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# Analysis of Self-efficacy of High-end Manpower in Bio-related Field in Taiwan

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# Table of Content

Chapter 1. Introduction ..... 1
Chapter 2. Background Introduction of Biotechnology ..... 3
2.1 Definition of biotechnology ..... 3
2.2 The features and range of biotechnology ..... 4
2.3 Development of biotechnology in Taiwan ..... 7
2.4 Demand analysis of manpower of biotechnology in Taiwan ..... 12
2.4.1 Related industry of six categories ..... 12
2.4.2 Bio-related educational departments in colleges ..... 13
2.4.3 Estimation of job demand in bio-related fields in Taiwan ..... 15
Chapter 3. Theory Review ..... 22
3.1 Definition of self-efficacy ..... 22
3.2 The costruct of perceived self-efficacy ..... 22
3.3 Four theories of self-efficacy ..... 24
3.3.1 Social cognitive theory ..... 24
3.3.2 Social learning theory ..... 25
3.3.3 Self-concept theory ..... 25
3.3.4 Attribution theory ..... 25
3.4 Four sources of self-efficacy beliefs ..... 26
3.4.1 Mastery experience ..... 26
3.4.2 Vicarious experience ..... 27
3.4.3 Social persuasions ..... 27
3.4.4 Somatic and emotional states ..... 28
3.5 Efficacy-activated process ..... 29
3.6 General self-efficacy (GSE) ..... 30
Chapter 4. Methodology ..... 32
4.1 Rationale ..... 32
4.2 Survey question design ..... 33

4.2.1 Section I: Questions of general perceived self-efficacy ..... 33
4.2.2 Section II: Questions of sources ..... 34
4.2.3 Section III: Questions of personal information. ..... 35
4.3 Survey distribution ..... 35
Chapter 5. Data Analysis ..... 36
5.1 Survey outline ..... 36
5.2 Results ..... 37
5.2.1 Distribution ..... 37
5.2.2 Correlation between GSE and sources ..... 39
5.2.3 Countries of highest degree obtained ..... 41
5.2.4 Working category ..... 43
5.2.5 Education level ..... 45
5.2.6 Gender ..... 47
Chapter 6. Discussion and Conclusion ..... 49
6.1 Discussions ..... 49
6.1.1 Countries of highest degree obtained ..... 49
6.1.2 Working category ..... 51
6.1.3 Education level ..... 52
6.1.4 Gender ..... 53
6.2 Conclusion ..... 54
References ..... 57

# List of Figures

Figure 2-1 Six categories of biotechnology industry _____6
Figure 2-2 History of biotechnology development in Taiwan _____9
Figure 2-3 Related industries of six categories _____13
Figure 2-4 Estimation job demand in short, medium, and long terms in industry and academic institution of biotechnology _____15
Figure 2-5 Job demand in industry in Taiwan (Short-term, < 1 year) _____16
Figure 2-6 Job demand in academic institution in Taiwan (Short-term, < 1 year) _____16
Figure 2-7 Job demand in industry in Taiwan (Medium-term, 1 ~ 3 year) _____17
Figure 2-8 Job demand in academic institution in Taiwan (Medium-term, 1 ~ 3 year) _____18
Figure 2-9 Job demand in industry in Taiwan (Long-term, > 5 year) _____19
Figure 2-10 Job demand in academic institution in Taiwan (Long-term, > 5 year) _____19
Figure 2-11 The known and predicted job demand of bio-related fields in Taiwan from year 2010 ~ 2013 _____21
Figure 3-1 The relationship between sources and process _____30
Figure 4-1 Questions of general perceived self-efficacy _____34
Figure 4-2 Questions of sources_____35
Figure 5-1 Survey outline _____36
Figure 5-2 Distribution of scores of each question on GSE survey _____37
Figure 5-3 Distribution of scores of each question on source survey _____38
Figure 5-4 Correlation between GSE and sources of self-efficacy for people in bio-related fields in Taiwan _____39
Figure 5-5 Influence of countries of highest degree obtained on GSE (US vs. TW)_____41
Figure 5-6 Influence of country of highest degree obtained on the sources of self-efficacy (US vs. TW) _____42
Figure 5-7 Influence of working category on GSE (Industry vs. Academic) _____43
Figure 5-8 Influence of working category on the sources of self-efficacy (Industry vs. Academic) _____44
Figure 5-9 Influence of education level on GSE (PhD vs. Master) _____45
Figure 5-10 Influence of education level on the sources of self-efficacy (PhD vs. Master)_____46
Figure 5-11 Influence of gender on GSE (Female vs. Male)_____47
Figure 5-12 Influence of gender on the sources of self-efficacy (Female vs. Male) _____48

# CHAPTER 1. INTRODUCTION

The purpose of this paper is to explore perceptions held by high-end manpower in bio-related filed in Taiwan. The perception difference is examined by dividing the sample group into two subgroups as follows: country of highest degree obtained (US vs. Taiwan); working category (industry vs. academic); education level (PhD vs. master); gender (female vs. male). Comprehensive result is derived through analyzing the combination of above-mentioned subgroups.

The focused topic of this paper is self-efficacy that has been defined as the belief that one's capability in attaining certain goals in a certain manner (Bandura, 1995). I focused on this topic since self-efficacy is the fundamental factor that affects almost every motivation and achievement of individuals. It is believed that personal perception of self-efficacy affects one's social interactions in almost every way. It was found that in Bandura's social cognitive theory of self-efficacy, and it emphasizes the role of observational learning and social experience in the development of personality. One's self-efficacy is influenced by both external experiences and self-perception, affecting the outcome of many events. It is interesting to understand that, whether self-efficacy of bio-related professionals with high educational level in Taiwan is affected by many internal and external factors. On the other hand, Bandura (1995) described four sources that directly affect the development of self-efficacy. The four sources are mastery experience, vicarious experience, social persuasion, and somatic and emotional states.

In the current paper, the influence and correlation of factors include country if highest degree obtained, career category, education level and gender on self-efficacy and the four

sources are examined. The methodology of this paper combines questionnaire and quantitative analysis. The quantitative survey was conducted on 66 professionals in industries and research institutions of bio-related fields in Taiwan. To investigate the self-efficacy issue, evaluation of general self-efficacy (GSE) was performed. In addition, four questions were designed in the survey here to address the four sources of self-efficacy.

My result showed that GSE assay for self-efficacy strongly correlates to the four sources of self-efficacy. Interestingly the country of highest degree obtained (e.g. US or Taiwan), the career category (e.g. industry or academic) and the education level (e.g. master or PhD) are the three main factors strongly affecting self-efficacy as well as the sources of self-efficacy. I found that, in bio-related fields in Taiwan, people either of higher degree, of graduate degree in US or of position in industry have higher score in self-efficacy.

This paper is consisted of five chapters. In the second chapter the development and classification of bio-related fields, ranging from conceptual definition to actual dynamic evolvement in Taiwan, are reviewed. In the third chapter the overview of self-efficacy, the four sources of self-efficacy and their correlation are described. The fourth chapter contains the rationale and methodology of the present study. The results and discussions are mentioned in the chapter five. The conclusion is in the chapter six. I hope this thesis will provide valuable information for industry, academics and the government for human resource arrangement and policy design.

# CHAPTER 2. BACKGROUND INTRODUCTION OF BIOTECHNOLOGY

## 2.1 DEFINITION OF BIOTECHNOLOGY

The term "Biotechnology" is the combination of "bio" and "technology". Bio means everything related to life and living organisms whereas technology implies techniques and industry. Taken together, biotechnology signifies "industries and techniques with life science" (United Nations, 1992). In 1995, National Science and Technology Council defines biotechnology's new horizons for the 21st century as "Biotechnology is a set of powerful tools that employ living organisms or parts of organisms to make or modify products, improve plants or animals, or develop microorganisms for specific uses". Examples of the "new biotechnology" include the industrial use of recombinant DNA, cell fusion and novel bioprocessing. In UN Convention on Biological Diversity, biotechnology is defined as any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use. In 2005, the Organization for Economic Cooperation and Development (OECD) further defines biotechnology focuses on the techniques that either modify existing living organisms/part of them, or transform material, or living origin or not, by the use of processes involving living organisms, for the purpose of producing new knowledge or developing new products or new processes.

Unlike other properties or industries defined by their products (e.g. cars for motor industries, garments for textile industries), bioindustry is defined by techniques applied

during production. The strategy and goal regarding bioindustry development vary from country to country. In order to find a niche among competitors, governments usually try to combine their nature and intelligent resources to develop bioindustry with unique value (Tang, 2010).

## 2.2 THE FEATURES AND RANGE OF BIOTECHNOLOGY

Developing over decades, the spectrum of application of biotechnology is getting broad, from drug discovery, medical diagnosis, agriculture, food science to eco-protection; each field has its own feature and opportunity. The biotech products are thus very diverse from medicine, diagnosis kits, specific biochemical compounds, gene-modified grains, and foods to medical services. Thus biotechnology is now defined as the technology utilizing biological process to solve life science-related problems or to produce biology-related products. Biotechnology would apply characters and features of microbes, plants or animals for any form of production. Biotechnological personnel also apply techniques of molecular biology to design new products or new platform such as poly-chain-reaction (PCR) or high-speed-sequencer (Tang, 2010).

In 1973, Stanley Cohen considered that the advance of modern biotechnology is based on three major breakthroughs: gene cloning, DNA sequencing and PCR. The core concept and technique of biotechnology is popular, common and interactive and must be verified by repetitive experiments. Bio technique can be transferred and commercialized. It is conceptually important that, instead of developing techniques, one should focus on applying techniques to solve problems. In other words, the key point of biotechnology is to efficiently and correctly utilizes appropriate methods to answer important and meaning

questions. The modern biotechnology is a typical industry of knowledge. Unlike other industries that rely on the value of substance of products, in bioindustry, knowledge is valuable and always has a price. As such a unique feature, innovation, experiences and knowledge in people's brain is the only critical factor of bioindustry. Scientists in Harvard, Stanford, Yale, Berkley and Cambridge might have only averaged capability in conducting experiments, but their ideas in experimental designing and experiences in data interpretation make them superior and outstanding (Sun, 2002).

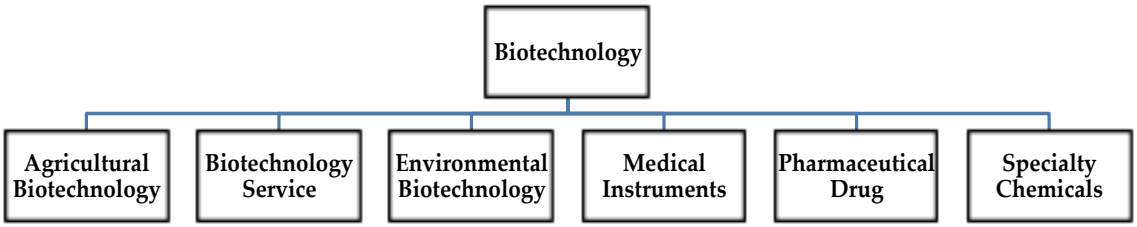
Nowadays the biotechnology is the field that combines different knowledge. In terms of Bio-informatics, for example, at the early " gene sequencing status" people of informatics are involved to develop tools to process and align great volume of row data. After enter the following "genomic and proteomic" status, the data obtained from sequencing would need analysis and interpretation from biologists. More importantly, experts who are capable of integrating biology and informatics are critical factors at this stage. Therefore, how to integrate scientists and engineers is the main issue for every country that develops genetic technology (Sun, 2002).

Because nearly all genetic information is collected in non-profit, public resources and then extracted by private or profit companies for further research and commercialization, the importance of intellectual property is then emphasized. In fact, with systematic, organized and strategic support of intellectual property plan and consulting the value and margin of biotechnology could be greatly enlarged. Therefore lawyer and attorneys will also play important roles in bio industry (Sun, 2002).

