AC 2011-2068: GLOBAL INITIATIVES: SHAPING THE CURRICULAR AND CO-CURRICULAR LANDSCAPE AND ITS IMPACT ON STUDENT DEVELOPMENT

Barbara A Masi, Massachusetts Institute of Technology

Barbara A. Masi Ph.D. is the Director of Education Innovation and Assessment in the MIT School of Engineering.

Global Initiatives: Shaping the curricular and co-curricular landscape and its impact on student development

Abstract

This study examined the impact of global initiative campus programs as an integrative learning experience and its impact on student ability development and career paths. An undergraduate survey was distributed to freshmen and again to seniors. Students were also asked to report their level of confidence in their engineering, science, professional and integrative disciplinary abilities used in complex problem solving as well as career plans at each point in time. In addition, seniors were asked about their participation in global initiative activities including initiative choice, type of activities, length of participation, and motivations for choice. Those who engaged in exploration of a global initiative area reported higher self-efficacy for integrative disciplinary and professional ability factors than non-explorers. Significant differences were also noted for career paths, and certainty of career choice, for explorers versus non-explorers. It is suggested that global initiatives in each area created an organized, more coherent, learning space which students were able to use to, in effect, uniquely organize their undergraduate learning experience. Explorer students were able to use activities in this space to further development of key integrative disciplinary abilities and shape careers that connected engineering with other disciplines.

Introduction

Developing engineering graduates who are able to use a range of engineering and social science or humanities perspectives, as well as professional abilities, in addressing complex global problems has become a important effort in engineering programs around the world.[14,17] Many colleges and universities have sought to design learning experiences that develop the range of complex abilities needed to address major global issues, such as energy, global health, or international development. The variety of learning experiences spans the curricular and co-curricular landscape to include new programs, such as multi- or interdisciplinary degree programs, theme-based learning communities, minors, or co-curricular activities. Global initiative themes drawn into these experiences are many: international development, urban design, global health and energy are some examples. Moreover, such programs often contain a service learning philosophy or a global experience element. A common factor in many of these learning experiences is the goal of integrating engineering, science, humanities, and social science disciplines. Another common factor is the integration of experiential learning with formal academic subjects so that students can use real-world projects to reinforce learning with practice.[1,3,5,15,16]

Some have noted that a drawback of such experiences is that they can exist in isolation, from the students' perspective, from other parts of an undergraduate's educational experience. Moreover, even when students may complete elective or minor subjects in disciplines outside of their major discipline, they often see their coursework as disconnected subjects both from one another and, more importantly, from their major learning experience. Recently, some authors have asked how colleges and universities might design educational experiences that help students develop capacity to integrate the pieces of undergraduate experience into a comprehensive whole. In a recent Carnegie Foundation study, the authors asked how can we create a sense of integrative learning experiences that are greater than the sum if its parts?[6,7]

During the past decade, many campuses have initiated major efforts around theme-based global initiatives. For example, an institution might organize an initiative in energy or global health which includes a comprehensive array of activities in research, education, and co-curricular activities in which undergraduates can participate. The question is how might such initiatives help create an integrative learning experience for undergraduate education? What constitutes an integrative learning experience? And how might impact on students be measured?

Background

Perceived self-efficacy is defined as a person's belief in his or her abilities to successfully complete a task or reach a goal. The choices that people make are directly governed by their perception of their self-efficacy – people will gravitate towards activities and situations that they are confident they will succeed in and avoid situations that require skills and abilities that they might lack.

According to Bandura, students who have the opportunity to successfully complete a real-life task report an increase in their perceived self-efficacy. Such "mastery experiences" may be incorporated into engineering courses to allow students to perform tasks similar to those that they may be required to perform in the real-world. Furthermore, the career decisions made by college-aged students will be directly impacted by their confidence in their abilities: "the higher the level of people's perceived self-efficacy the wider the range of career options they seriously consider, the greater their interest in them, and the better they prepare themselves educationally for the occupational pursuits they choose and the greater is their success."[2]

Bandura showed that an individual's self efficacy could be increased by mastery experiences, experiences where one's confidence in ability to successfully and competently complete an authentic task. Ponton[12] pointed out that engineering subjects could be intentionally designed to incorporate such mastery experiences. The authors argued that students gain a sense of mastery in engineering practice from comprehensive subjects that permit students to engage in tasks that require the synthetic decision making and comprehensive design projects of real-world engineering.

