



First Learning, then Lifelong Learning: Engineering Study Abroad to Increase Access and Retention among Minorities and Under-represented Groups

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Introduction

In today's increasingly global economy, there is an urgent need for a diverse engineering workforce, representing self-confident and culturally literate individuals who are able to tolerate ambiguity as well as empathize with the socio-cultural nuances of different people groups. However, according to the American Society for Engineering Education's (ASEE), *Going the Distance* report, 53.6% Hispanics, 61.4% Native Americans, 61.7% African Americans and 49% Female students who enter engineering programs do not graduate in this major.¹ This translates to an engineering workforce that comprise of about 6% Hispanics, 0.3% Native American, 4% African Americans and 13% females according to the latest National Science Foundation's report.² With such high attrition rates among minorities and underrepresented groups, changing the current engineering workforce's diversity portfolio is of grave national importance and requires a plethora of high impact approaches. In the aforementioned ASEE report, over 60 strategies and best practices were proposed. High impact practices included first-year seminars, internships, learning communities, and capstone projects compared to only two anecdotal references to study abroad.

This paper postulates that ABET's Student Outcome 3(h) "*the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context*" and Student Outcome 3(i) "*a recognition of the need for, and an ability to engage in lifelong learning*" are not mutually exclusive but rather interdependent and mutualistic in nature. Outcomes by their very nature describes what students should know or can do by the time of graduation. The implication is therefore, that lifelong learning and a global perspective must originate within the 4-year engineering curriculum/program. The proposition being advanced here is that the mutualism emerge from the commonality of the underlying skill sets required for success in achieving these two outcomes. That is, the skills required to persist and arrive at the end of one's undergraduate engineering program having acquired a "*broad education...*" are consistent with those that drive engagement in lifelong learning. Further, the case is also being made, that the study abroad experience engenders, facilitates and fosters these very competencies and must be seriously considered among high impact practices currently being employed to increase underrepresented participations in engineering programs.

What is lifelong learning and what are the attributes of lifelong learners?

In his seminal work, Philip Candy³ conveyed, "*lifelong learning takes, as one of its principal aims, equipping people with skills and competencies required to continue their own self-education beyond the end of formal schooling*". Taking responsibility for one's education is more important today than ever before as the "*half-life*" (i.e., time before half of what is known becomes obsolete) of an engineer's undergraduate technical skills rapidly decreases, which for some disciplines can be less than 2.5 years.⁴ What therefore are the mental characteristics as well as attitudes of the individual who will continue their self-education beyond graduation?

To propose traits of lifelong learners, research in this area typically utilize the domains of learning framework which was developed to identify, measure and address how and why people learn. This construct theorizes that learning occurs on a continuum whereby growth and changes to the brain's architecture results from the ways the learner acquire information, make connections and apply what they know.⁵ It categories learning outcomes into learning domains such as cognitive (mental skills/knowledge) and affective domains (attitude/value). According to Bloom's taxonomy of educational objectives, the cognitive domain consists of six progressively complex levels of competencies (i.e., knowledge, comprehension, application, analysis, synthesis and evaluation).⁶ The affective domain describes the learner's personal motivation and interests and, consists of five proficiency levels (i.e., receiving, responding, valuing, organization and characterization).⁷ The consensus is, to subsequently be a lifelong learner, a graduating senior must, at minimum, demonstrate proficiency at the analysis and organizational levels in the cognitive and affective domains respectively.^{8,9} Here cognitive analysis is defined as "*students are able to deal with ambiguity in new, ill-defined situations by formulating models and seeing relationships*", while affective organization proposes that "*students are able to balance their responsibilities and formulate a cohesive and systematic approach to learning*".⁸

These two proficiencies work in tandem to promote learning. For example, a new ill-defined situation or problem requires analysis wherein prior knowledge and/or skills are used to deconstruct concepts, to examine the interrelationships of the parts and determine their contribution to the whole. While organization employs compare and contrast strategies to resolve conflicts between prior knowledge and the new challenge in a systematic effort to create a consistent value system. Both skills are thus used iteratively to formulate new mental models that will facilitate inquiry, reflection and application of the newly acquired knowledge to future encounters. In their groundbreaking work, Felder and Silverman¹⁰ concurred, "*most of what we learn on our own (as opposed to in class) originates in a real situation or problem that needs to be addressed and solved,...*".