As mentioned, the modern biotechnology industry include broad field such as agricultural biotechnology, environmental biotechnology, biotechnology services,

pharmaceutical drug, medical materials, specialty chemicals, bioinformatics, etc. Considering the broad range of biotechnology and bioscience, Taiwan government has classified those fields into six categories and developed certain incubating plans based on the six categories. Figure 2-1 describes the categories of biotechnology industry (Sun, 2002). In general, biotechnology can be classified into six categories: Agricultural biotechnology, biotechnology service, environmental biotechnology, medical instruments, pharmaceutical drugs and specialty chemicals.

**Figure 2-1 Six categories of biotechnology industry**




Source: Original work by Sun (2002), and modified by author

Compared with other industries, which require mass of labor or equipment, the knowledge of professionals is probably the most important and only factor for the success of bioindustry. As there is a right team and unique technology as a core, with appropriate support and investment, a successful company can be established (Sun, 2002).

If we reviewed the history of biotechnological industry in US and Europe, excluding traditional pharmaceuticals are excluded, almost every company is started from an innovation or finding from campuses or research institutes. Principle investigators or professors who own certain technology would seek for investment from venture capitals.

Vise versa, venture capitals also attend every conference and read every report to dig out and invest in any potential project developed by researchers in the campus. Although money and strategy is critical for biotechnological companies, the core technique incubated from academic is no doubt the base. Therefore, a good academic system is also essential for the development of biotechnology and bioindustry. A well transition of research manpower between academics and industry will definitely create a good and complete circuit of bio industry (Sun, 2002).

## 2.3 DEVELOPMENT OF BIOTECHNOLOGY IN TAIWAN

The start-up of bioindustry in Taiwan can be traced back to early 80's. Taiwan government announced "Science and Technology Development Program" in 1982 in which biotechnology is one of the core projects. On the base of several related bills and regulations, the government funded Development Center for Biotechnology (DCB) in 1984. Afterward, organic chemical production and pharmaceuticals were listed on top ten emerging industries. In 1995, the Executive Yuan passed the bill "Strengthening the Biotechnology Industry Program" to reorganize infrastructures including regulations, investments, research projects, national integrated projects, human resource, and science parks. On the other hand, Biotechnology Industry Steering Group integrated with every department of Executive Yuan was set up to execute the development of bio industry (Sun, 2002).

In 1996, Biotechnology and Pharmaceutical Industries Promotion Office, MOEA, was established to take over the developmental policy of bio-technological industry. MOEA is also responsible for coordinating resources from each department of Executive Yuan. In the

same year, National Health Research Institute was established. In addition, the Science Council invited worldwide experts to join the Strategic Review Board (SRB). After five times of conferences certain suggestions were made and conclusions were reached. At the end of 1995, National Development Fund (NDF) of Executive Yuan decided to directly invest 20 billion NTD to large-size biotechnical companies established in the island. The NDF also combined venture capitalist's expertise and knowledge to indirectly invest small-size biotech companies' worldwide. Through serious direct and indirect investments, the government wished to facilitate the development of bio-industry in Taiwan and to encourage private ventral capitals toward biotech fields. (Sun, 2002)

In 1998, the government again listed bioindustry as one of the top ten emerging industries and proclaimed their determinant in developing biotechnology. Meanwhile, the Industrial Technology Research Institute (ITRI) established Biomedical Engineering Center (BEC). BEC recruited experts from diverse fields including electric engineering, materials, biology, and chemistry. They focused on cross-field products and technologies such as biochips and biomaterials to assist related companies and industries in Taiwan (Sun, 2002).

The history of the Biotechnology development in Taiwan is summarized in Figure 2-2 as following:

**Figure 2-2 History of biotechnology development in Taiwan**

| Year | Event |
|---|---|
| 1982 | The government announced" Science and Technology Development Program". |
| 1984 | The government funded Development Center of Biotechnology. |
| 1995 | The Executive Yuan passed the bill " Strengthening the Biotechnology Industry Program". |
| | National Development Fund invested 20 billion NTD to large-size biotechnology companies established. |
| 1996 | Biotechnology and Pharmaceutical Industries Promotion Office was established. |
| | National Health Research Institute was established. |
| | The Council of Exective Yuan invited worldwide expperts to join the Strategic Review Board. |
| 1998 | The Government listed bioindustry in top ten emerging industries and proclaimed their determinant. |
| | The Industrial Technology Research Institute established Biomedical Engineering Center. |

Source: Original work by Sun (2002), and modified by author

Traditionally, biotechnology in Taiwan focused on agricultural biotechnology such as flower, aquaculture, pesticide, health food, scientific Chinese medicine and generics. To date, biotechnology implies technologies that apply life science knowledge, including genomics, proteomics, gene engineering, cell fusion, cell culture, fermentation and enzyme modification to create novel products, technology and services to benefit human beings in every aspect (Sun, 2002).

In particular, having a drug on market is always the grail of bioindustry in Taiwan. The process of drug discovery is highly relied on biotechnology; at the current stage Taiwan government particularly involves pharmaceuticals and medical instrumental industry into whole picture of plan. Besides, the property and yield generated from agriculture, food, eco-protection, ocean industry, energy resources, bio resource and

services are also involved in the whole picture of plan (Sun, 2002).

With government's counsel, promoting, and the global trend of biotechnology, more and more experts and researchers devoted to this high-tech industry. Like the development of electric and computer industry in Taiwan which is greatly contributed by overseas researchers and experts who receive their graduate degree abroad, lots of talents in bio-fields come back to Taiwan to devote their knowledge and expertise in both academic and industry.

Gradually, biotechnology companies mushroomed. Unlike traditional pharmaceuticals, some newborn companies focused on biochip or drug targeting, the areas combining new technology and knowledge. For years, lots of companies disappeared and only few survived (Sun, 2002). Sunrise Inc. of agricultural bioindustry, for instance, has experts of machinery engineering, electrical engineering, agricultural chemistry, agricultural biology, agricultural entomology, and computer science in the management team. The management team applies and integrates different knowledge to overcome the limitation in plant reproduction and genetics, as well as trying to set up a "plant factory" (Sun, 2002).

In bioindustry, research and development (R&D) itself is indeed an important activity. In Taiwan, electronic and computational industry can focus on manufacturing and survive without any R&D activity. On the contrary, even an original equipment manufacturer (OEM) of bioindustry must run their business based on basic research. It is impossible to substantially separate R&D and manufacture in bioindustry. Moreover, this feature of bioindustry indicates that a company must spend great number of energy and resource on R&D activity yet the uncertain rewards of R&D activity would obviously risk the company

(Sun, 2002).

To enlarge the scale and to conduct possible transformation, and most importantly, to help newborn biotechnological companies to survive, industrial banks, venture capitals, other large biotech companies, even traditional industries are organized and encouraged by Taiwan government for direct/indirect investment or technology transferring on biotechnological companies (Sun, 2002).

Taiwan Government has supported and encouraged biotechnology industry for more than 30 years, the scale of the industry yet remains limited and the niche is still unclear. Most of R&D talents have to reside in academics and non-profit institutes such as Academia Sinica, National Health Research Institute, Industrial Technology Research Institute, and Development Center for Biology and universities. In bio-related field an unbalance of high-end manpower or R&D occupation between academic and industry has been warned recently. Such an unbalance always exists throughout the development of bioindustry in Taiwan. Nevertheless, some good products and technology have been developed. Being on the right track, the biotechnology industry keeps steady progress and hopefully some breakthrough will take place in the near future (Sun, 2002).

Dr. James Shen, the former chair of Institute of Molecular Biology of Academia of Sinica, pointed out that there are currently about 800 post-doctors of bio-related fields and the number rise at the rate of 80 post-doctors per year. The principle investigator position in academics, including universities and research institutes, however, are very limited and competitive. Therefore those post-doctors with great scientific knowledge and experience are expected to pursue their careers in the industry. Unfortunately, not many biotechnological companies survive in Taiwan. Due to survival pressure, the active

companies prefer to hire PhD with practical experience to inexperienced new PhD holders. In addition, these companies are unwilling to spend time and resource to train inexperienced PhD. Taken together, biotechnological companies always headhunt experienced PhD while inexperienced PhD seek for positions in industry all the time (Wang, 2002).

## 2.4 DEMAND ANALYSIS OF MANPOWER OF BIOTECHNOLOGY IN TAIWAN

### 2.4.1 Related industry of six categories

In Taiwan, the bio-related industries can be classified into six categories. Figure 2-3 shows the correlated fields and business in accordance with six categories of bioindustry. Among listed fields, some frontier technology (e.g. artificial organs of medical instruments; gene therapy of pharmaceutical drugs) remains immature. On the other hands, some industries are relatively matured and well-developed in Taiwan (e.g. aquaculture and plant tissue culture of agricultural biotechnology) (Sun, 2002).

**Figure 2-3 Related industries of six categories**

| | Related Industry | | | | | |
|---|---|---|---|---|---|---|
| **Agricultural Biotechnology** | Animal cultivation | Animal medicine and vaccine | Aquaculture | Biological fertilizer | Biological pesticide | Feed additives |
| | Plant seeding | Plant tissue culture | Transgenic animal | Transgenic plant | Other agricultural biotechnology | |
| **Biotechnology Service** | Bio-information service | Clinical trial | Commissioned R&D (CRO) | Cord blood storage | Investigation service | Laboratory animal |
| | Laboratory equipment supplies | Laboratory technique supplies | Manufacturing subcontractors (CMO) | Sequencing service | Synthesis service | Other supporting service |
| **Environmental Biotechnology** | Biodegradable materials | Biological indicator technology | Bioremediation technology | Detection analysis | Environmental biological product | Toxic waste treatment |
| | Waste resource | Wastewater treatment | Other environmental technology | | | |
| **Medical Instrument** | Artificial organs | Biochip | Biomedical materials | Biosensor | Diagnosis instrument | Nucleic acid probe |
| | Personal care and health care equipment | Test instrument | Therapy instrument | Other medical equipment | | |
| **Pharmaceutical Drug** | Biosynthesis active pharmaceutical ingredient | Biotech (protein) drug | Blood products | Cell and tissue engineering | Drug delivery | Drug development |
| | Gene therapy | Generic drugs | Herbal medicine | Human vaccine | Testing agents | Other pharmaceutical drugs |
| **Specialty Chemicals** | Biological surfactants | Biotech cosmetics | Fermented foods | Food additives | Food enzyme | Food seasoning |
| | Functional health food | Industrial enzyme | Living body polymers | Pigments and spices | Other specialty chemicals | |

Source: Original work by Sun (2002), and modified by author

### 2.4.2 Bio-related educational departments in colleges

In Taiwan, the category of bio-related education, as shown in Table 2-2, is very diverse. For instance, students who prefer theory and academics go to department of biology, chemistry or immunology; students who prefer application can choose department of dentistry, agricultural engineering and technology management (Sun, 2002).

Every year lots of students graduate from bio-related departments and Institutes and launch their careers in related fields. Therefore, the balance of job demand and supply is a very important and serious issue for both the government and graduates.