Hutchinson[9] developed a survey tool to deeply investigate factors that influence engineering students' engineering self efficacy, and its connection with learning environment. The survey questions examined 9 factors that might influence students' confidence in their success in engineering: understanding/ learning, drive/ motivation, teaming, computing abilities (students were surveyed in a computing freshman subject), help with academics, working on assignments, problem solving abilities, interest/ satisfaction, and grades. The study used a mix of closed and open ended questions to gather from students the particular tasks that led to a student's sense of self efficacy for each factor. The study found that understanding/ learning was the most important factor, being cited by 70% of men and 55% of women. This factor was followed by, in order, drive/motivation, teaming, and computing abilities, and problem solving. A key theme running through students' sense of engineering self efficacy for every factor was the "ease" with which they could use a given ability in their engineering studies. With respect to understanding/

learning, for example, students cited understanding concepts, being able to learn and apply concepts quickly. For teaming, students cited working with other students in a team in general, but also in a manner where students supported one another in working on a problem. With respect to problem solving abilities, students again cited the ability to work through problems without any difficulty as a factor in self efficacy.

This study drew on Bandura's and Hutchinson's works by listing tasks for a set of ability factors, and asking students to rate their confidence to perform that task, rather than provide students with an open ended opportunity to lists those tasks. The questions in this study drew out students' sense of understanding of concepts, ability to apply concepts quickly in several of the factor areas noted by Hutchinson, namely teaming, problem solving. In this area, a composite factor of engineering including computing, math, and application of technical concepts was developed in place of computing used in the Hutchinson study.

One might place service learning and global experience programs as exemplars of learning experiences that, by virtue of their community, social/ cultural context, support students' ability to address complex technical problems that often span beyond a engineering disciplinary perspective. Such programs are often structured to integrate engineering theoretical concepts and abilities, particularly complex problem solving and design, with social, cultural, political, and economic contexts within which engineering problem solving and design are embedded. In assessing the impact of such programs, studies have found that student knowledge and abilities in understanding context have been measurably improved.[1,3,5,15,16]

Some authors have recently taken a even broader approach to the design of undergraduate education.4,[6,7,8] These authors have suggested models of undergraduate educational experience as an integrative learning experience. In this case, a student's academic and co-curricular experiences are intentionally integrative so that a student may begin to develop critical awareness of how to think about, and address, complex problems that span disciplines. In this integrative educational model, a student would be able to draw on his or her entire range of academic and co-curricular experiences that would span academic major perspective as well as other disciplinary perspectives in addressing complex global problems. In the ideal, one result of an integrative education, might be a liberal arts major who would be able to sufficiently comprehend technical concepts in consideration of historical events. Or an engineering major would be able to deeply and critically consider cultural, historical, or economic context in consideration of technical solutions to a complex problem.

A number of authors have studied pedagogies that improve engineering student learning. Among those studied, enabling students to make connections between theoretical concepts and real-world, experiential or hands-on experiences have been found to strengthen student learning for many students. Pedagogies such as problem or project based learning, cooperative experiences, collaborative learning, or community projects are examples of such. Context-driven engineering education experiences, such as service learning or global education, have often been designed to integrate experiential learning with academic subjects, with the result of enhanced student motivation and learning.[1,3,5,14,15] One might imagine that an integrative learning experience could also build on key pedagogies that promote integration of disciplinary perspectives.

