor Darul Ta'zim. http://www.uthm.edu.my

QUALITY SYSTEM
SIRIM Certified
MS ISO 9001 : 2000
Reg. No. AR2478

Pusat Pengajian Siswazah
Tel. : (06)07-453 7906 / 7905
Faks. : (06)07-453 6111

Rujukan Kami (Our Ref.) :
Rujukan Tuan (Your Ref.) :

Ruj. Tuan :
Ruj. Kami :UTHM/PS/600 – 3/9 (27)
Tarikh : 3 April 2008

LOKE CHOY YEAN
No. Matrik Pelajar : HB060103
Fakulti Pendidikan Teknikal
Universiti Tun Hussein Onn Malaysia

KELULUSAN PERMOHONAN MENULIS TESIS DALAM BAHASA INGGERIS

Dengan hormatnya saya merujuk perkara di atas.

2. Sukacita dimaklumkan bahawa Senat Bil. 7/2007/2008 yang bermesyuarat pada 19 Mac 2008 telah meluluskan permohonan pelajar untuk menulis tesis dalam Bahasa Inggeris.

Sekian untuk makluman dan tindakan, terima kasih.

"DENGAN HIKMAH, KITA MENEROKA"

Yang benar,

PROF. MADYA DR. MAIZAM BINTI ALIAS
b/p Dekan
Pusat Pengajian Siswazah
☎ 07-4537901

s.k - Fail Pelajar

Ma/csuo/03042008/tesis

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

" I declared that I read this project and in my point of view this project is qualified in terms of scope and quality for purpose of awarding the Master in Technical and Vocational Education."

Signature : .....

Supervisor : **Mr. Tan King Hiyang**

Date : 16-4-2009

PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

SKILL STANDARDS FOR BIOTECHNOLOGY GRADUATES IN MALAYSIA: AN INDUSTRIAL PERSPECTIVE

LOKE CHOY YEAN

A project report submitted in partial fulfillment of the requirement for the
Master in Technical and Vocational Education

PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

Faculty of Technical Education
Tun Hussein Onn University of Malaysia

APRIL, 2008

"I, hereby declare that this study is designed, conducted and completed based on my own efforts. The references quoted or reviewed in this study are solely serving as guidance. I honestly declare that there is strictly no plagiarism involves in this study."

Signature : .....

Author : **LOKE CHOY YEAN**

Date : 17 MARCH, 2008

PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

ACKNOWLEDGEMENT

The researcher would like to sincerely thank Mr. Tan King Hiyang, Prof. Dr. Sulaiman bin Yamin, Mr. Ghazally bin Spahat and Mr. Sim Choon Cheak for providing useful advises upon accomplishing this study. The researcher would also like to thank Prof. Dr. Maziah Mahmood, Dr. Tan Chon Seng, and Dr. Rozilini Mary Fernandez-Chung for their precious time in viewing the skill standards of this study and providing useful inputs upon completing this study. Last but not least, a big thank to Madam Norashikin binti Abdul Talip from Ministry of Higher Education for providing useful documents upon accomplishing this study.

PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

ABSTRACT

21st century is seen as a biotechnology era and Malaysia aspires to be a biotechnology hub which is clearly spelled out in the National Biotechnology Policy (NBP). In order to rationalise this ambitious plan, the quality of human resources is identified as vital in order to succeed its growth and development. Since there are worries about how well biotechnology graduates get prepared in the real working environment, the purpose of this study was to determine Malaysian biotechnology industries' requirements on the generic skills, technical skills and academic skills, with the aims to identify a list of skill standards that may act as a guideline for the biotechnology educators, students, employers, and employees. This study had employed qualitative and quantitative research design with a survey instrument to collect data. Purposive sampling was conducted by which 41 out of 66 respondents had replied the 5-point Likert-scale questionnaire. Both descriptive and inferential statistics were employed in analysing the data. It was found that generic skills served as the most fundamental pre-requisite in Malaysian biotechnology industry nowadays. This was followed by technical skills and lastly, academic skills. Interestingly, it was found that there was significant difference on technical skills requirements between agriculture and healthcare biotechnology; and between industrial and healthcare biotechnology. Upon data analysis, findings from this study were successfully validated by three high profile biotechnology stakeholders with different working experiences and educational backgrounds, through semi-structured interviews. Hence, validated skill standards depicting biotechnology industrial requirements on generic skills, technical skills and academic skills were generated. The skill standards can serve as useful reference for biotechnology curriculum development, job training design, and biotechnology occupational skill standards setup.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

ABSTRAK

Dalam era kemajuan bioteknologi ini, Malaysia beraspirasi untuk menjadi pusat bioteknologi dan matlamat ini telah dinyatakan di dalam Polisi Bioteknologi Kebangsaan. Bagi merealisasikan matlamat ini, kualiti sumber manusia telah dikenalpastikan sebagai faktor utama bagi memangkinkan pertumbuhan dan pembangunan bioteknologi negara. Memandangkan wujudnya kebimbangan terhadap tahap kesediaan para graduan untuk menghadapi cabaran di alam kerja nanti, kajian ini bertujuan untuk mengenalpasti keperluan industri dari segi kemahiran generik, kemahiran teknikal dan kemahiran akedemik. Sehubungan itu, mewujudkan senarai piawaian kemahiran yang boleh dijadikan sebagai panduan untuk golongan pendidik, pelajar, majikan dan pekerja yang terlibat dalam bidang bioteknologi. Kajian ini telah mengaplikasikan rekebentuk kajian jenis kualitatif dan kuantitatif dengan suatu instrumen kajian disediakan untuk mengumpulkan data kajian. Di sini, persampelan bermatlamat telah dijalankan dimana 41 daripada 66 responden telah membalas soal selidik berskala Likert yang disediakan. Kedua-dua statistik diskriptif dan statistik inferensi telah digunakan dalam proses penganalisan data. Ia didapati bahawa kemahiran generik merupakan kemahiran paling penting dalam industri bioteknologi di Malaysia pada masa kini. Ini diikuti oleh kemahiran teknikal dan kemahiran akedemik. Di samping itu, terdapat perbezaan yang signifikan pada permintaan terhadap kemahiran teknikal di antara sektor bioteknologi pertanian dengan bioteknologi perubatan; dan antara bioteknologi industri dengan bioteknologi perubatan. Setelah siapnya analisis data, sesi temubual telah dijalankan dimana hasil kajian ini telah disahkan oleh tiga orang *stakeholder* bioteknologi yang berpengalaman perkerjaan dan mempunyai latar belakang akedemik yang berlainan. Oleh demikian, suatu senarai piawaian kemahiran yang menyatakan keperluan industri bioteknologi telah dihasilkan. Justeru, senarai ini dapat dijadikan sebagai sumber rujukan yang berguna dalam pembangunan kurikulum bioteknologi, latihan pekerjaan dan penghasilan piawaian pekerjaan bioteknologi.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

TABLE OF CONTENT

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

CHAPTER 2 LITERATURE REVIEW

PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

CHAPTER 3 METHODOLOGY

CHAPTER 4 DATA ANALYSIS

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

LIST OF TABLE

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

LIST OF FIGURE

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

LIST OF APPENDICES

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

CHAPTER 1

INTRODUCTION

1.0 Introduction

Malaysia is one of the 12 mega diversity countries in the world. This treasure house has much potential for bio processing. Therefore, biotechnology is seen as a tool, which could enable exploration of this rich biological endowment. Most of the research and development (R&D) projects related to biotechnology in this country is agro-based (Mohamed Senawi, 1990; Zakri, 2000).

