ENHANCING THAILAND'S INTERNATIONAL COMPETITIVENESS THROUGH WOMEN'S ENROLMENT IN TECHNICAL FIELDS IN TERTIARY EDUCATION

by

KEIRA RAPSON
H. Bachelor of Arts, McMaster University 2007

MAJOR PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF INTERNATIONAL DEVELOPMENT

In the
International Studies Department

SIMON FRASER UNIVERSITY
Summer 2010

APPROVAL

Name: **Keira Rapson**

Degree: **Master of Arts in International Studies**

Title of Research Project: **Enhancing Thailand's International Competitiveness through Women's Enrolment in Technical Fields in Tertiary Education**

Supervisory Committee:

Chair: **Dr. John Harriss**
Professor of International Studies

Michael Howard
Senior Supervisor
Professor of International Studies

John Harriss
Supervisor
Professor of International Studies

Date Approved: August 16, 2010

Declaration of
Partial Copyright Licence

ABSTRACT

Women's low enrolment in technical fields in tertiary education is a worldwide phenomenon that has been identified as an area of concern for women's equality. While this concern is substantial, a much greater concern for women's low enrolment in technical fields is how their absence can affect a developing country.

The purpose of this paper is to explore the role of women in technical fields on development. This paper hypothesizes that women represent a distinctive body of labour in technical fields as a result of their unique ideas and contributions. Their absence in these fields can have negative consequences on societies and countries in that, if women pursued more technology-based educations, they could greatly influence the creative and productive capacity of a country in relation to international competitiveness.

By examining the country of Thailand and its current development struggles, this paper identifies the value of women in technical fields and on developing countries.

Keywords: Women; technology; Thailand; tertiary education; competitiveness; innovation; knowledge- economy.

DEDICATION

To my family, for their unwavering support and love.

To my friends in IS who made this year much more than a degree.

ACKNOWLEDGEMENTS

Thank you to those who have supported and encouraged me, especially in my intellectual endeavours and this work, in particular. To Michael Howard and Allan MacKinnon whose guidance I could not have done without.

TABLE OF CONTENTS

LIST OF FIGURES

GLOSSARY

ADB	Asian Development Bank
AIT	Asian Institute of Technology
APEC	Asian Pacific Economic Conference
ATSI	Association of Thailand Software Industry
GED	Global Education Digest
GDP	Gross Domestic Product
ICT	Information Communication Technology
IT	Information Technology
IMD	Institute for Management Development

MOE	Ministry of Education
NECTEC	National Electronics and Computer Technology Centre
NITCS	National Information Technology Committee Secretariat
NSO	National Statistics Office
NSTDA	National Science and Technology Development Agency
OECD	Organization of Economic Cooperation and Development
PDCC	Partnership for Development Country Context
R&D	Research and Development
SEA	Southeast Asia
SERD	School of Resources and Development
SET	School of Engineering and

	Technology
UNDP	United Nations Development Program
UNESCO	United Nations Educations, Statistics and Culture Office
US	United States
WBG	World Bank Group

Introduction

Over the past few decades, globalization has increased dramatically and resulted in new ways of thinking, communicating, and developing. Globalization refers to the process by which economic, financial, technical, and cultural interactions become increasingly interconnected (Alav and Entwisle, 2002: 304). It has changed our access to products, while simultaneously changing and creating a vast international market, made up of countless consumers and producers. Success in this international market has increasingly been based on a country's' ability to be competitive in distinct areas such as technology and education (UNESCO, 2009b). As the world becomes continues along this trajectory, both countries and people must adapt to become and remain successful players in the international market.

The era of globalization is characterized by breakthroughs in technology, making it necessary for developing countries to adopt high-skilled technologies such as genetic engineering, microelectronics, data processing, and telecommunications (National Report, 2004). The information technology (IT) and information computer technology (ICT) revolution have given rise to a new global economy by promoting greater access to more information about products, which has lead to increased consumer choices (Park, 2005:317). As a result, markets are becoming more competitive. These competitive markets demand a much higher degree of learned skill and knowledge. Thus, the education attained by a population plays a large part in determining the competitiveness of the country.

Developing countries tend to lack an edge in the international market because they have not been able to make comparable investments into technology and have therefore not been able to take advantage of current trends in globalization (Gender Working Group, 1995: 2). Consequently, these countries may become progressively more marginalized. While there are many different components to countries development in the global economy, education, specifically in technical fields, remains a focal point. Thailand is one such country where both education and technology are important aspects of current development plans and strategies.

Despite years of national development plans and technology planning, Thailand has made little progress in advancing its technical capacity in a manner that will further its industry growth. The United States State Department (2010) documented Thailand's shortage of engineers and skilled technical personnel as a limitation to Thailand's future technological creativity and productivity, and therefore its competitiveness. However, the primary challenge facing Thailand's ability to compete in a global market is their lack of a highly skilled workforce. Thailand has long struggled with national labour shortages and has a history of taking workers from abroad. The number of foreign workers has been increasing over the past twenty years and is expected to continue (UNESCO, 1995b). While Thailand continues to import workers, it is overlooking one very important resource: women. Women constitute an important and underutilized labour resource in the field of technology. Around the world, they account for only 20% of the technology labour force (Wentling, Rose, and Thomas, 2004). Their

enrolment in technical fields, and in related technical areas remain drastically low despite the recent influx of women into tertiary education. As Thailand struggles to gain an edge in the global market, women offer a potential solution to filling the labour gap and making the country more able to compete in the global market.

This paper seeks to explore the role that technology, education, and women have in advancing development, in a multitude of ways. Firstly, technology will be examined as a means to spurring growth. Secondly, education will be analysed as a component of human capital. Thirdly, women as caregivers and familial role models will be looked at. Lastly, women and their role in technology will be studied. Together, these areas will provide a foundation for analysing the current education trends and labour shortages in Thailand. For the purposes of this paper, Thailand is presented as a case study of women in technology and their impact on development. This section will encompass both an in depth look at Thailand, and one of its premier university education facilities: The Asian Institute of Technology (AIT).

This paper hypothesizes that women represent a distinctive body of labour in technical fields as a result of their unique ideas and contributions. Their absence in these fields can have negative consequences on societies and countries in that, if women pursued more technology-based educations, they could greatly influence the creative and productive capacity of a country in relation to international competitiveness. If all the creativity and innovation of women in the world could be accessed and they could be empowered with the tools and the energy they needed to compete, connect, and collaborate, it would

lead to an explosion of innovation-in science and technology, arts and literature-the likes of which the world has never seen (Friedman, 2009: 205). In other words, women represent one of the most underutilized groups in developing countries. The unique perspectives, skill-sets, creativity, and knowledge bases women can offer to a particular field can lead to greater inventions and technological advancements. An increase of women in technical fields in tertiary education in Thailand can therefore provide Thailand with the competitiveness it requires for the global market.

1: LITERATURE REVIEW

1.1 Technology

Technology is a collection of physical processes that transform inputs into outputs and knowledge, as well as skills that structure the activities involved in carrying out these transformations (Chu and Hill, 2006: 6). Technology encompasses such areas as engineering, information technology, information computer technology, and manufacturing. It plays a central role in the development process, which can best be demonstrated in the Solow model.

The Solow model in development establishes the idea that technology can be used to deter diminishing returns (the problem in which the supply of labour does not grow as fast as the capital input, therefore the resulting output erodes over time). The Solow model sees the capital output of a country as being endogenous; meaning that a country's ability to expand its output in relation to its capital is determined by the internal factors of the country. As diminishing returns erode capital stock, countries must seek new ways to increase their supply of labour. Technology and technical innovation can enhance labour, making capital output more effective. The Solow model claims that in the absence of technical innovation, a country cannot indefinitely sustain a growth of per capita income. The conclusions of this approach to development indicate a need, not only for countries to embrace technology but also for them to establish a continuous

relationship with technology that allows for the constant expansion of technical capacity. Solow saw technology as the key to a country's growth overtime. Today, Solow's ideas are both valued and critiqued. Like most development panaceas, while important and necessary, technology alone is not sufficient for a country's continued growth (Easterly, 2001). Technology is only one aspect of a country's success in development and economic growth, and it must be combined with other modes of capital in order to maximize its effectiveness.

Despite doubts about the ability of technology to further a country's development, a significant amount of literature communicates the idea that technology is inherently linked to a country's competitiveness in the international market. Aguel, Idialu, and Aluede (2008) argue that the role of technology in the development of a nation cannot be overemphasized, and that it is essential to harnessing the potential of a nation. In essence, technology acts as one possible vehicle in transforming a nation.

As competition in the world changes overtime, it is greatly affected by cost, innovation, and speed (Suh and Chen, 2007: 2). Competitiveness in relation to technology and the international market is based on two main components: innovation, and research and development (R&D) expenditures and outputs (Mathews and Hu, 2007: 1007). Innovation is defined as the introduction of new or improved products, production techniques, and organizational structures as well as the discovery of new markets and the use of new input factors (Balzat, 2002: 4). Similarly, Furman, Porter, and Stern (2001) describe national innovative capacity (NIC) as the ability of a country as an economic and political entity, to

produce and commercialize a flow of new-to-the-world technologies over the long-term. Therefore, a country that is to be innovative also needs to be one of constant learning and evolution.

There are three building blocks necessary for NIC: 1) The presence of a strong, common innovative infrastructure including organizations and higher education for new ideas to be developed; 2) specific innovative environments found in industrial clusters; and 3) strong linkages between industrial clusters and innovative infrastructure (Furman, Porter, and Stern, 2001: 2). According to these three blocks, countries need to actively create the environment for NIC and take steps in supporting that environment. Together, these foundational blocks contribute to a country's ability to innovate.

The most effective way of measuring a country's innovative capacity is through patents. Patents describe the declaration of a government concerning the rights of an invention and their attribution to a certain individual. As a result, the granting of patents in a country is a reflection of new inventions and ideas. The range of possible inventions includes much more than technology-inclusive items; nevertheless, technology is a key factor in what people invent and how they invent it.

R&D expenditures and outputs can be partly attributed to universities and the role they play in educating and in generating knowledge, they are also related to other organizations that support technological capacity (Mathews and Hu, 2007: 1012). Both universities and public and private organizations contribute to the R&D outcomes. The technology that is taught and developed in universities

creates the foundation of R&D in a country. Countries with more R&D expenditures have been seen to be more competitive, as they develop more inventions and innovative capacity. R&D professionals, essentially, have become one of the most critical drivers in the economy of rapid technological change (Mathews and Hu, 2007: 1018).