Assessment and evaluation of integrative learning experiences is dependent on the definition of a learning experience that span disciplinary boundaries. Some authors have considered definitions of "multidisciplinary", "interdisciplinary" and "integrative" learning experiences, what constitutes learning experiences and student work within each definition, and how to assess student learning.[4,6,7,8] In this work, the global initiative programs best fit the definition of "integrative" learning experiences where a student's program of study spans major, minor, or elective academics and co-curricular experiences, organized within a broad thematic frame. The result, in the ideal, is a graduate who is able to draw on this variety of academic and co-curricular experiences to:

- Connect skills and knowledge from multiple sources and experiences in addressing a complex, global problem that requires multiple areas of knowledge and modes of inquiry;

- Apply theory from several disciplines, including engineering and social science or humanities disciplines, to the understanding of complex, global problem;

- Utilize diverse points of view in understanding issues and positions, and being able to utilize those points of view in making choices, considering solutions, for a given complex, global problem;

- Be sufficiently motivated and confident in the utilization of multiple areas of knowledge and modes of inquiry in addressing complex global problems so that a graduate will choose a post-graduation career path that includes aspects of this motivation and confidence.

Global Initiatives and Undergraduate Engineering Education

This study took place at a U.S. research university where several major university-spanning global initiative programs had been initiated during the past decade. Such programs included theme-driven, and somewhat overlapping, areas including energy, global health, environment, and international development. Over the decade, the programs expanded to include a wide range of highly organized and well-publicized academic, research, and co-curricular activities available to undergraduates. While the programs were not formal academic departments, the programs took on many of the features and roles of both academic departments and co-curricular activity offices. Also over time, students' participation in activities associated with the programs grew. Students used the programs to shape unique sets of experiences, whether academic subjects completed via a minor, elective subjects, certificates or co-curricular experiences completed via internships, clubs, design competitions or long term community or international projects that fit their own unique interests.

During the past several years, global issues program officers began to notice a broad pattern of student involvement in these programs. Significant numbers of students would complete 2 or more sets of academic subjects and supplemented by co-curricular experiences within a single broad global issue theme. For example,

- A student might become involved in a freshman year energy seminar with an intensive project-based learning component. The student would begin an engineering major, and also begin an undergraduate research project with faculty in a similar energy area, and continue this project during the summer. By junior year, the student might complete several elective subjects in energy which include social science or humanities subjects, such energy economics, or history of U.S. industrial development and energy use.

- Another engineering student might complete a minor in international development that includes cultural and historical perspectives and complete several intensive international projects in technology solutions for developing nations.

- Yet another engineering student might participate in a global health summer internship that takes the student to intensive participation in projects abroad. The student might return to school to continue research and academic subjects that integrate global health economics, and management of health delivery systems along with engineering subjects.

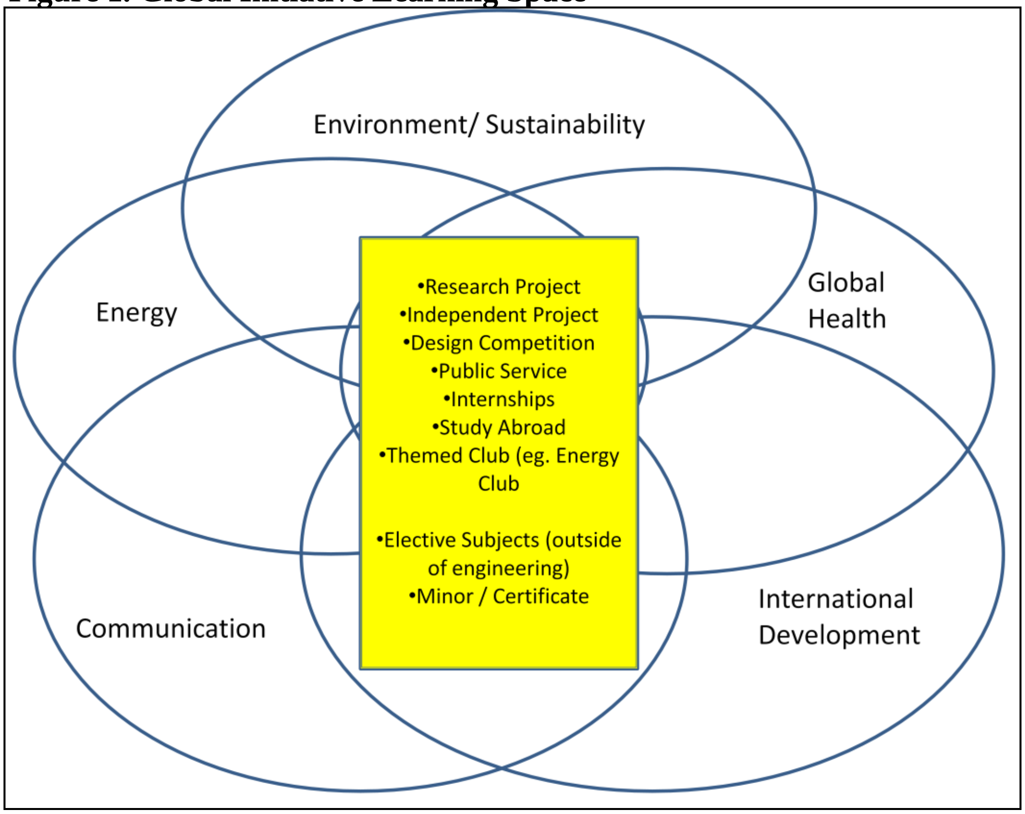
The question for this study is how students' significant participation in integrative, theme-driven program activities, along with completion of their primary engineering majors, impacted their ability development, and, potentially, career motivations and career paths. In particular, this study examined how participation impacted student ability to concretely apply knowledge from both engineering and social science or humanities disciplines in complex problem solving and design, as well as abilities to critically evaluate and defend positions where multiple disciplinary perspectives on a complex problem solving are required.

