

AC 2010-742: EPLUM MODEL OF STUDENT ENGAGEMENT: EXPANDING NON-TRAVEL BASED GLOBAL AWARENESS, MULTI-DISCIPLINARY TEAMWORK AND ENTREPRENEURIAL MINDSET DEVELOPMENT

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eplum Model of Student Engagement: Expanding Non-Travel Based Global Awareness, Multi-disciplinary Teamwork and Entrepreneurial Mindset Development

Abstract

Common strategic goals for many universities include the internationalization of the curriculum and an increased emphasis on innovation and entrepreneurship, multidisciplinary teamwork and public scholarship. Common approaches to teaching these skills and developing mindsets often reach only a limited numbers of students. Universities are challenged with how to expand these educational experiences from a select few to the vast majority. We have developed and are currently testing the eplum model which engages students and faculty mentors across campus in various international humanitarian engineering and social entrepreneurial ventures. This is accomplished in various formal and informal ways from the sub-credit to multi-credit level. Students participate at different levels of engagement such as honors thesis, focused courses, embedded projects, commissioned assignments, volunteer effort, etc

The objective of the eplum model is the convergence of disciplines, concepts, cultures, and countries towards a freer, friendlier, fairer and more sustainable planet. This paper discusses the model's philosophy, mechanics and assessment framework. Preliminary assessment results that provide the baseline to understand how different forms and levels of engagement in these ventures leads to global awareness, multidisciplinary teamwork and social entrepreneurial mindset development outcomes at various levels are also discussed.

Introduction: Internationalizing the curriculum

Globalization has increased the interconnectedness between nations and peoples of the world. It has put increased pressure on educational institutions to prepare students for life in an increasingly connected and borderless world. The engineering profession is one of the most global professions with international design teams developing technologies for international markets. In response to this “flattening” of the world, there is a growing trend towards internationalizing the curriculum at universities.

Traditionally, internationalization of the curriculum has been linked to globalization and focused on student mobility through study abroad, exchange programs, and the recruitment of fee-paying international students. Common approaches to enhancing students' global competencies and developing global mindsets reach only a limited number of students – those who can afford to be mobile and those students in the host country who interact with them. Rising travel costs and risk management issues further hinder the growth of such opportunities, especially to developing countries in Africa and Asia. We cannot expect everyone to participate in these programs, or expect them to do so more than once. Universities are seeking creative ways of bringing these experiences back to the classroom through faculty initiatives, smart use of technologies, global virtual teams, and others. The challenge is to find ways to internationalize the curriculum for all students in a planned and systematic way without requiring them to travel to a foreign country.

The concept of global education is relatively new in university curricula. It has appeared in response to globalization and a rapidly changing world. One of the main functions of an internationalized curriculum is the “formation of the skills....required to operate in the global environment itself.”¹ Thus, internationalization of the curriculum is clearly linked to globalization, and relates to “those processes by which the peoples of the world are incorporated into a single world society, a global society.”² A better understanding of the complexities of the world empowers people to overcome challenges and more adequately leverage opportunities to improve their own well-being.

Five dimensions have been proposed to assist in defining ‘global education’. These include: perspective consciousness, “State of the Planet” awareness, cross-cultural awareness, knowledge of global dynamics, and awareness of human choices.³ These five dimensions require that students/individuals (1) recognize that each individual in the world has his/her unique world view, which may continuously be influenced and shaped by the changing world and may not be shared by others; (2) be aware of the prevailing world conditions, developments, trends, and problems; (3) be aware of the diversity of human cultures and societies and how others might view one’s own culture; (4) understand the interconnectedness of the key mechanisms of the world system; and (5) be aware of the problems of choice which individuals, nations, and the human species confront, and understand that these choices will affect other people and nations, and future generations.