In East Asian countries specifically, R&D expenditures have emerged as an important indicator of a country's overall economic competitiveness (Mathews and Hu, 2007:1055). This is demonstrated most predominately in the countries of South Korea (Korea) and Taiwan. Each of these countries has obtained substantial amounts of economic growth and have become leaders in technology-driven industries (Suh and Chen, 2007: V). Koreas' use of technology and knowledge accumulation allowed it to boost its innovation through intensive R&D by increasing funding and enhancing its university systems (Keller and Samuels, 2003: 87). It has since experienced sustained economic growth for more than four decades and this growth can be attributed to its ability to harness technology. In Taiwan, universities also contributed to an increase in innovation and R&D. Universities were used as a source of knowledge flows and as a way for knowledge diffusion. Their open-ended approaches to technology development were of great importance for economic growth. These National Innovative Systems (NIS) deal with the organizations of innovation; such as the education system, and work in conjunction with other organizations to produce technological performance. In turn, NIS is an important determinant of a country's economic performance. This can be seen in Figure 1.

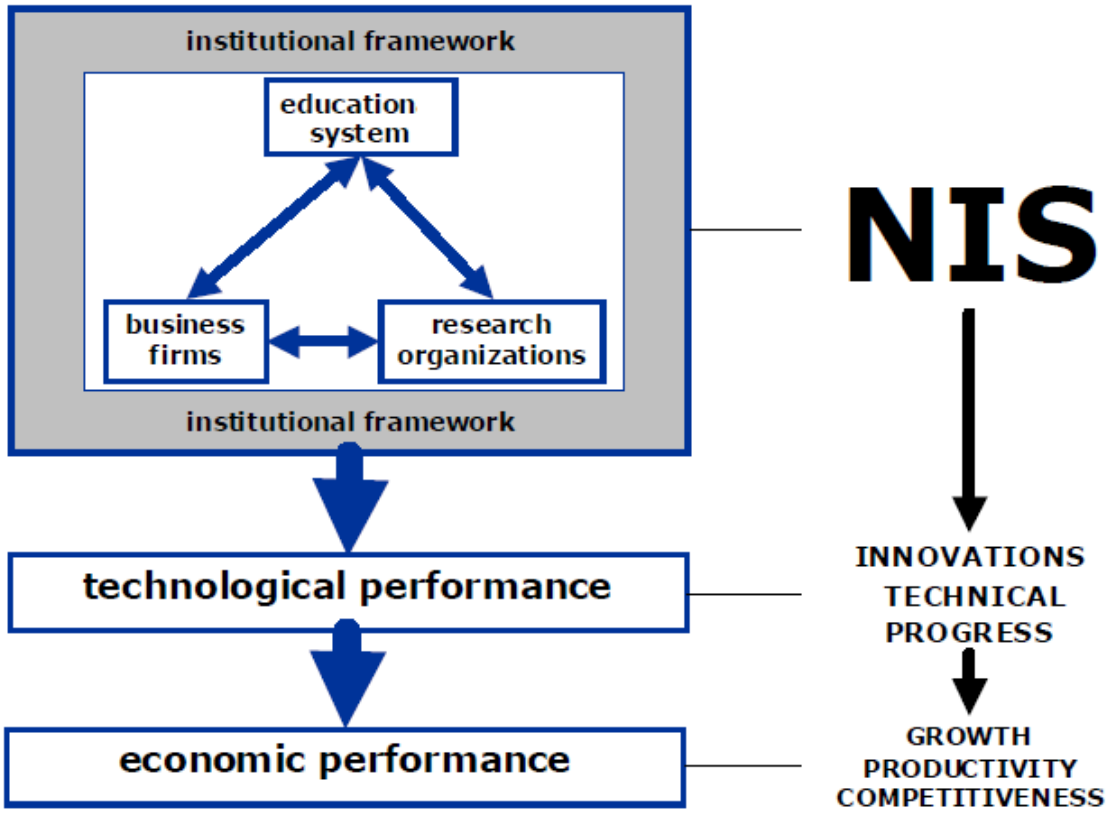

Figure 1: National Innovation System. Source: Balzat (2002)

1.2 Education

As has been demonstrated in Korea and Taiwan, it is not just technology that can further a country in development but rather a combination of technology with education that truly helps in the development process. Technology can improve a country's well-being and make them more competitive overall, but in

order for this to occur, technology must first be transferred to the people of a country; education is the most effective way of doing this.

Plainly stated, education is an important aspect of development for any country. Usually, when we think about education to aid a country we are implying the importance of human capital. Human capital is the term used to describe the value of human labour. It implies that a labour force that is skilled, can operate sophisticated machinery, and can communicate new ideas and methods. Human capital theory (HCT) states that developing countries are likely to have low-skilled labour and therefore a shortage of high-skilled labour. The best way for a country to increase its skilled labour force is through education because it serves to expand their stock of human capital. As a result, perpetual growth is made possible. Essentially, this theory is an extension of the Solow model since it allows people to save and gain in human capital.

Much of the literature on education and development revolves around primary or secondary education. These levels of education are usually deemed to be the most important as they transfer basic skills such as reading and writing. Easterly (2001) finds that while education is normally correlated with growth, it only does so at lower levels of education. At higher levels (tertiary education), education has more diminishing returns. Higher-skills are viewed as productive only if they are matched with high-tech machinery, adaptation of advanced technology, and other investments (Easterly, 2001: 84). However, tertiary education holds a significant amount of importance for countries that occupy mid-range levels of gross domestic product (GDP) and have established intermediate

levels of infrastructure and establishments (such as Thailand). The reason tertiary education is important is due to its association with a country's labour force. Tertiary education represents the highest and most sophisticated level of education, and often involves training for specific jobs. The role of tertiary education is increasingly being recognized for the higher-level skills and competencies it offers that are necessary for national development (UNESCO, 2009c). This is especially true in the context of globalization and the shifting trend towards knowledge economies.

As more countries have adopted knowledge economies, the need for higher-skilled labour has increased. A knowledge economy is one that uses knowledge as the key engine of economic growth (Suh and Chen, 2007: 3). Knowledge is acquired, created, disseminated, and used to enhance economic growth. For a country to adopt a knowledge economy, four main pillars must be established. These include:

1) Economic incentive and an institutional regime that provides good economic policies and institutions

2) An educated and skilled labour force that continuously upgrades and adapts skills to efficiently create and use knowledge

3) An effective innovation system of firms, research centres, and universities that keep up with knowledge and assimilates and adapts new knowledge to local needs

4) A modern and adequate information infrastructure that facilitates the effective communication, dissemination and processing of information and knowledge (Suh and Chen, 2007: 4).

Education is therefore a central component in creating a knowledge economy, as well as the establishment of high-quality universities that consistently improve their organization to meet market needs.

Education has a strong effect on innovative capacity (Suarez-Villa and Hasnath, 1993: 350). Without a skilled labour force, a country cannot take advantage of its opportunities in the global market and in the local market. This becomes particularly important when we look at who is educated in a country. In many societies around the world, women are less educated or receive less education than men (World Bank, 2008). This trend has developed from traditional roles in societies and has recently begun a slow change towards equality. UNESCO's world conference on higher education ended with an appeal for investment and cooperation in higher education for all, stating: "At no time in history has it been more important to invest in higher education as a major force in building an inclusive and diverse knowledge society and to advance research, innovation, and creativity" (UNESCO, 2009b). Women, being a well-documented, under-utilized group, therefore have great potential in furthering a country.

1.3 Women

Enrolment in tertiary education throughout the world has increased dramatically over the last ten years. The worldwide demand for tertiary education

has gone from 100 million students in 2000 to 152 million in 2007 (UNESCO, 2009c). This growth has been particularly strong among women. Women now outnumber men in graduation in 75 of 98 countries, and account for approximately 65% of graduates (UNESCO, 2009c). The influx of women into higher education generally translates into improvement in the social and economic position of women in society, and extends to other generations through women's influence on children. King and Hill (1993) find that educating women yields far-reaching benefits for girls and women themselves, their families, and the societies in which they live. Since the impact of educating women spans generations, making an investment in women's education is the highest-return investment available in the developing world (King and Hill, 1993: 27).

Given women's traditional role as caregiver in the family, they contribute directly to what children learn by transferring knowledge to children, thereby increasing a child's future opportunities. Furthermore, the education that a woman gains often leads to better life skills such as proper nutrition and childcare. This in turn can reduce the mortality rates of children and provide great social benefits (Sen, 1999: 195). These benefits can include greater equality, social justice, and social services. Sen (1999) also notes that women's involvement in gainful employment has many positive effects on women's agency roles, meaning that they are able to assert their roles as leaders in the home and community more effectively. As such, educated women are better able to exercise their rights and responsibilities in society, which has a direct impact on the overall equality of a society.

When we examine poverty in the world, it is important to note that women occupy a large proportion of the poor. Of the world's 1.3 billion poor, it is estimated that nearly 70% are women (Aguele, Idialu, and Aluede, 2008). Women's position in the poor remains depressing as they occupy a large number of the illiterate, malnourished, and unacknowledged. Women in developing countries are much more likely to suffer these fates than those in developed countries as a result of their unequal social standing. The increasing poverty of women has been directly linked to their unequal situation in the labour market and their status in familial power (Aguele, Idialu, and Aluede, 2008: 123). In developing countries, women occupy only 31% of the official labour force, while in developed countries they occupy 47% (UNESCO, Women at a Glance, 1997). With this clear disadvantage in the labour market, the value of education and skill sets becomes ever more obvious in enhancing women's position in the labour market.

The influence of an educated woman on a society and country is vast. When it comes to developing a nation, the importance of a woman's education should not be overlooked. In conjunction with a basic education, the effects of a specific and technically oriented education are far-reaching.

