AC 2010-2152: PREPARING UNIVERSITY STUDENTS FOR GLOBAL WORKFORCES: COMPARISONS BETWEEN ENGINEERING AND BUSINESS SCHOOL STUDENTS

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Preparing University Students for Global Workforces: Comparisons Between Engineering and Business School Students

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Abstract

There is a growing concern among universities that students in undergraduate and graduate engineering and business programs will be unprepared or underprepared to work in global workforces. In their 2005 publication, *Engineers for 2020,* the National Academy of Engineering (NAE) urged university engineering schools nationwide to embed curriculum and assessment measures into academic programs that provide opportunities and associated assessment metrics to meet this international challenge. Specifically, the NAE charges universities and colleges to prepare engineers that are leaders in global engineering fields with strong communication, leadership and interdisciplinary research, and professional skills in diverse in engineering environments. Businesses, and business school have similar globally focused charges.

This paper describes a university's response to an important challenge of preparing students for global workforces. This paper describes assessment metrics related to preparedness for working in diverse globally focused engineering and business contexts. In this study, engineering and business school students received interdisciplinary globally focused training via their coursework, research and international field experiences and were assessed as to their preparedness to work in global workforces, research, and diverse environments. Accordingly, global preparedness index was developed and administered to assess the impact of diverse educational and research experiences summatively. Results of this important assessment metric were compared across programs and to students' course grades, work related efficacy, international field experiences and outcomes-based academic program success. Results of this research indicate that engineering and business students who were most globally prepared were also most efficacious, had international experiences, and received higher grades in courses. Additionally, diversity in preparedness among the subscales of the index was noted, suggesting that students with diverse socio-demographic profiles had diverse preparedness indices.

Keywords: Global, global preparedness, engineering education, business comparisons, preparation for global workforces

Introduction

We live in an era with unprecedented changes due to dramatic advances in technology on many fronts. The explosive growth in computing and communication has revolutionized the way we work and live. Increasingly, both engineering and business work forces are becoming more diverse with teams working with global foci. The forces of globalization, demographics, and technological advances are changing the role of both the engineering and the business communities in society,[1] identifying a significant challenge in the way universities address the diverse professions, university education, and associated university student assessment processes.

There have been many national studies about critical issues facing universities regarding engineering and business education.[2, 3] With the world becoming "flat" due to globalization, increasingly, jobs requiring basic technical and business skills are moving outside of U.S. by companies to reduce cost. United States college graduates must bring higher-level skills including innovation, a problem solving approach, and leadership to their workplace. Accordingly, there are recent reforms in university education as efforts to meet the changing needs of engineers and businesspersons nationally and globally. Unfortunately, sparse research exists that comprehensively assesses and evaluates the outcomes associated with such recent university education reform efforts.

Traditionally, university education involves deductive instruction and associated assessment in which the faculty lecture on general principles with limited application of the principles to real life globally focused engineering or business situations and simulations. As such, the primary focus of current assessment is simply on testing students on fact focused lecture materials resulting from deductive instruction. Deductive instructional approaches and static assessment with such pedagogical practices have significant limits in preparing engineers and business students for a changing global society and for measuring their preparedness as required by the National Academy of Engineering (NAE)[2,4] and other professional agencies. The necessity for university education reform requires radically new, innovative, and closely aligned curricular and assessment approaches. Such approaches must solve important worldwide business and engineering problems and measure preparedness for employment with global impact.[5]

Global Preparedness in STEM Education

Science, technology, engineering, and mathematics (STEM) undergraduate and graduate programs in the United States are dominated by international students. Specifically, foreign students make up 47% of all graduate enrolments in engineering in the U.S. Accordingly, other nations are outpacing the U.S. in producing scientists, and engineers. Of all undergraduate degrees awarded worldwide in science and engineering, 72 % were awarded outside the United States. Similarly, of all doctoral degrees earned worldwide in science and engineering, 78% are earned outside the United States.[6] Blumenthal and Grothus[7] posit that "engineers need global competencies and multicultural skills as much as any other professionals." Additionally, the NAE[2] requires that engineering students be prepared for global workforces. Business schools face similar calls from their respective professional societies. Both engineering and business schools require global preparedness however, they have great difficulty measuring their students' preparedness for global markets.

Global preparedness cannot be measured with a traditional examination as it involves difficult to measure constructs that fit together as metrics of preparedness. Throughout the past two decades, researchers have attempted to measure related constructs such as citizenry and readiness for global workforces. Unfortunately, none of these metrics have been precisely aligned to career preparedness in the way that this paper intends to describe. As such, there is currently sparse research on global preparedness of business and engineering students. In an effort to meet challenges put forth by various professional societies, this paper addresses an assessment comparison between engineering and business students on preparedness to work in global workforces.

Research Design and Metric Development

After exploring appropriate metrics in engineering and business education that measure students' preparedness for global workforces and discovering that there are no such metrics, the researcher sought to design a measure to measure these important constructs. The engineering and business fields were chosen to be measured and compared as they are two career areas where preparedness for global marketplaces is critically important.