Global initiative programs, through significant programmatic organization and publicizing of available subjects and activities have, it is hypothesized, created an organized learning space within which students can choose academic and experiential learning activities to complement in-major learning experiences. Rather than choosing a somewhat random set of out of major learning experiences, such as an unrelated internship experience, or another unrelated public service experience, followed by an unrelated economics subject, students gain integrative learning experiences that, again hypothesized, enhance their confidence in non-engineering disciplinary knowledge and abilities complementary to their engineering knowledge and abilities. Figure 1 presents a global initiative "learning space".

Methods

An undergraduate freshman survey was designed, tested and distributed to engineering freshmen at the end of their freshman year (after choosing engineering as a major).[10] A survey was also given to engineering seniors at the end of their senior year.[11] Using a Bandura 11 point (0-10) confidence scale (0=no confidence and 10=very strong confidence), students were asked to report their self-efficacy on a series of concrete tasks associated with engineering, science, humanities and social science perspectives as well as professional and integrative disciplinary abilities used in complex problem solving. The expanded measures permit a more nuanced portrait of the impact of different types of integrative curricular and co-curricular experiences on student self efficacy. Seniors were also asked about their interest in and pursuit of global initiative areas including initiative choice, type of activities, length of participation, and motivations for choice. Seniors were also asked to respond to a series of open ended questions that permitted them to elaborate on details of their particular choice of activities, and about connection of global initiative activities with their major. Finally, seniors were asked to report on their post-graduation career plans and career plan connections with global initiatives.

Figure 1. Global Initiative Learning Space



For each ability area on the survey, specific tasks were listed that are common, and recognizable to undergraduate engineering students. The survey was tested with undergraduates from all class years during the academic year prior to its distribution to freshmen. While additional survey items were included in the survey for each ability area, a subset of tasks for each item were found to be key as measures of self-efficacy. A total of 17 self efficacy questions were used in the analysis for freshmen and 20 for seniors. Table 1 lists the number of survey items for each self-efficacy measure, and the reliability coefficient for that measure. In the freshman survey, the questions related to student ability to separately use economics, management, political or other social science or humanities knowledge in problem analysis, was not included in the freshman survey, hence the factor “integrative ability 1” could not be calculated. Table 2 lists sample survey items.

Students were asked to identify whether they were able to “explore” a single global initiative area as an undergraduate (defined in the survey as having completed 2 or more significant academic or co-curricular activities outside of their engineering major (from a defined list of activities) and all within a given global initiative area (from a defined list of global initiative areas at the institution). Academic subjects could include elective or minor subjects outside of their engineering major. Co-curricular experiences could include research projects, independent projects, significant global initiative club participation, design competitions, study abroad, or internships.