1.3.1 Women and Technical Fields

The absence of women in technical fields has been observed for many years in many different countries around the world, including some of the most technologically advanced countries. The OECD (2007b) observed that while

women obtain more than half of all university degrees, they obtain less than 30% of university degrees awarded in science and technology. More specifically, women accounted for only 14% of engineering degrees (OECD, 2007b). When we look at a country like the United States, a country that is the most innovative based on patent licences; it is hard to see them as being technologically deficient. Nevertheless, while women in the United States occupy 50% of the workforce, they only account for 20% of the technology sector workforce (Wentling, Rose, and Steven 2004: 90). If the United States is competitive and innovative, women's low participation may not be seen to have a large impact, but a closer look at the United States job market exposes a shortage in their IT workforce. In 2004, the Information technology Association of America found that there was a shortage of more than 190,000 workers for the IT field (Wentling, Rose, and Steven 2004: 91). Essentially, the demand for IT workers now exceeds the production of IT talent in universities.

Women's participation in education has largely been focused in traditional fields such as humanities, social sciences, and law. There has been an influx of women into the fields of business, medicine, and science but little increase in women's enrolment for fields like engineering, IT, and ICT (UNESCO, 2009c). The entry of women into new, or previously male-dominated fields, holds significant potential, especially with regard to innovation. The best example of women receiving education in non-traditional fields and essentially changing the field is medicine. Before women became important players in medicine, the information known about the human body was limited to men, which had an

impact on diagnoses and cures for women. Today, with more women in medicine, the world knowledge about women, health, and life for half the world population has dramatically changed the way people live and the way practitioners treat women. The inclusion of women in technology holds the same potential for development that medicine did when medical knowledge expanded to include the other half of the population. The presence of half the population is limited in the field of technology and increasing women in technical fields can open up a world of knowledge and ways of doing things never seen before.

The overall benefits of women in education are felt by society at large, however, a substantial amount of benefits are overlooked when women do not enrol in technical fields. Cohoon and Aspray (2006) identify four reasons why increasing women's enrolment in technical fields is important:

1) A larger labour pool will be available to society, filling the IT labour shortage gaps.
2) IT conditions are favourable and pay well providing women with higher living standards.
3) A diverse workforce is highly valuable as it leads to a wider range of products and is more inclusive of the different needs of a society.
4) Computer skills are considered critical for future economies and future markets.

When women participate in technology and receive an education in technical fields, we see cascading benefits throughout society. Fully incorporating the contributions of women will tap an underutilized resource of

human capacity for the development of a national knowledge society (Huyer and Hafkin, 2007: 4). Not only will women enhance the labour pool of a country, but they will bring specific and diverse skills to the workforce. A study conducted by Catalyst (2004) looked at the impacts of gender in the workforce. Findings indicate that a gender-diversified workforce has better rates of return and overall success (Catalyst, 2004: 1). The finding that diversity and financial success are related is based on the attributes that women bring to the table. Women have a large influence on purchasing decisions, and as a result, women can design products that are more appealing to women consumers (Catalyst, 2004: 2). This implies that women, as designers in IT, can make markets both more vibrant and more lucrative.

The continuing underrepresentation of women in IT signifies a serious loss to the IT field, and is widely recognized as an issue of continuing importance (Cohoon and Aspray, 2006: 421). Causes of underrepresentation include the social construction of what has been regarded as appropriate work for women; an educational pipeline where women get stuck in one of several fields and; inequitable resources and opportunities offered to women compared to men in both education and employment (Sonnert, Fox, and Adkins, 2007: 1335). These causes dominate a large portion of the literature on women and technology. They are viewed as problematic and as such are followed by ways to bring about change. Understanding why women remain underrepresented in these fields is important, as well as understanding how more women in IT could have an impact on a country's economic performance.

Another plausible cause of this shortage stems from social constructivism. Social constructivism identifies this gender divide in technology as being a result of the social roles men and women take on. It is not a reflection of genetics but rather a reflection of society. This social shaping of technology has resulted in a masculine association of this field that excludes women, thus creating inequalities (Wentling, Rose, and Steven, 2004: 93). While the shortage of women in IT is widely studied, the role that women can play in IT is greatly understudied. As women's role in society changes, they are better able to escape from traditional stereotypes. However, it is not just about women escaping from gender stereotypes and bettering their lives, it is also about bettering whole countries. For instance, the shortage of technical workers in the United States has been estimated at costing as much as $4 billion a year in lost production (Wentling, Rose, and Steven, 2004: 91). Four billion may seem like a small portion of GDP for a large country like the United States, but for a smaller developing country, this could mean a substantial difference in living standards. If social and educational circumstances are more conducive to women's participation, they have the potential to bridge this gap (Cukier, Shortt and Devine, (2002).

Soft skills constitute an important aspect of technology and include content design, development, communications and interpersonal skills and project management (Cukier and Devine, 2002: 143). They can be identified as the more personable side of technology, dealing effectively with connecting technology to people. These skills are of particular interest when it comes to

technology because they offer support to a country's ability to be competitive. OECD (2006) recognizes that women bring different perspectives and research interests to the table, contributing to the improvement of technology R&D. A higher involvement of women in technology will also help to raise living conditions in a country as IT jobs are often well paid. Currently, with men predominately designing technology, women are excluded from products designed with men's needs in mind. An industry that is influenced by both male and female designs would be able to meet broad consumer needs by making technology more balanced and user-friendly (Cukier, Shortt, and Devine, 2002: 147). These friendlier products could in turn reduce business costs for tech support.

Another important aspect of women designing technology is that the technology will have the potential to connect more with young girls. When men design products and computer content, the content has a higher probability of excluding female preferences. When girls do not receive appropriate content this can deter their interest in technical fields, furthering the gender divide in technology. (Cohoon and Aspray, 2006: 410). An increase of women designers in technology has the potential to break the social shaping of technology.

Having more IT and engineering graduates in general, would enhance the availability of specific skills and knowledge deemed necessary for innovation and growth. Increasing the participation of women is a crucial step in both easing market issues and expanding access to a major growth area of the economy (Cohoon and Aspray, 2006: 421). National development, quite simply, needs to

involve more women, and the potential impacts of this increase in women's involvement will be examined in Thailand.

2: THAILAND

2.1 Southeast Asia

The region of Southeast Asia (SEA) represents a diverse and unique mix of countries and development strategies. East Asia in particular, is known for its 'development miracles' of Korea and Taiwan, while further south, Malaysia, Laos, and Thailand represent countries that have continuously struggled in developing.

Over the past decade, enrolment in tertiary education has increased drastically in the region, more so than any other area of the world (UNESCO, 2009c). UNESCO's (2009c) Global education digest notes that since 2000, the number of students in the region has raised an average of 10% a year. While still lower than enrolment rates in North America, these increased rates have indicated an important change in the way SEA is working to develop; investment in human capital.

Education is proving to be a successful way in which a country can make improvements in both its people and overall economic well-being. The push for education is a result of a change in the structure of economies in SEA. The Asian Pacific Economic Conference (APEC) in 2006 identified the 'new economy' to be one based on knowledge and investment in information and communications technology. Thought to provide sustained economic growth and development, this became the focus of many Asian economies. Many of these countries (most

notably Korea) have turned their industrial economies into knowledge economies. As previously noted, a knowledge economy uses knowledge as the primary driver of growth. Knowledge must be both harvested and harnessed successfully to become an effective driver of growth. Koreas' rapid advancement has become a role model for the underdeveloped countries of SEA.

2.2 Thailand: A Changing Country

The country of Thailand has seen both success and failure in development. In four decades, it has progressed from an agricultural economy to an industrial economy. Since the 1960's Thailand has progressed from an agriculture economy to an industrial economy (Chu and Hill, 2006). Over this time, it has had eight development plans focused on economic and social development. These plans included a strong emphasis on education and an initiative to change the direction of the Thai economy. In the 1960's agriculture accounted for more than 39% of the country's' GDP (Hawley, 2008). This focus on agriculture, while the predominant job source of the Thai people, was not an adequate industry to advance Thailand's economy and was not catalysing growth. This realization led to the pursuance of a new industrial economy. The next several decades in Thailand saw a dramatic change in agriculture and today it accounts for only 12% of the country's GDP (WBD, 2009).

As a result of this shift towards an industrial economy, the workforce also experienced a dramatic shift. The proportion of people employed outside agriculture increased while a much more complex skill set was required (Hawley,

2008). Industry and manufacturing now account for more than 45% of the country's GDP leading to a large demand for high-skilled workers (WBD, 2009).

Today, the country has a population of more than 67 million people, of which, more than 97% of the available workforce is employed (NSO, 2009). On average, when we consider economic indicators, a 5-7% unemployment rate is viewed as ideal for a country by allowing for mobility and choice among both workers and employers. Thailand's low unemployment rate therefore indicates both a constraint on the available workforce and a lack of available labour. Evidence of this is seen in Thailand's history of migration and employment. UNESCO (1995b) documented Thailand's large influx of workers from abroad to fill gaps in the labour force. Over the last twenty years, the country has seen the increasing trend of both legal and illegal workers entering the country from abroad (UNESCO, 1995b). Low unemployment rates and the large portion of migrant workers is a sign that the labour force in Thailand is not satisfactory for the development needs of the country. In fact, it was this shortage of skilled labour that resulted in the importing of necessary knowledge workers to compensate, in order to meet market demands (NITCS, 2003).

Thailand's change to an industrial economy saw an increase in GDP growth to an average of 9% during the 1980's and 1990's and an increase in trade exports (WBG, 2006b). These exports largely centred on small technology machines, rubber, refined fuel, circuits, and automobile parts (US State Department, 2010). This increasing diversity in products led to a large increase in

the county's growth in the early 1990's, however, the Asian financial crisis of 1997/98 ended the country's brief success with development.

The Asian financial crisis proved to be both a detrimental and enlightening experience for Thailand. The 97/98 crisis was a combination of a shortage of currency leading to a significant devaluation of the Thai Baht, the role of the IMF and inadequately developed financial sectors (WBG, 2009c). The results of the crisis were massive layoffs in different sectors and a halt to Thailand's growth success. In addition, a sharp fall in export competitiveness during the financial crisis essentially confirmed Thailand's need to move from traditional industries relying on low-cost labour, little capital, and simple technology, toward upgraded skills and a higher technological base (ADB, 1998). The shock of the crisis caused the Thai government to restructure itself and the economy. Once macroeconomic stability had been restored, the government embarked on a comprehensive structural reform program. This program focused on the financial, corporate, and social sectors of the country (WBG, 2006b). Of these reform programs, perhaps the most extensive was in education. The crisis prompted the urgent need to enhance the abilities of the Thai people in order to keep up with the rapid changes of globalization and be successful in what had proved to be an increasingly competitive and global world (MOE, 2004). Thailand was now working towards a different type of economy, one that was believed to be more sustainable in a global world: A knowledge economy.

