

The potential influence of international exposure on engineering education in a Latin American Country

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ABSTRACT

Literature suggests that international exposure of faculty might enhance different skills and abilities which could be beneficial in the classroom. There is a limited amount of research that has been conducted with Latin American faculty trained abroad. In this paper we offer an insight of the influence that skills gained through international exposure might have on engineering education in a Latin American country.

Interviews were conducted with two Latin-American doctoral students in the US and Europe. Both were engineering instructors in their home country previous to embarking in international educational training and currently have teaching responsibilities in their doctoral studies. Findings suggest the relevance of the global perspectives gained from international exposure and the potential impact that this may have in the engineering classroom.

Keywords: international exposure, human capital, social capital, teaching, research

1. INTRODUCCION

Engineering education is not static, it is constantly informed by the context in which it is embedded and the external influences from an international environment. The underlying principles of education suggest the presence of individuals that due to their knowledge and experience in the subject of interest, such as engineering, and their embedment in their respective countries become engage in the diffusion of knowledge to other individuals (e.g engineering students). This benefits individuals as well as society in general. Engineering education is further influenced by educators which have mastered the basic principles of their field, or specialty in engineering schools, and have applied their knowledge in industry, academia or applied research thus gaining further experience and knowledge enhancement.

The endowment of educators has been studied under the principles of human capital (Becker, 1975). This theory would suggest that the skills, knowledge and competencies of an engineering educator would provide an enhancement to the human capital of others in the classroom. The level of human capital of an individual has been traditionally measured through years of schooling and experience. Indeed, an increase of the human capital of engineering educators is achieved through formal education. Nevertheless, the relevant mode of education has increasingly suggested the appropriate combination of research and practice (Khortagen, 2007) in which a social perspective would benefit both educators and students. We argue that such mode can be developed in the country of origin but also through international professionalization.

We refer to international exposure in education as the participation of individuals in activities that enhance their skills and competencies from education in a country different from their countries of origin. From this starting point the underlying question for this study is: *how could international exposure of doctoral students influence engineering education for a Latin American country?*

For potential engineering educators, we suggest that such exposure can be attained through the pursuit of a doctoral degree. This would suppose an increase of an individual's human capital, knowledge and skills that can later be utilized in teaching activities back to their countries of origin. Nevertheless the impact of international exposure has been mainly considered through the view of augmented human capital for an individual, the addition of qualifications in the statistics of international human capital development.

Literature suggests that the pursuit of a doctoral degree not only supposes an enhancement in human capital but also the development of social relations (Pole, 2000). Rarely a doctoral student will act in isolation. The process that leads to the achievement of a doctoral degree supposes the development of diverse relationships which can be beneficial in the future application of knowledge in an engineering faculty. We propose the consideration of social capital theory (Portes, 1998) to appreciate a broader view of international exposure and its potential impact for engineering education.

2. LITERATURE REVIEW

HUMAN CAPITAL

Human capital theory has been used in a diversity of studies, its premises have been considered in diverse contexts. Human capital is generally defined as "the knowledge, skills and competences and other attributes embodied in individuals that are relevant to economic activity." (OECD, 1998: 9). The human capital theory uses economic logic to postulate that the inventory of skills and abilities gained by an individual leads to productivity-enhancing choices. The sources of human capital are embedded in education and experience, and studies embarked accordingly on a quantitative measure of such sources. The prevalent view is that the higher the number of years spent on acquiring education and professional experience supposes a higher endowment in human capital.

This endowment includes both explicit knowledge, formally acquired in educational centres, and implicit (tacit) knowledge acquired during one's experience in a particular domain (Polanyi, 1998; Burt, 1992). Human capital, on a simplistic and instrumental view, suggests a strong emphasis on individuals and the benefits for institutions such as universities. The transfer of knowledge from educators to students is created in an effort to develop higher human capital in others. Such view mainly addresses assets that are hard to replicate and reside within the individual itself but that their transfer can be facilitated by the socialization that occurs in the engineering classroom. This socialization provides the educator with knowledge from his environment through the experiences of students when applying the knowledge and experience transferred. Human capital in engineering education then is also the result of a process which endows an individual with diverse resources to interact with his environment.

Further qualifications in engineering education such as a specialized doctoral degree would then suppose an enhancement in individual human capital through increased years of schooling and the amount of research and teaching conducted. The exposure of individuals to international contexts while pursuing their doctoral degrees would suppose that alternative and novel perspectives embedded in such milieus would also be attained, but at the same time, the educator, being aware of the peculiarities of their native context based on their previous teachings experiences endows them with potential challenges to traditional theories or bodies of knowledge. Such challenge originates in that in the socialization that occurs in the classroom, students can pose potential difficulties to apply traditional engineering knowledge in their every day experience (Butterfield & Nelson, 1989).

