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RESEARCH

**Development of the Global Engineering Programming Model:
A Participatory, Mixed-Methods Approach**

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Introduction

Engineers in academics and industry are recognizing the importance of preparing current and future generations of engineers to be successful in the global economy (Ball et al., 2012; Downey et al., 2006; Grandin & Hirleman, 2009; Jesiek, Thompson, & Mazurco, 2014; Lohmann, Rollins, & Joseph Hoey, 2006; Parkinson, 2009; Warnick, 2010). Many educators now believe that success in a global context requires students to acquire specialized knowledge to augment their technical and professional skills, as well as attitudes. Although global perspectives and experiences are being developed through a wide variety of initiatives and opportunities, engineering programs often operate with limited knowledge regarding the effectiveness of their international program strategies and the organizational capacity for supporting the internationalization process. Research is needed regarding programming target areas and their relationship to sustained programming efforts in engineering.

This study draws on a participatory, integrative mixed-methods approach that combines qualitative and quantitative data from engineering programs across the U.S. A thematic, qualitative analysis of semi-structured interviews was conducted with subject matter experts (SMEs) from nine institutions regarding their global programming strategies, intended outcomes, and organizational resources that support these efforts. To investigate global programming strategies, Group Concept Mapping (GCM) (The Concept System® Global MAX, 2012) was used to develop an expert-authored operational framework for global strategies, policies, and programs geared towards engineering schools. GCM is a mixed-methods approach for organizing the ideas of a group of stakeholders and aiding in the development of a conceptual framework that can be used for planning and evaluation (Kane & Trochim, 2007). This approach helped the SMEs describe global engineering programming target areas and represent these areas visually through a series of related two-dimensional maps. In doing so, this study provides an empirically-based Global Engineering Programming (GEP) model that can be used by universities in general and engineering programs in particular. The following questions are addressed in this research:

1. What are important strategic areas for sustained internationalization efforts in engineering schools?
2. What areas are most useful in developing sustained, school-wide programming strategies?

This work was motivated by the interest of universities and engineering programs to build comprehensive and sustainable global programming strategies. Producing successful engineering graduates requires a systematic and intentional approach to internationalization efforts (Leask, 2013). Results from this relational study provide both explicit and implicit programming strategies, as well as actionable information to engineering schools on how to prepare engineering students for the global economy.

Background Literature

State of Global Engineering Education

The necessity for engineering global competency has been recognized and spotlighted by both professional and educational engineering communities in conferences, national reports, and publications (American Society for Engineering Education, 2010). The National Academy of Engineering (NAE), the National Science Foundation (NSF), and the National Research Council (NRC) have urged engineering schools to prepare engineers for global workforces (National Academy of Engineering, 2004; National Science Foundation, 2011; National Research Council, 1985). Accreditation bodies and national engineering organizations have also recognized the importance of global education for the success of engineers in today's interconnected world. ABET first introduced a global element (criterion 3h) into its innovative Engineering Criteria 2000 (EC200) for undergraduate engineering programs (ABET, 2013) in 1997. The American Society for Engineering Education's (ASEE) Green Report has called for engineering schools to adapt curricula and programs to incorporate "an appreciation of different cultures and business practices, and the understanding that the practice of engineering is now global" (American Society for Engineering Education, 2010). As a result, many universities have begun to embrace global education at the institutional level, yet a gap exists between rhetoric and practice regarding global engineering programming at the school and department level, partially due to financial and logistic constraints for sending students abroad (Yershova, DeJaeghere, & Mestenhauser, 2000).

Many engineering programs have not emphasized global education programming as a core piece of their strategic goals. In the NSF-supported project "Creating a Culture for Scholarly and Systematic Innovation in Engineering Education", Jamieson and Lohmann conducted a survey of faculty committees, chairs, and deans from 110 departments representing 72 colleges on the "state of culture" in engineering education. They found that international programs are not widely promoted, and nearly half of the faculty committees rated international programs as not important (Figure 1) (Jamieson & Lohmann, 2012, p. 35). It appears that many engineering administrators and faculty value traditional learning environments and put less emphasis on global programming as a strategic effort.

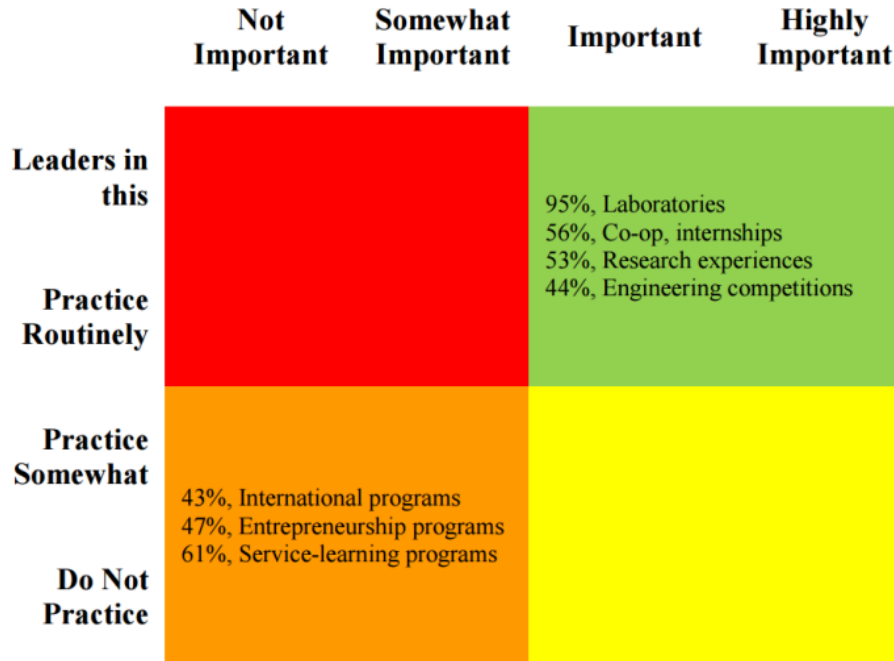


Figure 1. Undergraduate learning environments (Jamieson & Lohmann, 2012, p. 35)

Mestenhauser argues that the global programming in general has focused too much on isolated projects and programs, which target far fewer students than a cohesive strategy would otherwise (Leask, 2009). Study abroad programs remain the most prevalent method to incorporate global programming into an engineering curriculum (Warnick, Magleby, & Nelson, 2012). Yet, there are constraints on these programs that make it difficult for all students to be involved. Challenges such as a highly sequenced curriculum, high implementation costs for institutions, risks in delaying graduation, difficulties with transferring credits, and the need to find suitable partners indicate that a more comprehensive, and operational approach to global engineering programming is necessary to meet the changing needs of society (Grandin & Hirleman, 2009).

Group Concept Mapping and its Applications

Group Concept Mapping (GCM) is a structured conceptualization method designed to organize and represent ideas from an identified group, and has demonstrated value in addressing a variety of questions (Rosas & Kane, 2012; Trochim, 1989). The output of GCM is a series of stakeholder-driven visual diagrams that show the relationship between ideas that are taken from qualitative studies, e.g., semi-structured interviews, Delphi studies (Streiner, Vila-Parrish, & Lunsford, 2016). The results can be used to guide planning on matters important to the involved stakeholders (Kane & Trochim, 2007).

GCM involves five steps (Figure 2): idea generation, idea reduction, sorting and ranking ideas, compute maps, interpret and utilize maps. GCM integrates both group processes such as brainstorming and unstructured sorting with multivariate statistical methods of multidimensional scaling and hierarchical cluster analysis (Schröter, Coryn, Cullen, Robertson, & Alyami, 2012).