In order to rationalise biotechnology development in this country, the National Council for Scientific Research and Development (NCSRD) established a Biotechnology Expert Group in 1984 with the purposes to examine the implications and the status of biotechnology in this country, and thus making recommendations to the Council. In 1985, some recommendations were made by the Biotechnology Expert Group. The Expert Group highlighted the needs to establish a National Biotechnology Committee to provide advices, promote cooperation in R&D, and establish funding for R&D. It also suggested the establishment of centres of excellence for some major areas in biotechnology.

The National Biotechnology Directorate (BIOTEK) was established in April, 1995; with the mission to forefront the development of biotechnology in Malaysia through R&D activities directed at the commercialisation, and to establish Malaysia as the leading centre for biotechnology industry (Zakri, 2000). BIOTEK had set

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

some clear goals to achieve, where the human resources or manpower was one of the biggest concerns in order to rationalise this mission.

Together with these, biotechnology was identified as one of the key technologies that may drive and support the nation to evolve into a knowledge-based economy under Eight Malaysia Plan (2001-2005). The quality and skills of human resources was identified as vital in order to succeed the growth and development of biotechnology in this country. During the Plan period, a total investment of RM715.5 million involving 30 manufacturing projects was approved in the areas of agricultural, healthcare and industrial biotechnologies, with the potential employment of 1441 jobs (Office of the Prime Minister of Malaysia, 2006a). Table 1.1 shows the approved biotechnology manufacturing projects and the number of employment under the Plan. It was found that there is an increasing demand on human resources as the time goes by.

Table 1.1: *Approved Biotechnology Manufacturing Projects, 2001-2005*

Year	2001	2002	2003	2004	2005	8MP
No. of Companies	2	6	4	11	7	30
Employment	56	199	129	519	538	1,441
Proposed Investment (RM million)	6.1	79.8	215.7	237.8	176.1	715.5

Source: Ministry of International Trade and Industry

In 28 April 2005, the National Biotechnology Policy (NBP) was launched by current Prime Minister YAB Dato' Seri Abdullah bin Haji Ahmad Badawi, which pointed out the importance of human capital development in this nation. One of the major thrusts of this policy is to build the nation's biotechnology human resource capability in line with market needs through special schemes, programmes and training.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Under the National Biotechnology Policy (NBP), 3 centres of excellence were established as part of the creation of BioNexus (launched on 7 September 2006, then), which were:

1. The Centre of Excellence for Agro-biotechnology (focuses around MARDI and UPM)

2. The Centre of Excellence for Genomics and Molecular Biology (focuses in UKM)

3. The Centre of Excellence for Pharmaceutical and Nutraceuticals (focuses in USM)

(Ministry of Science, Technology and Innovation, Malaysia, 2005)

Following the launching of NBP, the Ninth Malaysia Plan which was announced in 31 March 2006 focuses on the implementation of NBP, with the aims to develop the nation's niches in agricultural biotechnology, healthcare related biotechnology, industrial biotechnology and bioinformatics. An amount of RM 2 billion for development of infrastructure and R&D activities is allocated during this Plan. In this regard, the Plan intensifies the promotion of foreign and domestic investments and close collaboration with foreign entities to access new technologies, expertises and markets. To succeed this Plan, the government readdresses the importance of enhancing the supply and quality of skilled human resources required for technology and industrial upgrading. What's more, the current Prime Minister has stressed on the National Mission, which plots the road ahead for the country for the next 50 years that the importance of human capital, value-adding and knowledge enrichment as high on the Prime Minister's list of priorities (Ranjeetha Pakiam, 2007).

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

1.1 Problem Background

The importance of biotechnology human resources was clearly spelled out during the announcement of Ninth Malaysia Plan in 31 March 2006, by which it focuses on implementation of the National Biotechnology Policy (NBP) to develop Malaysia's niches in agriculture biotechnology, healthcare biotechnology, industrial biotechnology and bioinformatics (Office of the Prime Minister of Malaysia, 2006a). The Plan clearly stated that: "The quality and skills of human resources is vital to the success of biotechnology." (p. 158).

A huge amount of money has been invested in R&D activities by the government, with the expectation to come out with fruitful results or products which are suitable for commercialisation. Thus, the requirements on higher technical skilled workforce have been increasing tremendously, as a result of more investments in higher value-added industries. This has led to a greater demand on highly skilled professionals in R&D area. It was estimated that by 2020, biotechnology sector would create 280,000 jobs and contribute 5% to the country's Gross Domestic Product, and the total investment under the National Biotechnology Policy was expected to be around RM30 billion (Malaysian Biotechnology Information Centre, 2006).

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Sadly, the availability of highly skilled scientists or researchers is still very limited in this nation. It was found that there were critical shortages of specialised workforce in resource based sector such as rubber, palm-oil, fishery, livestock, fruit and vegetable sectors, to carry out R&D activities to produce value-added products (Office of the Prime Minister of Malaysia, 1996). A statistical data revealed that, by year 2002, there were only 18 scientists per 10,000 workers in Malaysia, compared to 112.8 in Japan, 99 in Australia, and 83.5 in Singapore (Office of the Prime Minister of Malaysia, 2006b).

New Straits Times (3 November 2005) revealed that, nearly 60,000 Malaysian graduates were unemployed. Most of the graduates lacked a good

command of the English language and possessed irrelevant qualifications to meet the industrial demand (Cruez, 2005). Hence, are there doubts if biotechnology graduates are amongst this population? Moreover, according to the Third Industrial Master Plan 2006-2020, while Malaysia offers a pool of talented human resources, there is presently a serious shortage of skilled workforce in specialised fields in information and communication technology (ICT) and high technologies including biotechnology (Office of the Prime Minister of Malaysia, 2006b).