The educator then, when pursuing specialized research, can inform their potential interest on the particularities of their native contexts. For such human capital to be developed a common belief has been the international preparation of academics to later take academic positions in their countries of origin. Nevertheless, the impact of international exposure for the enhancement of human capital, suggest a very individualistic view, in which the contributions to the engineering education is based on the human skills and knowledge gathered by the individual that pursues doctoral studies.

Being exposed to diverse and novel theoretical and practical underpinnings would provide future educators with both new skills and knowledge to be applied on their respective countries (Austin, 2002). By bringing new

knowledge, individuals would be able to provide a different perspective for students and the society in general since the diffusion of such knowledge through universities and institutions of higher learning would increase individual human capital accordingly.

However, the pursuit of doctoral studies, strongly suggest that such process although supposes a gradual attainment of human capital, especially in research and teaching oriented activities, it also encourages the development of a social component, based on the previous and the future teaching and research experiences of educators. Then the view of human capital would be limited if social relationships developed in the doctoral process are not considered. We argue that human capital should be considered alongside social capital theory in engineering education.

2.2 SOCIAL CAPITAL

Social capital is relatively a new concept. Nevertheless it has been widely regarded in the study of diverse disciplines. It is proving to be adaptable to the study of many phenomena and its applications can be observed in studies of different disciplines (Portes, 1998) and diverse contexts such as Latin America (Portes and Landolt, 2000).

Contemporary studies pose that social capital is hard to define (Adler & Kwon, 2002). Nevertheless, the myriad of studies in diverse fields that have considered a social capital lens suggest that a basic consensus seems to exist in that it derived from social relations. It supposes the creation and nurturance of personal networks, based on relationships by and within individuals (Coleman, 2000).

Different studies pose that social capital differs from other kinds of capital in that it is not easily bought, sold, or traded, and contrary to residing within an individual, such as human capital, it pertains to the relationships between them (Coleman, 2000). The nature of social capital, i.e. whether it bonds or bridges or performs additional roles has also been the focus of discussion by some writers. For example, bonding social capital, refers to the relationships among one's own groups which strengthens ties, and bridging social capital, refers to relationships outside of one's own group which strengthens relationships and networks across different groups (Nahapiet & Ghoshal, 1998).

Based on such premises, we then purported in the pursuit of doctoral studies human capital develops in parallel with social relationships. This occurs at the bridging and bonding levels, the former with supervisors and in latter with colleagues of different nationalities in the doctoral course. On the former aspect, social capital theory would advocate that the frequency of contact between a doctoral student and a supervisor, or several, gradually develops social capital. In the latter aspect, further relations are developed with fellow doctoral students in joint research, as colleagues (Bozeman & Corley, 2004). We then argue that investigating international exposure of future educators through the lens of human capital alone provides a limited account of the impact that international exposure can achieve for educators. We approach this issue through the consideration of skills and competencies that doctoral students can gain and the relationships they develop over time.

2.3 RESEARCH METHOD

Qualitative studies provide rich contextual evidence surrounding sensitive issues when aspects have not been explored in depth (Yin, 2000). Furthermore, they are depicted as an ideal approach when comprehending interactions, which can lead to identifying broader patterns and processes in an exploratory intent (Eisenhardt, 1989).

Due to the current involvement of the researchers in international exposure, two cases were selected. Basic criteria for the chosen individuals was that they would be pursuing doctoral education in a country different from their country of origin but would come from the same country, close to finish their doctoral degrees (< 1 year), and consider themselves as potential educators in their country of origin once they finish. Prior to the interviews, different theoretical constructs were identified from literature that referred to human capital attained and social relationships developed.

The interviews provided relevant information of the interdisciplinary of their human capital, the type of relationships developed and the potential impact perceived out of their international exposure for the future.

3. CASES

Case A

Doctoral student A got his industrial and systems engineering degree in UNITEC Honduras. This student has worked on governmental and private organizations both in his country and abroad. His teaching experience includes courses in decision making models, logistics and production and technology management. His studies abroad include post-graduate degrees in engineering and management. Family support and international scholarships provided the opportunity to study abroad. Has presented research findings on several conferences and has published at international level with academics and doctoral colleagues. Currently in his final year of doctoral studies sponsored by a British Scholarship scheme.

Case B

Doctoral student B got her industrial and systems engineering degree in UNITEC Honduras. This student has worked in the manufacturing department of a multinational company in Honduras. Her teaching experience includes production control, inventory systems, and operations research. Her post-graduate studies include a master degree in business administration with a concentration in finance. Currently in the final year of doctoral studies sponsored by the LACC scholarship.

A summary of the cases is provided in Table 1.