Similarly, five substantive dimensions of a global perspective have been identified⁴, which includes understanding of universal and cultural values and practices, global interconnections, present worldwide concerns and conditions, origins and past patterns of worldwide affairs, and alternative future directions in worldwide affairs. In addition, to prepare students for these dimensions, it was suggested that educators should address five cognitive and affective attributes that are associated with a global perspective. These are: open-mindedness, resistance to stereotyping, anticipation of complexity, inclination to empathize, and nonchauvinism⁴

A summary of the definitions of the major scholars in the field provided a framework of global education consisting of eight elements.⁵ These elements are: human beliefs and values, global systems, global issues and problems, cross-cultural understanding, awareness of human choices, global history, acquisition of indigenous knowledge, and development of analytical, evaluative, and participatory skills. Among these, the emphasis on indigenous knowledge and analytical, evaluative, and participatory skills are an addition to those cited by earlier studies.^{3, 4} The importance of preservation of and respect for indigenous knowledge in a globalized world is recognized.^{6, 7}

Educating global-minded social problem-solvers

The National Academy of Engineering envisions engineers being leaders in the movement towards wise, informed, and economically sustainable development and has asked engineering educators to prepare students with a strong foundation and new knowledge of innovative technologies that advance society.⁸ In response, engineering education has seen a significant increase in emphasis on experiential education and on the development of “soft skills” that engineering students will need when they enter the workplace. This evolving vision of

engineering education emphasizes the development of students as emerging professionals and educated citizens, equally at home with societal concerns as they are with technical issues.

It can be argued that traditional engineering curricula quite often do not afford the opportunity for students to develop expertise in these “soft skill” areas other than on a piecemeal, random basis. For example, many curricula currently do not weave and integrate concepts such as personal development, social awareness, global contextualization, complexity, ethics, cultural sensitivity, multidisciplinary teamwork and public scholarship into the fabric of the engineering curriculum. This issue is not constrained to engineering; most colleges face similar challenges with preparing students to become well-rounded professionals.

In attempts to attain these objectives, a common strategic approach employed by many universities is to offer formal programs which focus on innovation and entrepreneurship, internationalization, multidisciplinary teamwork or public scholarship. Such programs often limit and constrain students already burdened with overcrowded schedules. For those that do seek to broaden their traditional engineering education, they find themselves part of a small band who are intrinsically motivated and engaged due to their passion to acquire such breadth in their education. For example, at Penn State, many students want to participate in public scholarship initiatives but do not want to sign up for the minor in Civic and Community Engagement or the certificate program in Engineering and Community Engagement, both of which have been formally instituted within the University and College of Engineering respectively. Universities are thus challenged with how to expand these educational experiences from a select few to the vast majority.

This paper details the eplum model of student engagement and curricular development which supports and complements existing formal initiatives in the areas of internationalization, multidisciplinary teamwork and entrepreneurship education. The eplum model attempts to expand opportunities for students to participate in the educational benefits while being mindful of the time and credit constraints for the students. The model focuses on experiential, cross-disciplinary, international education with an entrepreneurial flavor to develop technology products that help disadvantaged people living in extreme poverty in developing and underdeveloped countries.

Humanitarian Engineering and Social Entrepreneurship at Penn State

The College of Engineering at Penn State University has numerous ongoing humanitarian engineering and social entrepreneurship (HESE) initiatives.⁹ The basic philosophy behind the initiatives is the convergence of concepts, disciplines, cultures and countries towards a freer, fairer, friendlier and more sustainable planet. HESE challenges students and faculty from across campus to break down the barriers between their disciplines and truly collaborate to develop technology-based solutions for the most compelling problems facing humanity today. The objective is to develop transformative social innovations and business models to transform these technology solutions into sustainable and scalable ventures that enable and accelerate positive social change throughout the world.

HESE seeks the convergence of the tripartite university missions of teaching, research and outreach to educate globally-engaged social problem solvers and create sustainable value for developing communities, while generating and disseminating knowledge and lessons learned. The real-world context and focus on indigenous communities around the world fosters “inreach”: bringing back knowledge, perspectives, problems and solutions to inform, guide and enrich the program. Subject matter experts from industry and the professional world, as well as local knowledge experts advise and mentor the students engaged in the various ventures and research initiatives. HESE has developed long-term relationships and work with industry, government, non-profit, faith-based and UN partners spanning colleges, universities, countries and continents. More than 300 students and over twenty faculty members representing almost all Colleges at Penn State participated in various HESE initiatives in 2009.

A twelve-credit certificate program in Engineering and Community Engagement is offered to undergraduate students from all disciplines. The most important piece of the certificate program is participation in a technology-based social venture that is integrated into academics by way of the eplum model (discussed further below). The next section discusses technology-based social ventures that students engage in as part of the eplum model.