In fact, the R&D activities will be in advanced, only if the country has sufficient numbers of qualified scientist or experts, because human resource development always serves as the highest priority in order to speed up the development of a country. Without the appropriate number of qualified human resource, technology transfer that serves as one of the important steps in biotechnology industrial development cannot be accomplished.

Recent research carried out in United States found that schools and institutions of higher education in that country were in danger of not preparing competent graduates, including biotechnology graduates, to qualify for the entry-level technical jobs in the integrated nanotechnology, information technology, and biotechnology-based economy during the 21st century (Bacon, 2003; Daggett, 2006). The programs from colleges and universities seemed to be failing to prepare the graduates for specific occupations because the educators did not understand the skills occupation required in the industries. Daggett (2006, p. 2) also mentioned that: "The skills needed to do school do not necessarily connect well with the skills requirements of the 21st century workplace." As more Malaysian biotechnology fresh graduates go into the real working environment, are they facing the similar paradox that the knowledge and skills which they learn in institutions of higher education do not meet the industry requirements?

Since Malaysian society do not has a clear idea whether or not the biotechnology graduates possess the desirable working skills, skill standards can serve as a very powerful tool to include information on the type of academic and workforce preparation the graduates may seek employment in the industry. It can be

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

a useful guideline for the educators to understand what is really required by the industry, and thus preparing curriculum that is in consistent with the market demand.

1.2 Statement of Problem

Specifically, the problem of this study is that there is no national skill standards stated clearly on biotechnology sector in Malaysia. None of biotechnology-related skill standards are available from National Occupational Skill Standards (NOSS) in this nation (Department of Skills Development, 2007b). This causes biotechnology educators in this nation face difficulties to understand the industry requirements in order to produce biotechnology graduates with the right skills in the job market.

Therefore, this study was conducted to identify "compartmentalised" skill standards to illustrate what kind of skills the biotechnology companies would expect the graduates to know and be able to perform. To be more specific, the skill standards can be named as "compartmentalised" content standards by which it focuses on the kind of knowledge and skills which are expected and required to be learned by a biotechnology graduate. The "compartmentalised" content standards may act as a guideline for the biotechnology educators and students to meet the challenges and fulfil the industry requirements.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

1.3 Purpose of Study

There are worries about how well the skills possessed by the biotechnology graduates in this country to meet the requirements of biotechnology industries. Thus, the purpose of this study was to determine the essential skills to equip biotechnology graduates based on the industrial point of views; with the aims to identify "compartmentalised" skill standards. With the standards, it may enable a large and

growing number of biotechnology graduates to prepare for skilled, well-paid occupations and careers in national biotechnology industries with high growth potential.

1.4 Research Objectives

Based on the purpose of study, the following research objectives were listed as below:

i. To determine the industries' requirements on the generic skills, technical skills, and academic skills in biotechnology graduates in Malaysia.

ii. To ascertain whether there is significant statistical difference on skills requirements between agriculture biotechnology, healthcare biotechnology, industrial biotechnology and bioinformatics sectors.

Null Hypothesis (Ho): There is no significant difference on skills requirements between agriculture biotechnology, healthcare biotechnology, industrial biotechnology and bioinformatics sectors.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

1.5 Research Questions

Based on the purpose of study, the following research questions were asked:

i. What are the industries' requirements on the generic skills in biotechnology graduates in Malaysia?

ii. What are the industries' requirements on the technical skills in biotechnology graduates in Malaysia?

iii. What are the industries' requirements on the academic skills in biotechnology graduates in Malaysia?

iv. Is there any significant statistical difference on skills requirements between agriculture biotechnology, healthcare biotechnology, industrial biotechnology and bioinformatics sectors?

1.6 Scope of Study

This study focused on investigating the essential skills to equip biotechnology graduates in Malaysia based on industrial requirements; and hence, to identify a list of biotechnology skill standards by utilising the "compartmentalised" approach. The scope of this study focused on examining:

i. generic skills

ii. technical skills

iii. academic skills

required in agriculture biotechnology, healthcare biotechnology, industrial biotechnology, and bioinformatics companies nationwide.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

1.7 Limitation of Study

Up to now, there are more than a hundred biotechnology-related companies established in Malaysia. The biotechnology companies are located all around this nation. Therefore, it is almost not possible to carry out the study on the perspective of every biotechnology company nationwide due to time constraints. The researcher thus, only focused the study on the skills requirements from agriculture biotechnology, healthcare biotechnology, industrial biotechnology and

bioinformatics companies, where the companies' information was provided from Biotechnology Corporation Malaysia. Additionally, it is also impossible for the researcher to carry out a face-to-face survey with every respondent which will come out with higher response rate due to time constraints.

Meanwhile, it takes a long period to generate a complete list of biotechnology skill standards that may consisting both content standards and performance standards. Due to time constraint, the researcher only capable to study on the content standards that focus on what kind of knowledge and skills which are expected and required to be learned by a biotechnology graduate in order to meet the industrial requirements.

1.8 Significance of the Study

This study was identified as being of importance to the biotechnology educators, biotechnology students, biotechnology employers, the biotechnology employees/ workers.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

1.8.1 Biotechnology Educators

This study may provide the educators a better understanding on the skills required by the industry sectors in order to filling up the "skills gap". It may act as a guideline for the educators to keep track on the industry needs by identifying the core competencies. For this reason, alteration on certain curriculum such as creating and continuously updating education and training programs criteria could be made; and thus producing more competence biotechnology graduates.

1.8.2 Biotechnology Students

The biotechnology students may gain benefits by knowing what is really required by the real working environment, and hence, equip themselves with additional skills. This study can help the students to be well preparing for the future challenges and become more work-ready and competence. Work-ready students may be hired at higher rates of pay and can experience faster advancement in their chosen fields.

1.8.3 Biotechnology Employers

This study may guide the employers as they interview prospective employees, and develop programs to prepare future employees for in-house training. Such program may ensure a supply of qualified employees and thus, reduce the time and expense of recruitment efforts.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

1.8.4 Biotechnology Employees/ Workers

This study may enable the workers to assess their skills against those required for career advancement. The workers may enhance their performance and achievement by determining the skills and abilities needed for advancement or transfer within related industries; and determining the continuous learning and training they need to upgrade their skills in order to become more competence.

1.9 Theoretical Framework

Development of the theoretical framework (see Figure 1.1) depicting the requirements of Malaysia's biotechnology industries on the generic skills, technical skills and academic skills to equip Malaysian biotechnology graduates; with the aim to identify a "compartmentalised" skill standards (more specific, it is called "compartmentalised" content standards).