Table 1: Background

Background	Case A	Case B
<i>Native country Exposure</i>	Honduras	Honduras
Years of schooling in engineering	7	8
Years abroad	5	4
Previous Experience in industry	Aerospace, retail, government.	Manufacturing
Previous teaching experience	Decision making models, logistics	Inventory systems, operations research
<i>International Exposure</i>	UK, Canada, US	US, Mexico
Doctoral studies	Management	Industrial Engineering,
Current teaching load	3 courses	2 courses
Research	Entrepreneurship	Emergency Management
Conferences	3	2

4. ANALYSIS

THE INFLUENCE OF INTERNATIONAL EXPOSURE IN HUMAN CAPITAL

The cases suggest diverse findings on the skills and capacities attained by international exposure.

Research: The research activities that doctoral students undertake have to be founded on theoretical frameworks that demand the command of diverse techniques and bodies of knowledge. Although basic techniques have been known to the students, the use of new software allows them to conduct their investigations with novel resources. Case B expressed "...there is the awareness that when you research you are taking your own knowledge beyond, the different techniques that we are using are based on both the existing knowledge in engineering but also in new techniques...you learn to master diverse techniques to conduct your own models and experiments in new software..". Case A suggested "...the principles of basic research have to be mastered, you cannot do good research until you acquire the knowledge of how to conduct it, previous knowledge is greatly improved because of the use of new tools...these tools are often brand new, being here [abroad] allows you to pioneer the use of them". The

advantage of international exposure as Case B suggested was that such knowledge was provided "...by people that are the leading practitioners of such methods, they come from all over the world to sharpen your skills, it is a great advantage".

Both cases posed that their skills got grounded in research modules designed to increase their knowledge in quantitative and qualitative methodologies with corresponding novel software tools, techniques and a collective approach to research couched by experienced supervisor. Both of them had to become proficient in diverse research methods that demanded both individual and collective approaches.

Teaching: Both students had to teach courses in their fields of study as a requirement of their scholarships. On average three courses per semester were taught by each. Case A suggested that teaching got improved for two reasons, first a more diverse array of teaching methods and also the concentration of teaching to frame the international student diversity found in their institutions. He expressed "...here not only you have to diversify your ways of teaching, but also you have to consider that your knowledge has to be varied because you will have people from Asia and Europe asking you questions in your classes. These questions are always context based and you have to acquire knowledge as well about their context in order to answer accordingly".

Case B suggested "...there is always the awareness that you teach to a broader audience, you have to prepare to provide a simple theory and prone students to imply whether it is applicable in their countries or not". They further suggested that international exposure allowed them to attain skills in teaching that cater difference modes of learning case B suggested "...they all learn different [international students] and so you have to be more knowledgeable of diverse methods to deploy a course". We can interpret that besides human capital enhancement in the experience to handle an international classroom; several experiences can be shared from colleagues from diverse cultures in a PhD program about teaching complex subjects to students. Such skills are enhanced over time as they have to re-engage each semester in teaching diverse courses and using diverse assessments and techniques both for research and teaching (Karagiannopoulou, 2006; Olds et al., 2005; Brown & Atkins, 1998)

5. THE INFLUENCE OF INTERNATIONAL EXPOSURE IN SOCIAL CAPITAL

Student and supervisors: Case A suggests that international exposure provides them with a strong professional relationships with mentors. He suggested "...you develop a relationship gradually with your supervisors, both you and them come from diverse cultures and you feel you are an apprentice, you are learning to become a researcher, and no better person to guide you in that process that your supervisors, their experience aids tremendously when you are doubtful about your methods, your data and the way you should teach in different environments" Case B expressed "...that is the most important relationship, your supervisor will guide you through the PhD since they have already done it and have supervised other students, such a relationship provides you with what you need to survive this process"

Such view suggests a bonding social capital, since the relationship is built gradually. Both cases pose that a linear relationship in which a cognitive consensus forms. The process entails that by periodically discussing ideas and monitoring the progress in the PhD a sustainable relationship develops between the student and supervisor. Interestingly, it would imply that despite the difference in cultural background a cognitive dimension is developed, since shared meanings and understandings begin to develop in the theoretical and empirical framework that would develop a PhD thesis. Furthermore, the relationships with supervisors develops into a mentor-apprentice stage in the teaching environment (Beaudoin and Felder, 1997) since supervisor's advice and experience helps develop the appropriate ways in which a multicultural classroom is to be approached.

Student and colleagues: Both cases suggested the importance of the social relations with colleagues. Case B suggested "...we all come from different countries, but I notice we all have the same understandings about engineering issues, hence I can talk with a person from India about stock and discuss about the different theories, we have the same understanding ". Case A suggested "...when we approached a unit of analysis, we are given diverse theoretical frameworks to work with, we can be positioned at the same level and discuss aspects that pertain to the way each of us sees the world, then you see where the differences in applying theory lies".