Table 1. Global Initiative Survey - subscales reliability and minimum and maximum response values

Self-efficacy subscale item	No. of items	Cronbach's Alpha reliability coefficient	Scale minimum and maximum response values
Engineering Ability 1- Application of knowledge from engineering discipline in problem solving	3	.815	0 – 10
Engineering Ability 2- Using engineering design methods in design of a product, system or component	3	.890	0 – 10
Integrative Ability 1 -Application of knowledge from social science or humanities disciplines in complex problem solving	3	.771	0 – 10
Integrative Ability 2- Critical evaluation of complex problem using engineering, social science or humanities perspectives	1 (eng) 2 (soc.sci / hum.)	NA .795	0 - 10 0 – 10
Integrative Ability 3- Integrate engineering, social science, or humanities perspectives in complex problem solving	3	.833	0 – 10
Oral Communication- Persuasion or defending position as part of an oral presentation or team/ group debate	2	.711	0 – 10
Teamwork- Participation in a multi-disciplinary team.	3	.807	0 – 10

Students were also asked to clearly identify the key global initiative related academic and co-curricular activities in which they participated in. To ensure that students were correctly reporting related global initiative activities, students were asked to respond to additional open ended questions that further detailed activities or projects and level and types of participation. Students were also asked to further detail academic subjects completed, again to ensure correct reporting of related global initiative activity. Student responses were carefully reviewed and categorized to ensure that activities identified by students fit the definition of global initiative related activity used in the survey design.

Finally, students were asked to report on their post-graduate career plans and their possible relationship to global initiative undergraduate experiences.

Table 2. Global Initiatives Survey – Sample Subscale Items

Self-efficacy variable	**Sample item**
Engineering Ability 1- Application of knowledge from engineering discipline in problem solving	Apply engineering concepts from my major in complex problem solving
Engineering Ability 2- Using engineering design methods in design of a product, system or component	Use systematic engineering design procedures in design of product, system, or component
Integrative Ability 1 -Application of knowledge from social science or humanities disciplines in complex problem solving	Apply economics concepts in complex problem solving
Integrative Ability 2- Critical evaluation of complex problem using engineering, Social Science or Humanities Perspectives	Critically evaluate cultural context factors in addressing a complex problem
Integrative Ability 3- Integrate engineering, social science, or humanities perspectives in complex problem solving	Carefully balance technical, economic and cultural factors in making complex project choices
Oral Communication- Persuasion or defending position as part of an oral presentation or team/ group debate	Defend a point of view in oral debate of a major global issue
Teamwork- Participation in a multi-disciplinary team.	Make sure a team sets ground rules for how the team will work together.

Results

Students who responded to both the freshman and senior surveys were pulled from the survey responses; a total of 252 students completed both the freshman and senior surveys. To analyze survey responses, student responses were used to group respondents into 2 groups based on senior responses concerning global initiative activity:

- Explorers: students who completed 2 or more significant activities outside of their engineering major requirements that were related to a single global initiative theme, such as energy, international development, global health, education, or environment.

- Non explorers: students who may or may not have been interested in a global initiative area, but did not complete 2 or more significant activities outside of their major requirements.

Of the 252 engineering major survey respondents, 161 or 64% of respondents fit the category of "explorers" of a single global initiative outside of their major, with 36% categorized as "non-explorers."

For many education research studies, random assignment of students to experimental and control conditions is not a possibility. Since it was impossible to randomly assign students to participation or non-participation in global initiative activity, it was only possible to examine the characteristics of the explorer versus non-explorer groups at the beginning of this study- the end of their freshman year, when each group completed the initial survey. It was determined that students who were similar in key ability self efficacy measures as well as choice of major, engineering, were most important baseline variables to confirm similarity between the explorer and non-explorer groups.