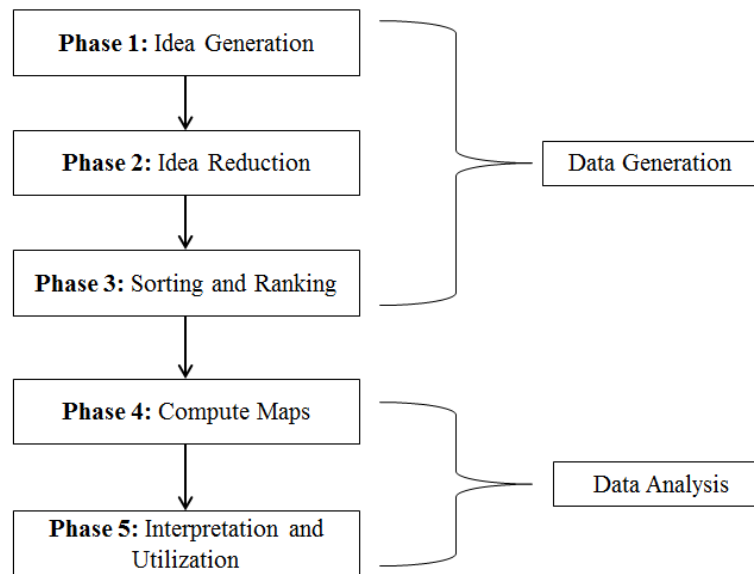


Figure 2. Group Concept Mapping Framework (Abrahams, 2010)

GCM has been applied in a number of fields over the last two decades, including business, public health, energy policy, and others (McLinden & Trochim, 1998; Burke et al., 2005; Schröter et al., 2012; Keith, 1989; Rosas & Camphausen, 2007; Streeter, Franklin, Kim, & Tripodi, 2011). Within the higher education space, GCM has been used in the development of accreditation standards for graduate programs, the development of learning goals for university departments, the examination of issues and barriers for adopting technology into faculty instruction, and investigation of engineering students' global workforce perceptions (Trochim, 1996.; Handley, Pappas, & Kander, 2004; Abrahams, 2010; Streiner et al., 2016). GCM is used in this study to create an operational framework for global strategies, policies, and programs, and to describe the relationship of the target areas of the framework therein.

The Spectrum of Global Engineering Programming Strategies

While previous studies have focused on “internationalizing the curriculum” (Horn, Hendel, & Fry, 2007; Leask, 2013; Qiang, 2003), the engineering education community’s understanding of global engineering programming remains limited about the strategic actions administrators and faculty can take to prepare students to be successful in the global work environment. According to the Center for Internationalization and Global Engagement (CIGE), internationalization refers to “the efforts of institutions to meet global challenges by incorporating global perspectives into teaching, learning, and research; building international and intercultural competence among students, faculty, and staff; and establishing relationships and collaborations with people and institutions abroad.” Because the focus of this study is on engineering programs, an adapted version of CIGE’s Model for Comprehensive Internationalization is used to better understand the scope of GEP strategies and to guide the SMEs responses during the semi-structured interviews (see Figure 3).

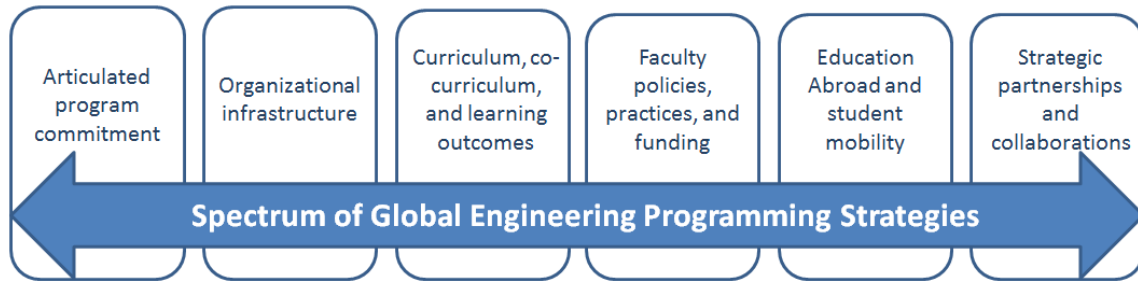


Figure 3. Adapted Model for Comprehensive Internationalization
(American Council on Education, 2012)

The initial spectrum of GEP consists of the following six elements:

1. Articulated program commitment – mission statements, strategic plans, and formal assessment mechanisms;
2. Organizational infrastructure – reporting structures, staffing levels and configurations;
3. Curriculum, co-curriculum, and learning outcomes – general education and language requirements, co-curricular activities and programs, and specified learning outcomes;
4. Faculty policies, practices, and funding – hiring guidelines, tenure and promotion policies, faculty development opportunities and provisions;
5. Education abroad and student mobility – study abroad programs and international student recruitment and support; and
6. Strategic partnerships and collaborations – joint-degree or dual/double degree programs, branch campuses, and other offshore programs.

Research Approach

To examine GEP target areas, a participatory, integrative, mixed-methods approach was employed across multiple universities. The study began with semi-structured interviews that covered GEP resources, strategies, outcomes, and assessment (Appendix A). The interviews were thematically coded based on a deductive, theory-driven coding schema, informed by program theory logic model areas, the Model for Comprehensive Internationalization as provided by the American Council on Education's Center for Internationalization and Global Engagement (CIGE) (Figure 3) and prior research on institutional change. After several iterations, the final GEP coding schema included: Organizational Structure and Governance; Strategic Areas; Success Factors; Success Barriers; Program Inputs; Program Outputs; Outcomes/Goals; Intangible Benefits; and Assessment. Particular focus was placed on the strategic areas and success factors discussed throughout the interviews. Next, the research team unitized the GEP strategy statements into a list of unique strategies, which was used as the focus for the content of the GEP concept mapping activity. Finally, the resulting concept map, related analyses, and interview data were used to create an operational model that represents the strategic practices that support sustained GEP efforts (see Figure 4).

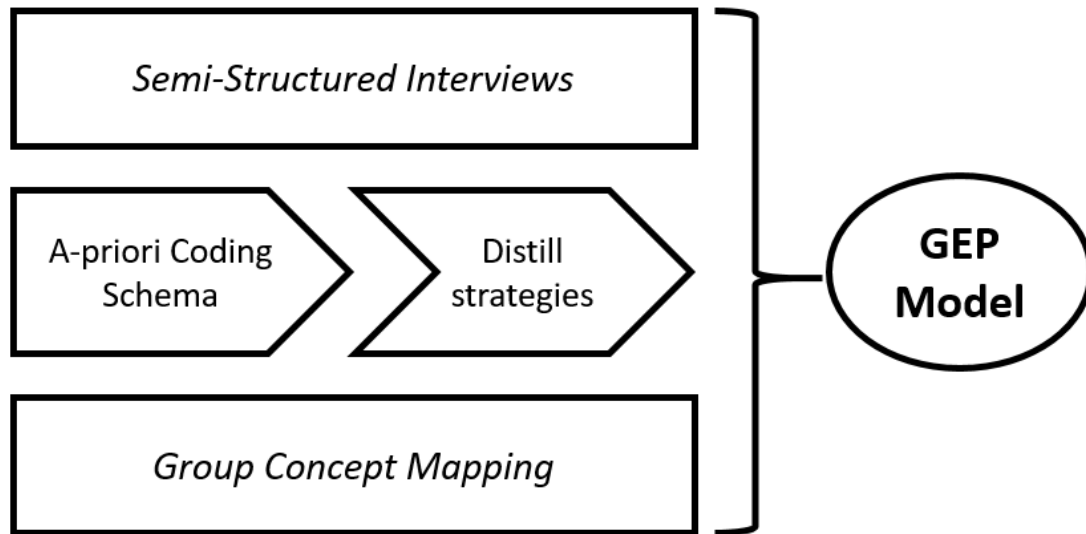


Figure 4. Research Framework

The GCM process structured the methodological approach for this study is represented in Figure 2 (Kane & Trochim, 2007; Trochim, 1989), and is described in the following subsections. This paper is adapted from the lead author's dissertation work (Streiner, 2017) and the Institutional Review Board at the authors' university approved this study under IRB #PRO16020008.

Case Selection

Multiple universities and job roles were selected due to the contextual variation in global education practices and to capture the perspectives of different types of people in the global education space. Universities and their engineering programs were purposively sampled by non-randomly selecting a broad range of engineering programs that were likely to reflect the full GEP spectrum. A mix of public and private institutions was selected based on their variety of global programming efforts, geographical location, variety in student populations, the existence of established international programs and people who run them. Out of the 15 universities that were selected, 9 participated in the study. Two SMEs were interviewed the authors' university, where the study was conducted. Table 1 includes the summary of background information of the 10 SMEs and their universities. Organizational structure refers to the administrative structure of the global activities and programs at the institution.