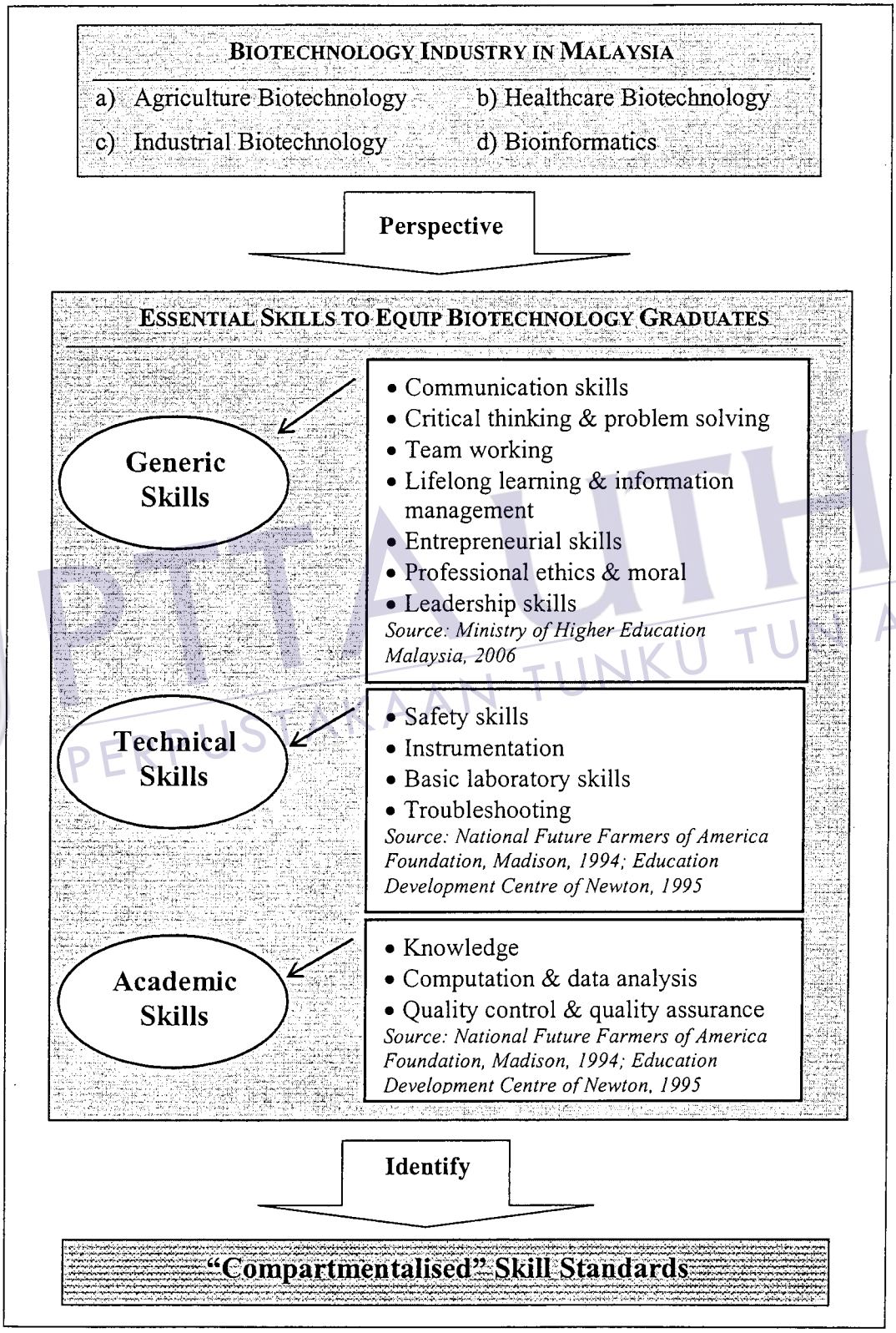
Amongst the industry, agriculture biotechnology, healthcare biotechnology, industrial biotechnology and bioinformatics sectors were the focus of this study since the Ninth Malaysia Plan had recognised these four sectors as the main biotechnology sectors to drive and support the nation to evolve into a knowledge-based economy.

According to Bailey and Merritt (1995), a set of standards may contain only generic skills, technical skills, or academic skills; or it might be the combination of all three types of skills. Therefore, the researcher would like to identify a "compartmentalised" skill standards which consisting of generic skills, technical skills, and academic skills in this study. Bailey and Merritt (1995) also explained that "compartmentalised" standards strictly differentiate the generic skills, technical skills and academic skills. It does not relate to any workplace scenario in which employees' skills and activities can be integrated.

It is important to note that the elements used to determine generic skills in this study were based on seven elements listed by the Ministry of Higher Education Malaysia (2006). Whilst, elements used to determine technical skills and academic skills in this study were based on adaptation from two US government documents, which were National Future Farmers of America Foundation (1994) and Education Development Centre of Newton (1995).

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Figure 1.1: The Theoretical Framework (Adaptation from National Future Farmers of America Foundation, Madison, 1994; Education Development Centre of Newton, 1995; Ministry of Higher Education Malaysia, 2006)



PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

1.10 Operational Definition

Certain terms in this study are specific and may be unfamiliar. To avoid confusion, it is necessary to define some important key words of this study. The following are definition of some terms that frequently used throughout this study:

1.10.1 Skill Standards

Losh (2000, p. 5) reported that skill standards "come in many sizes and shapes, have no consistent definitional base, and include diverse degrees of content." However, according to Wills (1997), the primary goal of skill standards is to improve the content and instructional quality of an education program. Skill standards can serve as a guidance to motivate students to learn by focusing their attention on the knowledge, understanding and skills which they need to possess in order to succeed in the workplace. Skill standards may include information on the type of academic and workforce preparation the students may seek employment in the industry.

PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

1.10.1.1Content Standards

Normally, there are two different types of standards across the industry and education areas which are content standards and performance standards (Wills, 1997). Therefore, the researcher would like to employ content standards throughout this study.

Usually, content standards refer to the area of knowledge, understanding, and skills which are expected and required to be learned by an individual (Losh, 2000). Marzano and Kendall (1996, p. 16) explained this term in such way: "In other words, a content standard is a statement of the knowledge or understanding we would expect students to have."

Moreover, Wills (1997, p. 8) explained that "Content standards refer to what we expect learners to know and be able to perform."

With these explanations, the researcher would like to identify content standards which addressing skills that biotechnology graduates would be able to understand and perform – by utilising the "compartmentalised" approach recommended by Bailey and Merritt in 1995.

1.10.1.2 "Compartmentalised" Approach

Bailey and Merritt (1995, p. 29) explained that, by employing "compartmentalised" approach, the generic skills, technical skills and academic skills are "strictly differentiated" and "include no workplace application".