Ongoing HESE Ventures

Three technology-based ventures were offered during the Spring 2009 and Spring 2010 semesters. Collaborators on these projects include diverse entities including Jomo Kenyatta University of Agriculture and Technology (JKUAT), Children and Youth Empowerment Center, Kenya, United Nations Industrial Development Office (UNIDO), US & Kenyan Industry, and grassroots organizations. The ventures have received funding from various agencies including the National Collegiate Inventors and Innovators Alliance (NCIIA), Clinton Global Initiative University Program, IJSLE-Carter Academic Service Award, EPA P3 program, and Ideablob. The funds support the ventures but are not intended to support student travel.

The ventures are:

- Mashavu: Networked Health Solutions for the Developing World
- WishVast: Building Trust and Social Capital using Cellphones
- EssentialDesign: Appropriate Infrastructure Technologies.

Mashavu: Networked Health Solutions for the Developing World

According to the World Health Organization, there is one doctor for every 50,000 people in East Africa compared to one doctor for every 390 people in the United States.¹⁰ It costs a significant amount of time and money for individuals to consult a doctor, which is a critical decision. Mashavu is a telemedicine system that enables medical professionals around the world to connect with patients in the developing world using modern technology and communications infrastructure.¹¹ Trained operators at Mashavu stations in developing communities collect essential medical information including weight, body temperature, lung capacity, blood pressure, photographs, stethoscope rhythms, and basic hygiene and nutrition information for patients. We are designing ultra-inexpensive biomedical devices based on virtual instrumentation. Web servers aggregate this information from various Mashavu stations over a cell-phone link and

provide it on a web-based portal. Medical professionals can view the patient's information and respond to the patient and the nearest doctor(s) with their recommendations. Validation efforts prove that numerous entities are willing to purchase Mashavu stations. They can charge customers a small fee, thereby making Mashavu economically sustainable and creating an additional revenue stream.¹²

The Mashavu team aims to:

1. Design, prototype and test inexpensive computer-based biomedical devices (Mashavu station) and the networked system (Mashavu network).
2. Perform preliminary on-the-ground testing of the Mashavu stations, Mashavu network and the business plan.
3. Implement the system in a top-down manner and bottom-up manner and craft the final scale-up strategy based on lessons learned.

WishVast: Building Trust and Social Capital using Cellphones

Social networks can be very powerful, and Western nations have realized the potential of these networks over the past decade due to tools such as Facebook, mySpace, and LinkedIn amongst others. A BBC report estimates that 97% of the people in Tanzania have access to a cellphone.¹³ WishVast is a cellphone-based social networking system that attempts to harness the pervasiveness of cellphones in developing countries to build trust and optimize resource utilization and supply chains to facilitate people-to-people trade with the ultimate goal of alleviating poverty.¹⁴

WishVast allows users to join groups of local relevance to transmit information, meet new people, and build trusting relationships. WishVast users can create or join cellphone-based groups and send SMS text messages to the entire group to advertise themselves, their products or services, or get access to resources. WishVast users can realize the value of their current social networks, forge new relationships, and expand their social and business networks. Upon the completion of a transaction over the WishVast network, users can exchange points to rate the quality of their interaction. Over time, these points add up, allowing trustworthy individuals to point to their ratings, and for a level of trust to already be understood when two people first meet. While digital trust can never be a full substitute for the real thing, it is a building block that can help allow more people to exchange reliable information and do better business by leveraging their digital reputation and fostering a new means of accountability. The WishVast team is working on developing the technology, researching various application scenarios and developing the business model to make WishVast economically sustainable.

EssentialDesign: Appropriate Technologies

The challenges that face our world at the most fundamental levels are staggering. For example, 40% of the world's population lacks access to clean water. Approximately 50% do not have any wastewater treatment facilities at all. In addition, 20% have no electrical power. Other problems include inadequate transportation system and inefficient, low-yielding agricultural systems, which permeate the world. It is obvious that there exists a tremendous need around the world for basic infrastructure development and enhancement.