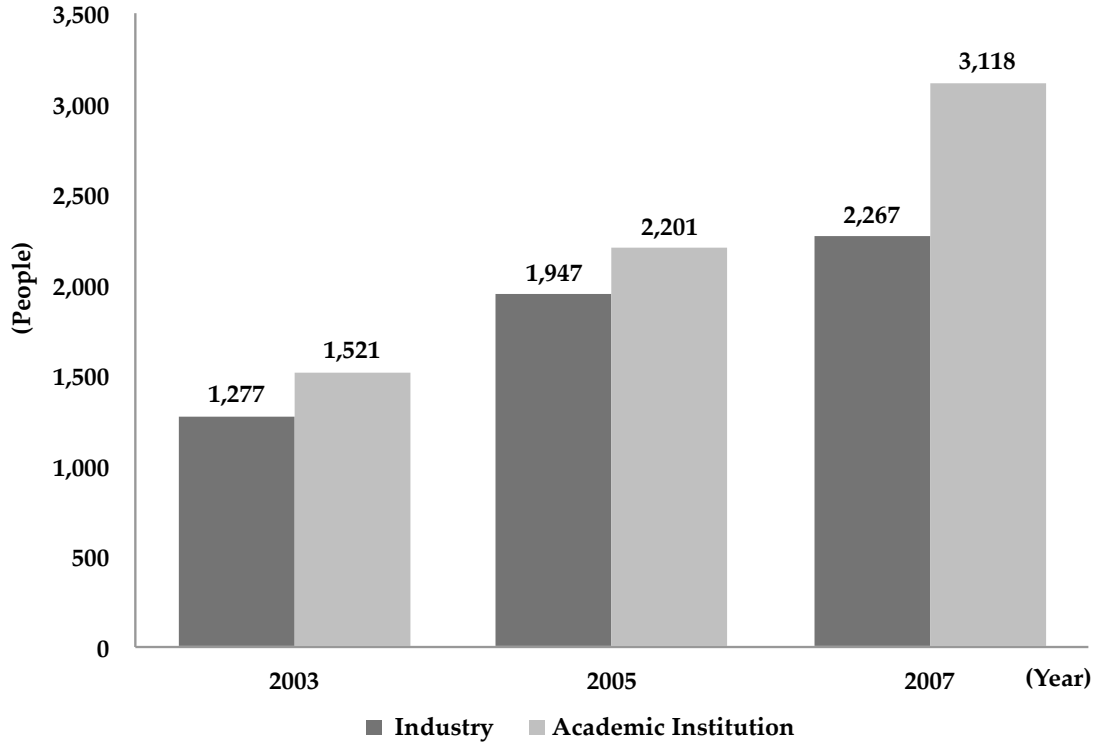
In 2011, the Ministry of Education of Taiwan listed sixty bio-related educational departments of university in Taiwan. These sixty bio-related departments in universities areas agricultural chemistry, agricultural engineering, agronomy, anatomy, animal science, aquaculture, biological chemistry, biology, biomedical science, cell biochemistry, cell biology, chemical engineering, chemistry, Chinese medicine, Chinese pharmaceutical science, clinical medicine, computer science, dentistry, electrical engineering, electronics engineering, entomology, environmental engineering, finance, food science, forestry, genome science, horticulture, immunology, industrial engineering, information engineering, information management, law, life science, marine biotechnology, material science, mathematics, mechanical engineering, medical engineering, medicinal chemistry, medicine, microbiology, molecular biology, molecular medicine, neuroscience, nutrition, pathology, pathology, pharmacology, pharmacy, photonics, physics, physiology, plant science, preventive medicine, statistics, technology management, toxicology, veterinary science and zoology.

2.4.3 Estimation of job demand in bio-related fields in Taiwan

The jobs of bio-related fields can be basically classified into two areas: academics as universities and research institutes and industries as pharmaceuticals and biotech companies.

Figure 2-4 shows the job demand of both bioindustry and academics in short-term (less than 1 year.), medium-term (1 to 3 year.) and long-term (3 to 5 year.). As shown in Figure 2-4, the job demand of industry is 1,277 people, 1,947 people and 2,267 people in year 2003, year 2005 and year 2007 respectively. The job demand of academic is 1,521 people, 2,201 people and 3,118 people in year 2003, year 2005 and year 2007 respectively.

**Figure 2-4 Estimation job demand in short, medium, and long terms in industry and academic institution of biotechnology**




Source: Original work by Sun (2002), and modified by author

**Figure 2-5 Job demand in industry in Taiwan (Short-term, < 1 year)**

| Specialty | PhD | Master | Others | Total |
|---|---|---|---|---|
| Pharmacy | 30 | 59 | 50 | 139 |
| Biochemical Science | 16 | 55 | 10 | 81 |
| Molecular Biology | 19 | 38 | 16 | 73 |
| Chemistry | 15 | 36 | 9 | 60 |
| Chemical Engineering | 5 | 29 | 26 | 60 |
| Traditional Chinese Medicine | 12 | 28 | 13 | 53 |
| Life Science | 14 | 29 | 3 | 46 |
| Immunology | 15 | 27 | 0 | 4 |
| Biomedicine | 10 | 28 | 3 | 41 |
| Biomedical Engineering | 12 | 18 | 11 | 41 |
| **Total** | 148 | 347 | 141 | 598 |

Source: Original work by Sun (2002), and modified by author

**Figure 2-6 Job demand in academic institution in Taiwan (Short-term, < 1 year)**

| Specialty | PhD | Master | Others | Total |
|---|---|---|---|---|
| Medicinal Chemistry | 43 | 64 | 23 | 130 |
| Molecular Medicine | 30 | 45 | 23 | 98 |
| Statistics | 21 | 36 | 19 | 76 |
| Computer Science | 9 | 28 | 37 | 74 |
| Biomedical Engineering | 21 | 30 | 15 | 66 |
| Molecular Engineering | 18 | 16 | 7 | 41 |
| Animal Science | 9 | 17 | 7 | 33 |
| Cell Biology | 9 | 10 | 7 | 26 |
| Biochemical Science | 6 | 10 | 4 | 20 |
| Life Science | 7 | 10 | 3 | 20 |
| **Total** | 173 | 266 | 145 | 584 |

Source: Original work by Sun (2002), and modified by author

The temporal job demand is further analyzed in accordance with specialty and educational degree. The short-term (less than 1 year) job demand of industry and academics are shown in Figure 2-5 and Figure 2-6, respectively. Based on Sun's investigation, the requirement of high-end manpower of the industry and academic is different. In industry people of specialty of pharmacy, biomedical science, molecular

biology, chemistry, chemical engineering, traditional Chinese medicine, life science, immunology, biomedicine and biomedical engineering are most required in short-termed while the top-three demands of specialty in industry are pharmacy, biomedical science and molecular biology. In academics, personnel with specialty of medicinal chemistry, molecular medicine, statistics, computer science, biomedical engineering, animal science, cell biology, biochemical science and life science are most required in short-termed while the top-three demands of specialty are medicinal chemistry, molecular medicine and statistics. Experts of molecular medicine and molecular biology are highly in demand in both categories. In addition, lots of fields require people of statistics, bioinformatics and medical engineering. People with chemistry or chemical engineering that has potential application are also welcome in industry. Notably, experts and graduates with background of Chinese medicine are highly in demand recently, which is correlated to the policy of encouraging bioindustry in combination with our unique culture and niche (Sun, 2002).

**Figure 2-7 Job demand in industry in Taiwan (Medium-term, 1 ~ 3 year)**

| Specialty | PhD | Master | Others | Total |
|---|---|---|---|---|
| Pharmacy | 28 | 70 | 76 | 174 |
| Biochemical Science | 29 | 81 | 16 | 126 |
| Molecular Biology | 32 | 66 | 11 | 109 |
| Chemistry | 27 | 45 | 32 | 104 |
| Chemical Engineering | 12 | 40 | 42 | 94 |
| Life Science | 25 | 53 | 5 | 83 |
| Biomedicine | 13 | 49 | 12 | 74 |
| Pharmacology | 19 | 30 | 19 | 68 |
| Traditional Chinese Medicine | 14 | 33 | 20 | 67 |
| Medicinal Chemistry | 13 | 31 | 16 | 60 |
| **Total** | 212 | 498 | 249 | 959 |

Source: Original work by Sun (2002), and modified by author

**Figure 2-8 Job demand in academic institution in Taiwan (Medium-term, 1 ~ 3 year)**

| Specialty | PhD | Master | Others | Total |
|---|---|---|---|---|
| Medicinal Chemistry | 45 | 66 | 25 | 136 |
| Molecular Medicine | 33 | 47 | 25 | 105 |
| Molecular Biology | 36 | 42 | 19 | 97 |
| Computer Science | 13 | 34 | 38 | 85 |
| Statistics | 24 | 38 | 22 | 84 |
| Biomedical Engineering | 26 | 39 | 18 | 83 |
| Cell Biology | 22 | 28 | 18 | 68 |
| Life Science | 16 | 20 | 8 | 44 |
| Animal Science | 11 | 13 | 19 | 43 |
| Biochemical Science | 18 | 16 | 9 | 43 |
| **Total** | 244 | 343 | 201 | 788 |

Source: Original work by Sun (2002), and modified by author

Similar to the result of the short-term job demand of industry and academics, the job demand of mid-term in industry and academics are organized and shown in Figure 2-7 and Figure 2-8, respectively. The top-three mid-term (1 to 3 year) demands of specialty in industry are pharmacy, biomedical science and molecular biology that are as same as short-term demand. In industry people of specialty of pharmacy, biomedical science, molecular biology, chemistry, chemical engineering, life science, biomedicine, pharmacology, traditional Chinese medicine and medical chemistry are most required in mid-termed while the top-three demands of specialty in industry are pharmacy, biomedical science and molecular biology. In academics, personnel with specialty of medicinal chemistry, molecular medicine, molecular biology, computer science, statistics, cell biology, life science, animal science, biochemical science and are most required in mid-termed while the top-three demands of specialty are medicinal chemistry, molecular medicine and molecular biology.

**Figure 2-9 Job demand in industry in Taiwan (Long-term, > 5 year)**

| Specialty | PhD | Master | Others | Total |
|---|---|---|---|---|
| Pharmacy | 46 | 65 | 55 | 166 |
| Life Science | 48 | 84 | 14 | 146 |
| Biochemical Science | 39 | 82 | 25 | 146 |
| Molecular Biology | 36 | 83 | 16 | 135 |
| Chemistry | 27 | 46 | 43 | 116 |
| Chemical Engineering | 12 | 37 | 48 | 97 |
| Medicinal Chemistry | 22 | 36 | 25 | 83 |
| Traditional Chinese Medicine | 22 | 42 | 19 | 83 |
| Business Administration | 1 | 36 | 42 | 79 |
| Aquaculture | 4 | 28 | 39 | 71 |
| **Total** | 257 | 539 | 326 | 1122 |

Source: Original work by Sun (2002), and modified by author

**Figure 2-10 Job demand in academic institution in Taiwan (Long-term, > 5 year)**

| Specialty | PhD | Master | Others | Total |
|---|---|---|---|---|
| Medicinal Chemistry | 50 | 71 | 30 | 151 |
| Molecular Biology | 46 | 47 | 28 | 121 |
| Molecular Medicine | 37 | 50 | 30 | 117 |
| Biomedical Engineering | 34 | 59 | 24 | 117 |
| Biochemical Science | 50 | 46 | 11 | 107 |
| Computer Science | 19 | 39 | 42 | 100 |
| Cell Biology | 38 | 33 | 27 | 98 |
| Statistics | 29 | 42 | 27 | 98 |
| Biomedicine | 30 | 40 | 17 | 87 |
| Life Science | 30 | 27 | 11 | 68 |
| **Total** | 363 | 454 | 247 | 1064 |

