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"Owing to the scope and pace of change, society has become increasingly knowledge-based so that higher learning and research now act as essential components of cultural, socio-economic and environmentally sustainable development of individuals, communities and nations." UNESCO, 1998

Comparative Analysis of Higher Education of Technology in China, India, and Mexico as a Factor for Economic Development 2000-2005

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ABSTRACT

The use and adoption of Information and Communications Technologies (ICTs) in some regions has been significantly lower than others increasing the digital divide between developed and developing countries. An increasing number of studies indicate that secondary and tertiary levels of education specifically in areas of technology, and not primary education, explain the differences of use and adoption of ICTs. Aware of the importance of education of technology to boost the use and adoption of ICTs, some of the most prominent emerging economies of this century such as China, India, and Mexico, have been investing a considerable amount of resources to increase and improve their institutes of technical higher education. The purpose of this multi-case study is to conduct a descriptive comparative analysis of the most prominent technical institutes of higher-education from China, India, and Mexico from the years 2000 to 2005 in order to highlight the relationships between the institutions and their contribution to the regional economies, specifically in the use and adoption of ICTs. Results of the study might assist practitioners at other institutions in other nations to implement and develop new educational reforms and practices based on these models.

Keywords: ICT, Education, Technology, Economy, Development

1. INTRODUCTION

As the world is rapidly shifting from an agro-industrial to a knowledge-based economy the services sector is increasing in importance as a factor for economic development. Between the years 2000 to 2005, the contribution of the services sector of the economies in China and India, the two most prominent economies of the 21st century, has been up to 50% of their Gross domestic product (GDP), while Mexico's services sector has risen to 69.5% (World Bank Group, 2006).

Production and utilization of Information and Communications Technologies (ICTs) are the driving forces for the growth of the services sector. Rölle and Waverman (2000) found a positive correlation between the utilization of ICTs and economic growth in developed countries. Although there is not conclusive econometric evidence on the causality between ICTs and economic growth in developing countries, "it would be dangerous for developing countries to use this as an excuse for not developing national e-strategies" (Gillwald, 2005).

Some regional economies in many parts of the world are facing increasing economic, social, and cultural difficulty in adjusting to the demands of the new orders of commerce and governance dictated by the increasingly

knowledge-based societies. This disadvantage is directly related to the phenomenon of the digital divide defined as the economic and cultural consequences of the unequal access to ICTs by different sectors of the society, which leads communities in disadvantage "toward economic poverty and to social and political isolation" (UNESCO, 2005).

An increasing number of studies indicate that education plays a significant role in the use and adoption of ICTs; therefore, education is an indispensable factor for sustainable economic growth (e.g., Lewin and Caillods (2001); De Hann, Huysman, and Steyaert (2002); UNESCO (2005)). However, empirical evidences show that secondary and tertiary levels of education, specifically in areas of instruction of technology and applied science, and not primary education, explain the differences of ICT adoption and development (Lee, 2001). In the new international knowledge-based economy advanced training in universities specifically in the area of technology is necessary for developing countries to stimulate the adoption and use of ICT's in order to promote their services sector. Emerging economies like China, India, and Mexico are investing heavily in higher technical education due to its significant role in economic development (Junzheng & Motwani, 2001).

2. ECONOMIC GROWTH AND ECONOMIC DEVELOPMENT

It is essential to this study that the distinction between economic growth and economic development is clarified. The former is defined as the national or regional increase in production and/or consumption while the latter is defined as the increase of production and/or consumption by each person. As an illustration, "economic growth may increase the weight of a nation in world affairs, but it may fail to make life any easier for its inhabitants. Economic development provides this increase in goods and services which may be felt by the population." (Morris, 1998, p.1).