Both cases suggest that when PhD studies are undertaken abroad, the discussion of ideas between colleagues not only helps understanding the theories and methods used but also suggest potential research avenues (Bozeman &

Corvey, 2004). Both students are in process to make comparative studies, such as this one, with students from other countries, based on the shared understandings that they have but aware that the peculiarities of their own context can provide interesting research venues. By collectively approaching research, these students develop both bonding with diverse researchers that can be later exploited in the collaborative approach to study specific phenomena. Hence international exposure provides students with the basis of long-lasting relationships which, if maintained, can be useful in the future.

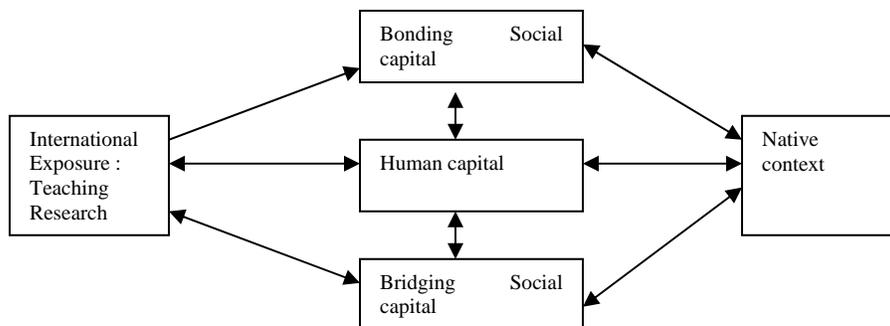
Student and the academic community: The academic community is represented by an interdisciplinary range of individuals which based on their own fields can collaborate in multiple arrangements. Case A suggested "...you have the advantage that you can meet with leading academics in diverse fields that come from all over the world, you can then chat and out of such informal chats convey new studies and potentially the outlook of new findings". Case B suggested "...you can take your ideas and discuss with a wide range of specialists, I see for example the application of my field in the overlap between engineering and entrepreneurship and I can take advantage of top researchers in both fields to get more information and to see whether I can contribute as well.... this international environment gives you that chance."

Both cases suggested that the structure in academic institutions due to the position of the student to access a wider network provides them with valuable information. We can suggest that such position is relevant in bridging between several academics and hence be fruitful when new interdisciplinary studies are conducted. It impacts on the way new fields are embedded in future engineering course curricula and research (Wang & Kleppe, 2001).

6. DISCUSSION

Engineering education can be greatly enhanced by the international exposure of educators. The increases in human capital a doctoral pursuit provides influence the skills in research and teaching an increasingly international classroom. Furthermore the outcomes from relationships established suggest an individual with extended networks of contacts that can influence both teaching and research. Such endowment of both human and social capital can potentially transpire into the country of origin given that institutions provide access to research context, industry and the wider academic community. Furthermore, we have, in a very timid way, provided exploratory evidence that social capital is also constructed in the relationships that are developed in such exposure. We, as researchers, attempt not to make such concept vulnerable to a mere simplistic application. We argue that the use of social capital permits new ways of thought, conceptualizations and empirical work to be conceived in the development of engineering education in Latin America in the basis of a collaborative view.

The cases suggested that both bonding and bridging occurs due to international exposure. Bonding occurs in the dyadic relationship between supervisors and doctoral students, strongly based on both relational and cognitive bases creating a strong base of social capital. Bridging occurs with peers and colleagues in the doctoral program based on structural and cognitive issues. Both shared understandings and relational structures contribute to initiate and cement long-standing relationships between colleagues, supervisors and the academic community in general. We argued that human capital was not sufficient to explain the potential influence of international exposure for engineering educators, our evidence suggest that it is on the relationships between different actors that the greater impact is observed with potential repercussions in the future when doctoral students return to their countries of origin. We can then propose a basic conceptual framework in which we ascertain that international exposure influences both human and social capital. In doing so, the professor can have a benchmark to develop collective studies that address the particularities of their context once they return to their countries of origin. (Figure 1)



7. FUTURE RESEARCH

Interestingly individuals that embark in doctoral studies abroad of their native countries have the opportunity to contribute in bringing forward the peculiarities of their own context to suggest the generalization of existing theories and develop interdisciplinary studies that can then be applied in their countries of origin. This aspect can be further researched in the context of pursuing PhD studies. Furthermore, there is work to be done in measuring the real impact of international exposure in the classroom by conducting quantitative studies that provide a better scale of the potential influence.

8. LIMITATIONS

Our research was limited in several ways. This study considered the development of social capital while pursuing doctoral studies, a longitudinal study would be needed to further access the impact of such international exposure after individuals return to their countries of origin. Furthermore, the study fails to provide as well a more detailed account of other parties involved, for instance, supervisors and other colleagues, results would be more robust if a multi-respondent approach was taken. We are conscious of such limitations and encourage researchers to consider them if a similar study is to be conducted or built upon this article.

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