The "compartmentalised" approach creates a fundamental distinction between the three types of skills and does not have connection to any workplace scenarios or settings. This approach does not necessarily provide any background to indicate how a skill should be mastered by an employee in the performance of the tasks given.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

1.10.2 Essential Skills

Essential skills are the skills needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change (Human Resources and Skills Development Canada, 2006). In this study, essential skills are defined as the crucial and vital skills that required in workplace and learning. The generic skills, technical skills and academic skills are included as essential skills in this study. The following are the definition of each term:

1.10.2.1 Generic Skills

Generic skills can be defined as skills that can apply across a variety of jobs and life contexts. They are skills that directly applicable in another industry or occupation or skills that facilitate the acquisition of the skills required in the new industry. Generally, generic skills have a value in a number of industry sectors (National Centre for Vocational Education Research, Australia, 2003; Smits, 2006). They are also known by a number of terms overseas such as in Table 1.2. The seven different key competencies in the generic skills in this study were based on elements listed by the Ministry of Higher Education Malaysia (2006), they are: communication skills; critical thinking and problem solving; team working; lifelong learning and information management; entrepreneurial skills; professional ethics and moral; and leadership skills (see Table 1.3).

Table 1.2: *Terms Used in Various Countries to Describe Generic Skills*

United Kingdom	Core skills, key skills, common skills
New Zealand	Essential skills
Australia	Key competencies, employability skills, generic skills
Canada	Employability skills
United States	Basic skills, necessary skills, work know-how
Singapore	Critical enabling skills
France	Transferable skills
Germany	Key qualifications
Switzerland	Trans-disciplinary goals
Denmark	Process independent qualifications

Source: National Centre for Vocational Education Research, Australia

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Table 1.3: *The Domains of Generic Skills, Technical Skills and Academic Skills*

Generic Skills	Technical Skills	Academic Skills
• Communication skills • Critical thinking & problem solving • Team working • Lifelong learning & information management • Entrepreneurial skills • Professional ethics & moral • Leadership skills	• Safety skills • Instrumentation • Basic laboratory skills • Troubleshooting	• Knowledge • Computation & data analysis • Quality control & quality assurance

1.10.2.2 Technical Skills

Technical skills serve as the most fundamental type of skills. Technical skills are kind of work-content skills required for a specific job, thus, they only have a value in one particular sector of industry. Strong technical skills can be developed as an integral part of one's personal development efforts. The skills can save time and increase income (Darrah, 1994). They are explicit knowledge and capabilities that are necessary for an employee to perform occupational specific tasks or duties (Bailey & Merritt, 1995).

The technical skills include safety skills, instrumentation, basic laboratory skills and troubleshooting skills in this study (see Table 1.3). The domain of technical skills in this study is based on the adaptation from National Future Farmers of America Foundation (1994) and Education Development Centre of Newton (1995).

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

1.10.2.3 Academic Skills

According to Matthews and Alpert (1989), the academic skills are about the reading, mathematics and writing skills that are required for a student or worker in order to perform effectively in carrying out a task. Stasz and Brewer (1999) explained that academic skills are skills that learned prior to specific technical and vocational skills. They are very useful to help the employees to master the required list of tasks. In this study, the domain of academic skills (see Table 1.3) includes knowledge, computation and data analysis, quality control and quality assurance (adaptation from National Future Farmers of America Foundation, 1994; and Education Development Centre of Newton, 1995).

1.10.3 Biotechnology

The name "Biotechnology" first appeared in Yorkshire early in the 20th century. It refers to any technology that seeks to preserve or transform biological materials of living organisms such as animals, plants, microbial or viral origin into products of commercial, economic, social and hygienic utility and value (Hulse, 2004). Based on Ninth Malaysia Plan, the government will focus on the development of agriculture biotechnology, healthcare biotechnology, industrial biotechnology, and bioinformatics. Thus, the following are their definitions:

1.10.3.1 Agriculture Biotechnology

Agriculture biotechnology is a range of tools, including traditional breeding techniques that alter living organisms or parts of organisms, to make or modify products; improve plants or animals; or develop microorganisms for specific agricultural uses. Modern biotechnology today includes the tools of genetic engineering (United States Department of Agriculture, 2005).

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

1.10.3.2 Healthcare Biotechnology

It is a tool that targeting both genetic and acquired diseases to develop new drugs such as vaccines and antibodies, "designer" drugs such as synthetic drugs and DNA drugs, and new methods of drug delivery that will affect the types of healthcare treatments a person receives (Barnum, 1998).

1.10.3.3 Industrial Biotechnology

This term is known as "white biotechnology" in Europe, where it is a technique relies on the use of microbial, plant or animal cells, or their components or enzymes, as catalysts. It includes the integrated application of disciplines such as biochemistry, microbiology, molecular genetics and process technology to develop useful processes and products (Hatti-Kaul, Törnvall, Gustafsson & Börjesson, 2007).

1.10.3.4 Bioinformatics

Bioinformatics is the science of informatics as applied to biological research. Informatics refers to the management and data analysis using advance computer techniques. Whilst, bioinformatics serves as an adjunct to genomic research because of the large amount of complex data this research generates (Borem, Santos & Bowen, 2003).

1.11 Summary

Biotechnology was identified as one of the key technologies that may drive and support the nation to evolve into a knowledge-based economy under Eight Malaysia Plan (2001-2005). The quality and skills of human resources was identified as vital in order to succeed the growth and development of biotechnology in this country. Moreover, National Biotechnology Policy (NBP) which was launched in 28

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

April 2005 had also pointed out the importance of human capital development in this nation.

However, there appears worries about how well biotechnology graduates get prepared in the real working environment. There is currently no national skill standards stated clearly on biotechnology sector in Malaysia. This causes biotechnology educators in this nation face difficulties to trace industry requirements in order to produce biotechnology graduates with desired competencies.

Hence, the purpose of this study was to determine the industries' requirements on the generic skills, technical skills and academic skills in biotechnology graduates in this country, with the aims to identify a list of skill standards that may act as a guideline for the biotechnology educators, students, employers, and employees. The skill standards in this study could be named as "compartmentalised" content standards since the researcher would like to identify the kind of knowledge and skills which are expected and required to be learned by a biotechnology graduate by employing a "compartmentalised" approach. Indeed, the "compartmentalised" approach creates a fundamental distinction between the generic skills, technical skills and academic skills.

PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Malaysia is one of the 12 mega diversity countries in the world with 12,500 species of flowering plants, 1,100 species of ferns, and one of the world's most diverse coral communities. This nation has a very diverse biological sources and very much potential for bio processing (Richard Goh, 2005). Therefore, biotechnology is seen as an area which could enable sustainable use of this rich biological endowment.