2.3 Thailand as a Knowledge Economy

Thailand is striving to model Korea's knowledge economy. It is working to become the 'next Korea' in terms of technological advancement and development. Arkhom (2007) notes that in recent years Thailand's development paradigm has shifted. Its previous paradigm was centred on low labour costs and natural resources, while today it is centred on knowledge in conjunction with labour and natural resources. It is believed that this new paradigm will provide more sustainable and competitive development by continuously advancing the country's knowledge base (Arkhom, 2007:2).

In its attempt to become a knowledge economy, Thailand passed the National Education Act of 1999 followed by an amendment in 2002. This act outlines the importance of quality and rights to education that the Thai people have (National Education Commission, 1999). It clearly places education as an important issue in the country and enrolment in tertiary programs reflects this. Overall participation in tertiary education programs averaged 68% in 2006 for 18-21 year olds; women's participation was 75% for the 18-21 years of age population, while men's participation was 60% (UNESCO, 2008). Despite this enrolment success, participation has been uneven in certain fields. In a knowledge economy, certain fields are known to promote more growth than others. Emphasis has been placed on technical fields like engineering and IT to further the innovative capacity of a country.

Becoming a knowledge economy is not simple and it requires investments in education, incentives, innovative systems of organizations and an educated

and skilled labour force (Suh and Chen, 2007). Thailand has the incentive to become a knowledge economy as it realizes the increased need for skilled workers. It has a substantial system of higher education controlled by the Ministry of Education, which was revamped in 1999 with the Education Act to create a more cohesive organization and; it has a significant amount of students enrolled in tertiary education. However, the investment into education is severely lacking when compared to other Asian countries. Education spending makes up 3.9% of Thailand's GDP, of which, spending for tertiary education accounts for less than 18% (WBG, 2009a). Without a larger investment into education, Thailand will be unable to fully pursue a knowledge economy.

Knowledge economies are based on acquiring knowledge, however, their success is conditional on the type of knowledge acquired. If that knowledge cannot be transferred across countries and markets it will be of little use to the developing country. A knowledge economy needs investment in education that boosts R&D and therefore innovation, thereby enabling countries to fully participate and become a knowledge economy (Suh and Chen, 2007).

Women in tertiary education in Thailand have entered into the more traditional fields of humanities, social sciences, and law. In spite of their higher participation in tertiary education, their numbers have failed to increase as drastically in technical fields (UNESCO, 2008). Given that women represent fifty percent of the available labour force, not having women engage in fields that will drive the knowledge economy can have detrimental effects on the country's ability to pursue this type of economy. Educational attainment in the Thai labour

force is low. Higher-level education is achieved by only 12.6% of the labour force (Arkhom, 2006). Increasing the education level of the labour force is necessary for Thailand in improving their knowledge economies.

2.4 Technology in Thailand

Technology promotes growth and competitiveness in a country by allowing for more efficient and productive ways of creating goods and performing activities. Competitiveness can be measured using numerous criteria including R&D expenditures and patents. Information technology is the technology required for information processing. In particular, the use of electronic computers and computer software to convert, store, process, and transmit information (NOS, 2004). Information technology becomes of central importance to maintaining a knowledge economy, as it aids in the transfer of information.

In 2009, the International Institute for Management Development (IMD) ranked 57 countries for their overall competitiveness. Thailand ranked 26th out of 57, behind several other Southeast and East Asian countries including Taiwan, Singapore, China, and Malaysia (IMD, 2010). Taking a more detailed look at Thailand's competitive ranking, we see that Thailand ranked 36th out of 57 for its technology infrastructure which includes high-tech exports, technological skill, communications technology, funding for technological development and more. Thailand ranked 47th out of 57 for its scientific infrastructure including total R&D expenditure, basic research, patents in force and patent productivity. Finally, the country ranked 47th out of 57 for education including total expenditure on

education, higher education achievement, university education, qualified engineers and education achievement (IMD, 2010). Thailand's failure to be competitive stems from both its technological and educational institutions, as well as its low-skilled workforce.

The national development plans that began in the 1960's failed to include science or technology until the late 1980's, when development plan number five included a chapter on science and technology (WBG, 2006b). However, this chapter did not include science and technology in the broader economic policies of the period. It was not until more than a decade later that Thailand began to clearly pursue advancements in technology. The government goals became to enhance science and technology via improved capability in technical innovation, setting up mechanisms and institutions for knowledge diffusion and transfer (Arkhom, 2007). To achieve these goals, the government has created several different institutions to support technology and nurture its growth. Two of the most important organizations include The National Science and Technology Development Agency (NSTDA) and The National Electronics and Computer Technology Centre (NECTEC)

NSTDA is the driving force for the national science and technology capacity. Its primary goals are to enhance Thailand's competitiveness and the development of human resources in science and technology (NSTDA, 2010). While it works primarily with the private sector, its overarching purpose is to develop the appropriate mechanisms for implementation in educational institutions. In this way, it recognizes the importance of transferring technology to

educational institutions so it can appropriately reach a large number of students, and alter the workforce.

NECTEC was founded in Thailand in 1987. It is responsible for the development of information technology in Thailand. It works to ensure Thailand's competitiveness in electronics and computer usage, the use of IT to stimulate economic and social development through R&D programs, as well as R&D funding to universities (NECTEC, 1998). NECTEC acknowledges several important things concerning Thailand's technological abilities; Thailand can no longer be competitive through low cost technologies, it needs to be less dependent on foreign parties for intellectual properties, and it must prepare its human resources to be more competitive in the long run (NECTEC, 1998). As the country works towards becoming a knowledge economy NECTEC acknowledges Thailand's need to further advance its workforce by first enhancing its technical knowledge.

As Thailand changes from an industrial economy to a knowledge economy, it needs to make a dramatic change to its workforce. Change has occurred rapidly and largely in the manufacturing sector, but not the area of human resources (UNESCO, 1995a). This change towards more modern technology includes growth in such areas as technical engineering, civil engineering, industrial technology, and industrial manufacturing. Currently, a large majority of its workforce are low skilled, meaning the workers do not have high levels of education or specific skill sets. Thai industries have lower-margins because of a lower level of skilled labour, lower product quality, and higher

material costs (Kagami, Tsuji, and Giovannetti, 2004). This means higher risk in the industry due to the low-skilled workforce. This risk applies to both the workers and the industry as both become susceptible to changes that occur in the global economy. Thai women occupy less high-skilled jobs than men, so they will not be able to take advantage of the shift to high-skilled work (ADB, 1998). This will continue their disadvantaged economic position in the country and potentially affect the future generations. This is an example of Thailand's lower margins.

The lack of highly skilled workers in the country is not only contributing to the country's overall labour shortage, but the shortage of a technical human capital base has also reduced the country's ability to create or receive effective technology transfers from foreign industrialised countries (Krongkaew, 2006). This has made Thailand significantly less competitive in industries that require high-level technology. Recent studies from the World Bank have noted the shortage of workers to meet the labour market demands. The study indicated that high-skilled industries in the country have been unable to find candidates with the required qualifications to fill positions (Ranstad, 2010). In addition to this, *Swing Out Thailand* magazine (26 January, 2010) documented a study by the Labour Market Research Division in Thailand that reported an expected increase demand in labour between 2010-2014 in the industrial sector. In 2009, the industrial sector needed close to 500,000 workers but far fewer graduates than that joined it (Swing Out, 2010). A significant portion of the documented labour shortage includes technology driven occupations and contribute to the overall

labour problems that contribute to Thailand's inability to compete. The Association of Thai Software Industry (2003) found that Thailand's contribution to the technology labour force was devastatingly low. It contributed only 14% of test engineers, 14% of systems engineers and 4% of project managers in the country's' industries (ATSI, 2003). This labour shortage in industry is a direct contributor to Thailand's failing competitiveness in the international market. Without the appropriate labour force, Thailand cannot enhance its technical capacity.

With patents and R&D expenditures being the main outcomes of technical capacity it is important to look at the World Patent Office statistics. In 2008, the United States had 231,588 patents, South Korea had 23,584, Taiwan 18,001, Singapore 1266, and Malaysia 297, while Thailand had only 96 (US Patent Office, 2009). While the United States is the overall world leader in innovation via patents, in Asia South Korea and Taiwan have substantial numbers and this is reflected in their overall development of technological capacity in Asia. Thailand is clearly lacking in this aptitude. In addition, R&D expenditures of Asian countries like South Korea average 3% of GDP, while Thailand's expenditure is a mere 0.23% of its GDP (Suh & Chen, 2007). Innovation and invention need substantial amounts of R&D funding to develop. However, if there are no researchers or skilled human resources to take advantage of the funding, innovation and invention will not flourish. The lack of funding for R&D is not a cause of the labour shortages, rather, it is the labour shortages and limited high-skilled human resources that are contributing to the limited money given for R&D.

Thailand realizes this problem. It knows it has severe labour shortages in technology that are becoming a disability for the country (if they were not already). With this in mind, Thailand is attempting to change both its ranking in international competitiveness and its human resources by improving its relationship with technology. The IT-2010 framework (2001) was created to address this problem.

2.4.1 IT-2010

In conjunction with NECTEC, Thailand created the IT-2010 framework. IT-2010 seeks to address the weakness of the Thai economy resulting from its unskilled workforce, deficiencies in the education system and an out-dated industrial technology (NITCS, 2003). The purpose of this framework is to address not only the country's lack of technological skills but also related inadequacies in its workforce. IT-2010 recognizes the importance of building a knowledge economy and the role that information plays amidst the globalized world. It argues that Thailand must rapidly enhance its use of IT in all sectors (NITCS, 2003). The overarching goal of IT-2010 is to use technology for development.

There are three main components to the IT-2010 framework. These include building human capital, promoting innovation in economic and social systems, and strengthening information infrastructure and industry (NITCS, 2003). By strengthening these three areas, Thailand is hoping to improve its competitiveness in the international market. IT-2010, specifically, is trying to increase knowledge workers from 12% to 30% of the workforce, and to make

knowledge-based industries contribute a 50% share of the GDP (NITCS. 2003). To make this a reality, the focus must be on the increase of skilled workers. Utilizing human resources is the key to the enhancement of competitiveness; a solution to Thailand's labour shortages. By focusing on education, Thailand can produce a high-level workforce and meet the demands of the industrial sector (NITCS, 2003).