3. PURPOSE AND SIGNIFICANCE OF THE STUDY

The purpose of this multi-case qualitative study is to conduct a descriptive comparative analysis of technical institutes of higher-education from three of the most emerging and prominent economies of the XXI century (i.e., China, India, and Mexico) from the years 2000 to 2005. The use of comparative strategies will allow a methodological description of these educational institutions in their particular economical, cultural, political, and social settings, as well as a description of their processes and outcomes in order to highlight the relationships between the institutions and their contribution to the regional economies, specifically in the use and adoption of ICTs.

Results of the study might assist practitioners at other institutions in other nations to implement and development new educational reforms and practices based on these models as well as inductively serve as a springboard for the implementation of new educational policies in the area of education of technology to propel the use and adoption of ICTs as a factor for economic development.

4. PEOPLE'S REPUBLIC OF CHINA, INDIA, AND MEXICO: A COMPARATIVE STUDY

In comparative research, elements for comparison must have differences and similarities in order to give validity to the study (Ragin, 1987). Although Mexico does not share the magnitude of population, the long tradition of scientific education, and the relatively well-developed scientific infrastructure of China and India (Altbach, 1998), these countries do share some important similarities. From an economic perspective the three nations are still considered developing countries. From the year 2000 to 2005 India's GDP in current US dollars was 582 billion. This indicator is more comparable with Mexico's 632 billion than with China's 1.6 trillion (World Bank Group,

2006). Although none of these countries are part of the Group of Eight industrialized countries (also known as G8 and consisting of Canada, France, Germany, Italy, Japan, Russia, United Kingdom, and the United States) China, India, and Mexico, jointly with Brazil and South Africa, created the Group of Five (also known as G5). This step towards the acquisition of international economic recognition has allowed them to participate in G8 summits more specifically in the area of international finances and in environment discussion issues.

From the perspective of higher education these countries, as most of the countries that want to participate in the international community, have adopted a western educational system primarily modeled from England and the United States (Altbach, 1998). It was only during the last two decades that the three nations implemented higher educational reforms as a reaction to the internationalization of their economy and the competitive knowledge-based global market. China's recent educational reform system only dating back to 1980 was a reaction to the failure of the centralized system adopted form the Soviet Union in the 1950's. India's educational system has confronted years of ineffective quality control, and it was not until 1994 that the University Grants Commission (UGC) established an autonomous entity called the National Assessment and Accreditation Council (NAAC) as a mechanism to control the quality of higher education. In 1991 Mexico created an inter-institutional committee for the evaluation of higher education (CIEES) with the goal to evaluate academic programs.

In the area of technology, India's achievements in software and applied computer sciences are in part the result of new educational polices. For instance, market forces and the private sector are allowed to determine the rate of growth of higher education (Altbach, 1998). A successful result of this policy is the creation of the Indian Institutes of Technology (IIT), ranked as the 57th best overall universities in 2006 (Times, 2006). China's educational reforms have been successful not only expanding higher education but also upgrading the quality of the leading national universities to world-class status (Altbach & Umakoshi, 2004). Some of China's institutes of technology, such as Tsinghua University, are exemplary models of academic and research institutions. Mexico's technical institutes of higher education, such as the Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM), are gaining international recognition and catching up with the demands of a competitive knowledge-based market. The experiences of these countries in the area of education of technology in recent years can provide relevant lessons for other developing countries to follow.

5. RESEARCH QUESTIONS

•What are the institutional and academic differences in the education of technology among the most prominent technical institutes in China, India, and Mexico from the year 2000 to 2005?

•What are the differences between institutions in aspects related to objectives, assessments, and processes for improvement?

•What are the differences between programs in aspects related to objectives, assessments, and processes for improvement?

•What are the differences in aspects related to faculty such as hiring processes, size, commitments, interests, qualifications, scholarly activities and contributions, promotions, and advising?

•What are the differences in aspects related to admission of students?

•What are the differences in aspects related to advising to students?

•What are the differences in course descriptions, curriculums, credit hour definitions, prerequisite flow charts, and course requirements?

•What are the differences in laboratories?

•What are the differences in aspects related to institutional support and financial resources for faculty and students?