Table 1. Background Information of Subject Matter Experts (N=10)

Job Role	n
Directors of Study Abroad	6
Vice Provosts of International Education	4
Organizational Structure	
Centralized	6
Decentralized	4
Presence of Internationalization Strategic Plan	
Yes	6
In-Development	3
No	1
School Size*	
Large	5
Medium	5
Control*	
Public	7
Private	3

*Defined according to Carnegie Classification of Institutions of Higher Education

Data Collection

One-on-one semi-structured interviews were conducted by the author, either in person or via the phone. Each interview lasted approximately 60-90 minutes, was audio recorded, and transcribed verbatim. The interviews focused on GEP strategies at the interviewee's institution and within the engineering programs at their university, along with essential resources, outcomes, and assessment of those outcomes. The SMEs were informed and guided by the adapted CIGE Model for Comprehensive Internationalization. The interview protocol contained only open-ended questions (Creswell, 2007), and was supported with prompts when necessary. The salient interview questions were:

1. Tell me about the global programming strategies that have been adopted at your school. These can be either explicit or implicit. What makes these strategies different from other colleges and/or institutional strategies?
2. How do schools move away from one-off programs to creating a committed and sustained school-wide global programming strategy?
3. What conditions and/or factors need to be considered when adopting global engineering programming strategies? How can schools develop a more articulated GEP strategy?

Distill GEP Strategies

The responses to the interview questions above were used to create the units of analysis for the GCM process. The responses were unitized by breaking sentences (and paragraphs) into single concept phrases that are distinct from one another. For example, one response was, "Our unwritten strategy focuses on creating a series of attractive, short-term programs to increase participation...and to augment that with the number of students who go on semester long programs. We have also focused on providing students with international research opportunities over the summer." This response was broken into three separate units: (a) Create a series of attractive, short-

term programs to increase participation, (b) Increase the number of students who go on semester long programs, and (c) Provide students with international research opportunities over the summer. This was done for all the relevant responses across the 10 interviews and resulted in 90 unique strategy statements, which is a manageable number according to a meta-analysis that studied GCM research over the past 20 years (Rosas & Kane, 2012). Additionally, the authors ensured that each statement was understandable and syntactically similar for ease of sorting and rating in subsequent steps.

Sorting and Rating Strategy Statements

Concept Systems, Inc. (The Concept System® Global MAX (Build 2013.322.11) [Web-based Platform], 2012) was used to create an online platform to organize, collect, and analyze data from multiple universities simultaneously. The SMEs were asked to sort the 90 strategy statements into piles based on perceived similarity in theme or meaning and asked to create a label for each of their piles. Specific constraints were included in the instructions including: (1) Do not create piles according to priority or value, (2) Do not create piles such as “Other” that group together dissimilar statements, and (3) Do not sort a statement into multiple piles. Sorting concepts in this manner allowed for a web of concept relationships to be represented by the people immersed in the environment, instead of introducing the arbitrary biases of the researchers (Jackson & Trochim, 2002). Additionally, instructing sorters to create their own categories helps ensure that categories are exhaustive (a common threat to external validity).

The SMEs were then asked to rate each statement on a five-point Likert-type scale based on three measurable variables: usefulness, likelihood of success, and priority. In this context, “likelihood” does not refer to statistical probabilities, but instead a subjective measure of whether strategies are feasible at an institution. Specifically, the rating prompts were as follows:

1. Rate each strategy based on *usefulness in terms of developing comprehensive international programs and strategies*, where 1= Not useful, 5=Very useful
2. Rate each strategy based on the *likelihood of success at your institution*, where 1=Extremely unlikely, 5=Extremely likely
3. *If all strategies were feasible at your institution*, rate each strategy based on priority for strategic planning purposes, where 1=Not a priority, 5=Essential

The SMEs were directed to think of the relative value of each of the variables associated with each statement (i.e., all statements cannot be “Very useful” or “Extremely unlikely”). The rating step happened after the sorting step to disallow the grouping of statements based on the variables.

Data Analysis

Multidimensional Scaling and Clustering

Quantitative approaches were applied to convert the sorted and rated statement data into a visual point map representing individual statements. The main strength that GCM offers to validity is that it uses multidimensional scaling and cluster analysis to

represent the similarity judgements of multiple coders (Abrahams, 2010). This allows meaning and relationships to emerge by aggregating the ‘biases’ or ‘constructions’ of many. Multidimensional scaling (MDS) was performed based on aggregated individual understanding of the responses. MDS was used to create a two-dimensional point map of Euclidian distances between the statements based on the aggregate sorts by the SMEs (Figure 5).

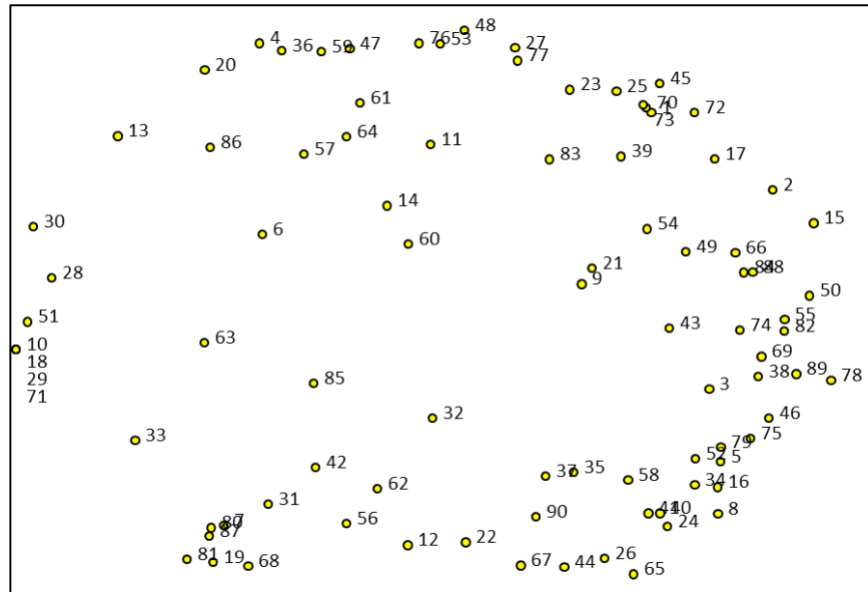


Figure 5. MDS Point Map of Statements

The distance between the points represents the estimates from MDS of how similar the statements are judged to be by the SMEs. Only the distance between points is important, not the position of the points themselves. A key internal validity measure in MDS is the ‘stress index’ (Kane & Trochim, 2007) that measures the degree to which the distances on the map are discrepant from the values in the aggregate similarity matrix, with lower values suggesting overall better fits. The stress value for Figure 4 is 0.3005, well within acceptable range for GCM (Kane & Trochim, 2007; Moreno, Kota, Schoohs, & Whitehill, 2013). The X-Y coordinate matrix that results from the MDS was used as the input for the subsequent clustering analysis.

GEP Framework

In creating the GEP framework, an agglomerative hierarchical clustering analysis using Ward’s algorithm (Kane & Trochim, 2007) was employed, and yielded non-overlapping partitions on the MDS point map. The resulting ‘cluster map’ divided the point map into conceptual clusters based on the similarity of concepts. The final number of clusters was determined using a sequential process of generating versions of the concept map with a change of one cluster per version. The lower and upper bound of the number of clusters considered was determined by the minimum and maximum number of clusters created by the SMEs. Consequently, concepts maps ranging from 5 clusters to 11 clusters were considered.

Concept Map Description

A 7-cluster solution was selected because it produced the richest, most differentiated and robust understanding of the target areas of GEP. Each cluster was labeled based on the predominant GEP idea and the labels suggested by SMEs (see Figure 6). Generally, the size of each cluster corresponds to the number and variation of statements contained therein. Clustering is helpful in arriving at a more interpretable solution (compared to the Point Map) than as a definitive analysis.