Student responses to the self-efficacy questions were calculated as seven ability factors described earlier and relabeled as follows: engineering 1 (engineering concept application in problem solving), engineering 2 (use of engineering design methods), oral communication, teamwork, and integrative 1 (social science/humanities knowledge application), integrative 2 (critical evaluation of complex problems using technical, social science, or humanities perspectives), and integrative 3 (integration of technical/social science/ humanities knowledge and perspectives in complex problem solving).

In examining freshman student responses in the explorer and non-explorer groups, as mentioned, all students in both groups were chosen because they selected engineering majors at the end of their freshman year. Mean responses for each ability factor were compared using an independent sample t-test. It was found that “explorer” mean responses were statistically similar to the mean responses for “non explorers” for the 2 engineering abilities, 2 integrative abilities, and teamwork. The group means differed statistically for oral communication ability. Table 3 summarizes the mean responses and independent sample t-test results for freshmen.

Based on the results of the freshman survey, and comparison of the explorer and non-explorer groups, it was concluded that the 2 groups were equal in self-efficacy in all key engineering and integrative abilities at the end of their freshman year.

These engineering students were surveyed again at the end of their senior year, and asked about their self efficacy, involvement in global initiatives, as well as career plans. Mean responses for seniors were also calculated and analyzed, and each ability factor was compared using an independent sample t-test. It was found that “explorer” mean responses were statistically higher than the mean responses for “non explorers” for the three integrative abilities and for oral communication. Mean responses were not statistically different for the two engineering abilities and for teamwork. Table 4 summarizes the mean responses and independent sample t-test results.

Table 3. Mean Ability Responses for Global Initiative "Explorers" versus "Non-Explorers as Freshmen

Self-efficacy subscale item	"Explorer" Mean Response (St.Dev.) N=161	"Non Explorer" Mean Response (St.Dev.) N=91	Difference in "Explorer" and "Non Explorer" Mean Responses is Statistically Significant (independent sample t-test)
Engineering Ability 1- Application of knowledge from engineering discipline in problem solving	7.32 (1.28)	7.21 (1.42)	No
Engineering Ability 2- Using engineering design methods in design of a product, system or component	6.24 (2.02)	6.42 (1.95)	No
Integrative Ability 1 -Application of knowledge from social science or humanities disciplines in complex problem solving	NA	NA	NA
Integrative Ability 2- Critical evaluation of complex problem using engineering, social science or humanities perspectives	6.20 (eng) (2.36) 6.55 (soc. sci/ hum.) (1.80)	6.38 (eng) (2.06) 6.15 (soc. sci/hum.) (1.72)	No No
Integrative Ability 3- Integrate engineering, social science, or humanities perspectives in complex problem solving	6.46 (1.97)	6.03 (1.78)	No
Oral Communication- Persuasion or defending position as part of an oral presentation or team/ group debate	6.79 (1.79)	5.93 (1.61)	Yes $t(247)=-2.25$, $p<0.01$
Teamwork- Participation in a multi-disciplinary team.	7.05 (1.77)	6.68 (1.67)	No

Table 4. Mean Ability Responses for Global Initiative "Explorers" versus "Non-Explorers as Seniors

Self-efficacy subscale item	"Explorer" Mean Response (St.Dev.) N=161	"Non Explorer" Mean Response (St.Dev.) N=91	Difference in "Explorer" and "Non Explorer" Mean Responses is Statistically Significant (independent sample t-test)
Engineering Ability 1- Application of knowledge from engineering discipline in problem solving	8.74 (1.53)	8.62 (1.49)	No
Engineering Ability 2- Using engineering design methods in design of a product, system or component	8.40 (1.83)	8.17 (1.79)	No
Integrative Ability 1 -Application of knowledge from social science or humanities disciplines in complex problem solving	7.30 (2.09)	5.99 (2.08)	Yes $t(250)=-3.48$, $p<0.001$
Integrative Ability 2- Critical evaluation of complex problem using engineering, social science or humanities perspectives	8.36 eng (1.78) 7.49 soc sci/hum (1.95)	7.98 eng (1.71) 6.33 soc sci/ hum (1.78)	No Yes $t(248)=-3.34$, $p<0.001$
Integrative Ability 3- Integrate engineering, social science, or humanities perspectives in complex problem solving	8.04 (1.84)	7.12 (1.81)	Yes $t(250)=-2.75$, $p<0.01$
Oral Communication- Persuasion or defending position as part of an oral presentation or team/ group debate	8.60 (1.86)	7.38 (1.55)	Yes $t(248)=-3.75$, $p<0.001$
Teamwork- Participation in a multi-disciplinary team.	8.92 (1.81)	8.34 (1.67)	No