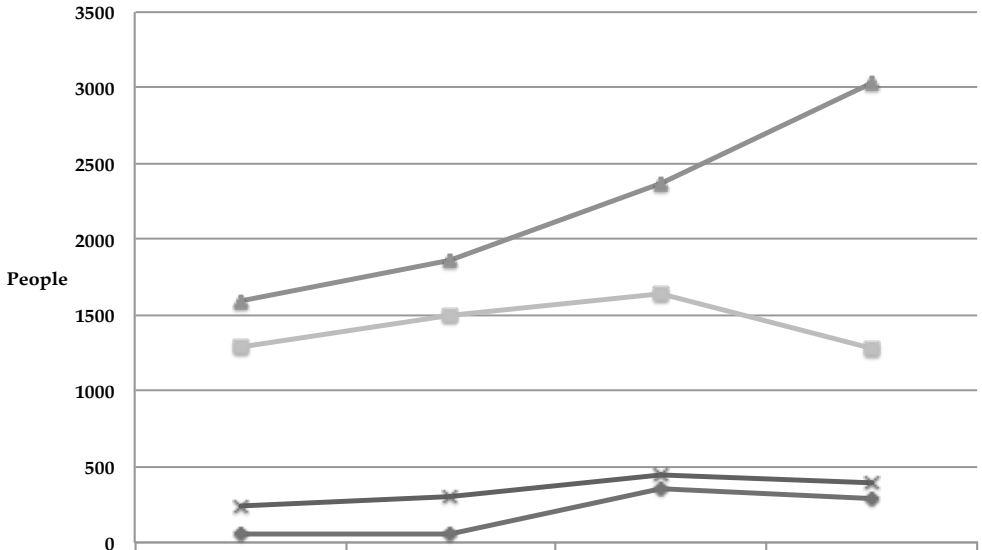
Source: Original work by Sun (2002), and modified by author

The long-term (more than5 year) job demand in industry and academics are organized and shown in Figure 2-9 and Figure 2-10, respectively. The top-three long-term demands of specialty in industry are pharmacy, life science and biomedical science. In industry people of specialty of pharmacy, life science, biomedical science, molecular biology, chemistry, chemical engineering, medical chemistry, traditional Chinese medicine,

business administration and aquaculture are most required in mid-termed while the top-three demands of specialty in industry are pharmacy, life science and biomedical science. Notably, for long-term manpower demand, people with specialty of business administration and aquaculture are on the list. The long-term requirement of people of business administration indicates that, unlike other specialties such as chemistry and biology that can be trained in the schools, people of business administration are mostly trained and enabled by years of practical experience that companies have to arrange a long-term schedule for recruiting people for business administration. On the other hand, aquaculture is a relatively established industry in Taiwan. To aquaculture the unpredictable factors from the environments, the practical experiences are much more important than knowledge learned from the classes. It is reasonable that aquaculture industry require people to work longer to accumulate experiences. In academics, personnel with specialty of medicinal chemistry, molecular biology, molecular medicine, medical engineering, biomedical science, computer science, cell biology, statistics, biomedicine and life science, are most required in mid-termed while the top-three demands of specialty are medicinal chemistry, molecular biology and molecular medicine.

Conclusively, pharmacy is at the top of specialty in all short-term, mid-term and long-term job demand, which might reflect the situation that, in Taiwan, the traditional pharmaceuticals that have developed for long time have larger scale and expand stably and thus constantly recruits manpower with specialty of pharmacy. On the contrary, the requirement of people of medical chemistry and molecular biology in academics suggests the function of these specialties in basic research.

**Figure 2-11 The known and predicted job demand of bio-related fields in Taiwan from year 2010 ~ 2013**




| | Year 2010 | Year 2011 | Year 2012 | Year 2013 |
|---|---|---|---|---|
| Others | 55 | 57 | 351 | 290 |
| Bachelor | 1,286 | 1,504 | 1,639 | 1,281 |
| Master | 1,594 | 1,861 | 2,374 | 3,028 |
| PhD | 241 | 305 | 440 | 395 |

Source: Original work by Tom (2010), and modified by author

On the other hand, the job demand of bio-related fields is analyzed by educational degree level. In Figure 2-11, the known and predicted job demand in bio-related fields from 2010 to 2013 is displayed. The requirement of manpower with master degree increases stably from 2010 to 2012 and is predicted to grow in 2013. The demand of PhD degree appears to be saturated temporally. It is very likely that both academic and bioindustry focus more on R&D and management so jobs opened for bachelors decreases gradually. All together, the overall demand of high-end manpower as masters and PhD in bio-related field in Taiwan increases stably (Sun, 2002). Interestingly, it is a trend that students are encouraged to have their highest educational degree aboard. Studying aboard not only enriches individual's life experience and vision but also practically could polish his/her resume.

# CHAPTER 3. THEORY REVIEW

## 3.1 DEFINITION OF SELF-EFFICACY

Self-efficacy is to describe a person's belief in his/her own competence in psychology that an individual can act properly to accomplish a set of goals in certain situation. It is believed that individuals' concepts and perception of self-efficacy influence their social interactions in almost every way. Therefore, it is an important issue in psychology to reveal the development of self-efficacy that may contribute to a more happy and productive life.

Perceived Self-efficacy is defined as people's beliefs in their own capabilities of prospective performance or accomplishing certain goal. Self-efficacy beliefs are thought to govern peoples' feeling, thoughts, motivation and behaviors through four major processes including cognitive, motivational, affective, and selection process (Bandura, 1994). Perceived self-efficacy is also considered as an optimistic sense of personal ability that seems to be a common phenomenon responsible for one's motivation and accomplishments (Scholz, 2002). To date, the construct of self-efficacy is basically derived from Bandura's social-cognitive theory. Having self-efficacy is very important for positive psychology and can have people a more productive and happy life.

## 3.2 THE COSTRUCT OF PERCEIVED SELF-EFFICACY

Self-referent thought has become an issue that pervades psychological research in many domains. It has been found that a strong sense of personal efficacy is related to better health, higher achievement, and better social integration (Schwarzer, 1992; Bandura, 1997). The construct of self-efficacy represents one core aspect of Bandura's social-cognitive

theory (Bandura, 1977, 1997, 2000, 2001). Bandura, in a unifying theory of behavior change, hypothesized that expectations of self-efficacy determine whether coping behavior will be initiated, how much effort will be expended, and how long it will be sustained in the face of obstacles and aversive experiences. While outcome expectancies pertain to the perception of possible consequences of one's action, perceived self-efficacy refers to personal action control or agency. A person who believes in being able to produce a desired effect can lead a more active and self-deter-mined life. This "can do"-cognition mirrors a sense of control over one's environment. It reflects the belief of being able to control challenging environmental demands by taking adaptive action. It can be regarded as an optimistic and self-confident view of one's capability to deal with certain life stressors.

According to theory and research, self-efficacy makes a difference in how people feel, think and act (Bandura, 1997). In terms of feeling, a low sense of self-efficacy is associated with depression, anxiety, and helplessness. Persons with low self-efficacy also have low self-esteem, and they harbor pessimistic thoughts about their accomplishments and personal development. In terms of thinking, a strong sense of competence facilitates cognitive processes and performance in a variety of settings, including quality of decision-making and academic achievement. Self-efficacy has an influence on preparing action because self-related cognitions are a major ingredient in the motivation process. Self-efficacy levels can enhance or impede motivation. People with high self-efficacy choose to perform more challenging tasks (Bandura, 1997). They set themselves higher goals and stick to them. Actions are pre-shaped in thought, and people anticipate either optimistic or pessimistic scenarios in line with their level of self-efficacy. Once an action has been taken, highly self-efficacious people invest more effort and persist longer than those low in self-

efficacy. When setbacks occur, they recover more quickly and maintain commitment to their goals. High self-efficacy also allows people to select challenging settings, explore their environment, or create new ones.

## 3.3 FOUR THEORIES OF SELF-EFFICACY

Self-efficacy is generally described with four theories: social cognitive theory, social learning theory, self-concept theory and attribution theory.

### 3.3.1 Social cognitive theory

Psychologist Albert Bandura defined self-efficacy as one's belief in one's ability upon certain situations. In Bandura's social cognitive theory, the center is the concept of self-efficacy which observational learning and social experience play important roles in development of personality. In social cognitive theory, almost every action and response of an individual upon almost every situation is affected by observation about others. These observations help individuals to shape their social behaviors and cognitive processes. Theoretically, perception acknowledged during early stage of mental development could greatly affect individuals' mental processes lifelong. In social cognitive theory, the development of self-efficacy is based on external experiences and self-perception. Self-efficacy represents the personal perception of external social factors and affects one's actions. According to Bandura's theory, people with high self-efficacy are more likely to face difficult tasks in positive way (Luszczynska, 2005).

### 3.3.2 Social learning theory

Social learning is the process of the acquisition and development of social skills and values from social group. The extent of social learning is determined by how individuals either succeed or fail when interacting with others. Social learning promotes emotional and practical skills. In addition, social learning plays certain roles in individual's perception in terms of their competencies and limitations. Self-efficacy herein indicates ones' understanding of what they can contribute and offer in a group (Ormrod, 1999).

### 3.3.3 Self-concept theory

Self-concept theory explains how people perceive their own existence from external sources and environments. These perceptions could be organized and dynamically influence individuals lifelong. In this theory, almost every successes and failures people experienced correlate and affect the perception of themselves and the relationships with others. For behavioral therapists, self-concept demonstrates at least three qualities of interest: (1) it is learned, (2) it is organized, and (3) it is dynamic. Self-concept is learned and people accept the concept that newborn infants are with no self-concept. Self-concept organization means how we adapt and internalize external experiences to generate new ideas. Self-concept dynamics describes the dynamic feature of our perception that changes and adjusts lifelong (McAdam, 1986).

### 3.3.4 Attribution theory

Attribution theory describes how people attribute the cause of an event and how

those beliefs interact with internal perception. Three major elements of cause are mentioned in attribution theory: locus, stability, and control ability. Locus means the location of the cause, which can be either internal or external to individuals. Peoples' self-esteem and self-efficacy can be influenced by the locus factors (Heider, 1958).

## 3.4 FOUR SOURCES OF SELF-EFFICACY BELIEFS

Bandura (1977) proposed four main sources that affect the development of self-efficacy:

### 3.4.1 Mastery experience

Mastery experience is the most important factor for self-efficacy development. Successes build ones' belief in self-efficacy. On the contrary, failures weaken self-efficacy, especially when failures take place prior to the development of stable perception of self-efficacy. However, people are easily discouraged by failure if they experience only easy successes and expect results and achievements overoptimistically. A good sense of self-efficacy should be developed on the experience in overcoming obstacles through hard effort. Some retreats and difficulties are appropriate sense to let people understand that success usually requires sustained and hard effort. As long as people realize what it takes to succeed, they persevere upon adversity and quickly recover from failure. With such a sense regarding success, failure and efforts, people could overcome any adversity and get tougher (Bandura, 1994).

### 3.4.2 Vicarious experience

The vicarious experiences which individuals sense their own ability with others are another source for self-beliefs of efficacy. The vicarious experience is more important especially when individuals consider themselves of similar and comparable ability to peers. Individuals' self-efficacy is usually strengthened when peers who are recognized of similar ability perform well in certain situation. In contrast, individuals' self-efficacy will decrease when they see peer of comparison fails upon a task. Not as important as mastery experience, the vicarious experience is still an influential factor for self-efficacy development. The impact of vicarious experience on ones' self-efficacy is strongly correlated with perceived similarity of peers or observed subjects. The greater the similarity is perceived, the more persuasive the experience is. So, if people consider observed subjects with very different features from themselves, their self-efficacy is less influenced by the activities, successes and failure of observed subjects (Bandura, 1994).

### 3.4.3 Social persuasions

Social persuasion, that individuals are told and taught about what it take to succeed, is the third source for people's beliefs in self-efficacy. Social persuasions can be defined as encouragements and discouragements in certain circumstances. Special events or conversations can significantly encourage or discourage and alter individuals' confidence and self-beliefs. Positive persuasions strengthen ones' self-efficacy while negative persuasions weaken it. People who are persuaded positively in capable of mastering challenges and situations are likely to exhibit more efforts and sustain. In contrast,

individuals receiving self-doubts from others usually withdraw from problems and challenges. As social persuasions encourage individuals and lead them to try harder to succeed, the persuasions promote development of skills and a perception of self-efficacy (Bandura, 1994).