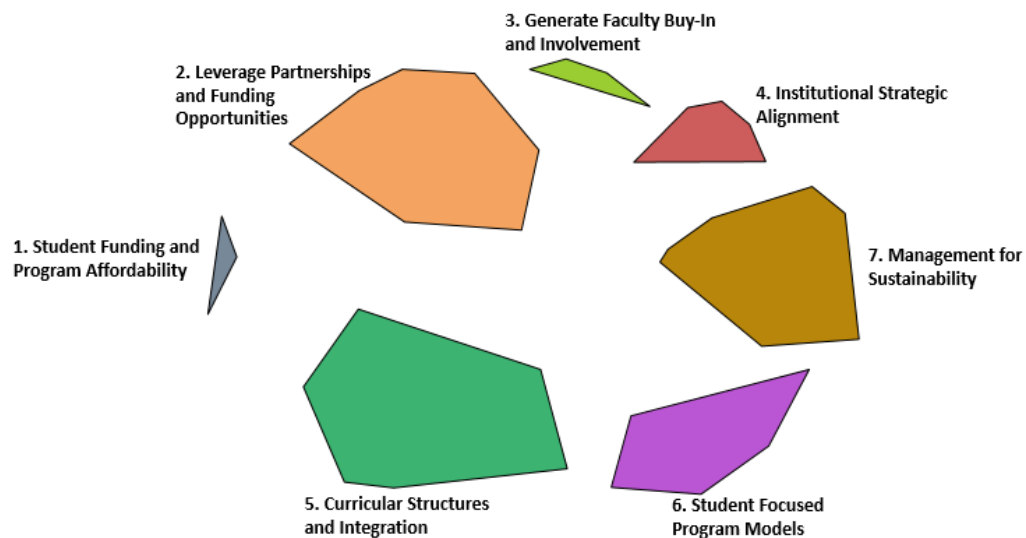


Figure 6. Cluster Map of GEP Strategies

Overlaid on this was an analysis of the ratings provided by the SMEs. An average rating for each strategy was calculated for each metric, along with average cluster ratings for each metric. In Table 2, average cluster ratings are shown along with the total number of statements per cluster.

Table 2. Description of GEP Target Areas

Cluster	GEP Target Area	# of statements	Usefulness	Likelihood of Success	Priority
1	Student Funding and Program Affordability	7	4.16	3.73	3.73
2	Leverage Partnerships and Funding Opportunities	14	3.54	3.39	3.36
3	Generate Faculty Buy-In and Involvement	6	4.03	3.47	3.72
4	Institutional Strategic Alignment	9	3.77	3.52	3.66
5	Curricular Structure and Integration	16	3.75	3.39	3.29
6	Student-Focused Program Models	19	3.72	3.63	3.61
7	Management for Sustainability	19	3.42	3.34	3.27

The three rating measures were all correlated above $r = 0.8$. Thus, a combination, rank-order measure was established for each cluster (and strategy statement) using mean normalization techniques for each rating variable. Those normalized ratings were summed together across the ratings to produce an overall importance index, which represents GEP areas and associated strategies that are considered (relatively) the most useful, have the highest likelihood of success, and should be given priority during strategic planning. Tables 3 and 4 display the importance indices for each GEP area and include the top three strategies for each GEP area, respectively.

Table 3. Rank-Order of Importance Indices

Normalized Ratings	Usefulness	Likelihood of Success	Priority	Importance Index
Student Funding and Program Affordability	1.10	1.07	1.06	3.23
Generate Faculty Buy-In and Involvement	1.07	0.99	1.06	3.12
Student Focused Program Models	0.99	1.04	1.03	3.05
Institutional Strategic Alignment	1.00	1.01	1.04	3.05
Curricular Structure and Integration	1.00	0.97	0.93	2.90
Leverage Partnerships and Funding Opportunities	0.94	0.97	0.95	2.86
Management for Sustainability	0.91	0.96	0.93	2.79

The clusters were rank-ordered based on their overall importance index. This breakdown provides an understanding of how institutions can focus their efforts and provides guidance regarding the order global programming could be executed. The most important GEP target areas consist of **Student Funding and Program Affordability** and **Generating Faculty Buy-In and Involvement**. These areas are the most useful in developing sustainable GEP strategies, have the highest likelihood of success, and should be given priority during the strategic planning process. Specifically, providing scholarships (based on financial need and diversity) and subsidies for students to go abroad; and creating sustainable programs by increasing the number of faculty and staff involved in global programming and encouraging active engagement in those programs.

Student-Focused Program Models and Institutional Strategic Alignment include offering global internship programs and short-term, faculty-led programs that are related to topics of interest to engineering students and that fulfill engineering requirements. These target areas also emphasize designing programs that are consistent with college/institutional missions/goals and establishing strategic partnerships with international universities that can help support GEP efforts.

Curricular Structures and Integration and Leveraging Partnerships and Funding Opportunities include framing global programming as a core educational piece, rather than as an alternative to education. To do this, global programming can be made part of the curriculum by integrating into the majors and offering different price points to give students more options for the types of international experiences available. Additionally, these target areas stress changing the culture of GEP by providing support to faculty to help them grow international curricula and strategic partnerships. The

SMEs also point out the benefits of leveraging external and local partnerships to help build internships and research opportunities abroad.

The final and least important target area is **Management for Sustainability**. While the contents and relationships of this area does not imply they are unimportant, the GEP target areas described above are relatively more important than managing for sustainability. The importance of all of the GEP target areas is directly related to what areas are being supported and which ones need more attention. **Management for Sustainability** includes creating a GEP portfolio that meets a variety of student needs, such as establishing flagship programs to attract faculty and students and moving past traditional study abroad models that have scalability and involvement issues.

Table 4. Most important strategies within each GEP target area

ID	Statement	Importance Index
Cluster 1: Student Funding and Program Affordability		
	Provide scholarships to go abroad based on financial need	3.54
	Provide subsidies for students to help offset the cost of studying abroad	3.49
	Provide scholarships to go abroad based on diversity (e.g., minorities, females, new locations, new majors)	3.15
Cluster 3: Generate Faculty Buy-In and Involvement		
	Create sustainability by having many faculty and staff involved in global programming efforts	3.23
	Encourage faculty engagement in global programming	3.24
	Generate faculty buy-in	3.15
Cluster 6: Student Focused Program Models		
	Increase the number of short-term, faculty-led offerings that fulfill engineering requirements	3.37
	Offer global programs and activities that students care about	3.48
	Offer global internship programs	3.51
	Develop thematically-based programs that are related to topics of interest to engineering students	3.34
Cluster 4: Institutional Strategic Alignment		
	Design global programs that are consistent with institution/college, and/or program missions	3.48
	Establish strategic partnerships with international universities	3.38
	Build international programs around globally strategic goals at the college and University level	3.23
Cluster 5: Curricular Structures and Integration		
	Offer different price points in global programming portfolio	3.54
	Integrate international experiences into the engineering majors	3.54
	Frame international experiences as a core educational piece, and not as an alternative to education	3.62
	Make global programming connected to the curriculum	3.65
Cluster 2: Leverage Partnerships and Funding Opportunities		
	Leverage external industry partners to grow new technology and provide internships/research opportunities abroad	3.36
	Change college culture regarding global engineering education	3.56
	Provide resources to faculty to help support their efforts to grow international curricula	3.44
	Offer seed grants for faculty to help them internationalize and build strategic partnerships	3.35
Cluster 7: Management for Sustainability		
	Establish flagship programs to garner wide faculty and student interest	3.56
	Move beyond traditional study abroad models which don't scale and don't have much faculty involvement	3.59
	Develop a global programming portfolio that has variety and meets different student needs	3.74
	Create a series of attractive, short-term programs to increase global programming participation	3.59

In GCM, every statement must be placed somewhere on the map. In some cases, MDS places a statement in an area because it was frequently sorted with statements immediately adjacent to it. In other cases, MDS places a statement in an intermediate area because it was sorted with statements somewhat distant on one side of it and somewhat distant on the other side of it. These are considered 'bridging' statements because they bridge between two more distant areas on the map (Kane & Trochim, 2007). Bridging values (B) assist in interpreting what concepts are associated with specific areas of the map. A bridging value is calculated for every statement, with a minimum value of 0 and maximum of 1. A cluster bridging value is calculating the average bridging value across all statements in a cluster. Clusters that are associated

with multiple areas of the map will have higher bridging values (Figure 7). Bridging values and rating results are used in the development of an operational framework of GEP target areas by establishing relationships between different areas of the map.