The majority of "explorers'" primary global initiative interests were in energy (3%) or global health (29%), with smaller groups in international development (10%), education, sustainable development, or communication. Some students' interests revealed an integration of several themed areas.

"Explorers" students chose a wide variety of academic and co-curricular activities that were directly related to one global initiative area. Of note among this group were two important findings. In choosing academic subjects: the majority of explorers who chose academic subjects outside of their major also chose subjects that were outside of engineering or science. In choosing activities: while nearly all students chose either elective or minor subjects, all explorers chose at least one experiential learning activity such as a project, a theme-driven group (eg. public service group), or an internship to supplement academic subject experience.

In choosing academic subjects, “explorer” students noted, in open comments, that they were curious to gain other disciplinary perspectives on global initiative themes from such disciplines as economics, urban planning and policy, political science, management, history, and anthropology. Some students completed minors with an emphasis on a given social science discipline and with subjects dedicated to a given global initiative theme (eg. energy economics, energy technology entrepreneurship, management of global health organizations, public policy and environment). Table 5 summarizes student participation in activities related to global themes.

Table 5. Student Participation in Activities Related to Single Global Initiative Theme

Activity	**Percent “Explorer” Students Who Chose Activity to Explore Global Theme**
Two/more elective subjects in social science or humanities field	55%
Completion of a minor in social science or humanities field	38%
Extracurricular group or design competition group	35%
Research or independent project	34%
Internship	27%
Study abroad	21%

Differences were also noted for “explorer” and “non explorer” career paths. Explorers chose full time work, whether directly or directly in engineering fields, over graduate school just after graduation: 49% of explorers chose work versus 39% of non explorers; 43% of explorers chose graduate school versus 53% of non explorers. Table 6 summarizes career results for each group. Explorers (N=161) were asked if they had a concrete plan, either through a graduate school research project or chosen employment, to continue to pursue some aspect of their chosen global initiative area after graduation. Forty-nine percent responded that they did have a concrete plan.

Table 6. Post-Graduation Career Plans for “Explorers” versus “Non Explorers”

Career Path	**“Explorers” : Percent choosing career path** **N=161**	**“Non explorers”: Percent choosing career path** **N=91**
Graduate School, Engineering	38%	45%
Graduate School, Science	5%	8%
Full Time Work, Related to Engineering Major	36%	28%
Full Time Work, Not Related to Engineering Major	13%	11%
Don’t Know	5%	4%

Summary and Discussion

The survey tool developed for this study has been shown to be effective in capturing changes in student self efficacy related to engineering and integrative ability development as they develop from their freshman year to senior year. The survey tool was also able to discern impact on student self efficacy as a result of completing a coordinated set of global initiative experiences chosen by students compared to students who did not complete such experiences.

The study found that engineering freshmen in this study who explored global initiatives ("explorer") and those who did not ("non-explorer") were similar in mean self-efficacy in both abilities directly related to engineering practice and those that require integration of knowledge and methods from other disciplines, such as social science or humanities fields. In contrast, explorer student mean self-efficacy was significantly greater for discipline integration abilities by their senior year compared to the non-explorer group. However, engineering related abilities remained statistically similar for both groups.

Compared to non-explorer students, explorer students also chose more diverse career paths outside of or tangential to traditional engineering paths (engineering graduate school, engineering job directly in student's major) after graduation.