IT-2010 indicates a strong realization by policy-makers in the country that major steps need to be taken to combat the current labour shortage and the need for a knowledge economy. IT-2010 has now been in motion for ten years and is in its final year. To date, improvements in the country in regards to technology that have occurred have been limited. The internet is now widely found and large numbers of people have in-home access. However, expenditures for R&D have increased but only slightly. Pressures for industries to change from low skilled to high skilled manufacturing are strong, but with limited labour resources the change is slow and difficult.

One of the most important points in the IT-2010 was the need to build human capital that was directly involved or could contribute to technological advancements in the country. The Ministry of Education, therefore, has played an important role in the implementation of IT-2010 in regard to how information and communication technology are transferred to the people of Thailand, in turn dictating the future competitiveness of the country. Thailand's ability to advance its enrolment in technical fields in tertiary education will play a large part in enhancing the country's human capital.

2.5 Tertiary Education in Thailand

Thailand became a constitutional monarchy in 1932, placing it on its first development path and creating the first Thai university (MOE, 2004). Since that time, the university system in Thailand has grown substantially and come to represent a key method of transferring knowledge in the country and moving the county forward. The university education system is large and encompasses both public and private universities, including several specialized types of institutions. Currently, public universities account for 82% of all higher education institutions, and private universities account for 18% (MOE, 2006b). Unlike the North American education system, the public institutions in Thailand are prestigious and represent the top institutions for educational attainment. As such, the gross education expenditures contribute greatly to the quality of education in the country. Current education spending makes up 3.9% of GDP (WBG, 2009a). This expenditure is low compared to other, more technologically advanced countries such as Korea, which has an education budget of 17.9% (MOE Korea, 2006). In addition, in their study of the effects of public expenditures in education on enrolment, Bergh and Fink (2004) found that levels of expenditure for primary and secondary school had a large impact on tertiary enrolment. Countries with high expenditures in primary and secondary schooling were more likely to see people enrol in tertiary education, indicating that the public expenditure rates are an indicator of more than just educational quality.

Enrolment in tertiary education in Thailand has grown significantly over the last ten years. Currently, gross enrolment rates have reached a record high in the

country of 68% for people between the ages of 18-21 (UNDP, 2007b). Worldwide, this trend has also appeared, particularly in East Asia where countries like Korea now have enrolment rates of 95% (UNESCO, 2009c). More than ever before, young people, of whom the majority have been women, are choosing higher education. This demonstrates both the change in economic goals since the 97/98 financial crisis and the increased demand for high-skilled workers.

Despite overall promising enrolment trends, the areas of study being pursued by most students constitute a potential problem for Thailand. Women outnumber men in the fields of humanities, social sciences, education, and medicine, while men outnumber women in engineering, agriculture and IT/ICT (UNDP, 2007b). This trend is fairly common for many countries around the world including the United States and Canada. It represents the typical gender stereotypes that exist pertaining to the socially appropriate jobs and types of knowledge women are designated to acquire. However, these gender stereotypes also represent detrimental limitations to a country that is pursuing a knowledge economy. As knowledge needs to be widely distributed among a population, it also needs to be concentrated in areas of importance that will contribute to the overall global competitiveness of a country: That area of importance today is IT, ICT, and engineering.

The UNDP study *Gender Disaggregated Statistics in Thailand*, found, for example, that women accounted for only 17% of engineering students while they accounted for more than 60% of students in courses like teaching, humanities

and law (UNDP, 2007b). This uneven enrolment distribution for women in IT, ICT, and engineering means that Thailand's ability to become a country with a knowledge economy based around IT and ICT is at risk of not developing. As women makeup fifty percent of the population, educating them in these fields would add a substantial amount of high-skilled people to the country's workforce.

The ability of women to participate in IT is based on their capacity to access IT fields. Recent trends in Thailand suggest that women have been granted a large amount of access, specifically with the push from the government to become a knowledge economy with higher IT skills. However, despite more access to these fields than ever before, women's participation is still low. This limited participation will prevent the progression of women into IT and ICT careers. Getting more women to participate in IT is a necessary step in increasing their overall participation.

International student mobility is a popular way in many countries to receive an education. The United States is a popular destination for such student mobility in higher education. This is especially true in the fields of medicine and IT. However, Thailand does not represent one of the many countries that have large amounts of students studying abroad. Outward mobility of students in Thailand has grown slower than local enrolment, averaging only 3% of students per year (UNESCO, 2009c). Thus, the vast majority of Thai students are receiving their education and pursuing careers in Thailand. As a result, providing high quality education that is directed towards the country's current labour needs

is the primary responsibility of Thailand's Ministry of Education (MOE) and its domestic tertiary institutions.

The Education Act of 1999 and its amendment in 2002 marked new goals and initiatives for the MOE. The Education Act came about as a result of the 97/98 financial crisis that caused not only the restructuring of the government but also the restructuring of the education system. The Education Act put in place administrative structures, decentralization, and a learner centred focus around the reform process. A Commission on Higher Education was created that is responsible for proposing policies, development plans, and standards for higher education in line with the needs specified in the National Economic and Social Development Plan and the National Scheme of Education (National Education Commission, 1999). In addition, technology was made a focus and large component of the Education Act. In it, the state is given control of the policies, development plans, co-ordination of research and development, and the utilization of technologies. It also specifies, under Section 65, the importance of personal development for both the producers and users of technology, so that they have the knowledge, capabilities, and skills required for the production and utilization of high-quality, and efficient technologies (National Education Commission, 1999). These new components of the Education Act reflect the country's desire to foster a knowledge economy. It is essentially working to make education, and education in technology a significant part of a country's national development plans.

The MOE is working towards developing skills for the 21st century. It recognizes the demands of the global knowledge economy and how the rapid utilization of ICT has placed new demands on knowledge seekers and education systems. It has outlined eight essential skills for this. These include creativity and innovation since the MOE believes that fostering students creativity and innovation will be essential for Thailand's long-term competitiveness in all sectors including science and technology. A second skill to note is the 21st century skill, which identifies the need for specialist skills and support for industries that have been created by ICT's (MOE, 2006a). Since 2002, the MOE has strived to create an education for the people of Thailand that has no limitations in participation and pursued the requirements for a globally competitive world. In conjunction with this, it has developed a policy on information technology. Components of this policy include encouraging the country to become a knowledge economy, improving human resources for information technology, and developing the communications technology industry (MOE, 2008a). The MOE is in fact leading the National ICT Plan to create the fundamentals for enhancing teaching and learning with technology. It has set important goals for itself in this regard- that all graduates from educational institutions will have a good standard of ICT literacy and knowledge, and to develop an ICT capacity to support Thailand's economic growth (MOE, 2006a).

While the MOE is responsible for all levels of education, the push for an inclusive IT education has largely been seen in the primary and secondary levels of education. In partnership with companies like Microsoft, the MOE is working to

close the digital gap. It is doing this by arranging for more PC's to more than 1,500 schools, giving school and student grants, helping to develop new local curriculum and identifying the teachers who have been given specific ICT training as innovative teacher (MOE, n.d.). All of this is meant to enhance Thailand's IT and ICT skills. The new IT and ICT based curriculum involves computer training in conjunction with online initiatives and multi-school interactive projects. The MOE has also developed 14 ICT primary and secondary model schools that serve to integrate ICT learning throughout the schools programs. These efforts, to close the country's digital gap, are aimed at providing young people with the skills to work with technology. However, the MOE has failed to address additional IT and ICT needs in tertiary education. This is not to say that universities are in need of donated computers, but rather, that tertiary institutions are in need of more human resources. Given that Thailand's National Development Plan serves to create an economy that is based on a knowledge economy in order to provide a high-skilled workforce, addressing IT concerns in tertiary education is of significant importance.

Research funding within the educational budget has been limited in Thailand's higher education. The research budget in 2005 was only 6% of the total education budget, demonstrating that universities need to seek more research funds, either from the MOE or from alternative sources (UNESCO, 2006a). Korea on the other hand has a relatively high public expenditure for tertiary education of 9%. This is especially important since one of the ambitions of the *Thai Higher Education Policies* is to become a centre and hub for

international education in the region of Southeast Asia. The country needs to bring its higher education and innovative capacity up to levels that can be deemed globally competitive. In order to do this it must address key problems such as the achieving and maintaining of quality education, and creating globally competitive institutions. By constructing a high-quality, competitive higher education program, Thailand will be able to bridge the current gap between university and industry.

The linkages between university education and industry are important. The information taught in universities contributes directly to the type of industries a country is able to support. To strengthen the qualified workforce in science and technology skills, the education system needs to strengthen its outputs in these areas. The MOE has somewhat addressed the IT and ICT shortcomings in the education system by promoting IT and ICT in primary and secondary schools. The MOE's National Report (2004) acknowledged Thailand's need to be more actively involved in innovations and developments in technology and science. It has created a strategic action plan to strengthen education for all, and to raise the quality and efficiency of education to enhance Thailand's competitiveness at the international level. The MOE's strategy to achieve this mission encompasses the promotion of education in science and technology, developing innovations and technologies through knowledge, and providing the work force that is needed for national development (MOE, 2004). These strategies indentify what Thailand needs and they demonstrate the importance of university-industry linkages.

Despite the country's awareness, little has been done since 2004 to remedy the missing university-industry linkages. In fact, labour shortages in the country seem to be getting worse. According to Krongkaew (2006), Thailand's education system has failed to produce a workforce that can compete in high-tech industries. The inadequacy of qualified staff in science and technology fields has prevented the full transfer of knowledge to industries (Krongkaew, 2006). At this rate, labour shortages will continue and Thailand will fail to develop a strong technology driven industry and knowledge-based economy. It can be argued that the skills crisis that Thailand is currently experiencing is due, in part, to the fact that a large segment- i.e. women – is under-represented in IT (Wentling, Rose, and Thomas, 2004). Their low levels of enrolment mean that fewer people are available to fill jobs in the IT and industry sector.