### 3.4.4 Somatic and emotional states

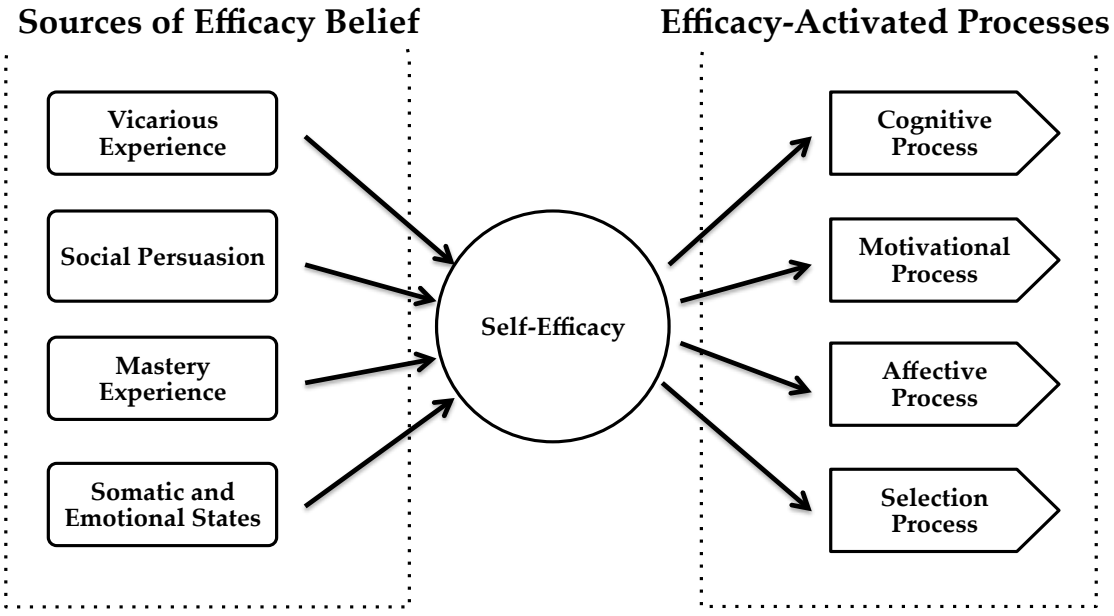
In some situation people judge their capabilities by their somatic and emotional states. They interpret their response upon stress and tension as signs of vulnerability or poor performance. In activities involving strength and stamina, fatigue, aches, and pains are thought to be signs of physical weakness. Individuals' perceptions of self-efficacy are also influenced by mood. Positive mood enhances self-efficacy perception and negative mood decrease it. By improving people's responses to stress as well as enlightening their negative emotions and misinterpretations of their physical states, individuals' self-beliefs of efficacy could also be enhanced. On the other hand, individuals' self-efficacy can greatly influence their perceptions of physical responses in certain situation. For instance, people usually response uncomfortably and show adverse signs such as shakes, aches and pains, fatigue, fear and nausea upon stress. Those who with low self-efficacy may take these stressful responses as a sign of incapability and this perception will negatively decrease their self-efficacy further. On the contrary, those with high self-efficacy are more likely to take these responses as normal and unrelated to their actual ability. Thus, peoples' perception of their physiological signs may alter their own self-efficacy (Bandura, 1994).

## 3.5 EFFICACY-ACTIVATED PROCESS

Mastery experiences, vicarious experiences, social persuasion, and somatic and emotional states are the four major sources for influencing personal competence. These four informational sources vary in strength and importance in the order presented here (Bandura, 1995).

Four major psychological processes, cognitive processes, motivational processes, affective processes, and selection process have been studied to understand which self-beliefs of efficacy affect human functioning (Bandura, 1995). A major function of thought is to enable people to predict events and to develop ways to positively control variants and factors that affect their lives. Such perception and thoughts require effective cognitive processing of information containing ambiguities and uncertainties. Mostly, motivation is cognitively generated and people motivate themselves and guide their actions anticipatorily by forethought. People's beliefs in their own capabilities significantly influence how much stress they can handle and sustain in difficult situations, and how strong their motivations are. Factors that influence decision-making behavior can deeply affect the direction of individuals' development in any aspects. This is because the social influences in the environments keeps affecting individuals' competencies, values, and interests long after the efficacy decisional determination has rendered its effect.

**Figure 3-1 The relationship between sources and process**




Source: Bandura (1995), Sugiura & Edagawa (2012)

In summary, Figure 3-1 depicts how self-efficacy is influenced and how self-efficacy is activated. Four sources including vicarious experience, social persuasion, mastery experience and physiological/mood states are the factors contribute greatly to the formation and alteration of self-efficacy. On the other hand, self-efficacy itself can be activated and affect individuals' function through cognitive, motivational, affective and selection processes.

## 3.6 GENERAL SELF-EFFICACY (GSE)

General self-efficacy (GSE) aims at a broad and stable sense of individual competence to deal with a variety of stressful situations effectively (Schwarzer, 1992; Schwarzer et al., 1999). The GSE scale, which is developed by Ralf Schwarzer and Matthias Jerusalem in 1979, has been applied to evaluate self-efficacy in numerous research projects.

GSE's stability has been examined in several longitudinal studies and it typically yielded internal consistencies. The instrument of German version contained 20 items and later been reduced to 10 items in 1981 and subsequently adapted to 28 languages (Scholz, 2002). The highest level of generality is given when broad optimistic self-beliefs are examined, for example, when individuals under stress have to readapt to novel life circumstances over an extended period of time. For example, in a study with cardiac surgery patients, Schröder et al. (1998) found that patients with high GSE scores had recovered better one week after surgery and experienced better quality of life half a year later than their low-GSE counterparts. In a study among East German refugees, people with high GSE were healthier, socially better integrated, and more frequently employed two years after the stressful transition than their low-GSE counterparts (Schwarzer et al., 1993).

In general, self-efficacy is considered as being domain-specific that one can have more or less solid self-beliefs in different aspects or specific condition of functioning. Some researchers, however, conceptualize a generalized sense of self-efficacy as overall confidence in one's coping ability over a wide spectrum of demanding or new circumstances (Sherer & Maddux, 1982; Skinner et al., 1988; Schwarzer & Jerusalem, 1999). The present authors agree with Bandura (1997) that perceived self- efficacy should be conceptualized in a condition-specific manner. But the extent of specificity of generality varies with the situation. For instance, if the questionnaire deals with solving an algebra problem or running a marathon, the description regarding self-efficacy will be more limited than when the professional self-efficacy of teachers or nurses is conducted (Schwarzer & Jerusalem, 1999; Schwarzer et al., 2000).

# CHAPTER 4. METHODOLOGY

## 4.1 RATIONALE

In addition to traditional pharmaceuticals, companies of diverse biotechnology have been funded in Taiwan after decades of development. High-end manpower, especially people of PhD and master degree of bio-related fields, plays important roles in R&D as well as management in these companies. Increasing numbers of young postgraduates have positions in bio industry, but the majority of them work in academia. So far no report or study about self-efficacy of high-end manpower in bio-related field in Taiwan has been published. As self-efficacy highly influences one's attitude, motivation and performance, evaluation of self-efficacy of the high-end manpower might shed certain aspect of their motivation, career choices and career performances.

In the present study, postgraduates working in bio-related fields in Taiwan will be surveyed in terms of GSE scale as well as four sources of self-efficacy. The experimental subjects will be further classified into various subgroups based on factors of career category, gender, educational degree level and where they obtain graduate degree; since I consider these factors might influence individuals' self-efficacy. The score of GSE as well as sources of self-efficacy of corresponded subgroups will be examined and compared. This study shall provide valuable information for the government, academic and bio industry to design more appropriate plans and policies in the aspect of high-end manpower arrangement and training.

## 4.2 SURVEY QUESTION DESIGN

### 4.2.1 Section I: Questions of general perceived self-efficacy

Perceived self-efficacy represents an optimistic sense of personal competence that seems to be a pervasive phenomenon accounting for motivation and accomplishments in human beings. The standard questions for general self-efficacy (GSE) scale were originally developed by Matthias Jerusalem and Ralf Schwarzer in 1979. In 1981 it was reduced to 10 items and subsequently adapted to 28 languages, and the English version was translated in 1985. The first question "I always can manage to solve difficult problems if I try hard enough" is translated into "difficult problem". The second question "if someone opposes me, I can find the means and ways to get what I want" is translated into "opposite situation". The third question "I am certain that I can accomplish my goal" is translated into "goal accomplish". The fourth question "I am confident that I could deal efficiently with unexpected events" is translated into "unexpected events". The fifth question "thanks to my resourcefulness, I can handle unforeseen situation" is translated into "unforeseen situation". The sixth question "I can solve most problems if I invest the necessary effort" is translated into "effort investment". The seventh question "I can remain calm when facing difficulties because I can rely on my coping abilities" is translated into "coping abilities". The eighth question "when I am confronted with a problem, I can find several solutions" is translated into "solution finding". The ninth question "If I am in trouble, I can think of a good solution." is translated into "solution resolution". The tenth question "I can handle whatever comes my way" is translated into "handling capabilities". The response range for GSE was designed from 1 (not at all true), 2 (hardly true), 3 (moderately true) to 4

(exactly true). The ten general perceived self-efficacy questions are summarized in Fig 4-1.

**Figure 4-1 Questions of general perceived self-efficacy**

| Number | General Self-efficacy Question | Abbreviation |
|---|---|---|
| 1 | I always can manage to solve difficult problems if I try hard enough. | Difficult Problem |
| 2 | If someone opposes me, I can find the means and ways to get what I want. | Opposition Situation |
| 3 | I am certain that I can accomplish my goals. | Goal Accomplish |
| 4 | I am confident that I could deal efficiently with unexpected events. | Unexpected Events |
| 5 | Thanks to my resourcefulness, I can handle unforeseen situations. | Unforeseen Situation |
| 6 | I can solve most problems if I invest the necessary effort. | Effort Investment |
| 7 | I can remain calm when facing difficulties because I can rely on my coping abilities. | Coping Abilities |
| 8 | When I am confronted with a problem, I can find several solutions. | Solution Finding |
| 9 | If I am in trouble, I can think of a good solution. | Solution Resolution |
| 10 | I can handle whatever comes my way. | Handling Capabilities |

Response Format: 1: Not at all true 2: Hardly true 3: Moderately true 4: Exactly True

Source: Original work by Schwarzer & Jerusalem (1985), and modified by author

### 4.2.2 Section II: Questions of sources

The questions responsible for the four sources of self-efficacy including mastery experience, vicarious experience, social persuasion, as well as somatic and emotional states were also listed in the survey. The first question “I can exert my specialty in my position with my training and profession” is to exam the first source “mastery experience”. The second question “My peers perform fine in their positions and so can I” is to elucidate the second source “vicarious experience”. For the third source “social persuasion”, the third question “According to other's suggestion, evaluation, encouragement, or affirmation, I believe I am able to work well in my position” is conducted. As for the fourth source “somatic and emotional states”, the fourth question “my personality or character fits in this position well” is conducted. In order to compare the results between general self-efficacy

and the sources of self-efficacy, the response range of four sources of self-efficacy were designed from 1 (not at all true), 2 (hardly true), 3 (moderately true) to 4 (exactly true). The four questions are summarized in Fig 4-2.