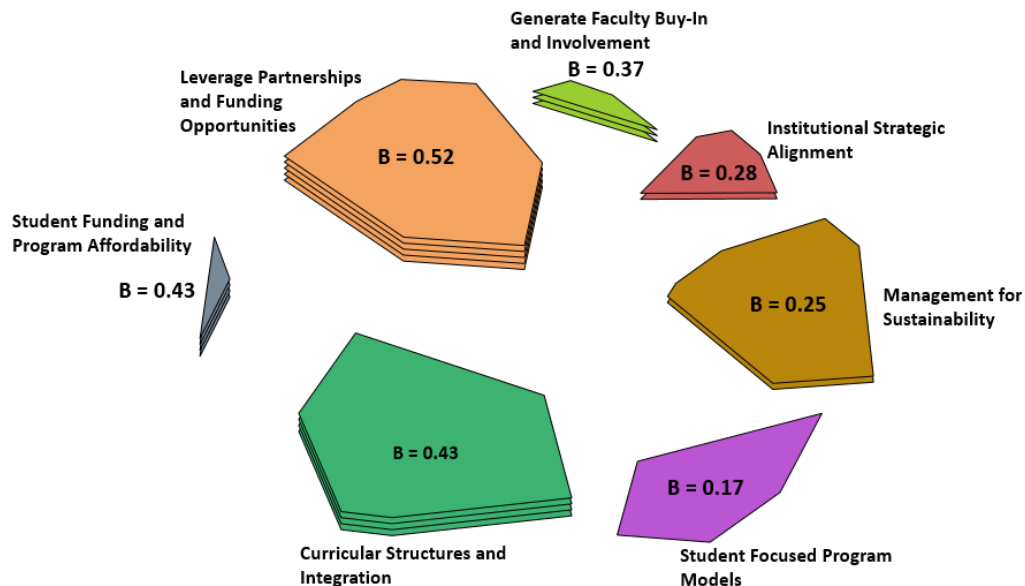


Figure 7. Bridging Map of GEP Target Areas

Discussion

Results from this study outline the key GEP target areas that may be considered during strategic program development and implementation. In this section, results from the GCM are combined with the interview data to generate a global programming framework that articulates GEP strategies. Finally, directions are provided regarding sustainable, school-wide GEP development.

Based on a review of the cluster maps and ratings, the GEP model was developed that outlines the strategic areas, goals, and actions that need to be developed for an internationalization strategic plan and sustainable global programming. Feedback was solicited from the SMEs regarding the content validity, interpretability, and application of the model and its contents. Five of the ten SMEs provided anonymous feedback through an online Qualtrics survey (see Appendix B), where they were provided their interview transcripts, concepts maps, ratings, and GEP model. The SMEs agreed with the model and its potential utility. Suggestions were given to improve the clarity of the strategic areas and generalizability to other institutions. The final GEP model and a discussion of its contents are presented in the following section.

Global Engineering Programming (GEP) Model

The GEP model was adapted for the specific context of practice used in undergraduate engineering programs to provide practitioners, directors, and deans with foundational elements of sustainable global program development. There are four primary target areas of sustainable global engineering program development, outlined in Figure 8:

Supportive Structures, Engaging Change Agents, Student Needs, and Operations. These areas emerged based on the proximity of the clusters on the concept map, the ratings of each cluster, and the bridging values. The clusters closer to each other were seen as areas that affect each other. Clusters with higher bridging values indicate a stronger relationship with the other clusters in the map (and thus were seen as more supportive in nature). Each area is described in more detail below, along with exemplary quotes from the interviews that describe the factors needed for success in these areas.

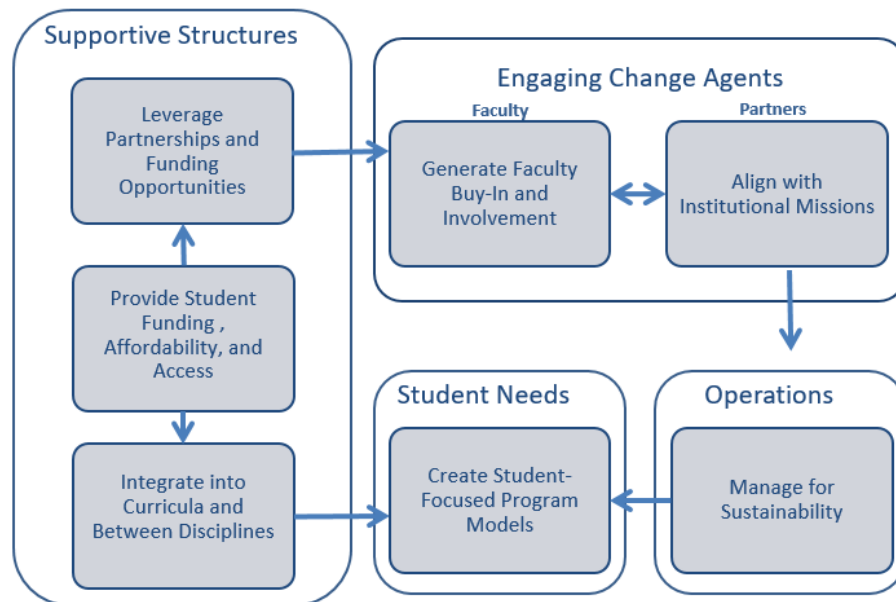


Figure 8. Final GEP Model

Supportive Structures

The three strategies that comprise the supportive structures target area are **Leverage Partnerships and Funding Opportunities**, **Provide Student Funding, Affordability, and Access**, and **Integrate into Curricula and Between Disciplines**. Data from the interviews provided evidence that global programming initiatives such as scholarships based on financial need and diversity (e.g. underrepresented groups, new locations, and new majors) and subsidies for students to help offset the cost of studying abroad are critical. Engineering programs and institutions should ensure affordability to both increase institutional funds for scholarships, and to tap more into industry partners who can support programs. Financial constraints faced by students are a primary reason for the increased popularity of short-term programs, which cost less than long-term programs (Bandyopadhyay & Bandyopadhyay, 2015). Fortunately, the additional expenses of study abroad programs are one of the easier challenges to fix via scholarships and cost structures (Parkinson, 2007). Many SMEs also remarked on reducing barriers for students to get involved in global programming. Here, an SME described her experience:

You need to actually have pipelines to send students out with as few barriers as possible. Because as students hit barriers, they get disenfranchised, or frustrated, and then drop out, or drop off. Some of that can be financial, in terms of scholarship. Some of that can be ease of credit transfer, in terms of bilateral agreements, or credits that fall right onto the transcripts, so on and so forth. Not necessarily institutional-level policy ... It's a process that gets students through with as few roadblocks as possible so that they don't get frustrated and leave.

From a curricular standpoint, the barriers for students to engage in international experiences are more present than other disciplines (Grandin & Hirleman, 2009; Salisbury, Umbach, Paulsen, & Pascarella, 2009). Curricular restrictions have been cited by engineering students as a significant factor in deciding not to study abroad (Salisbury et al., 2009; Stroud, 2010). The engineering curriculum is full and sequenced, limiting opportunities for students to experiment with language learning or education abroad (Grandin & Hirleman, 2009). Other barriers (perceived or otherwise) include logistic hurdles, delaying graduation, transferring of credits, and negative perceptions of educational value.

A difficult challenge regarding global programming involves changing the culture around international education within the school. Even though engineers will most likely work with colleagues from other cultures and nations, there has not been a tradition of sending engineers to study abroad (Grandin & Hirleman, 2009). Therefore, it is important to understand how programs see themselves and the types of institutions engineering programs sit in. A SME stated that institutional culture can be the single biggest determinant:

Universities have to be honest as to how important [global programming] is to them and how many resources, both human and financial, they're willing to put into it ... they have to be realistic not just about that, but about their student population ... I think it has to be really a well thought-out plan, because you're changing a culture ... If education abroad doesn't exist at your school, you are changing the culture ... you have to be really clear: how are you going to incentivize people to do something different ... you have to know your institution.

A way to overcome these barriers is to integrate international experiences more directly into the engineering education system. This includes making global programming connected to the curriculum, and framing international experiences as a core educational piece, and not as an alternative to education. Originally, the curriculum integration model was developed by the University of Minnesota. This model aimed at increasing the integration of study abroad into all majors and minors, providing scholarships, enhancing faculty awareness of the contributions of study abroad, developing innovative practices, materials, partnerships, and professional alliances, having 50% of the graduating class study abroad, and creating long-term institutional change (Woodruff, 2009). Curricular integration involves identifying learning objectives specific to an engineering major for study abroad, identifying what faculty are looking

for as curricular enhancements from students doing study abroad, and developing programs that advance those pieces. Many SMEs echoed these goals:

I think the key is to make [global programming] curricular-connected. Because if it's seen as extra, the faculty members are going to burn out, it's not going to be put into a bucket where it counts. It's not going to help them with advancement or any of those types of things. So I think curricular connection is the key.

I think it has to really be grounded in the curriculum ... there are a lot of schools that do programs that are really kind of add-ons for engineering students. So it's, "oh, because you need to learn about the culture, you should go do this. Or you should learn the language. Or learn how business is done, or engineering is done in this country" ... those things are fine, but that's not driven by the curriculum. That's in addition to the curriculum.