21st century is seen as a biotechnology era and Malaysia aspires to be a biotechnology hub which is clearly spelled out in the National Biotechnology Policy (NBP) that was launched in 28 April, 2005. The NBP is underpinned by nine thrust areas, where the fifth thrust addressing the necessity of human capital development in order to succeed its vision. This thrust area addressing the following:

> Building the nation's biotechnology human resource capability in line with market needs through special schemes, programmes and training.
>
> (Ministry of Science, Technology and Innovation, 2005, p. 5)

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

2.1 The Development of Biotechnology in Malaysia

Historically, the development of biotechnology in Malaysia can be divided into three phases: (a) establishment phase which is prior to 1995; (b) development phase between 1995 and 2000; (c) advancement phase that beyond 2000.

During the establishment phase, R&D activities took place in a number of public institutions where the development focused on establishment of basic infrastructure and establishment of basic expertise to handle R&D activities. Following this phase, the development phase took place during the period of Seventh Malaysia Plan (1996-2000). The most obvious changes was the establishment of the National Biotechnology Directorate (BIOTEK) in 1995 that played a major role in fore fronting biotechnology programs in this country via research, development and commercialization (R&D&C), corporate relations and human resource development. Meanwhile, the Biotechnology Cooperative Centres (BCC) and Contact Group Programme were established under BIOTEK (Hassan Mat Daud, 2003).

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Going into the new millennium, the government tended to endorse a mega plan to develop biotechnology in this nation. Under Eight Malaysia Plan (2000-2005), the government emphasised on building the capacity and capability of human resources as well as research institutions. National Biotechnology Policy (NBP) was launched in 28 April 2005, which saw the creation of a dedicated government agency to develop the biotechnology industry – the Biotechnology Corporation Malaysia; also the creation of BioNexus, the network of companies and research institutions. BioNexus acts as a business model for the biotechnology industries to adapt science and technology to make market sense (Malaysian Industrial Development Authority, 2006).

Consequently, the Ninth Malaysia Plan (2006-2010) emphasised on the implementation of NBP to develop the nation's niches in agriculture biotechnology, healthcare biotechnology, industrial biotechnology and bioinformatics. The main strategic thrusts included enhancing value creation in agriculture sector; capitalising

the strength of biodiversity; nurturing growth opportunities in industrial bio processing; leveraging the growth of bioinformatics industry; promoting BioNexus; establishing R&D centres of excellence; and enhancing human capital development. An amount of RM2 billion was allocated for infrastructure development, R&D activities and commercialisation as well as business development program (Office of the Prime Minister of Malaysia, 2006a).

Based on the document completed by Richard Goh (2005), the biotechnology industry in this country consists of companies specialising in agriculture biotechnology, bio-pharmaceutical, and bioinformatics as well as suppliers. Currently, there are about 500 biotechnologist and 3000 undergraduates working in this industry.

2.1.1 Agriculture Biotechnology

Although Malaysia has been a major shift from raw materials to manufactured products, agriculture continues to play a very important role in the overall economic growth in this nation. Agriculture biotechnology still recognised as a potential tool to ensure food security for this country (Hassan Mat Daud, 2003; Zehr, 2004).

Over these years, tissue culture of oil palms, rubber trees, rattan, and other forest trees, rice, banana, sago, herbs, and medicinal plants, ornamentals such as orchids and pitcher plants had been successfully carried out. In addition, there have been a number of ongoing researches on genetically modified plants (Malaysian Biotechnology Information Centre, 2006). According to Dr Umi Kalsom Abu Bakar, MARDI has been the pioneer of agriculture biotechnology in Malaysia for the past 15 years. The institution had focused on plant, food and animal biotechnology; and applied research in molecular biology, genetic engineering with the mission to transform the agriculture sector (Malaysian Industrial Development Authority, 2006).

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Under the Ninth Malaysia Plan, genetic engineering was encouraged to produce value added products as well as to improve the agronomic traits.

In fact, companies involve in this sector are mainly plantation (especially oil palm), herbal-based, and aquaculture companies. Most of the plantation companies in the oil palm area focused their business on tissue and cell culture to produce mass propagation of top-of-the-line plants (Richard Goh, 2005).

2.1.2 Healthcare Biotechnology

R&D activities in this sector are relatively new in Malaysia. Over the years, several animal recombinant vaccines had been produced to assist the development of animal husbandry (Malaysia Biotechnology Information Centre, 2006). Besides, some products such as anti-malaria drug artermisinin; disease and diagnostic kits for dengue, malaria, and Japanese Encephalitis had been developed. The diagnostic kits such as rapid test for malaria and typhoid; and kits for white spot virus syndrome were commercialised, which saved the local shrimp industry about USD 19 million annually (Richard Goh, 2005).

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Under Ninth Malaysia Plan, the National Institute of Pharmaceuticals and Nutraceuticals (NIPN) and the National Institute of Natural Products, Vaccines and Biologicals (NINPVB) were established. The NIPN focuses on the optimal utilisation of natural bio resources from plant, marine and microbial origins for use in nutraceuticals, cosmeceuticals and phytopharmaceuticals. Meanwhile, NINPVB implements programs to promote herbal medicine by harnessing local knowledge in traditional/complementary medicine, and to increase the production of vaccines.

2.1.3 Industrial Biotechnology

The application of bioremediation techniques in the treatment of industrial and agricultural wastes are accepted widely. New development in industrial biotechnology in this nation encompasses activities such as optimisation and enhancement of new treatment system through bio-augmentation or genetic engineering (Malaysian Biotechnology Information Centre, 2006).

Under Ninth Malaysia Plan, the development of biocatalysts such as enzymes for food and feed preparations, cleaning products and textile processing were identified as of importance. Moreover, bio processing and contract bio manufacturing were recognised as other growth areas. Another major concern is the increasingly demand of biofuel globally. Under this Plan, various strategies have been undertaken to increase the use of biofuel as an alternative to petroleum-based diesel. Document from Malaysian Industrial Development Authority (2006) reported that a local biotechnology company, Carotech Bhd planned to invest over RM100 million in R&D to produce more commercially viable biodiesel products. The biodiesel or vitamin E produced, will be sold locally and exported to about 30 countries overseas.

PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH

2.1.4 Bioinformatics

The advancement of molecular biology and the equipment for research had allowed the increasingly rapid sequencing of large portions of genomes that utilise database of biological information. Researchers can use the database to analyse and interpret information, too. However, Malaysian bioinformatics is very much in the start-up phase. The bioinformatics market was estimated at USD 7.1 million for year 2003. Up to 2005, there were just few institutions willing to invest on computational biology (Richard Goh, 2005).