Global initiative programs, through significant programmatic organization and publicizing of available subjects and activities have been shown, in this study, to have created an organized learning space within which students could choose academic and experiential learning activities to complement in-major learning experiences. Rather than choosing a somewhat random set of out of major learning experiences, such as an unrelated internship experience, or another unrelated public service experience, followed by an unrelated economics subject, students were able to create a unique, personalized set of integrative learning experiences, that included both academic and experiential learning activities, that enhanced their confidence in non-engineering disciplinary knowledge and abilities and which were complementary to their engineering knowledge and abilities. Moreover, students were able to develop integrative abilities that enabled them to integrate engineering with social science or humanities knowledge and perspectives and use these in complex problem solving. Students were also able to shape career paths that permitted them to continue to use integrative knowledge and abilities in post-graduate education and work.

Supporting engineering students' development of integrative educational experiences that enable them to address major global issues has become an important goal for many engineering programs around the world. With the wide variety of academic and co-curricular programs currently available at many institutions, each student is able to find an experience that fits his or her interests. Highly organized global initiative programs, such as those described in this study, can, it is suggested, organize activities in a manner that supports students' finding and participating in a coherent set of related activities that enhance student development.

Bibliography

1. Amadei, B., Sandekian, R., Summers, R.S., and Bielefeldt. 2006. Engineering for Developing Communities: Integrating Education, Research and Development, and Service/Outreach into Engineering Education. Proceedings of the ASEE Annual Conference 2006, June 18-21, Chicago, IL.

2. Bandura, A. 1997. Self-efficacy: The exercise of control. New York: Freeman.

3. Bidanda, B., Shuman, L., Thomes, K. and Arisoy, O. 2005. Adapting Engineering Coursework for Increased Global Relevance. Proceedings of the ASEE Annual Conference 2005, June 12-15, Portland, OR.

4. Boix Mansilla, V. 2004. Assessing Student Work at Disciplinary Crossroads, Project Good Work Project Report Series, Number 33, Project Zero, Harvard Graduate School of Education.

5. De Werk, G., Kamp, L. M. 2008. Evaluation of the Sustainable Development Graduation Track at Delft University of Technology. European Journal of Engineering Education, 33(2): 221- 229.

6. Field, M., Lee, R., and Field, M.L. 1994. Assessing interdisciplinary learning. New Directions in Teaching and Learning, 58: 69-84.

7. Gale, R. 2006. Fostering Integrative Learning through Pedagogy. Working Paper, Integrative Learning Project, Carnegie Foundation for the Advancement of Teaching.

8. Huber, M.T. and Hutchings, P. 2004. Integrative Learning: Mapping the Terrain. Washington, D.C.: Association of American Colleges and Universities.

9. Hutchinson, M., D. Follman, M. Sumpter, G. Bodner. 2006. Factors influencing the self efficacy beliefs in first year engineering students. Journal of Engineering Education, 95(1): 39-47.

10. Masi, B. Freshman Engineering Self-Efficacy Survey, 2007. Internal document, MIT, Cambridge, MA. Available from author.

11. Masi, B. Senior Engineering Self-Efficacy Survey, 2010. Internal document, MIT, Cambridge, MA. Available from author

12. Ponton, M., J. Edmister, L. Ukeiley, J. Seiner. 2001. Understanding the Role of Self-Efficacy in Engineering Education. Journal of Engineering Education, 90(4): 247-251.

13. Prince, M. 2004. Does Active Learning Work? A Review of the Research. Journal of Engineering Education. 93(2): 223-231.

14. Shuman, L. Besterfield-Sacre, M. and McGourty, J. 2005. The ABET Professional Skills- Can They Be Taught? Can They Be Assessed? Journal of Engineering Education. Jan: 41-55.

15. Surovek, A. and Karlin, J. Beyond the Classroom: Using a Lecture Series Format to Give Engineering Students a Societal and Global Context. Proceedings of the ASEE Annual Conference 2006, June 18-21, Chicago, IL.

16. Tsang, E. 2000. Projects that Matter: Concepts and Models for Service Learning in Engineering. Washington, D.C.: American Association for Higher Education.

17. Vest, C. 2006. Educating Engineers for 2020 and Beyond. The Bridge: 36(2), 38-44.