Ultimately, the strategies discussed in this cluster by the SMEs reflect the need to treat global programming as part of the educational process, and not as an alternative to education. Research has shown that integrated programming offers students opportunities to gain knowledge about other cultures in more engaging ways. Sustainable global programming development requires engineering program directors to integrate experiences into the normative learning process. As one SME reflected:

We all operate in environments with limited resources ... So it's making the case that international programs are just as valuable as some of the other kinds of work that we do: design experiences, diversity initiatives, student project teams, etc. So where possible, align the international strategy with the other [experiences] – so not set international as an alternative, but as a way to enhance diversity initiatives, design experience, project teams, student organization competitions, etc. ... frame international [experiences] as just taking the core education to the next level.

A vital supportive structure for sustainable global programming is leveraging partnerships and funding opportunities. This includes leveraging external industry partners to help grow technological advancements and provide internships/research opportunities abroad, changing the culture around global engineering education, and providing resources to help faculty internationalize and build strategic partnerships. The SMEs noted that having a multitude of external partnerships is not always necessary; instead, sustaining a few key partnerships is what engineering programs should focus on:

Work with strategic partners. Don't be all things to all people. If you're just getting started, pick and choose key partnerships and sustain those partnerships. Work on student mobility with those key partners. Work on getting the top graduates through your programs so that you can build and grow it.

Faculty and staff are the ultimate drivers of the GEP vision, but external stakeholders must be invested in that vision as well. Along with creating strategic partnerships, there is value in the importance of knowing when an engineering program should leverage a partner. Engineering programs should be clear about which partnerships are appropriate and how it fits into the current programming strategies and initiatives.

Engaging Change Agents

The two strategies that comprise the area of engaging change agents are **Generate Faculty Buy-In and Involvement** and **Align with Institutional Missions**. Sustainable global programming requires champions and change agents to drive initiatives and visions. Data from the interviews suggested that creating sustainability involves having a multitude of faculty and staff involved in GEP efforts and catalyzing faculty engagement in internationalization efforts. An SME put it the following way:

Faculty buy-in is critical, because ultimately the faculty are the best advocates for these types of programs, particularly if they're running them themselves. Because they can stand in front of a class and say, "This is my program; I've helped to design it. I believe in it. It's my thing. Come with me and you'll get more out of your educational experience and career, educational experience than you would otherwise." That makes a world of difference.

Faculty are the primary drivers in academic departments. If programs want engineering students to be more globally competent at graduation, faculty need to value this proposition. In establishing GEP strategies, it is important to understand how it affects faculty and how they can have power over the process:

It takes faculty passion to make that work ... the number of engaged faculty I think is absolutely critical to [global programming]. And not only the number of engaged faculty, I'd call it duplicity or multiplicity of faculty engaged. And that is making sure that we're not relying upon one faculty member.

Additionally, the level of buy-in is posited to be related to the intercultural competency of the engineering faculty:

Intercultural open-mindedness of the faculty at any institution plays a big role, and certainly at any engineering role, since that's specifically where you're looking, plays a big role in how quickly things internationalize, and what form that internationalization takes.

How a student receives information on global learning opportunities is equally as important as the information itself, and faculty are often the mouth pieces for many GEP initiatives (Stohl, 2007). What messages are faculty sending students about education abroad? How many faculty members encourage students to take advantages of GEP opportunities as part of their professional development? Understanding how

faculty conceptualize global programming and their perspectives on global learning should not be overlooked during the planning process.

Running an international program can be labor intensive in terms of time and logistics. To encourage faculty buy-in, those who are willing to run programs should be rewarded financially (Parkinson, 2007). Providing the resources necessary for faculty to build programs and create strategic partnerships can jumpstart a plurality of faculty involvement as one SME states:

I think funding is a critical piece ... Faculty are so busy and if they have a lot of pressure to go after grants, even seed grants, even small amounts of money can matter. And that funding goes out to scholarships, program support, and faculty or staff site visits ... and specifically for student mobility, it ends up having a huge impact for the ability to build relationships or do course mapping for study abroad.

Another part is recognition of the need for funding, for the institution to show some support, and one of the ways to do that is to have seed grants for faculty to help them internationalize. And it's not huge amounts of money – they're just seed grants but there are a couple of different sources and sometimes they're very specifically geared towards a strategic partnership that we're trying to build up.

What often drives university policy and faculty interests is curriculum development and research (Grandin & Hirleman, 2009). Thus, developing GEP strategies should touch upon those areas. Otherwise, programs and initiatives will only have an impact around the edges. The data provides evidence that designing programs that are consistent with the institution/college missions, building programs around strategic goals of the university, and aligning institutional, faculty, and student needs is critical to sustainable GEP development. The GEP strategies that are most successful are the ones that are consistent with the college and/or institution's mission. One SME remarked on her own institution:

I have high hopes about what's happening with the development of these research programs because undergraduate research is something that [our university] is very committed to – we do it really well. We have just a great commitment and investment across the campus in our undergraduate research program. So to take that model and expand it into an international context makes so much sense and should be easy to do ... I think things that kind of fit in that way is really important.

While the champions of programs and initiatives are generally the faculty, institutional buy-in and support from senior leadership (e.g., the president and provost) is needed for sustained success. If international engagement is seen as important to the university or department leadership, this can influence faculty engagement:

Institutional buy-in is critical. If the institution doesn't support global programming, or sees it as a burden, it is very difficult to have success, in terms of output of numbers, in terms of student satisfaction – because oftentimes, that leads to cutting corners, or not designing things, or just simply outsourcing your students and having no real jurisdiction over them.

As mentioned both top-down (institutional) and bottom-up (faculty, student) support is critical for GEP success. With only faculty buy-in, programs will go away when faculty stop running them. With only institutional buy-in, GEP efforts and priorities changes when leadership at the school changes. There is a synergy that must exist between leadership at the school that impart the vision, the faculty that are the primary agents of that vision, and the students (Parkinson, 2007). This point is supported by research on institutional and/or organizational change. According to Henderson, Beach, and Finkelstein, effective change strategies must be aligned with or seek to change the beliefs of the individuals involved (Henderson, Beach, & Finkelstein, 2011). All three entities are stakeholders in GEP and must collectively develop a shared vision of what it means to be international. Developing successful change strategies also means understanding the university system and then designing a strategy that is compatible with this system (Beach, Henderson, & Finkelstein, 2012).

Student Needs

This target area, ranked third in terms of importance, consists of **Creating Student-Focused Program Models**. This includes strategies such as increasing the number of short-term experiences that fulfill engineering requirements and offering global programs that are related to topics of interest to engineering students (such as global internships). This relates to what students want to get out of the experience, what students are prepared to do, and how it relates to their engineering discipline and career. Engineering students are often ill-prepared to accept the norms of another culture. Their educational experience is generally lacking in cross-cultural knowledge, setting them up for difficult transitions (Grandin & Hirleman, 2009). Data from the interviews stressed the importance of knowing your student population:

It is knowing your student population. Are you an elite institution? Are you a broad access institution? What do your students come into the table with? What is the SES of your students? What can they afford? How many first- generation students do you have? I think too often I see program professionals or faculty with these really complex, lofty ideas for what would be cool, when actually what their student population needs are a few gateway experiences to just initiate the cultural change.

Some research has been conducted regarding the effects of prior backgrounds and international experiences on students while in college. Having a better understanding of the background of your incoming students can help programs tailor their GEP portfolio to their student populations. Of particular importance is being more intentional about helping students who have never had the privilege of traveling abroad gain experience during college:

We all certainly have a portion of our population that comes from fairly privileged backgrounds, and they've had the pleasure of traveling with their families or doing that ex-pat assignment with their parents or going to boarding school overseas. But I think it's equally important that we think about these students who might be more regional, or from our home state, or from smaller towns, being more focused on getting them out the door so that we can level the playing field.

Addressing student needs when developing global programming strategies means meeting their curricular needs. Designing program models where students can get transfer back is critical. Credit systems vary around the world, with the U.S. based on contact hours (Grandin & Hirleman, 2009); hence, determining equivalencies can be cumbersome particularly when ensuring accreditation fidelity. This stresses the importance of pre-approved courses and course mapping.