•What are the differences in aspects related to institutional facilities such as libraries, classrooms, student community areas, and faculty offices?

•What are the administrative differences in aspects related to finances, staff, and policies?

•What has been the economic impact of these technical institutions of higher education in the use and adoption of ICTs as a factor for economic development?

•What are the economic-socio-cultural similarities and differences between these nations that might validate or require qualification for generalizations between them?

6. LIMITATIONS OF THE STUDY

The framework selected for this research is a comparative-qualitative case study. Within the academic community there is an opposition to the idea of case study on the grounds of lack of rigor, small ground for scientific generalizations, and the massive collection and analysis of data (Yin, 1994). Although mathematical models can be useful tools for forecasting and policy simulations, they rarely take into account emerging trends that are not significant but are commonsense in the field (Kai-ming, 1997). Most of the quantitative research assume a passive role that is non-reflective and in which researchers might learn nothing during the process of the study or from their findings (Preston, 1997).

Scholars who conduct educational research in developing countries concur that although large-scale cross-national quantitative studies are important for the understanding of significant patterns in educational settings, case study frameworks are the most suitable approach for these type of inquires because their emphasis on social factors, in-depth fieldwork, and sensibility to local cultural contexts (Crossley & Vulliamy, (1997); Fry & Thurber (1989); Van Der Eyken, Goulden, & Crossley (1995)). Comparative education will miss making important contributions to the understanding of education if it does not participate in the development of case study approaches to educational processes and institutions (Stenhouse, 1979).

A particular problem for qualitative research is concerning with the degree of validation of the data which can be addressed in quantitative studies by the use of cross-checking and statistical tests. However, qualitative research can also be validated by the use of strategies such as audit trails and triangulation strategies. Qualitative data also have a particular problem for analysis because of the intrinsic textual characteristic of the information. Croosley and Vulliamy (1997) recommend a constant comparison strategy to address this issue.

Another foreseen limitation of this study is related to the degree of immersion in cultures and environmental settings. Deep understanding of culture, language, and the building of trust between interviewers and subjects are important factors for data collection, mainly during observations and open-ended interviews. A popular technique used to reduce the impact of these limitations is by working closely with a translator, who in many cases is a PhD student of the institution in observation, to help the researcher conduct interviews and understand linguistic and cultural factors. Nevertheless, being an outsider "is of a great benefit in an interview process because it enables very basic questions to be asked and explanations to be sought that would not be seen as necessary for a local teacher or researcher" (Davies, 1997, p.143).

For a more complete comparative analysis it would be useful to compare these three institutions with institutions from other countries that might have increased the use and adoption of ICTs but haven't had recent significant rise in the size of their service sector. A final potential issue that might result from this type of studies is to clearly determine causality between economic use and adoption of ICTs and economic development.

7. RESEARCH DESIGN AND METHODOLOGY

The methodology selected for this research is a descriptive multi-case comparative study. The outcome will be the interpretations of the data collected from the educational systems in order to understand their academic differences, their impact to each national economy by determining their contribution to the use and adoption of ICTs as a factor for economic development, and the economic-socio-cultural similarities and differences between these nations that might validate or require qualification for generalizations between them.

For research question number one which makes reference to the institutional and academic differences among the most prominent technical institutes in China, India, and Mexico from the year 2000 to 2005, the applied methodology will be a qualitative evaluation method (Posavac & Carey, 1997). This methodology includes surveys, direct observations, interviews with students, faculty, and administrators, and examination of program materials. This methodology is often applied to this kind of research to help researchers understand the programs and the relationship between the programs and the participants. Also it helps researchers to identify unique aspects of the programs and their settings (Strauss & Corbin, 1990). The methodology for interviews will involve the use of open-ended questions, in which the researcher will avoid questions with "Yes" and "No" answers in order to encourage the interviewed subject to elaborate and provide insightful information, and semi-structured surveys to understand the programs and to help the subject of interview use their own words, thought patterns, and values (Patton, 1980).