Mourtos⁸ offered the following link between the learning framework and Student Outcome 3(i) "*a recognition of the need for (affective - organization), and an ability to engage in lifelong learning (cognitive - analysis)*". Thus, the potential lifelong learner must at some point in their academic career develop value for information that pertains his or her discipline and has a strong enough sense of self-efficacy to be intrinsically motivation to independently learn. Concomitantly, in exploring his or her discipline, the student will face new, ill-defined and challenging tasks which require concerted, systematic and extended efforts in order to succeed and subsequently graduate. These principles are similarly applicable to Student Outcome 3(h) "*the broad education necessary to understand the impact (cognitive – analysis) of engineering solutions in a global, economic, environmental, and societal context (affective - organization)*". Given the rapid pace of new engineering solutions, subsequent impacts will similarly change. Thus, at the very heart of this outcome is the need for in-the-moment learning and future continual lifelong learning.

Why students drop out (stop learning) and why minorities are at greater risks?

Overall, the dropout rate for engineering programs is high, with between 40% to 50% of students switching to other majors within the first two years.^{11,12} However, there exist demographic disparities and minority students drop out at significantly higher rates.¹ The problem of minority underrepresentation in engineering correlates to several factors, such as level of pre-college

preparation in a highly sequenced and vertically organized curriculum¹³. Socio-economic status is a strong predictor of college preparedness. For example, there are higher proportions of minority students, under age 18, living in poverty (e.g., Whites (13%), Black (39%), and Hispanics (33%)).¹⁴ Large proportion of minority students attend urban high-poverty schools. For instance, 34 % of students in urban/city, compared to 13% of suburban areas were enrolled in high-poverty schools. In contrast 35% of students in suburban areas were enrolled in low-poverty schools compared to 15% in urban/city schools.¹⁵ High poverty schools tend to lack academic and financial resources and tend to have inadequately trained teachers. Thus predominantly minority schools tend to have underqualified teachers. The percentage of teachers with a college major and standard certification in their main teaching assignment for schools with more than 50% Whites, Blacks and Hispanics enrollment are Mathematics (65.2%, 48.6%, 44.8%) and Science (73.3%, 57.3%, 64.7 %) respectively.¹⁶ In high school, minority students tend to be placed in general academic tracks, do not have access to college preparatory classes and are less likely to do well on standardized test for gateway courses such as Calculus. For example, Blacks are three times less likely to be enrolled in Calculus compared to their White peers (e.g., Hispanics 9%, Blacks, 6%, Whites, 18%).¹⁷ For the National Assessment of Educational Progress 12th-grade Calculus exam, students in high-poverty schools scored less (163) compared to students in low-poverty schools (199).¹⁷ According to Haycock¹⁸, 12th grade African American and Latino students had skill levels in Math and Reading similar to 8th grade White students, a disparity that persists into postsecondary education. Therefore, minority students tend to be academically underprepared for highly sequenced majors such as engineering that demands specific levels of competencies.

While academic underpreparation certainly plays an important role in whether or not students persist in engineering programs, some interesting research findings indicate that women and students of color more often than not, dropout due to a loss in confidence and a feeling of “*lack of belonging*”.^{11,12,19} In fact, researchers corroborate that differences in learning abilities and rates among students only slightly correlates to natural ability.^{20,21} In addition, studies into how and why people learn, have indicated that students’ attitudes (affective development) was the best predictor of intellectual achievement (cognitive development) and subsequent academic buoyancy or resilience.²²⁻²⁴ When racial factors were controlled for, it was found that anxiety, which is strongly influenced by ethnicity and gender caused low academic performance and women were more negatively affected.²⁵⁻³¹ Of particular note is the fact that the preceding citations referred to national and international Math and Science studies which are *sin qua non* for gaining admission to and advancing through engineering programs. These findings provide strong support for the hypothesis that students, especially women and minorities tend to dropout, not because of underpreparedness per se, but loss of self-efficacy or confidence in their ability to learn, which incidentally is also requisite for lifelong learning. It follows therefore, *ceteris paribus*, providing structured opportunities for minority and underrepresented students to develop self-directing competencies facilitate the skill sets they need to both successfully learn and complete engineering degree programs, as well as participate in future lifelong learning.