**Figure 4-2 Questions of sources**

| Number | Source Name | Question Design |
|---|---|---|
| 1 | Mastery Experience | I can exert my specialty in my position with my training and profession. |
| 2 | Vicarious Experience | My peers perform fine in their positions and so can I. |
| 3 | Social Persuasion | According to other's suggestion, evaluation, encouragement, or affirmation, I believe I am able to work well in my position. |
| 4 | Somatic and Emotional States | My personality or character fits in this position well. |

For each question in the survey, response format is designed universally as:

1: Not at all true 2: Hardly true 3: Moderately true 4: Exactly True

### 4.2.3 Section III: Questions of personal information.

It contains factors of age, gender, place of graduation, career categories, and educational degree.

## 4.3 SURVEY DISTRIBUTION

Survey has been conducted on people who work in bio-related field in Taiwan and has distributed through Internet by Google Document. The survey was designed by author and published through internet on Google Document from 12th April 2012 to 14th April 2012. The link of the survey was originally emailed to author's friends and former colleagues who work in bio-related field in Taiwan and subsequently being forwarded to other people who work in the same field.

# CHAPTER 5. DATA ANALYSIS

## 5.1 SURVEY OUTLINE

From 12th April to 14th April, a total of sixty-six Internet survey data were collected. The average age of the subjects is 31.38 years old. Among the subjects twenty people obtained their highest degree in US and forty-six people earned their highest degree in Taiwan. For working category, thirty-one people work in industry and thirty-five people in academic institution. For education level, twenty-one people are PhD and forty-five people are with master degree. For gender distribution, thirty-three males and thirty-three females were included in the survey. The response rate of the survey was 100%, meaning that all the data collected could be analyzed completely. The data was analyzed by T-distribution and confident level was 95% (2 sides). The data analysis is conducted by Office Excel. Figure 5-1 shows the outline of the survey.

**Figure 5-1 Survey outline**

| **Survey outline** | |
|---|---|
| Response | 66 people |
| Response percentage | 100% |
| Average age | 31.38 years old |
| Accuracy | Confident level is calculated by T-distribution (2 sides) at 95% |
| Country of highest degree obtained | 20 (30.3%) in the US: 46 ( 69.7%) in Taiwan |
| Working category | 31 (47%) in industry: 35 (53%) in academic |
| Education level | 21 (31.8%) PhD: 45 (68.2%) master |
| Gender | 33 (50%) male: 33 (50%) female |

## 5.2 RESULTS

### 5.2.1 Distribution

**Figure 5-2 Distribution of scores of each question on GSE survey**

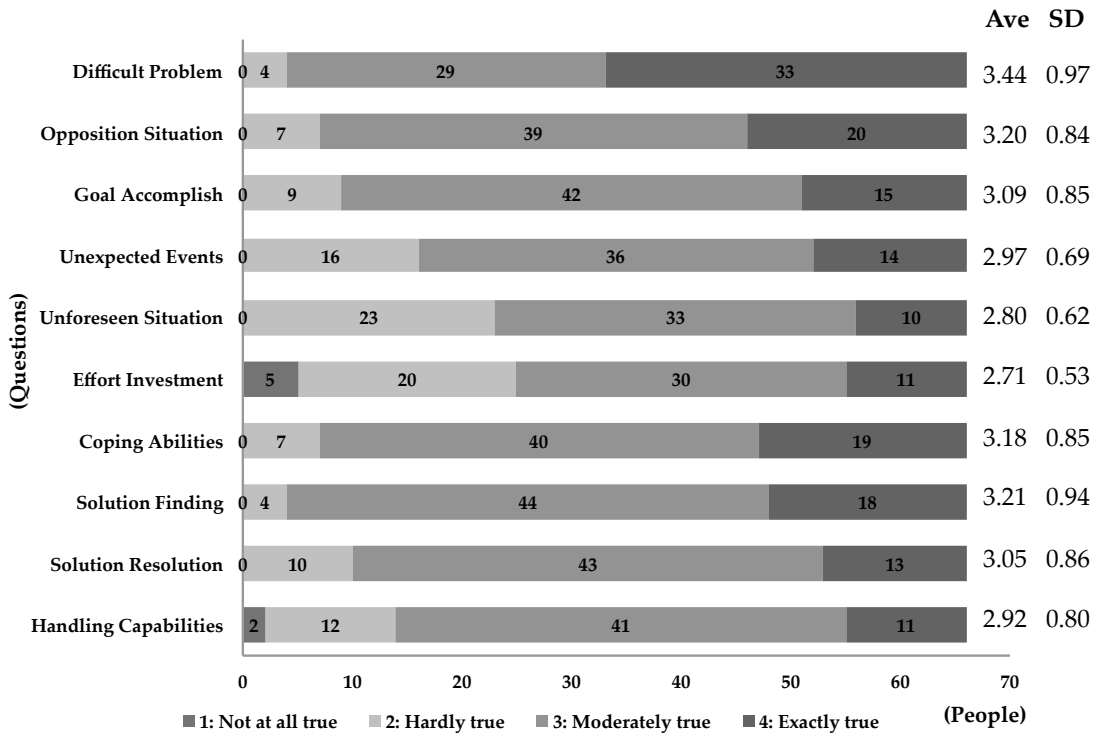



Figure 5-2 exhibits the overall score distribution, average (Ave) and standard deviation (SD) of each question of GSE scores based on sixty-six recoveries of the survey. In this figure score 4 of "exactly true" locates at right side; score 3 (moderately true) locates at middle right side; score 2 (hardly true) locates at middle left side and score 1 (not at all true) locates at left side. Except question "difficult problem" in which score 4 (exactly true) is the highest proportion, most people answered score 3 (moderately true) in question of "opposition situation", "goal accomplishment", "unexpected event", "unforeseen situation", "effort invest", "coping abilities", "solution finding", "solution resolution" and

" handling capability". Five and two subjects selected "not at all true" in question of effort investment and handling capability, respectively. Among all ten GSE questions the question of "difficult problem" showed the highest average at 3.44 while the question of effort investment showed the lowest average at 2.71.

**Figure 5-3 Distribution of scores of each question on source survey**

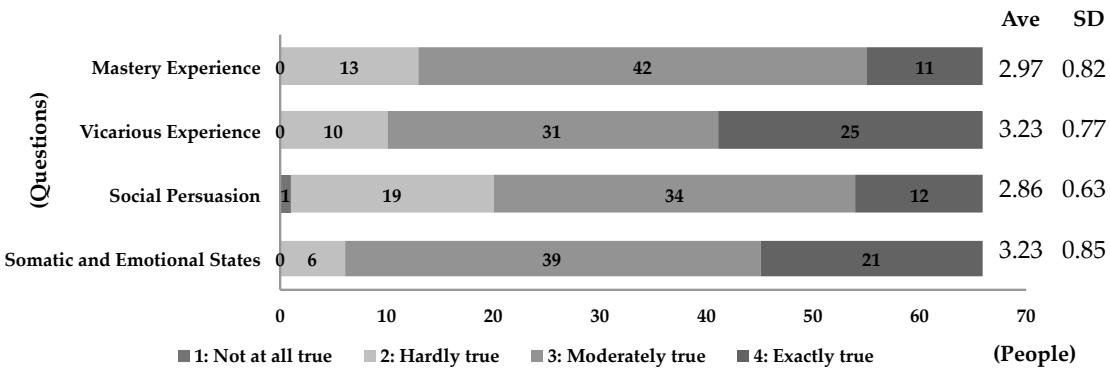



Figure 5-3 exhibits the overall score distribution, average (Ave) and standard deviation (SD) of each question of four sources of self-efficacy based on sixty-six recovery of the survey. In this figure score 4 of "exactly true" locates at right side; score 3 (moderately true) locates at middle right side; score 2 (hardly true) locates at middle left side and score 1 (not at all true) locates at left side. The response of score 3 (moderately true) is the highest proportion of questions of four sources. There was one subject responded score 1 (not at all true) in source of social persuasion. Among all four questions, the question of " vicarious experience" and "somatic and emotional states" showed the highest average at 3.23 while the question of "social persuasion" earned the lowest average at 2.86.

5.2.2 Correlation between GSE and sources

**Figure 5-4 Correlation between GSE and sources of self-efficacy for people in bio-related fields in Taiwan**

| | GSE Score | Mastery Experience | Vicarious Experience | Social Persuasion | Somatic and Emotional States |
|---|---|---|---|---|---|
| **GSE Score** | 1 | 0.48*** | 0.42*** | 0.56*** | 0.28* |
| **Mastery Experience** | 0.48*** | 1 | 0.38** | 0.59*** | 0.31** |
| **Vicarious Experience** | 0.42*** | 0.38** | 1 | 0.40*** | 0.39** |
| **Social Persuasion** | 0.56*** | 0.59*** | 0.40*** | 1 | 0.25* |
| **Somatic and Emotional States** | 0.28* | 0.31** | 0.39** | 0.25* | 1 |

The comparison between GSE and sources of self-efficacy was conducted. The results of Pearson's Product-Moment Correlation Coefficient between GSE and the sources of self-efficacy are listed in Figure 5-4. The Pearson's coefficients are further analyzed by T-distribution. The significant level of each comparison is marked as asterisks. *** indicates p -value is less than 0.001 and the significant level is over 99.9%. ** indicates p-value is less than 0.01 and the significant level is over 99%. * indicates p-value is less than 0.05 and the significant level is over 95%.

As shown in Figure 5-4, GSE score highly correlates to sources of mastery experience, vicarious experience and social persuasion and the significant level of each correlation is over 99.9%. GSE score also correlates moderately to source of somatic and emotional states with the significant level over 95%.

In addition, in terms of the correlation among the four source of self-efficacy themselves, the highest correlation with the significant level of 99.9% is found when comparing mastery experience with vicarious experience and vicarious experience with

social persuasion; correlation with significant level of 99% is found when comparing mastery experience with social persuasion, mastery experience with somatic and emotional states and social persuasion with emotional states and social persuasion. The correlation with significant level of 95% is found when comparing vicarious experience with emotional states and social persuasion. According to the shown comparisons of the results, the strong correlation between GSE and all four sources of self-efficacy for people in bio-related field confirmed the known Bandura's theory that the four sources of self-efficacy directly and positively influence the formation of individual's self-efficacy. The results also confirmed the concept that GSE score system can perform the evaluation on the sources of self-efficacy perceived by individuals.

5.2.3 Countries of highest degree obtained

**Figure 5-5 Influence of countries of highest degree obtained on GSE (US vs. TW)**

| | US (N=20) | TW (N=46) | Average score of US - Average score of TW | | |
|---|---|---|---|---|---|
| | Average | Average | Difference | p-value | t-test |
| **Handling Capabilities** | 3.40 | 2.72 | 0.68 | 0.0001 | *** p<0.001 |
| **Unexpected Events** | 3.40 | 2.78 | 0.62 | 0.0034 | ** p<0.01 |
| **Coping Abilities** | 3.55 | 3.02 | 0.53 | 0.0004 | *** p<0.001 |
| **Difficult Problem** | 3.80 | 3.28 | 0.52 | 0.0085 | ** p<0.01 |
| **Goal Accomplish** | 3.45 | 2.93 | 0.52 | 0.0005 | *** p<0.001 |
| **Solution Resolution** | 3.40 | 2.89 | 0.51 | 0.0011 | ** p<0.01 |
| **Opposition Situation** | 3.50 | 3.07 | 0.43 | 0.0046 | ** p<0.01 |
| **Solution Finding** | 3.50 | 3.09 | 0.41 | 0.0132 | * p<0.05 |
| **Unforeseen Situation** | 3.00 | 2.72 | 0.28 | 0.1370 | |
| **Effort Investment** | 2.85 | 2.65 | 0.20 | 0.7846 | |
| **GSE Score** | 42.94 | 40.87 | 47.70 | 0.0001 | *** p<0.001 |

Effects of the countries that people earned their highest education degree on GSE are unclear. Different education system in different country might cultivate different talent with unique spirit, personality and values. The data was analyzed by where experimental subjects earned highest degree. In the present study, the country is classified as Taiwan and US since postgraduates aboard mainly go to US. As shown in Figure 5-5, the questions are ranked by the score difference between two countries of highest degree obtained. Postgraduates who had their highest degree in US earn higher GSE score in every question as well as the overall average than those who had degrees in Taiwan. In particular, people graduated from US got higher score on handling capabilities, unexpected events, copies abilities, difficult problem, goal accomplish, solution resolution, opposition situation and solution finding with significant difference of p-value less than 0.05 while handling

capabilities, unexpected events and copies abilities are the top 3 among all the items.