For research questions number two and three regarding the economic impact of these technical institutions of higher education in each national economy and the economic-socio-cultural similarities and differences between these nations, the methodology selected will be based on the Strategic Restructuring Framework for Analysis (SRS) (Wilson III, 2004). This methodology consists of collecting and analyzing data through participation of the institutions under study for the diffusion and adoption of ICTs based on their economic and socio-cultural structure, relationship with other institutions that promote the use and adoption of ICTs, and relationships with politics and government policies.

SUBJECTS

The institutions selected for the study are exemplary models of academic and research in each respective country. The programs selected for the study are in the areas of computer sciences, engineering, and technology. Surveys will be provided to administrators, faculty, and students in the last year of studies. For the interviews, student population will be selected randomly while faculty and administrative staff will be selected from key informants defined as the people who know the community well and "could be expected to know what community needs are going unmet" (Posavac & Carey, 1997, p.111).

INSTRUMENTS

The instruments selected for this research are based on the Accreditation Board for Engineering and Technology's (ABET) self-study questionnaire, which consists of a series of steps that institutions can voluntarily follow in order to auto-assess their programs in the areas of applied science, computing, engineering, and technology. The use of this self- study questionnaire is free of charge and it does not require a permission from ABET for its use (Van Tyne and Bond 2007). It can be download from the ABET website at www.abet.org.

ABET is a non-profit organization created in the United States in 1932 with the mission of accrediting higher-education programs in the areas of applied science, computing, engineering, and technology. ABET defines accreditation as a peer review process that ensures the quality of these programs. Accreditation is not a ranking system but simply assurance that the programs meet the requirements established by ABET. ABET is formed by 28 professional and technical societies and over 1,500 professional volunteers from academia, government, and the industry. Currently ABET has accredited 2,700 programs on 550 colleges and universities in the United States (ABET, 2007).

ABET does not accredit programs outside the United States because of differences at the institutional and pedagogical level in international settings. However, ABET evaluates these programs in order to determine if they are equivalent to the programs in U.S. The instruments selected for this study are an adaptation of the ABET self-study questionnaire in order to allow these international and cross-cultural differences to emerge, and make possible an adequate comparative analysis between the institutions selected. The instruments also include questions regarding the ideal citizen, and pedagogical questions in order to address issues related to the institutional theory, as well as questions about the contributions for the adoption and diffusion of ICTs as a factor for economic development.

VALIDITY OF THE INSTRUMENTS

In the 1990's the engineering community questioned the validity of the ABET instrument for accreditation. After one year of intense dialogue with the engineering community, ABET designed a new criteria known as Engineering Criteria 2000 (EC2000). In 2002 ABET commissioned the Center for the Study of Higher Education at Pennsylvania State University to evaluate a three-and-a-half-year study in order to assess the new adopted EC2000 criteria. Researches employed a cross-sectional, pre-/post-test design where students who graduated after EC2000 were compared with students who graduated before EC2000. Researches concluded that the EC2000 criteria "had a positive, and sometimes substantial, impact on engineering programs, student experiences, and student learning" (Lattuca, Terenzini, & Volkwein, 2006, p.12)

DATA COLLECTION

The collection of data will be non-participatory since the researcher will not be able to take a participant or active role in the research, but will have a passive role by collecting data, interviewing, and observing the institutions in order to developing an understanding of how the programs operate. Each college will be visited twice during a one to two week period.

ON-GOING DATA ANALYSIS

Qualitative research aims to generate theories and hypotheses from the data that emerge rather than testing preconceived theories avoiding the inappropriate use of frameworks of reference and providing the researcher with greater flexibility in the research design, data collection, and analysis (Crossley & Vulliamy, 1997). The qualitative characteristic of this study will require an on-going data analysis in order to encourage the researcher to review the approach and be able to amend or develop new strategies of inquiry when required. Additionally, the time gap between the first and the second visit will provide the researcher with an opportunity to analyze data and alter strategies if it is necessary.

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