BIBLIOGRAPHY

Agresti, A., & Finlay, B. (1997). *Statistical methods for the social sciences (3rd Edition)*. Upper Saddle River, New Jersey: Prentice Hall.

Ary, D., Jacobs, L. C., & Razavieh, A. (2002). *Introduction to research in education (6th Edition)*. Belmont, CA: Wadsworth/Thomson Learning.

Bacon, P. (2003, September). *The supply and demand for skills in the biotechnology sector*. Irish: Expert Group on Future Skills Needs.

Bailey, T., & Merritt, D. (1995). *Making sense of industry-based skill standards*. (ERIC Document Reproduction Service No. ED 389897)

Barnum, S. R. (1998). *Biotechnology: An introduction*. Belmont, CA: Wadsworth Publishing Company.

Bell, J. (1993). *Doing your research project: A guide for first-time researchers in education and social science (2nd Edition)*. Buckingham: Open University Press.

Bingham, R., & Drew, S. (1999). *Key work skills*. Hampshire, UK: Gower Publishing Limited.

Borem, A., Santos, F. R., & Bowen, D. E. (2003). *Understanding Biotechnology*. Upper Saddle River, New Jersey: Prentice Hall.

Bryman, A. (2004). *Social Research Methods (2nd Edition)*. Great Clarendon Street, Oxford: Oxford University Press.

Candy, P. (2000). Knowledge navigators and lifelong learners: Producing graduates for the information society. *Higher Education Research & Development, 19,* 261-277.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Cohen, C., Royal, M., Bailey, T., & Allan, J. (2001). *Biotechnology/ biomedical skill standards.* Washington, US: Washington State Board for Community & Technical Colleges.

Cohen, L., & Manion, L. (1994). *Research methods in education (4th Edition).* London: Routledge.

Cohen, L., Manion, L, & Morrison, K. (2000). *Research methods in education (5th Edition).* Abingdon, Oxon: RoutledgeFalmer.

Collet, C., & Wyatt, D. (2005). "Bioneering" – Teaching biotechnology entrepreneurship at the undergraduate level. *Education + Training, 47,* 408-421.

Cortina, J. M. (1993). What is coefficient alpha? An examination of theory and applications. *Journal of Applied Psychology, 78,* 98-104.

Cruez, A. F. (2005, November 3). 60,000 Malaysian graduates unemployed. *The New Straits Times Online.* Retrieved March 4, 2007, from http://www.nst.com.my

Daggett, W. R. (2006). *Jobs and the skills gap.* International Centre for Leadership in Education, US. Retrieved August 28, 2007, from http://www.leadered.com/pdf/Job-Skills%20Gap%20White%20PaperPDF.pdf

Darrah, C. (1994). Skill requirements at work: Rhetoric versus reality. *Work and Occupations, 21,* 64–84.

Department of Skills Development. (2007a, June 4). *NOSS, National Occupational Skills Standards.* Ministry of Human Resources Malaysia. Retrieved July 21, 2007, from http://www.nvtc.gov.my/bm

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Department of Skills Development. (2007b). *E-NOSS*. Ministry of Human Resources Malaysia. Retrieved July 21, 2007, from http://www.nvtc.gov.my/enoss/index.html

Department of Skills Development. (2007c). *What is NDTS?* Ministry of Human Resources Malaysia. Retrieved July 21, 2007, from http://www.nvtc.gov.my/bi/index.php?option=com_content&task =view&id=100&Itemid=215

Economic & Social Research Council, United Kingdom. (2005). *Research ethics framework*. Retrieved April 2, 2007, from http://www.esrcsocietytoday.ac.uk

Education Development Centre of Newton. (1995). *Gateway to the future: Skill standards for the bioscience industry*. (ERIC Document Production Service No. ED 392931)

Fischer, D. J., & Twomey, J. (2007). *A thousand cuts*. Center of an Urban Future. Retrieved March 18, 2007, from http://www.nycfuture.org

George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference 11.0 update (4th Edition)*. Boston, MA: Allyn and Bacon.

Graziano, A. M. & Raulin, M. L. (2000). *Research methods: A process of inquiry (4th Edition)*. Needham Heights, Massachusetts: Allyn & Bacon.

Hassan Mat Daud. (2003). The current and future outlook of agricultural biotechnology in Malaysia. *Asian Biotechnology & Development Review, 5,* 15-21.

Hatti-Kaul, R., Törnvall, U., Gustafsson, L., & Börjesson, P. (2007). Industrial biotechnology for the production of bio-based chemicals – a cradle-to-grave perspective. *Trends in Biotechnology, 25,* 119-124.

Hergoz, T. (1996). *Research methods in the social science.* New York: Harper Collins.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Hulse, J. H. (2004). Biotechnologies: Past history, present state and future prospects. *Trends in Food Science & Technology, 15,* 3-18.

Human Resources and Skills Development Canada. (2006). *Understanding essential skills*. Retrieved 11 April, 2007, from http://srv108.services.gc.ca/

Kenney, M. (1986). *Biotechnology: The university-industry complex.* New York: Yale University Press.

Lloyd, B., & Bailey, T. (2001). *Biotechnology/ biomedical skill standards.* Washington, US: Washington State Board for Community & Technical Colleges.

Losh, C. L. (2000). *Using skill standards for vocational-technical education curriculum development.* Colombus: ERIC Clearinghouse on Adult, Career, and Vocational Education, Centre on Education and Training for Employment, The Ohio State University.

Luthans, F. (2005). *Organisational behaviour (10th Edition).* New York: McGraw-Hill/Irwin.

Malaysian Biotechnology Information Centre. (2006). *Biotechnology in Malaysia.* Retrieved April 11, 2007, from http://www.bic.org.my/?action= localscenario&do=biotechnology

Malaysian Industrial Development Authority. (2006, February 15). *Rising to the biotech challenge.* Retrieved 7 April, 2007, from http://www.mida.gov.my/ beta/view.php?cat=14&scat=745

Malaysian Qualification Agency. (2007). *Draft criteria and standards for biotechnology.* National Accreditation Board.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Malaysia Qualifications Framework. (2006). *Malaysian qualifications framework: Reference point and joint understanding of the qualifications for higher studies awarded in Malaysia*. National Accreditation Board.