Prior to designing the domain specific instruments for business and engineering, the researcher was closely involved with an international research group that attempted to measure global citizenry. This group developed an instrument to test the constructs associated with global citizenry for students preparing for diverse professions. Through review of this instrument, it was posited that perhaps global preparedness was domain (or career trajectory) specific. Accordingly, this researcher set out to utilize some of the constructs associated with the generic global citizenry instrument that she had co-designed and tested, to design a domain specific global preparedness instrument. As previously described, two fields (domains), which often required global foci were of primary interest: engineering and business. Global preparedness in these two domains or fields is compared in this paper. Accordingly, the primary research questions addressed in this paper are: *How can we best measure the global preparedness of graduate and undergraduate engineering and business students? What are the differences in preparedness between the two domain specific student groups? Which elements of student profiles best predict global preparedness within and across the two student groups?*

In designing both the engineering global preparedness index (EGPI) and the business global preparedness index (BGPI), similar subscales of the previously described generic global citizenry instrument were utilized as these subscales have been closely aligned to global theory. To make the instrument domain/field specific, the individual survey items were altered within the subscales to reflect engineering and business foci. This paper presents the pilot comparative research results from implementation of the two domain specific indices. Methodologically, the engineering global preparedness index (EGPI) was designed, reliability and validity tested first and then from these results the instrument was adapted a second time to reflect business-focused items. The following seven subscales were utilized in creation of the two global preparedness indices.

> *Ethic of Responsibility:* Deep personal and care concern for people in all parts of the world; sees moral responsibility to improve conditions and take action.
>
> *Cultural Pluralism:* Appreciation of diversity of cultures and dispositions: belief that all have something of worth to offer; enjoyment of exploration and trying to understand other cultures.
>
> *Personal Efficacy:* Belief that one can make a difference; support for personal involvement in local, national, international issues and activities towards greater good.
>
> *Global-centrism:* Valuing what is good for the global community, not just one's own country or group; making judgements based on global not ethnocentric standards.
>
> *Interconnectedness and Global Kinship:* Awareness of humanity and appreciation of interrelatedness of all peoples and nations; global belonging or kinship as member of "human family."
>
> *Skilled Disposition and Open-Mindedness:* Valuing of alternative perspectives and points of view; ability to suspend judgement and change one's views;

collaborates and interacts with others as part of the process of forming one's position on issues.

Peaceful Resolution: Commitment to and belief in peaceful resolution of conflict; belief that even competitive activities should adhere to principles of non-violence.

Initially, there were 60 items on the Index with 6-8 items per subscale. Once reliability testing was completed, the index was shortened to 30 items with 4-5 items per subscale to avoid item response bias. This item distribution and scale number is supported by item response theory for designing difficult to measure constructs[8] with maximal reliability and validity. Table 1 (below) provides sample items for each of the seven subscales in each index and includes the reliability coefficient for each subscale. An alpha value (α) of > than .75 indicates high reliability (per statistical research). In terms of adaptation from engineering to business indices, the word "business" was substituted for the word "engineering" in all approriate items for the purpose of measuring domain specific student groups. Most of the items were otherwise left intact when possible in adjustment for domain so that the construct and item comparisons between business and engineering were content plausible.

Table 1: Sample items with adjustments by construct with relibility indicators

Subcale	**Sample Item**	**Relibility Coefficient (α)**
Ethics of Responsibility	Engineers (or business people) in my country have a moral obligation to share their engineering (business related) knowledge with the less fortunate people of the world.	.78
Cultural Pluralism	Enhancing a person's ability to be part of a multicultural society and global engineering (or business) economy should be part of higher education in today's universities.	.72
Personal Efficacy	I believe that my personal decisions can affect the welfare of others and what happens on a global level.	.86
Global-centricism	I think my country needs to do more to promote the welfare of different racial and ethnic groups in engineering (or business) industries.	.79
Interconnectedness and Global Kinship	To treat everyone fairly, we need to ignore the color of people's skin.	.82
Skilled Disposition and Open-mindedness	I try to consider different points of view on an issue in my work before making up my own mind, even when I have a strong first impression.	.91
Peaceful Resolution	If people in engineering (or business) industries were treated more fairly, there would be fewer problems and less conflict and disagreement in this country.	.90

In concert with item response theory, in addition to item per subscale minimums, one to two items per subscale were reverse scored items in support of best practice in survey development. Although at first, the researcher used a 5-point Likert type scale in reliability and validity testing of the EGPI, once validity testing was completed on the EGPI instrument, a four-point Likert type scale was adopted for the index to avoid neutral (or non-commital) item response.

In addition to reliability testing of the instrument, the researcher engaged in a cognitive interviewing technique to test the content validitity of each index item for both the business and engineering indices. Accordingly, four Ph.D. students completed the two draft indices and then were cognitively interviewed to provide the rationale that they followed for making response choices. Woolley, Bowen and Bowen describe such cognitive interviewing as having the

individual discuss the message behind his or her responses.[8] These scholars'[8] measurement research has provided great credibility for this validity technique as a powerful and viable means of developing content validity of survey-type instruments. Once the cognitive interview data were collected and appropriately analyzed, all index items for both indices were adjusted according to the results of the set of cognitive interviews. Once the researcher was satisfied with the index items, the index was piloted with undergraduate and graduate engineering and business students.