Study abroad as a structured opportunity to develop self-direction

Spatial mobilization of the engineering sector predicated by a global economy as well as engineering program accreditation requirements for students to have “*the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context*” have led to the market demand for more culturally savvy

engineers. Studying abroad is a great way to satisfy these demands as well as have impact on students' personal and academic development³². Study abroad exercises students' cognitive analysis, affective organizational skills as well as self-efficacy, which is a proximal predictor of proficiency in both these domains.³³ Self-efficacy is, "*an individual's judgments of his or her capabilities to perform given actions*".³⁴

Indeed, study abroad can be very challenging, as culture shock requires adjustment to the host culture, and may also elicit "*feelings of not belonging*".³² However culture shock provides students with opportunities to "*deal with ambiguity in new, ill-defined situations*". Felder¹², describes the cognitive development trajectory of college students as a continuum of knowing everything, "*ignorant certainty*", recognition that context determines answer, "*intelligent confusion*" to a point where students begin to trust their own process of organizing their learning and judgment. A similar process occur during the study abroad experience. According to self-efficacy framework and intercultural transformation theory, study abroad participants' equilibrium are disturbed when seemingly familiar interactions occur without familiar signs or social cues. This cognitive dissonance leads to "*identity confusion*" an analogous to "*intelligent confusion*".³⁵ Each such interaction, however, leaves the student better equip to handle similar encounters because of "*greater cognitive and affective capacity*".³³

Moreover, by its very nature preparing to study abroad and actually going abroad requires setting and achieving a set of goals. From planning when to study to applying for a passport, each step provides opportunities for students to set goals and get feedback on how well they are doing. In self-efficacy theory, goal setting is an intervening or moderating process towards achieving self-directed learning.³⁶ Students who perceive themselves as having low self-efficacy in engineering, will avoid engineering-related activities, employ minimal effort and will not persist.^{34,37} However, the process of leaving one's country and surviving cultural differences in another, especially, if the student is the first in the family to do so, creates a deepened sense of belief in his or her abilities. Goals therefore mediate an individual's acquisition of learning and lifelong learning skills by rallying effort and persistence as well as encouraging the organization of action plans to creatively solve problems. Exercises in goal setting increase individuals' task performance, self-efficacy, and intrinsic interest in a specific task and related skills.³⁸

Engineering study abroad

The preceding discussion showcases study abroad's potential to not only increase self-efficacy, but to assist in building learning and lifelong learning capacity. The leaving of one's country, independently learning how to assimilate into the host country's culture without direct support from one's social network is analogous to independent pursuit of learning without formal institutional support or affiliation. Studying abroad therefore represents a pivotal moment in a young person's life and informs one's outlook for years after the event has ended.³⁹ The experience provides opportunities to reflect on one's social norms as well as biases, thereby facilitating self-awareness and self-confidence. This immersion experience also fast tracks the language and intercultural development acquisition process. Increasingly, studies are showing that students who study abroad, are retained and graduate within four years at higher rates with higher GPA scores, than their non-study abroad peers.⁴⁰ Traditionally, engineers and minorities typically do not study abroad citing strictly structured curriculum or financial constraints. However, this perception is changing. For example, according to the latest Open Doors data the number of engineers who studied abroad in 2013 grew by 6% over the previous year. Finally,

study abroad already have some built leverage. For example more women study abroad than men,⁴¹ a strength that can be employed to encourage women to persist in engineering.

Finally, while the number of students study abroad has been steadily increasing, African Americans and Hispanics account for only 5% and 8% respectively (Open Doors 2012 data).⁴² Many strategies are currently being employed to reduce minority and underrepresented attrition from engineering programs. Study abroad has not been previously considered as a high impact activity. Traditionally, study abroad has been marketed as an opportunity to experience other cultures. For minority students, this angle might not have the same impact as they interact across culture on a daily basis.³⁹ However, an opportunity to increase skill sets that can assist in persisting and doing well in their current engineering programs as well as prepare them for continual lifelong professional development might just work.

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