**Figure 5-6 Influence of country of highest degree obtained on the sources of self-efficacy (US vs. TW)**

| | US (N=20) | TW (N=46) | Average score of US - Average score of TW | | |
|---|---|---|---|---|---|
| | Average | Average | Difference | p-value | t-test |
| **Social Persuasion** | 3.30 | 2.67 | 0.63 | 0.0120 | * p<0.05 |
| **Mastery Experience** | 3.35 | 2.80 | 0.55 | 0.0009 | *** p<0.001 |
| **Vicarious Experience** | 3.45 | 3.13 | 0.32 | 0.0790 | |
| **Somatic and Emotional States** | 3.30 | 3.20 | 0.10 | 0.4270 | |

There is not report about the effects of the areas where people earn their highest education degree on their perception of fours sources of self-efficacy. Therefore, it is interesting to dissect whether the areas people of bio-related fields in Taiwan earn their highest degree have any effects on their perception of the sources of self-efficacy. In the present study, the country where experimental subjects earned highest degree were classified as Taiwan and US since the Taiwanese students mainly went to US for advanced graduate degrees. As shown in Figure 5-6, the four sources of self-efficacy grouped by countries where the highest degrees are obtained at were ranked by the difference of average. People who have their highest degree in US selected higher average in the question of every source of self-efficacy than those who have degrees in Taiwan. In particular, comparing with graduates in Taiwan, people graduated in US got higher score in social persuasion and mastery experience with significant difference of p-value less than 0.05 and less than 0.001, respectively.

5.2.4 Working category

**Figure 5-7 Influence of working category on GSE (Industry vs. Academic)**

| | Industry (N=31) | Academic (N=35) | Average score of Industry - Average score of Academic | | |
|---|---|---|---|---|---|
| | Average | Average | Difference | p-value | t- test |
| **Handling Capabilities** | 3.13 | 2.74 | 0.39 | 0.0215 | * p<0.05 |
| **Coping Abilities** | 3.35 | 3.03 | 0.33 | 0.0305 | * p<0.05 |
| **Solution Finding** | 3.35 | 3.09 | 0.27 | 0.0440 | * p<0.05 |
| **Unforeseen Situation** | 2.94 | 2.69 | 0.25 | 0.1370 | |
| **Goal Accomplish** | 3.19 | 3.00 | 0.19 | 0.1940 | |
| **Unexpected Events** | 3.06 | 2.89 | 0.18 | 0.2892 | |
| **Solution Resolution** | 3.13 | 2.97 | 0.16 | 0.2820 | |
| **Effort Investment** | 2.77 | 2.66 | 0.12 | 0.5685 | |
| **Opposition Situation** | 3.23 | 3.17 | 0.05 | 0.7194 | |
| **Difficult Problem** | 3.42 | 3.46 | -0.04 | 0.8024 | |
| **GSE Score** | 42.94 | 41.51 | 44.55 | 0.0726 | |

There is no report about the effects of the career difference on GSE. It is thus interesting to analyze whether the category of career of people in bio-related fields in Taiwan has any influence on their perception of self-efficacy. The GSE scores of experimental subjects were further grouped by their career, industry and academics, and the questions of each group were ranked by the difference of average. As shown in Figure 5-7, people working in bioindustry earn higher GSE score in overall average and in almost every question except question of difficult problem than those who work in academics. In particular, people in industry got higher score on handling capabilities, copies capabilities and solution finding with significant difference of p-value less than 0.05. For question of difficult problems, academic people earn higher scores than industry people yet without significant difference as p-value is less than 0.05.

**Figure 5-8 Influence of working category on the sources of self-efficacy (Industry vs. Academic)**

| | Industry (N=31) | Academic (N=35) | Average score of Industry - Average score of Academic | | |
|---|---|---|---|---|---|
| | Average | Average | Difference | p-value | t- test |
| Social Persuasion | 3.06 | 2.69 | 0.38 | 0.0290 | * p<0.05 |
| Mastery Experience | 3.10 | 2.86 | 0.24 | 0.1061 | |
| Vicarious Experience | 3.19 | 3.26 | -0.06 | 0.7103 | |
| Somatic and Emotional States | 3.19 | 3.26 | -0.06 | 0.6718 | |

In the last paragraph people of industry have shown to earn higher score in GSE questions of handling capabilities, copies capabilities and solution finding with significant difference. So far, no report has ever mentioned the effects of the career difference of people in bio-related fields on their perception of the four sources of self-efficacy. It is interesting to investigate whether the career difference influences the sources of self-efficacy. The scores of the four sources of self-efficacy were analyzed by experimental subjects' career, industry and academics, and the questions were ranked by the difference of averages. As shown in Figure 5-8, people working in bioindustry earn higher score on the sources of social persuasion and mastery experience while the significant difference is found in social persuasion, as p-value is less than 0.05. In contrast, people working in academics earn higher score on sources of vicarious experience as well as somatic and emotional states yet are without significant differences. The result indicates that people who work in bio-related fields in Taiwan thought the source of social persuasion such as evaluation, encouragement and appreciation from peers considerably influences their perception of the sources of self-efficacy.

5.2.5 Education level

**Figure 5-9 Influence of education level on GSE (PhD vs. Master)**

| | PhD (N=21) | Master (N=45) | Average score of PhD - Average score of Master | | |
|---|---|---|---|---|---|
| | Average | Average | Difference | p-value | t- test |
| **Coping Abilities** | 3.48 | 3.04 | 0.43 | 0.0042 | ** p<0.01 |
| **Opposition Situation** | 3.48 | 3.07 | 0.41 | 0.0130 | * p<0.05 |
| **Goal Accomplish** | 3.33 | 2.98 | 0.36 | 0.0384 | * p<0.05 |
| **Handling Capabilities** | 3.14 | 2.82 | 0.32 | 0.0933 | |
| **Solution Resolution** | 3.24 | 2.96 | 0.28 | 0.0861 | |
| **Difficult Problem** | 3.62 | 3.36 | 0.26 | 0.1020 | |
| **Unexpected Events** | 3.10 | 2.91 | 0.18 | 0.3193 | |
| **Unforeseen Situation** | 2.90 | 2.76 | 0.15 | 0.3926 | |
| **Solution Finding** | 3.29 | 3.18 | 0.11 | 0.4644 | |
| **Effort Investment** | 2.71 | 2.71 | 0.00 | 0.9883 | |
| **GSE Score** | 42.94 | 41.78 | 45.43 | 0.0386 | * p<0.05 |

It remains unknown whether the education level has any effect on individual's self-efficacy. The data was analyzed by experimental subjects' education level and the questions were ranked by the difference of averages. In the present study the education level is classified as master and PhD degree. As shown in Figure 5-9, PhD graduates earned higher GSE score in overall average than master graduates. PhD graduates earn higher score in every question as well as the sum than master graduates. In particular, PhD graduates got higher score on copies abilities, opposition situation and goal accomplish than master graduates with significant difference. Comparing with master graduates, PhD graduates are educated and trained more rigidly and systematically to gain professionals and visions. A qualified PhD graduate is expected to judge professional issues independently and manage a research project independently. In general, PhD graduates

are more experienced in regard of profession. It is reasonable that PhD graduates are more confident with their own capability and knowledge and therefore earn higher scores in GSE.

**Figure 5-10 Influence of education level on the sources of self-efficacy (PhD vs. Master)**

| | PhD (N=21) | Master (N=45) | Average score of PhD - Average score of Master | | |
|---|---|---|---|---|---|
| | Average | Average | Difference | p-value | t- test |
| **Vicarious Experience** | 3.48 | 3.11 | 0.37 | 0.0491 | * p<0.05 |
| **Mastery Experience** | 3.05 | 2.93 | 0.11 | 0.4742 | |
| **Somatic and Emotional States** | 3.29 | 3.20 | 0.09 | 0.6078 | |
| **Social Persuasion** | 2.90 | 2.84 | 0.06 | 0.7503 | |

In last paragraph the effects of educational level on individual's self-efficacy is demonstrated. It is interesting to elucidate whether the education level also has effect on the sources of self-efficacy. The educational level of original population of experimental subjects was intentionally set as master and PhD to reflect the real status of high-end manpower in bio-related fields in Taiwan. The data was grouped by experimental subjects' education level as master and PhD degree and the questions of each source of self-efficacy were ranked by the difference of averages. As shown in Figure 5-10, PhD graduates earned higher score than master graduates on every question of each source yet significant difference of p-value less than 0.05 was only obtained in the question of vicarious experience. Although PhD selected higher score than masters on every source of self-efficacy, it is relatively certain that vicarious experience is influenced by educational level of master and PhD degree.

5.2.6 Gender

**Figure 5-11 Influence of gender on GSE (Female vs. Male)**

| | Female (N=33) | Male (N=33) | Average score of Female - Average score of Male | | |
|---|---|---|---|---|---|
| | Average | Average | Difference | p-value | t- test |
| **Handling Capabilities** | 3.18 | 2.67 | 0.52 | 0.0056 | ** p<0.01 |
| **Effort Investment** | 2.88 | 2.55 | 0.33 | 0.1395 | |
| **Solution Resolution** | 3.18 | 2.91 | 0.27 | 0.1521 | |
| **Goal Accomplish** | 3.21 | 2.97 | 0.24 | 0.1186 | |
| **Difficult Problem** | 3.55 | 3.33 | 0.21 | 0.3038 | |
| **Unforeseen Situation** | 2.88 | 2.73 | 0.15 | 0.4987 | |
| **Solution Finding** | 3.27 | 3.15 | 0.12 | 0.4691 | |
| **Unexpected Events** | 3.03 | 2.91 | 0.12 | 0.4560 | |
| **Opposition Situation** | 3.24 | 3.15 | 0.09 | 0.6579 | |
| **Coping Abilities** | 3.21 | 3.15 | 0.06 | 0.8009 | |
| **GSE Score** | 31.64 | 29.52 | 2.12 | 0.0820 | |

It is unclear whether the gender factor has any effect on GSE of people of bio-related fields in Taiwan. The original result of GSE was further analyzed by experimental subjects' genders and questions were ranked by the difference of averages. As shown in Figure 5-11, females working in bio-related fields earn higher score than males on every question by the rank of handling capabilities, efforts investment, solution resolution, goal accomplish, difficult problems, unforeseen situation, solution finding, unexpected events, opposition situations and coping abilities as well as the sum. However, the significant difference of p-value less than 0.01 was only observed in the question of finding capabilities. For the rest nine questions of GSE than males, no significant difference was observed. The result indicates that, for people of bio-related fields in Taiwan, gender is not a considerable factor for their perception of self-efficacy.