Western nations have addressed their shortages of women in IT and many academics have studied it. They have come up with reasons for the shortcomings, which have led to discussions concerning how to remedy the situation. Thailand has not yet viewed women's low enrolment as a problem or presented ways of dealing with the enrolment discrepancy. Thailand has acknowledged the importance of technological capacity in education and development but has not taken steps to make the country an inclusive learning society in technical fields. It is believed that ICT in education will reduce the gaps that exist between socioeconomic realities and the outputs of education systems (UNESCO, 2009a). Therefore, the continued improvement of ICT in

education can do much more than just address the high-skilled worker shortage in the country.

The Thai Education system is vast and complex. With more than eighty universities throughout the country, it is hard to say which schools are becoming globally competitive, innovative, delivering high-quality education, and developing their technical programs. To provide a more in depth analysis of the higher education system in Thailand in regards to technology, data from the Asian Institute of Technology (AIT) will be examined.

2.6 The Asian Institute of Technology

AIT is Thailand's premier school for technology development. Established in Bangkok in 1959, it is the leading postgraduate institution in technology related fields. It specifically focuses on integration into the global economy, meaning, it is working to adapt to the changing global environment and bring global skills to fruition. AIT notes its two specific strengths as being technical expertise and internationality (AIT, 2010). Combining these two strengths creates an environment suitable for competing in international markets. AIT therefore represents a school in Thailand that is able to both develop high-skilled workers and innovative capacity. AIT's position at the forefront of technology was evident in 1991, when it became the first school in Thailand to hold an internet workshop, subsequently putting it in the spotlight for technology development (Kagami, Tsuji, and Giovannetti, 2004).

The school's mission is "to develop qualified and committed professionals who will play a leading role in the sustainable development of the region and its integration into the global economy" (AIT, 2010). It is clear that AIT's position in both fostering and transferring technical skills to the Thai people is vast. Both the quality of courses at AIT and operations are advanced for Thailand, and offer standards in regards to technology that are higher than other schools in the region.

There are close to 100 professors from more than twenty countries at AIT. Of the faculty, more than 30% are Thai while the rest come from a large range of countries including India, the Philippines, Nepal, Canada, and the United States (AIT, 2008). The international faculty at AIT has given the school an international reputation and is helping to lead the school to new technological frontiers

The school has three main schools of study: the school of environment, resources, and development (SERD), the school of management (SOM), and the school of engineering and technology (SET). From1961 to 2008, the number of students graduating from AIT has been steadily increasing. Out of the more than 16,000 graduates, however, women accounted for just less than one third. As this paper is primarily concerned with SET, it will focus on women's enrolment in this school of study.

Trends in women's enrolment in AIT show only a very small increase every year. In 2009, total female enrolment in AIT was 859 students, approximately 37% of the student population. However, when examining the data for SET enrolment, we find that women are least likely to be enrolled in this

school. Only 28% of women at AIT were enrolled in SET, accounting for only 10.5% of the school population (AIT Data, 2008). These low levels of enrolment convey the current trend throughout Thai universities- that of women's under-representation in technical fields.

As an acknowledged leader in technology, AIT's limited female enrolment demonstrates the lack of progress in addressing this uneven trend and a potential reason why the country is having problems becoming internationally competitive. AIT has the means and the right education tools to transfer the appropriate technical knowledge to the people of Thailand. The school has a strong mission (to provide a qualified workforce) and vision for itself, and it is exactly what the country needs right now. However, without addressing the gender disparities in enrolment numbers, the ability of AIT to complete this mission is questionable.

3: FINDINGS

The past ten years in Thailand have encompassed a significant amount of change and direction in the way the country pursues development and strives to improve itself. Since the 97/98 financial crisis, the country has been awakened to its shortcomings in the ways of its economic stability. The sharp fall in exports left Thailand in need of new products for new markets. This realization has been the spark to the country's current development itinerary; pursuing a knowledge economy that will create a continuous learning environment.

Thailand is in the midst of a major structural adjustment towards advanced industrial status. The last forty years in the country have seen the successful shift from an agriculture-based economy to an industry-based economy. However, the country is now in need of a major technological upgrading to adequately become a quality-oriented, efficient industrial producer. Thailand's previous dependence on low-cost, low-skilled labour, little capital, and simple technology is no longer satisfactory for competing in today's globalized world economy. The cost of labour in the country began to increase before the 97/98 financial crisis, but with the continued globalization of manufacturing production and changes in technological and demand conditions, labour costs have continued to rise (ADB, 1998). As foreign producers face higher labour costs and skill shortages, they can no longer look to Thailand for secure investments. The creation of a strong human resource pool can create and give Thailand a new competitive edge in

both foreign investments and national export markets. It needs to phase out products that are less competitive in the world market and focus more on developing its service sectors (ADB, 1998). Products that have become more competitive include items such as integrated circuits, hard-disc drives, electrical appliances, vehicles and vehicle parts (US State Department, 2010). The process of improving their competitive products has been delayed by open markets, enabling them to hang on to labour-intensive industries (Chu and Hill, 2006). Nevertheless, the importance of changing and upgrading Thailand's labour force is now greater than ever, as the world markets continue to be more available to more countries. The Thai economy, like most countries economies, has been highly dependent on world trade and investment conditions. Thus, continued change in the world economy means continued change in the Thai economy.

Women, in particular are subjected to, and feel the impact of this changing world. Most women in Thailand do not have the skills to participate in the industrial sector so as the market for high-skilled jobs becomes more prevalent, women get relegated into low-skilled jobs that are on the decline (ADB, 1998). Women currently make up a smaller portion of the workforce than men, and women will comprise an even smaller portion of the workforce with the decline in low-skilled jobs. Thailand faces a serious shortage of labour in general and this is anticipated to rise to an estimated 500,000 by 2014 (Swing Out, 2010). This labour shortage is especially acute in the fields of technology, engineering, and science. Expanding the country's export markets cannot occur without

addressing the changing demands in high-skilled vs. low-skilled labour. The government of Thailand has chosen to deal with these skill-shortages by pursuing a knowledge economy.

The government has taken several steps to making Thailand a knowledge economy. The two predominant ways are through the education system and NECTEC, which has created the IT-2010 framework. ICT policies have been created to address the current worker shortage and to put the country on the correct path to developing a strong technology foundation. With this, Thailand is moving towards the correct path for improvement in technology and innovation.

The development of the knowledge economy has rightly centred on bettering the education system in the country, more specifically improving the technology in schools and what is taught in school programs. The MOE is working towards a technology inclusive education system but with a focus on primary and secondary schooling. The present emphasis being placed on technology in higher education is intended to provide programmes that provide skills for learning and working in the changing age of modern technology that are related to market demands (UNESCO, 1995a). However, the presence of these skills in higher education is just as important as the human resources to learn them. While enrolment in tertiary education has increased drastically over the last ten years it has not been in the areas in which there are market demand; IT, ICT, and engineering. As women exceeded men in enrolment in university programs they do so unevenly, and largely in traditional fields of humanities and social sciences. IT, ICT, and engineering programs do not see many female students,

or at least not nearly as many as men. It is important to evaluate the impact of this gender segregation on employment outcomes given Thailand's labour problems.

Women occupy a special position in society as caregivers, while at the same time often occupying lower economic positions. As the demand for workforce skills change in Thailand, women are becoming more at risk of losing their occupations and falling even further behind on the economic scale. The market demand for high-skilled workers is based on Thailand becoming a country that can compete internationally as innovators and distributors of technology. While they are working to improve the technical capacity of the country by implementing programs like IT-2010, they are ignoring and under-utilizing the skills of fifty percent of the population. The women of Thailand offer a solution to the country's current problems and a way of enhancing the future generations of the country. They do this in several key ways that have not come into the country's National development plan.

Firstly, the shortage of workers in the fields of science, technology and engineering in Thailand go beyond what the male population of the country is able to fill. This is obvious when we consider the importing of necessary knowledge workers to compensate, in order to meet market demands (NITCS, 2003). Therefore, the male population in Thailand has reached its maximum potential in the workforce. Women's skills now need to be utilized. Women are interested in, and have easy access to higher education. As they enter the university system in large numbers, the only setback is that they are not entering

the fields that have such high market demand. If women began to pursue the fields of IT and engineering, they could fill the gaps in the labour market. Not only do they offer the potential to do this, but they offer more creative ways of thinking about technology. As noted in the literature review of women in technical fields, women in the technology workforce can lead to a wider range of products and ones that are more inclusive of the different needs of a society. As designers of technology, women offer a substantial amount of innovative capacity that has not been accessed before. As Thailand needs not only more technology workers, but also a unique position in the market to distinguish itself from other developing countries, it could greatly benefit from women's unique views and designs that have yet to be fully taken advantage of even in developed countries. Involving more women in technical fields can give Thailand the innovative edge it needs to compete in the international market. Taping into this "hidden" resource is not only an economical option but also a feasible one.

Secondly, women as caregivers mean they have a large amount of influence over future generations in the country. If women obtained the skills and knowledge available in technology those skills are likely to be transferred onto their children. This can help ensure a technology driven country that has the human capital to compete globally. In conjunction with this, women with technical skills will also improve the economic situation of the country. They can do this because technology and industry sector jobs typically provide more favourable pay then jobs in the agricultural sector. With more women earning more money, the country will achieve an overall higher level of economic development.

Women in Thailand are underutilized in the area of technology. Despite the country's national development plans to become much more tech savvy and innovative by improving their human capital, they have failed to address a significant portion of the population. Education is the key way to transfer skills to the population and while targeting the primary and secondary schools is effective in the long run, it does little to meet the market demands of today. Today, the labour shortage needs to be filled by female tertiary graduates as they mark not only the closest available resource but also a creative and dynamic one that can truly provide Thailand with the technology edge it so badly needs.

4: CONCLUSION

Developing countries around the world are struggling to find their panaceas to growth. As they develop new strategies several things have become clear; that education, women, and technology all play a role in bettering a country, and that the combination of these three things can significantly better a country's development path.

As the world continues to become more global, providing countries with more markets, more choice and more buyers, the world will become more competitive. The increasingly competitive nature of the world has brought technology and information to the forefront. Today, what can make a county more innovative, connected, and advanced, is the ability of that country to support a technology driven economy. Those economies have come to take on the term knowledge economy, designating an economy that is driven by the accumulation of knowledge. The more knowledge a country can accumulate and transfer effectively to its people, the greater chance it has of being successful in the 21st century.