Management for Sustainability

Data from this target area provide evidence that establishing flagship programs is an important aspect of sustainable GEP development. Once supportive structures are in place, change agents have been engaged, and programs are designed around student needs, there are a number of operational strategies that were encouraged by the SMEs to help manage the global programs and initiatives. Managing for sustainability involves thinking more broadly about the types of international experiences to offer, how faculty support those experiences, and being intentional about the scalability of programs. Research by the Institute of International Education (IIE) indicates that study abroad experiences are becoming shorter and sometimes have little cultural immersion (Grandin & Hirleman, 2009). According to Grandin and Hirleman, students seem to gravitate to these types of programs to “check a box” on their resumes, which is supported by how universities actually measure international engagement and success.

It is important to have a balanced GEP portfolio with some experiences that rely on faculty and others that do not. Programs built around a single faculty member and his/her international connections are fragile and typically fail when that individual loses interests or moves (Shuman, Besterfield-Sacre, & McGourty, 2005). Additionally, research by the author has started to suggest that students benefit more in terms of their global competency when engaged in variety of international experiences (in contrast to simply having a multitude of them). The qualitative data agrees with these initial assessments by two SMEs:

We need to start leveraging design teams, leveraging service-learning teams, leveraging student organizations ... we thought that credit was a huge driver, and we find that nearly half of our engineering who go abroad will do so not for credit. They want the professional development. They want the experience for their resume. They want the challenge ... So leveraging that co-curricular space ... to balance the portfolio with some faculty-led programs, and some programs that don't rely on faculty travel from year to year.

You can't just have exchanges. You can't just have faculty-led [programs]. You need to have internships; you need to have shorter programs, and longer programs. And you need variety in the types of programs that you offer. Part of that is because you involve different players across your campus, and even to run those programs. And so you're getting into the fabric of the institution and having a broad impact, also because to be able to reach faculty and do things that resonate with them, and students, and provide programs that resonate with them and that they'll sign up for, everybody doesn't want the same things. So a variety in the types of programs I think is really important.

In addition to having a diverse GEP portfolio that does not depend on only a handful of faculty members managing for sustainability also means being mindful of scale and moving beyond the traditional models:

Move beyond traditional study abroad models. So for example, bilateral exchanges don't scale. And a bilateral exchange typically has no faculty involvement. So think about having a couple programs that can accommodate a critical mass of students – thinking about programs that might blend a single course with experiential learning.

It is difficult to have one program meet the entire needs of a college, both in terms of scalability and geographic locations. When designing international experiences and programs, there needs to be a willingness to focus on programs that scale and eliminating programs that do not. Having a large GEP portfolio is not necessary for sustainable and effective student development. Rather, it should have variety in terms of content and size and should address student needs in innovative ways.

Implications

This research has important implications for practice and policy concerning GEP strategic development. As engineering programs formalize their strategic plans and global programming initiatives, the GEP Model can be used to better reflect the realities of and challenges associated with preparing an engineering student to be successful in the global workforce. Currently, there is no operational model to guide engineering programs in making informed decisions about how to internationalize their curriculum or globally preparing students. Existing models take an institutional approach that does not account for the needs, support, and challenges associated with the engineering discipline including CIGE's Model for Comprehensive Internationalization (American Council on Education, 2012). There is considerable variation among different disciplines with respect to internationalization. Hierarchy of authority, patterns of communication, interaction/coordination with the environment to achieve institutional goals, and college culture all represent differences in efforts with respect to internationalization (Bartell, 2003). The resulting GEP Model focuses on *engineering schools'* efforts to incorporate global programming into existing learning opportunities. As noted, study abroad has been the primary strategy to prepare engineering students, but it

unfortunately targets too few students (Yershova et al., 2000). Scholars have emphasized the need for comprehensive internationalization efforts (Agnew, 2012; Altbach & Knight, 2007; Betty Leask, 2013; Ozturgut, Cantu, Pereira, & Ramon, 2014; De Wit , 2011). The GEP Model can help provide a structured approach to develop school-wide sustainable global programming.

When engaging in comprehensive global programming efforts, it is suggested that engineering schools consider each GEP target area, the strategies contained within, and their interrelationships. Although the model is intended for engineering, non-engineering departments and colleges can adapt it for their respective disciplines. The GEP Model can also provide schools that are in the early stages of program development a contextually relevant framework to guide their planning. Further, practitioners can evaluate the effectiveness of their current global programming efforts by mapping them to the GEP Model to identify target areas that need improvement. As such, the GEP Model can be used to benchmark engineering programs against best practices.

Future work will also expand and strengthen the generalizability of the findings by collecting data from a more varied collection of engineering schools and leveraging supporting documentation. The qualitative findings, along with the results from this study, will aid in the development of a more robust GEP Logic Model. The GEP Logic Model will leverage theory-driven evaluation (Coryn et. al, 2010; Rogers et. al, 2000; Rosas, 2005), participant feedback, and interpretation from a larger sample of engineering schools, specifically ones that are actively engaged in international activity. The GEP Logic Model will include various types of resources necessary to implement international programs, strategies undertaken to bring about desired global programming outcomes, immediate results of those strategies, and the anticipated changes that occur directly or indirectly as a result of resources, strategies, and outputs.

A resulting GEP evaluation instrument will be designed around the GEP Model and Logic Model, which will broadly measure internationalization efforts by engineering programs and create a benchmark for areas of improvement for the discipline. The logic model will be used to identify and develop GEP outcome evaluation questions, with the larger sample of participants assisting in generating potential survey items. This work will be extended by further analyzing data regarding GEP resources, output metrics, outcomes (student and program), and assessment strategies.

Limitations

The data source for Study 1 were 60-90 minutes interviews with SMEs. Supporting documents were not obtained from the schools that outline their internationalization strategic plan or the organizational structure for which these programs operate. Because many schools did not have an articulated strategic plan or if they did, the plan was proprietary in nature, there was some information loss when translating strategies schools are actually adopting. Individuals were interviewed one-on-one from each institution (with the exception of our home institution). However, each person interviewed was an expert on international education at his/her respective institution. Some of the SMEs were housed in the engineering school, while others were part of the study abroad office of the university. This was due to the organizational infrastructure of international education at the institution. The data collected were from 9 institutions and 10 SMEs in a selective fashion, who have an established successful global programming initiatives and high student participation. Notwithstanding these limitations, the results of this study are of high quality because measures were taken to ensure validity and reliability throughout.

Conclusions

This research study was conducted to classify the practices and target areas for sustainable global programming design and to develop an operational framework for global strategies, policies, and programs geared towards engineering schools. Semi-structured interviews with experts in the field of international education were combined with a GCM methodology to highlight the important target areas related to sustainable global engineering programming efforts. As globalization trends continue, it is incumbent upon engineering programs to adequately expand the skill sets of graduating students to work across cultural, linguistic, and national boundaries. This study provides knowledge regarding the effectiveness and likelihood of success of programming strategies, as well as what strategic areas must be addressed to ensure the sustained success of these internationalization efforts.

Having the correct support system to develop GEP strategies is a natural starting point. It begins with the students and ensuring that funding exists to help those who want to engage in international opportunities. This is especially true for those who may not have had a chance to have international experiences prior to college, and for underrepresented minority groups. It also means that the programs developed must be accessible to students from a financial and logistical standpoint. A critical piece to sustainable GEP development is engaging the change agents and intentionally designing programming around a shared interest and vision. Faculty play a vital role in GEP; buy-in and active involvement are required for sustainable programming, both in terms of championing the various programs that might exist and running the program. Findings pointed to the importance of plurality of faculty support. There is also value in offering an array of student-focused international opportunities that are intentionally designed around different price points and student needs. Aligning the outcomes from global programming with other priorities in engineering schools (e.g., teaching, research, and service) and creating a common vision shared by staff, faculty, leadership, and students will lead to long-term success in international engineering education.

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Appendix A: Semi-Structured Interview Protocol

Opening/Explanation:

We are conducting interviews as part of research on investigative evidence-based approaches for global engineering education programming. Specifically, we are looking to comprehensively map out the global engineering education programming strategies (implicit and explicit) being used at engineering schools and the outcomes/goals they intend to support. This interview will be followed by a Group Concept Mapping exercise that will further explore the global engineering education programming strategies used at your institution. This will give you a chance to collaborate and share your ideas with the other participants of the study.