**Figure 5-12 Influence of gender on the sources of self-efficacy (Female vs. Male)**

| | Female (N=33) | Male (N=33) | Average score of Female - Average score of Male | | |
|---|---|---|---|---|---|
| | Average | Average | Difference | p-value | t- test |
| **Social Persuasion** | 3.00 | 2.73 | 0.27 | 0.3464 | |
| **Vicarious Experience** | 3.33 | 3.12 | 0.21 | 0.2827 | |
| **Somatic and Emotional States** | 3.24 | 3.21 | 0.03 | 0.9854 | |
| **Mastery Experience** | 2.97 | 2.97 | 0.00 | 0.7070 | |

The effects of the gender factor on the sources of self-efficacy are unclear. As mentioned in the last paragraph that gender is not a considerable factor for individual's perception of self-efficacy in bio-related fields in Taiwan, it is interesting to reveal whether gender factor has any influence on the four sources of self-efficacy. The data was grouped by experimental subjects' gender and the questions of sources of self-efficacy were ranked by the difference of averages. As shown in Figure 5-12, females selected higher scores than males on social persuasion, vicarious experience as well as somatic and emotional states. However, no significant difference was found in these three sources. In the question of mastery experience, females and males earned equal scores. The result here suggests that, for people of bio-related fields in Taiwan, gender is not a considerable factor for their perception of the sources of self-efficacy.

By analyzing GSE and the four sources of self-efficacy with gender factor, it is obviously and conclusively that, for people work in the bio-related fields in Taiwan, gender is not a factor to affect their perception of self-efficacy or the four sources of self-efficacy. The bio-related field in Taiwan appears to be a platform that provides equal opportunities and atmosphere for both male and female.

# CHAPTER 6. DISCUSSION AND CONCLUSION

## 6.1 DISCUSSIONS

In this study, postgraduates in bio-related fields in Taiwan were surveyed for GSE scale and four sources of self-efficacy. The experimental results were analyzed with factors of career category, gender, educational degree level and where they obtain graduate degree. The strong correlation between GSE and sources of self-efficacy for people in bio-related field is confirmed as the known Bandura's theory. The result also confirmed the importance of sources of self-efficacy could be evaluated by GSE.

### 6.1.1 Countries of highest degree obtained

By analyzing sources of self-efficacy with the country where people got their graduate degree, interestingly, source of social persuasion and source of mastery experience are two main factors for people studied in the US. The result dissected by the country where people earn their graduate degree strongly indicates that education system and spirit has great influence on students' self-efficacy. In general, students with independent thinking and working are more encouraged and appreciated in graduate education system in the US. In contrast, graduate students in Taiwan are asked to obey regulations and have less room for error due to limited resources as well as conservative atmosphere. Students of Taiwan system also have less opportunity to conduct creative or risky projects. Therefore, graduate students in Taiwan are often well trained with experimental skills but less confident with their own thinking, capability and achievements. How might culture influence various

sources of self-efficacy believe was discussed by Oettingen (1993). Cross-cultural research on self-efficacy beliefs reveals how efficacy beliefs start under different social and institutional circumstances. Mau (2000) also indicated that culture differences might influence career decision-making and self-efficacy. In Mau's study, Taiwanese students scored significantly lower on the decision-making self-efficacy measure than did American students. The collective-oriented culture may influence Taiwanese students to rely less on individual abilities than on group efforts. In contrast, the rational decision-making style of Taiwanese students is more predictive of their self-efficacy belief. As for American students, more independent the person was in career decision making, the more confident he or she was in making career decisions. In addition, Lin (2002) indicated that culture would influence preservice teachers' efficacy belief. In general, the US preservice teachers have higher efficacy beliefs than Taiwanese preservice teachers, no matter the investigation was done at the beginning or at the end of their programs. It is thought that the US culture tends to emphasize the importance of the individual. In my study, the cultural and educational differences on self-efficacy in bio-related field are observed. Many case studies all show that culture would affect self-efficacy. Actually, most of students receive their undergraduate education in Taiwan and only encountered American systems including culture, education, on-/off-campus life and extracurricular activities during their 2-to-7-year graduate study. Based on the result of the present study, interestingly, subjects with US-postgraduate degrees do exhibit great difference from those having graduate degrees in Taiwan in the aspect of self-efficacy. If capable, Taiwanese' parents believe that having US-education equals to international competitiveness and would send their children to the US for highest degree. This is the trend of education in Taiwan. Being in employers' shoes,

people who earn their highest degree in the US are more confident in their own capability, could handle business with various visions, and are with more mature and stable personality.

### 6.1.2 Working category

My result suggested that the sources of social persuasion such as evaluation and appreciation from others might influence peoples' career decision in bio-related fields. People having positions in industry must be more competitive than those who stay in academics since job demand is much limited in industry than in academics in Taiwan. On the other hand, high-end manpower, especially for PhD graduates who received research-oriented training during their graduate study, must to learn complicate knowledge and skills such as management, finance, business and politics to survive when working in industry. Therefore, industry people are much more confident on their own perception and capability due to diverse knowledge, skills and experiences than academic people who basically do research only. Career decision making and career indecision have received a great attention in career literature over years (Hackett, 1991) and several factors for effective career decision making have been identified as goal selection, career exploration, problem-solving capabilities, planning skills, and realistic self-appraisal skills (Crites, 1981).

Based on opinions of random-selected people on the result of the present survey, ones choice for career path in bio-fields could be affected by many factors, ranging from international and society trends to consideration of family and friend. Most people with bio-background in Taiwan prefer jobs in industry where they earn more money. In contrast, jobs in academics, mostly are basic research-related, are boring and routine. The

knowledge and skill people nurtured in academia may be cutting-edged and frontier but less applicable, thus their skill and knowledge have less chance to apply in industry for economic value. Therefore people in academic are less competitive than those working in industry in business perspective, given the fact that both have diffident objectives. On the other hands, many biotech companies funded in Taiwan are relatively young and small size and their finance is in the infant stage thus these young biotech companies are unstable and financially fragile. Large-size biotech companies or pharmaceutical companies may have stable finance and business, yet the job positions in these large-size companies are limited and competitive. Therefore, people who are able to work in the large-size and mature bio-tech/pharmaceutical companies are usually recognize their own capabilities and advantages and show higher self-efficacy. The idea that recruiting people with established career and experience in industry should be taken in consideration since people from industry are with higher competitiveness, capability and self-efficacy.

### 6.1.3 Education level

My result showed that sources of vicarious experience might affect education levels as master and PhD degree. A qualified PhD graduates are more educated and trained that they are expected to judge professional issues independently with higher vision and manage a project independently. The higher scores of GSE of PhD graduates thus reflected their confidence in ability and knowledge. Perceived academic self-efficacy is defined as personal judgments of one's capabilities to organize and execute courses of action to attain educational performance (Bandura, 1977; Schunk, 1989). Zimmerman (1989) summarized roles of perceived academic efficacy in different academic functioning-the level of

motivation affective reactions, the performance achievements, and individuals' ability in regulating their own learning. In 1996, Melchert suggested that educational level (first year of master program, second year of master program, third to sixth year of doctoral program, and psychologist) significantly affects self-efficacy by Counselor self-efficacy scale. Higher the educational level is, higher the self-efficacy scores. Interestingly, Melchert's study showed that the level of training accounted for slightly more of the variance in GSE scores than amount of clinical experience, suggesting that the academic training of doctoral programs in applied psychology increases professional self-efficacy and competence that cannot be obtained by additional clinical experience with bachelor's or master's level training. Thus, what individuals could learn is proportional to their education degree. More time spending on education, more professional knowledge and experience they could learn. Different extent of knowledge and experience would further influence self-efficacy. From employers' point of view, in bio-related field people received higher education or advanced degree have better visions, thoughts as well as ability than those with regular degree. In general, having employee with high degree could benefit companies.

### 6.1.4 Gender

Gender has no significant effects on four sources of self-efficacy in bio-related fields. Interestingly, the data analyzed by gender slightly indicates that females in bio-related fields are more confident to themselves than males in thinking and handling issues than males do yet such an indication is not solid. Unlike other careers that gender greatly affects individuals' self-efficacy (e.g. males of mechanics or females of cosmetician), gender is a

minor factor of self-efficacy of people in bio-related fields. In fact, applications of Banduras' self-efficacy theory (1977, 1986) on career development originated in the research about women's career development. It has been a concern of researchers of the problem of underutilization of women's talents and abilities in career and underrepresentation of women in higher positions and occupations that are usually male-dominated (Betz & Fitzgerald, 1987). In 1981, Hackett and Betz suggested that career efficacy beliefs play a more significant role than interests, values, and abilities in women's career choice. In 2000, Zeldin and Pajares studied personal stories of women who worked in areas of mathematics, science, and technology to understand the ways their self-efficacy beliefs influenced their academic and career choices. In their study, women have to develop the unnecessary competence and skills to succeed in their positions. It seems that proper self-efficacy beliefs make women to develop and maintain their position and confidence in male-dominated area. Career women nowadays earn more and more opportunities that men have already had. They are believed to perform as competent as men in their specific area. Particularly in bio-related fields, females exhibit equal self-efficacy to men. It is believed that gender would not be a specific issue in bio-related fields that both females and males have similar self-efficacy believes. Thus, gender is not an issue for human resource to concern when recruiting employees in bio-related fields in Taiwan.

## 6.2 CONCLUSION

Self-efficacy that has been defined as the belief that one's capability in attaining certain goals in a certain manner and is the basic factor influencing motivations and achievements of individuals in almost every aspect. Self-efficacy was first described by

Bandura's social cognitive theory that emphasizes the role of observational learning and social experience in the development of personality. Self-efficacy is influenced by external experiences, self-perception, and the outcome of many events. On the other hand, Bandura (1995) described four sources: mastery experience, vicarious experience, social persuasion, and somatic and emotional states that directly affect the development of self-efficacy.

In the present study, I aimed to explore the perceptions of self-efficacy as well as the four sources of self-efficacy held by high-end manpower, mainly PhD and master, in Research and Development (R&D) laboratories in bio-related fields in Taiwan. The study was conducted in the form of survey containing ten questions of general self-efficacy (GSE) and four questions corresponding to four sources of self-efficacy, respectively. The recovered survey was further analyzed by country of highest degree obtained (US vs. Taiwan), career category (industry vs. academics), education level (master vs. PhD) and gender (female vs. male).

According to the result from sixty-six subjects, the correlation between self-efficacy and the four sources was confirmed. The result also showed that self-efficacy, as well as the four sources of self-efficacy of people of bio-fields in Taiwan, are tended to be affected by career category, educational levels, and the place of education. People who work in industry who have PhD degree or earn their graduate degree in the US exert higher extent in self-efficacy. On the contrary, gender issue had no effects on self-efficacy or on the sources of self-efficacy of people in bio-related fields in Taiwan.

The information derived from this study may be useful for academia and industry of bio-related field when they make plans for high-end manpower recruitment, training, or any other HR arrangement. Academic institutes are the place for advanced and basic

research as well as the incubator of high-end manpower. The high-end manpower these academic institutes produce are supposed to be the backbone for both academic and industry in Taiwan. However, people graduated from academic institutes in Taiwan generally exert low self-efficacy than those who have graduate degree in the US. In general, students trained in Taiwan institutes have good research skills and logics that enable them to be globally competitive. As high self-efficacy usually results in good career performance, it is worthwhile that the institutes and mentors of graduate students should deliver positive messages to encourage students to be more faithful to their own capabilities. On the other hand, the government of Taiwan should design and provide a better policy and plan to help people transit from academics to industry. Courses on business model, finance or marketing may benefit academic people to realize business and therefore enhance their self-efficacy when start their industry career. It is nice to know that, from my survey, gender is not a concern in bio-related field in Taiwan. The opportunities being provided and the atmosphere being established in the work environment in Taiwan for females appear to be fair. Working females in Taiwan exhibit their ability and to compete with male fairly. Academic institutes and industry of bio-related fields in Taiwan should keep this philosophy and trend, as I believe this phenomenon can constantly benefit the development of bio-related fields in Taiwan.

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