All people in a country are capable of receiving knowledge and information as long as they have access to educational facilities. Women today have more access in more nations than ever before, including Thailand. They are able to receive an education and become economic actors in society just like men. As more women become educated and their enrolment rates surpass men, the type

of education they engage in has a large impact on society and the overarching future of a country. To make education efficient and effective in a knowledge economy, it must conform to the market demands of a country. Without linkages between university facilities and industries, education lacks both a purpose and presence. As such, the amount of students entering into fields such as IT, ICT, and engineering will have a direct impact on the market demands of a country.

Women are underutilized in the area of technology. This occurs all over the world, including Thailand. The current labour crisis in Thailand makes enrolment trends of women more important to the country's economic development. As Thailand struggles to improve its technological capacity and overall competitiveness, it has overlooked women in this field, and is therefore missing a valuable resource. Women can contribute unique perspectives and designs to technology that are capable of not only putting Thailand back on the development page but ahead of the development game. An investment into women's technology education can make Thailand more competitive in the international market as it will fix their labour shortage problems and deliver new perspectives on traditional male designs.

It is hard to understand exactly what Thailand and the world are missing without knowing the future. However, when we look to a previously male-dominated field like that of medicine (and see how the inclusion of women has forever advanced its progress) it is easy to see how women in technology will offer the same invaluable rewards to our future.

We are living in an age of mass innovation, everyone can contribute, and now more than ever, individual contributions will change the way the world works (Friedman, 2008). If Thailand and the world fully utilize women's ingenuity, new levels of innovation will be reached. In a country like Thailand, that so desperately needs an innovative human capital boost. Not making use of women in technology is not just a lost opportunity, but it is also a waste of creative capacity.

REFERENCE LIST

Aguele, Lawrence I., Ethel E. Idau, and Oyaziw Aluede. "Women's Education in Science Technology and Mathematics (STM): Challenges for National Development." *Journal of Instructional Psychology,* v. 35, n. 2, , June 2008, pp. 120-125.

Alva, S., and B. Entwisle. "Employment Transitions in an Era of Change in Thailand." *Southeast Asian Studies,* v. 40, n. 3, 2002, pp. 303-326.

Arkhom, K. "Thailand and Its Knowledge Economy." Retrieved on 20 March 2010 from <info.worldbank.org/etools/docs/library/233810/1khunArkhom.pdfNew>.

Asian Development Bank. *Country Briefing Paper: Women in Thailand.* Manila: Asian Development Bank, 1998.

Asian Institute of Technology. "About AIT." Bangkok: Asian institute of Technology, 2008. Retreived on 12 January 2010 from <www.ait.ac.th/about>.

Association of Thai Software Industry."ICT Market Outlook". *Association of Thai Software Industry 2003.* Accessed on 4 April 2010 from <www.atsi.or.th/>.

Baker, C., and P. Phongpaichit. *A History of Thailand: Second Edition.* Cambridge, UK: Cambridge University Press, 2009.

Balzat, M. "The Theoretical Basis and Empirical Treatment of National Innovation Systems." *Druid.dk*. Retrieved on 2 April 2010 from http://www.druid.dk/uploads/tx_picturedb/dw2003-693.pdf

Bergh, A., and G. Fink. “Higher Education: Does Public Expenditure increase Enrolment?” *JEL Classification* H520,1220. 2002

Catalyst. “The Bottom Line: Connecting Corporate Performance and Gender Diversity.” Toronto: Catalyst Publication, 2004 Retrieved on 2 April 2010 from <www.catalyst.org/publication/82/the-bottom-line-connecting-corporate-performance-and-gender-diversity>.

Chu, Y., and H. Hill (eds.).*The East Asian High-Tech Drive.* Northhamton, MA: Edward Elgar Publishing, 2006.

Cohoon, J., and W. Aspra. *Women and Information Technology: Research on Underrepresentation.* Cambridge, MA: MIT Press, 2006.

Costa, L. “Exploring the History and Women’s Education and Activism in Thailand”. *Exploration in Southeast Asian Studies*, v1, n2, 1997. Retrieved on 12 January, 2010 from <www.Exploring the History of Women's Education and Activism in Thailand.mh>.

Cronin, Catherine, and Angel Roger. “Theorizing Progress: Women in Science, Engineering, and Technology in Higher Education” *Journal of Research in Science Teaching*, v. 36, n. 6, 1996, pp. 637-661.

Cukier, W., D. Shortt, and I. Devine.” Gender and Information Technology: Implications for Definitions.” *Information Systems Education,* v. 13, n. 1, 2002, pp. 142-148. Retrieved on 25 March 2010 from Consortia Canada.

Easterly, William. *The Elusive Quest for Growth.* Cambridge, MA: MIT Press, 2001.

Everts, Saskia. *Gender and Technology: Empowering Women, Engendering Development.* London and New York: Zed Books, 1998.

Flowers, James C. “Female Educators and Students Assess Gender Equity in Technology Education A Survey of Women Involved in Technology Education.” Glen Allen, VA: Virginia Vocational Curriculum and Resource Center, 1996.

Fox, Mary F., Deborah G. Johnson, and Sue V. Rosser. *Women Gender and Technology.* Champaign, IL: University of Illinois Press, 2006

Friedman, Thomas L. *Hot, Flat, and Crowded: Why We Need a Green Revolution and How It Can Renew America.* New York: Picador/Farrar, Straus and Giroux, 2009.

Furman, J., M. Porter, and S. Stern. “The Determinants of National Innovative Capacity.” *Research Policy,* v. 31, n. 6, 2001, pp. 899-933.

Gender Working Group of thee United Nations Commission on Science and Technology for Development. *Missing Links: Gender Equity in Science and Technology for Development.* Ottawa: IDRC Books, 1995.

Hafkin, Nancy. “Enabled Women in Knowledge Societies: Case Study The Philippines and Thailand.” Online at www.I4donline.net, July 2008, pp. 6-10.

_____. “Gender Issues in ICT Statistics and Indicators, with Particular Emphasis on Developing Countries.” Paper presented at Joint UNECE/UNCTAD/UIS/ITU/OECD/Eurostat Statistical Workshop: Monitoring

the Information Society: Data, Measurement and Methods, Geneva, 9 December 2003. Online at <www.unece.org/stats/documents/ces/sem.52/3.e.pdf.>.

Harvie, Charles, and Hyun-Hoon Lee. *Korea's Economic Miracle Fading or Reviving?* Basingstoke, UK: Palgrave Macmillian, 2003

Hawley, Joshua D. "Vocational-technical Schooling and Occupational Matching in Thailand: Differences Between Men and Women." *Asia Pacific Journal of Education,* v. 28, n. 2, 2008, pp. 189–205.

Huyer, Sophia, and Nancy Hafkin. *Engendering the Knowledge Society: Measuring Women's Participation.* Orbicom and NRC Press, 2007. Online at <www.orbicom.ca/projects/knowledge_society/>.

IMD. *World Competitiveness Yearbook.* Lausanne: International Institute for Management Development, 2009. Retrieved on 4 April 2010 from <www.imd.ch/research/publications/wcy/World-Competitiveness-Yearbook-Results.cfm>.

Kapur-Fic, Alexandra R. *Thailand: Buddhism, Society, and Women.* New Delhi: Abhinav Publications, 1998.

Keller, William W., and Richard J. Samuels (eds.). *Crisis and Innovation in Asian Technology.* Cambridge, UK: Cambridge University Press, 2003.

King, Elizabeth, and M. Anne Hill. Women's Education in Developing Countries: Barriers, Benefits, and Policies. Baltimore, MD: Johns Hopkins University Press, 1993.

Mathews, J., and M. Hu. “Enhancing the Role of Universities in Building National Innovative Capacity in Asia: The Case of Taiwan.” *World Development.* v. 35, n. 6, 2007, pp. 1005-1020.

Mephokee, Chanin. “Information Technology: Some Implications for Thailand.” In M. Kagami, M. Tsuji, and E. Giovannetti (eds.), *Information Technology Policy and the Digital Divide: Lessons for Developing Countries:* 135-159. Northhamton, MA: Edward Elgar Publishing, 2004

Ministry of Education of Science and Technology (Korea). “Educational Finance Statistics.” Seoul: Ministry of Education, 2008. Retrieved on 25 May 2010 from <http://english.mest.go.kr/main.jsp?idx=0401050101>.

Ministry of Education (Thailand). “Thailand National Report.” Presented at the 47th Session of the International Conference on Education, Geneva, 8-11 September, 2004.

_____. “Enhancing Learning Through Information and Communication Technologies.” Bangkok: Ministry of Education, 2006a. Retrieved on 2 February 2010 from <www.bic.moe.go.th/fileadmin/BIC_Document/book/MOEleaflet/moe2__ict_s_.pdf>.

_____. “The Education System of Thailand”. Bangkok: Ministry of Education, 2006b. Retrieved on 2 February 2010 from <www.bic.moe.go.th/fileadmin/BIC_Document/book/MOEleaflet/Thai-ed-system.pdf>.

_____. “Policy Statement of the Council of Ministers. Ministry of Education, Thailand.” Bangkok: Ministry of Education, 2008a. Retrieved on 20 March 2010 from <www.bic.moe.go.th/fileadmin/BIC_Document/book/policy-statement-abhisit-ENG.pdf- pg24>.

_____. “Towards a Learning Society in Thailand.” Bangkok: Ministry of Education, 2008b. Retrieved on 2 February 2010 from <www.moe.go.th/English/>.

_____. “Developing 21st Century Skills.” Bangkok: Ministry of Education, 2008c. Retrieved on 2 February 2010, from <www.bic.moe.go.th/fileadmin/BIC_Document/book/MOEleaflet/develop21stcentskills.pdf>.

_____. “Partners in Learning: Customer Reference.” Bangkok: Ministry of Education, no date. Retrieved on 2 February 2010 from <download.microsoft.com/.../159_MSC05002_Thailand_MOE.pdf>.

Napier, Joan, Denise Shortt, and Emma Smith. *Technology with Curves: Women Reshaping the Digital Landscape.* New York: HarperCollins, 2000.

National Statistics Office of Thailand. “Key Statistics, 2008.” Bangkok: National Statistics Office of Thailand, 2008. Retrieved of 9 January 2010 from <web.nso.go.th/eng/en/stat/gender/table/etab30.htm>.