Study Population

As previously described, the study participants were a broad group of engineering and business students both at undergraduate and graduate levels at a major research university. A total of 238 students participated in the study. Equal numbers of engineering and business students were included in the sample, with 26% of the students being international students and a 26-57% split between female and male students respectively. This popuation diversity was deliberately selected using purposeful sampling in an effort to test diverse variables associated with global preparedness during the study.

Study Results

The results of this comparative study are intersting and diverse. They vary greatly by degree objective and subscale construct. While this is a relatively modest study size-wise, the results provide important information that informs researchers, university personnel, and practitioners about the importance of training engineering and business students for global workforces and also monitoring their progress as they prepare for globally focused engineering or business fields.

Figure 1: Global Preparedness Results

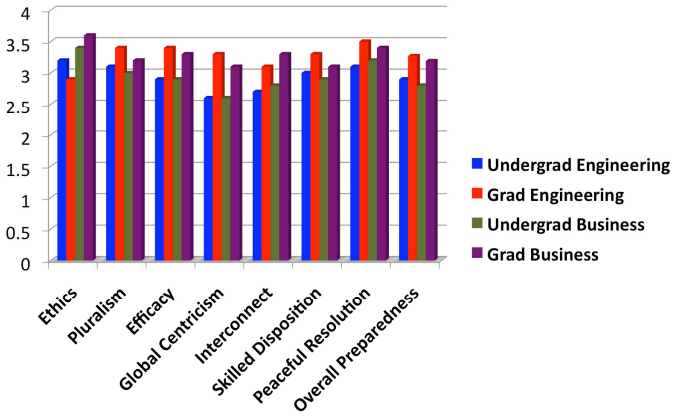

Figure 1 describes the means for each of the subscale constructs. It offers a comparison by subscale means across student groups, divided by the students' career objective and university major.

It is interesting to note that the means of the various subscales vary greatly. The graduate engineering students in the study sample had the strongest global preparedness overall (m=3.27). This subgroup of students had higher subscale means in all areas. This could be explained by the advanced age and experiences inside and outside of the university of the graduate engineering and business students and the fact that more engineering and business graduate students had international experiences than any other subgroup in the study. Both the graduate engineering and business students in general had higher mean global preparedness across scales when compared to their matched field/domain undergraduate students, however in the area of ethics of responsibility, the undergraduate engineering students (m= 3.20) had higher mean scores than the graduate engineering students (m= 2.97). Perhaps, this particular subscale indicates the undergraduate

engineering students' propensity for altruism. Aligned with human development theory, altruism often decreases as adults' experiences increase, because cynicism often sets in as a result of experiencing negative life experiences longitudinally.

Overall, the highest area of global preparedness in this study was in the area peaceful resolution (mean range = 3.1 to 3.5) and the lowest area of preparedness was in global centricism (mean range = 2.6 to 3.3). Importantly, the skill of peaceful resolution is a skill that may be closely aligned to the political ideology of many young US students today (particularly during our present war time). In this study, global centricism varied greatly in the university students. This skill may be more difficult for students to understand and accordingly, may be more difficult to accurately measure.

In addition to comparing the two student groups (answering the study's first two research questions), an effort was made to determine which sociodemographic and experiential factors best predicted global preparedness in th students (the study's third research question). This question was posed in an effort to determine if particular experience sets found to predict global preparedness could be scaled-up and expanded to benefit engineering and business students. To determine predictive factors, correlational analyses were performed with both sociodemographic and experience related independent variables for the students. Results of these analyses revealed the following. There were no significant gender differences in the students' preparedness. Results also indicate that engineering and business students who were most globally prepared were also most efficacious ($r=.279$, $p<.05$), received higher grades in courses ($r=.392$, $p<.05$). The students' national heritage was a strong predictor of students' preparedness ($r=.438$, $p<.05$). Students from other nations now living in the United States scored as more globally prepared than their domestic peers. International experiences also predicted global preparedness in this study ($r=.351$, p,.05). Students who experienced an international student exchange (for greater than two weeks) scored as more globally prepared than those with no international exchange experience.

Discussion and Future Work

This paper presents research on the results of relatively newly designed domain/field specific global preparedness indices for engineering and business students. Results of this study are preliminary as the population sample size is modest (N=238). These indices provide researchers and university educators with insight as to the "soft skill" training areas and experiences that must be provided for undergraduate and graduate students to be fully prepared to work in global societies. Specifically, the indices revealed that international experiences are important predictors of global preparedness and accordingly should be encouraged in both engineering and in business university programs.

Indices of global preparedness are important tools for measuring engineering and business students' readiness and preparedness for global workforces and marketplaces. The described indices can be used with diverse university students in their specific fields provided that the indices are adapted to match the domains of the specific field that they intend to measure.

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