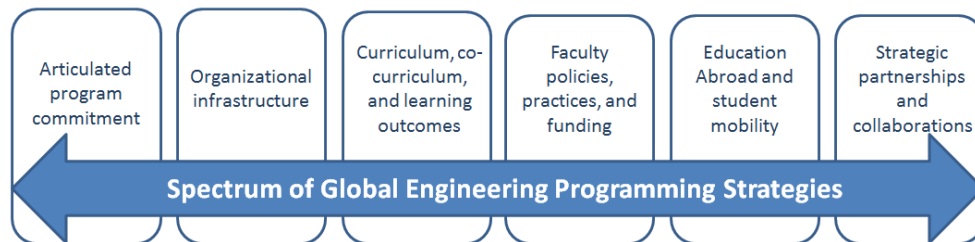
During this interview, I would like to take notes and record your responses to ascertain accuracy when coding and consolidating the final results. Do I have your permission to do so? Do you have any questions/clarifications before we begin? I am interviewing: _____ (say subject matter experts name and affiliation)

Warm-up Question:

1. Can you describe the organizational structure of the international programs and strategies at your university? Where do you fit into this organizational structure? Does your school and/or institution have an internationalization strategic plan?

Introduce Adapted GEP Framework:

I've provided you a Global Engineering Education Programming (GEEP) framework, which has been adapted from the Center for Internationalization and Global Engagement (CIGE)'s Model for Comprehensive Internationalization. It includes six interconnected dimensions for initiatives, policies, and programs geared towards engineering schools:



- Articulated Program Commitment and Vision
 - Mission statements, strategic plans, and formal assessment mechanisms
- Organizational Infrastructure
 - Resources programs provide to support and promote GEEP (e.g. dedicated office space, human resources, communication and technology support, reporting structures and staff/office configurations)
- Curriculum, Co-Curriculum, and Learning Outcomes

- Availability of for-credit, undergraduate academic offerings with an international focus (e.g. foreign language learning, globally focused general education requirements and course offerings)
- Co-curricular activities, clubs, and programs
- Specified learning outcomes
- Faculty Policies, Practices, and Funding
 - Professional development opportunities available to faculty to help them increase their international skills and knowledge
 - Funds earmarked for international education programs and activities
 - Funds to support international activities by faculty
 - Hiring guidelines, tenure and promotion policies
- Education Abroad and Student Mobility
 - Education abroad programs offered (e.g. study abroad, international internships, research abroad) and support for participation (e.g. address potential barriers such as cost and delaying of graduation)
 - International student recruitment and support (e.g. number of international students in program, funding to recruit international students, educate students abroad)
 - Program support for unscripted learning (e.g. existence of programs aimed at providing opportunities for U.S. and international students to learn from one another outside the classroom)
- Strategic Partnerships and Collaborations
 - Joint-degree or dual/double degree programs, branch campuses, and other offshore programs.

Please use these dimensions as a 'frame of reference' as you think about and answer the proceeding questions regarding your school's global engineering education programming (GEEP) strategies and outcomes. Keep in mind your school's strategies can contain any combination of elements from all six GEEP dimensions.

Strategies:

2. Tell me about the global programming strategies that have been adopted at your school. These can be either explicit or implicit. Are there any specific to the engineering school? What makes the engineering school strategies different from other colleges and/or institutional strategies? For example, Pitt's unwritten strategy focuses on "creating a series of attractive, short-term programs to increase participation; the current strategy is to augment that with increasing the number of students who go on semester long programs. Pitt has also focused on providing students with international research opportunities over the summer." – Larry Shuman

3. What is your reaction to the GEEP as it relates to your institution? To what extent do the dimensions exist on your campus? And where do these dimensions sit (e.g. institution level, school level). Where is the domain of control for the GEEP domains at your institution? How does your school or institution leverage third party providers?

4. Can you describe the relationship between the engineering school strategies and the larger university internationalization strategy? Is their coordination? Is the school's strategy part of a larger university strategy?
5. How does ABET overlay on your international programs and school strategies? How do you incorporate ABET into your GEEP strategies? How is ABET interpreted at your school regarding international programs and school strategies?
6. Tell me about the history of your international programs strategies and how they were developed. Who was involved? What was going on at the time? Why were these things done? How did it happen? How did it relate to the institution at large? Based on this, how do schools move away from one-off programs to creating a committed and sustained school-wide global programming strategy?
7. Who are the champions/influencers of your international programs and strategies? Who are the opponents? Why do you think this is?

Outcomes and Assessment:

8. What outcomes and/or goals do these strategies intend to support? (Send students abroad, faculty partnerships, further higher-level strategies) What are program outputs and/or measures of success of these strategies? Does your school have any formal assessment mechanisms in place to assess the outcomes of the international programs and school strategies? And if so, can you describe how the success of your strategies and/or programs are assessed?
9. How important do you believe it is to monitor (or otherwise track) these measures of program success? Which program outputs/outcomes are valued most highly? What program output metrics should be tracked, but aren't?
10. What conditions and factors should be considered when adopting global engineering education programming strategies? What factors, either positive or negative, affect the success of GEEP strategies? How can schools develop a more articulated global engineering education programming strategy?
11. Does your school adopt international programs or school strategies that specifically target certain demographic groups? (e.g. males, under-represented minorities, low socio-economic students) What percentages of your incoming freshman are international? And how do your strategies leverage this?

DEA - Efficiency of GEEP Resources:

As part of our research on investigative evidence-based approaches for global engineering education programming, we are also looking at how engineering schools are utilizing their resources regarding international programs and overall strategies. Specifically, we are interested in measuring the 'efficiency' of your school's GEEP, where highly efficient programs employ strategies that result in high levels of output metrics,

with relatively low levels of input metrics. The following set of questions attempt to determine the most *important* and *attainable* program inputs and outputs for engineering schools, and the *uncontrollable factors* that are plausibly related to levels of those program outputs.

12. What are the most important and attainable **inputs** to your international programs/GEEP strategies? For example, potential important inputs could be *total cost of programs to institutions, total cost of programs to students, resources required, and/or number of high-quality programs offered.*

13. What are the most important and attainable **outputs** to your international programs/GEEP strategies? Potential important outputs could be *the number of students who participate in the international programs, the number of students who participate in high quality programs and/or overall global competency attainment.*

14. Open Doors, published by the Institute for International Education, capture the total number of study abroad students that earned at least 1 credit per year at a particular institution. This number is also broken down by:

- Academic level
- Gender
- Ethnicity
- Destinations
- Duration
- Academic credit for internship, volunteer, or work abroad as part of study abroad experience
- Number of study abroad students who studied under institutionally organized programs (regardless of whether credit was given)
- Number of students with non-credit internships, volunteer, or work experience
- Number of study abroad students for the following year (possibly an estimate)

Which outputs do you feel are the most important to capture regarding strategy and/or program success?

15. What **uncontrollable factors** contribute to the success of adopted international programs and strategies? Potential uncontrollable factors could be *size of the engineering program, budget, and student backgrounds*

16. What are some of the most important **intangible benefits** to your school and/or institution regarding global programming strategies? Potential intangible benefits could be *impact on recruitment, impact on retention, and impact on institutional/school reputation*

17. Do you have any hypotheses regarding the relationship between program inputs and factors with program outputs and measures of success (both tangible and intangible)? If

so, what are they? What makes an engineering school's global programming strategy successful?

18. Is there anything you'd like to add about anything we've talked about today?

Closing:

Thank you for your time. Please feel free to contact me, if you have any questions or further clarifications. If I have any further questions or need clarifying information, can I contact you?

The next part of this study involves an approach called Group Concept Mapping. GCM is a participatory, mixed methods approach for organizing the ideas of diverse groups of stakeholders and aiding in the development of a conceptual framework. The approach incorporates qualitative individual and group process with multivariate statistical analyses to help a group of individuals describe ideas on any topic of interest and represent these ideas visually through a series of related two-dimensional maps. You and your colleagues can participate in this research activity to help develop an operational framework for global strategies, policies, and programs geared towards engineering schools. The activity is facilitated completely online and should require no more than 45 minutes to complete. You will receive step-by-step instructions throughout the activity. Do you agree to participate in this part of the study?

Appendix B: GEP Model Feedback Survey

- 1.** Do the GEP Model and logic model make sense? What changes would you make, if any? Please explain
- 2.** How can the GEP model be used in the context of the resources, outputs, outcomes, and assessment of your institutions global programming?
- 3.** How do the GEP strategies relate to the elements in the logic model (resources, outputs, outcomes, and assessment)?
- 4.** How do you see the GEP model being used on a broader scale at other institutions? Comment on how this can be used at different levels (institution, college, departments).
- 5.** Please select the job title that most closely reflects your current position
 - a.** Assistant Vice Provost for International Programs
 - b.** Director of Study Abroad or International Education (university-wide)
 - c.** Director of Study Abroad or International Education (engineering only)