National Education Commission. “National Education Act: B.E. 2542 (1999) and Amendments (2002).” Bangkok: National Education Commission, Office of the Prime Minister, Kingdom of Thailand, 1999.

National Electronics and Computer Technology Center (NECTEC). “Welcome to NECTEC.” Bangkok: National Electronics and Computer Technology Center, 1998. Retrieved on 2 February 2010 from <www.nectec.or.th/home/>.

National Science and Technology Development Agency (NSTDA). “Overview.” Bangkok: National Science and Technology Development Agency. Retrieved on 2 February 2010 from <www.nstda.or.th/en/index.php?option=com_frontpage&Itemid=127>.

National Statistics Office (NSO). “Thailand Labour Survey”. Bangkok: National Statistics Office, 2009. Retrieved on March 24 2010 from <web.nso.go.th>.

Organisation for Economic Co-operation and Development (OECD). “Promoting Entrepreneurship and Innovative SMEs in a Global Economy: Towards a More Responsible and Inclusive Globalisation.” Second OECD Conference of Ministers Sized Enterprises (SMEs), Istanbul, Turkey, 3-5 June 2004.

_____. “Women in Scientific Careers: Unleashing the Potential.” Workshop Summary. Paris: OECD, 2006. Retrieved on 2 April 2010 from <www.oecd.org/document/13/0,3343,en_2649_34269_37682893_1_1_1_1,00.html>.

_____. “Working Party on the Information Economy: ICTs and Gender.” Paris: OECD, 2007a. Retrieved on 2 April 2010 from <www.oecd.org/dataoecd/16/33/38332121.pdf>.

_____. “Workshop on Women in Science, Engineering and Technology: Strategies for the Workforce.” Workshop Summary. Paris: OECD, 2007b. Retrieved on 5 April 5 2010 from

<www.oecd.org/document/15/0,3343,en_2649_34269_37361295_1_1_1_1,00.html>.

Park, D. “Opportunities and Challenges of the New Economy for East Asia. Nanyang Technological University.” In V.P. Singh and H.S. Kehal (eds.), *Digital Economy: Impacts, Influences and Challenges.* Singapore: Idea Group, 2005.

Pfafflin, Sheila M. “Women, Science, and Technology”. *American Psychologist,* v. 39, n. 10, 1984, pp. 1183-1186.

Randstad. ”Thailand's Labor Market Facing 'Skills Shortage'.” Ranstad, 2010 Retrieved on 30 March 2010 from <www.ranstad.com/the-world-of-work/thailands-labor-market-facing-skills-shortage>.

Sanders, J. “Women in Science and Technology and the Role of Public Policy.” Washington, DC: Association for Public Policy Analysis and Management, 2000. Retrieved on 26 March 2010 from EBSCOhost.com.

Sen, Amartya. *Development as Freedom.* New York: Alfred A. Knopf, 1999.

Sonnert, Gerhard, Mary Frank Fox, and Kristen Adkins. “Undergraduate Women in Science and Engineering: Effects of Faculty, Fields, and Institutions over Time.” *Social Science Quarterly,* v. 88, Supplement, December 2007, pp. 1333-1356.

Suarez-Villa, L., and S. Hasnath. “The Effect of Infrastructure on Invention: Innovative Capacity and the Dynamics of Public Construction Investment.” *Technological Forecasting and Social Change,* v. 44, 1993, pp. 333-358.

Suh, J., and D. Chen (eds.). *Korea as a Knowledge Economy.* New York: Korea Development Institute and The World Bank, 2007.

Swing Out Thailand. ”Thailand May Face Labour Shortage Before Five Years.” *Swing Out Thailand,* January, 2010. Retrieved on 25 March 2010 from <http://swingoutthailand.com/2010/01/26/thailand-may-face-labour-shortage-before-five-years/>.

Tonguthai, P., S. Thomson, and M. Bhongsug. *Country Briefing Paper: Women in Thailand.* Manila: Asian Development Bank, 1998.

United Nations Children’s Fund (UNICEF). *UNICEF Thailand Statistics.* New York: UNICEF, 1995. Retrieved on 29 December 2009 from <www.unicef.org/infobycountry/Thailand_statistics.html#56>.

_____. *Education Statistics: Thailand.* New York: UNICEF, Division of Policy and Practice, Statistics and Monitoring Section, 2008. Retrieved on 5 January 2010 from <www.childinfo.org>.

United Nations Development Fund for Women (UNIFEM). *Gender and Development in Thailand.* New York: UNIFEM, 2003.

United Nations Development Programme (UNDP). *Country Program for Thailand (2007-2011).* New York: UNDP, 2007.

_____ and Office of Women’s Affairs and Family Development (Thailand). *Gender Development: Similarities and Differences.* Bangkok: UNDP and Office of Women’s Affairs and Family Development, 2007.

_____ and Office of Women's Affairs and Family Development (Thailand). *Report on Thailand Gender—Disaggregated Statistics.* Bangkok: UNDP and Office of Women's Affairs and Family Development, Bangkok, 2008.

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). *Women in Thailand: A Country Profile—Statistical Profiles No. 5, 1996.* Bangkok: Statistics Division, United Nations Economic and Social Commission for Asia and the Pacific, 1996.

United Nations Educational, Scientific and Cultural Organization (UNESCO). *National Profiles in Technical and Vocational in Asia and the Pacific: Thailand.* Paris: UNESCO, 1995a.

_____. *Asia Pacific Migration Research Network: Issue Paper from Thailand.* Paris: UNESCO, 1995b. Retrieved on 6 April 2010 from <www.unesco.org/most/apmrnw14.htm>.

_____. *Guide to Measuring Information and Communication Technologies in Education.* Paris: UNESCO, 1999. Retrieved on 22 March 2010 from <www.unesco.org/en/education/dynamic-content-singleview/news/guide_to_measuring_information_and_communication_technologies_ict_in_education/back/9195/cHash/417a649796/>.

_____. *Higher Education in South -East Asia.* Paris: UNESCO, 2006a. Retrieved on 2 February 2010 from www.unesco.org/en/education/publications/>.

_____. *Technology-based Training for Marginalized Girls: Cambodia, Indonesia, Nepal.* Paris: UNESCO, 2006b.

_____. *Guide to Measuring ICT.* Paris: UNESCO, 2009a.

_____. "World Conference on Higher Education Closes with an Appeal for Investment and Cooperation." Paris: UNESCO, 2009b. Retrieved on 23 January 2010 from <www.unesco.org/en/wche2009/>.

_____. *The Science and Technology System of the Kingdom of Thailand.* Paris: UNESCO, no date. Retrieved on 2 February 2010 from <http://portal.unesco.org/education/en/files/54658/11939295145Thailand.pdf/Thailand.pdf>.

UNESCO Institute for Statistics. *Global Education Digest 2009: Comparing Education Statistics Across the World.* Montreal: UNESCO Institute for Statistics, 2009c.

_____. *Education in Thailand.* Montreal: UNESCO Institute for Statistics, 2009b. Retrieved on 29 December 2009 from UNESCO Institute for Statistics.com.

Unterhalter, Elaine, Rajee Rajagopalan, and Chloe Challender. *Advocacy Brief: A Scorecard on Gender Equity and Girls Education in Asia 1990-2000.* Bangkok: UNESCO, 2004.

United States, Department of State. "Thailand." Washington, DC: United States, Department of State, 2010. Retrieved on 20 March 2010 from <www.state.gov/r/pa/ei/bgn/2814.htm>.

United States, Patent Office. "US Utility Patent Data." Washington, DC: United States Patent Office, 2010. Retrieved on 2 April 2010 from <www.uspto.gov/web/offices/ac/ido/oeip/taf/appl_yr.htm>.

Wagner, Daniel A., Bob Day, Tina James, Robert B. Kozma, Jonathan Miller, and Tim Unwin. *Monitoring and Evaluation of ICT in Education Projects: A Handbook for Developing Countries.* Washington, DC: infoDev, 2005. Available at <http://www.infodev.org/en/Publication.9.html>.

Wang, J. “From Technological Catch-up to Innovation-based Economic Growth: South Korea and Taiwan Compared”. *Journal of Development Studies,* v. 43, N. 6, 2007, pp. 1084-1104.

Washburn, Mara H., and Susan G. Miller. “Retaining Undergraduate Women in Science, Engineering, and Technology: A Survey of a Student Organization.” Journal of College Student Retention Research Theory and Practice, v. 6, n. 2, 2005, pp. 155-168.

Welch, A. “Access and Equity in SE Asian Higher Education: Finance, State Capacity, Privatization, and Transparency.” Paper presented at the World Conference on Higher Education, UNESCO Headquarters, Paris, 5-8 July, 2009.

Wentling, Rose Mary, and Steven P. Thomas. “Women in Information Technology”. Paper presented at the Academy of Human Resource Development International Conference (AHRD), Austin, Texas, 3-7 March, 2004.

World Bank. “Thailand Data and Statistics.” Washington, DC: World Bank Group, 2006a. Retrieved on 22 January 2010, from <http://ddpext.worldbank.org/ext/ddpreports/ViewSharedReport?REPORT_ID=9147&REQUEST_TYPE=VIEWADVANCED>.

_____. *The Science and Technology System of the Kingdom of Thailand.* Washington, DC: World Bank Group, 2006b.

_____. *Education Trends and Comparisons.* Washington, DC: World Bank Group, 2008. Retrieved on January 22, 2010, from <www.worldbank.org>.

_____. *Education at a Glance: Thailand.* World Bank Group, 2009a. Retrieved on 29 December 2009 from <www.worldbank.or.th/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/THAILANDEXTN/0,,contentMDK:21016343~menuPK:333327~pagePK:141137~piPK:141127~theSitePK:333296~isCURL:Y,00.html>.

_____. *Key Indicators: East Asia; Testing Times Ahead.* Washington, DC: World Bank Group 2009b. Retrieved on 8 January 2010 from <www.worldbank.org/eapeducation>.

_____. *Thailand Economic Monitor.* Washington, DC: World Bank Group 2009c. Retrieved on 7 January 7 2010 from <www.worldbank.org.th>.

_____. Country Context: Thailand Partnership for Development. Washington, DC: World Bank Group, 2009d.