Marzano, R. J., & Kendall, J. S. (1996). *The fall and rise of Standard-based education: Issues in brief.* (ERIC Document Reproduction Service No. ED 398643)

Matthews, J. M., & Alpert, R. T. (1989). Balancing State Initiative and Campus Participation in Texas. In W. P. Gorth, R. T. Alpert, & R. G. Allan (Eds.) *Assessing basic academic skills in higher education: The Texas approach* (pp. 25-34). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

McAvinia, C., & Oliver, M. (2002). "But my subject's different": A web-based approach to supporting disciplinary lifelong learning skills. *Computers & Education, 38*, 209-220.

McWhorter, K. T. (2000). *Study and critical thinking skills in college*. New York, US: Longman.

Ministry of Higher Education Malaysia. (2006). *Modul pembangunan kemahiran insaniah (soft skills) untuk Institusi Pengajian Tinggi Malaysia*. Selangor: Penerbit Universiti Putra Malaysia.

Ministry of Science, Technology and Innovation, Malaysia. (2005, April 28). *Biotechnology for wealth creation and social well-being: The way forward.* Putrajaya: MOSTI.

Mohamed Rashid Navi Bax, & Mohd Nasir Abu Hassan. (2003, June 24-26). *Lifelong learning in Malaysia.* Paper presented at International Policy Seminar Co-organised by IIEP/ UNESCO and KRIVET on Making Lifelong Learning a Reality, Seoul.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Mohamed Senawi bin Mohamed Tamin. (1990). Country paper: Malaysia. In *Biotechnology in Asia: Development strategies applications and potentials* (pp.325-329). Japan: Asian Productivity Organization.

National Future Farmers of America Foundation, Madison. (1994). *Agricultural biotechnology technician: National voluntary occupational skill standards.* (ERIC Document Reproduction Service No. ED 413487)

National Centre for Vocational Education Research, Australia. (2003). *Defining generic skills*. Retrieved 2 April, 2007, from http://www.ncver.edu.au

National Productivity Corporation. (2006). *Section IV: Issues and challenges*. Retrieved 19 September, 2007, from http://bond.npc.org.my/HRSuite/HRSuite/whitepaper/BPM/Trg/IMP3-HRD-Section%204.doc

National Vocational Training Council. (1997). *National skills certification in Malaysia: The accreditation approach.* Kuala Lumpur: Ministry of Human Resources.

Nist, S. L., & Holschuh, J. (2000). *Active learning: Strategies for college success*. Needham Height, MA: Allyn & Bacon.

Northcutt, N., & McCoy, D. (2004). Interactive qualitative analysis: A systems method for qualitative research. California: Sage Publications.

Office of the Prime Minister of Malaysia. (1996). *The second industrial master plan 1996-2005.* Kuala Lumpur: Ministry of International Trade and Industry.

Office of the Prime Minister of Malaysia. (2006a, March 31). *The ninth Malaysia plan 2006-2010*. Putrajaya: The Economic Planning Unit, Prime Minister's Department.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Office of the Prime Minister of Malaysia. (2006b, August 18). *The third industrial master plan 2006-2020.* Kuala Lumpur: Ministry of International Trade and Industry.

Parry, T., & Gregory, G. (1998). *Designing brain: Compatible learning.* Arlington Heights, IL, US: Skylight.

Quick, R. D. (2003, April 14). Troubleshooting skills can be learned. *Maintenance Technology.* Retrieved March 29, 2007, from http://www.mtonline.com/articles/0903quick.cfm

Ranjeetha Pakiam. (2007, April 19). PM: National Mission to achieve excellence. *The New Straits Times Online.* Retrieved April 19, 2007, from http://www.nst.com.my/Article/vArt?did=20070419073841

Ranjit Kumar. (1999). *Research methodology: A step-by-step guide for beginners.* London: SAGE.

Richard Goh. (2005, February). *Biotechnology in Malaysia.* Kuala Lumpur: Department of Industry and Resources.

Sibat, M. P. (2005). Leaping out the unemployment line. *Teaching & Learning Bulletin, 6.* Retrieved August 28, 2007, from http://www.calm.unimas.my/insite6/

Singer, D. C., Stefan, R, & Van Staden, J. F. (2005). *Laboratory auditing for quality and regulatory compliance.* New York: Informa Health Care.

Smith, G. F. (1998). *Quality problem solving.* Milwaukee: ASQ Quality Press.

Smits, W. (2006). Industry-specific or generic skills? Conflicting interests of firms and workers. *Labour Economics, 14,* 1-11.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Stasz, C., & Brewer, D. J. (1999). *Academic skills at work: Two perspectives*. (ERIC Document Reproduction Service No. ED 431137)

Stasz, C, Ramsey, K., Eden, R., Melamid, E., & Kaganoff, T. (1996). *Workplace skills in practice: Case studies of technical work.* Berkeley: Rand Corporation.

Suseela Malakolunthu. (2001). Pengumpulan dan analisis data kualitatif: Satu imbasan. In Marohaini Yusoff (Ed.) *Penyelidikan kualitatif pengalaman kerja lapangan kajian* (p. 139). Kuala Lumpur: Universiti Malaya.

Thieman, W. J., & Palladino, M. A. (2004). *Introduction to biotechnology.* San Francisco, CA: Pearson.

The Conference Board of Canada. (2000, May). *Employability skills 2000*$^{+}$. Retrieved March 28, 2007, from http://www.conferenceboard.ca/education

United States Department of Agriculture. (2005, June 10). *Agriculture.* Retrieved 11 April, 2007, from http://www.usda.gov

Victor Wee. (2003, July 11). *Vision 2020 and enhancing competitiveness.* Paper presented at Prime Leadership and Management Course, Bukit Kiara.

Wonacott, M. (2000). Standards: An embarrassment of riches. *National Dissemination Center for Career and Technical Education.* Retrieved November 29, 2007, from http://www.nccte.org/publications/infosynthesis/ in-brief/ in-brief04/inbrief04-standards.pdf

Wills, J. (1997). *Standards: Making them useful and workable for the education enterprise*. (ERIC Document Reproduction Service No. ED 410461)

Yukl, G. (2006). *Leadership in organisations (6*th *Edition)*. Upper Saddle River, New Jersey: Pearson Prentice Hall.

PTTA UTHM PERPUSTAKAAN TUNKU TUN AMINAH

Zakri. (2000). Country profiles: Malaysia. In G. T. Tzotzos & K. G. Skryabin (Eds.) *Biotechnology in the developing world and countries in economic transition* (pp. 112-124). Oxon, UK: CABI Publishing.

Zehr, U. B. (2004). Crop biotechnology in India, Thailand, Vietnam, Philipines and Malaysia. In P. Christou & H. Klee (Eds.) *Handbook of plant biotechnology: Volume 2* (pp. 1233-1242). West Sussex: WI

PTTA UTHM
PERPUSTAKAAN TUNKU TUN AMINAH