EssentialDesign projects focus on the development of appropriate infrastructure technologies which are sustainable – socially, environmentally, and particularly economically. These include projects related to: housing, water and wastewater systems, energy, and agricultural systems – with a strong emphasis on business development and entrepreneurship. Projects undertaken in Kenya in the past year involved a systems approach to the design of a village for former street-dwelling youth. These included the design and construction of the following:

- Water catchment system
- Rammed earth housing structure
- Inexpensive Biodiesel production system
- Merry-go-round water pumping system
- Alternative energy system
- High tunnel with drip irrigation system

eplum Model of Student Engagement

These three ventures require skills and knowledge from various disciplines: engineering, agriculture, medicine, business, earth and mineral sciences, information science and technology, liberal arts, education, international affairs and public policy, etc. The eplum model engages students and faculty mentors from various colleges in the three international HESE ventures in various formal and informal ways from the sub-credit to multi-credit level. This model reflects the philosophy of "E Pluribus Unum", the US motto which translates to "out of many, one". Hence, we call this model 'eplum', a portmanteau from E Pluribus Unum.

Core design teams are responsible for system integration and implementation/commercialization and form the nucleus of the venture team. The core teams are housed in a 2-credit senior-level Engineering Design course titled "Projects in Community Service Engineering (EDSGN 452)" (to be renamed Humanitarian Engineering). Every venture has its own section and it is open to undergraduate and graduate students from all disciplines. Students from specific disciplines are actively recruited to be a part of the core team. For example, the validation team for Mashavu consisted of students from chemical engineering, biobehavioral health, women's studies, kinesiology, political science and communication. The core design team for Mashavu in Spring 2009 had 12 students from eleven different majors across six colleges.

All the core team students also enroll for a common one-credit senior-level Engineering Design seminar class titled "Design for Developing Communities (EDSGN 497C)". This seminar course (discussed in details later) grounds students enrolled in the core team class and other related courses in the basics of humanitarian engineering, user-centered design for extreme affordability, social entrepreneurship, systems thinking, travel and fieldwork, and related issues. The seminar talks are streamed live for students at other campuses, counterparts in Kenya and industry professionals mentoring the teams. The talk is followed by a project management meeting to ensure that all the students working on the venture in various classes are working together towards the common goal. A similar seminar course focusing on developing communities in the US is being developed to support US-based social ventures.

Table 1: Courses involved in the eplum model

Form of Engagement	Role in the venture	Classes involved	Number of students
Travel to Kenya for fieldwork	A subset of the students enrolled in the courses		31
ECE Certificate	A subset of the students enrolled in the courses		
Honors thesis	Research / Design		2
Dedicated courses	Essential Design Core Team	EDSGN 452. A	24
	Mashavu Core Team	EDSGN 452. B	12
	WishVast Core Team	EDSGN 452. C	7
Venture integrated into the Course	Mashavu Biomedical Design	BIOE 401	48
	Mashavu Systems Design	EDSGN 597C	12
Course commissioned assignment	Mashavu Business Planning	BA 301H	5
	Essential Design Literature Review	CED 230	10
Independent study	All Ventures: various tasks	Various X96 & X94	10
Volunteer Effort	All Ventures: various tasks	None	8

ECE Certificate: 12-credit certificate in Engineering and Community Engagement

EDSGN 452: Projects in Community Service Engineering (Three sections for the three ventures)

EDSGN 497C: Systems Design

BIOE 401: Introduction to Bioengineering Research and Design

CED 230: Development Issues in the Global Context

BA 301H: Finance (Business Planning)

Various X96: Independent Study credits

Various X94: Research Project credits

Besides the core teams housed in the EDSGN 452 classes, a number of other courses participate in the various ventures. Table 1 shows the various forms and levels of engagement and the corresponding classes that participate in these ventures. The impact of participating at each individual level of engagement is not known at this time and is an important outcome of the assessment efforts currently in progress. The various levels of engagement are:

1. **Travel to Kenya:** Students who have participated in the various courses travel to Kenya for three weeks at the end of the Spring semester to conduct field-testing of their technologies, test their preliminary business models, conduct field research, etc. They work very closely with community members and various partnering agencies during that time. Students are not required to sign up for additional credits in the Summer but can receive three credits for their travel experience in the Fall semester. Students who want to travel to Kenya are required to sign up for the EDSGN 497C seminar class.
2. **ECE Certificate:** Students that participate in these ventures are encouraged to sign up for the twelve-credit certificate program in Engineering and Community Engagement.
3. **Honors Thesis:** Schreyer Honors Scholars and students majoring in Engineering Science are required to complete an undergraduate thesis. HESE provides a compelling context to conduct original research and development and write honors thesis. Students working on aspects of the ventures as part of their thesis may be enrolled in some of the courses as well.

4. **Dedicated Course:** The “Projects in Community Service Engineering” course is a senior-level integrated design course with students working in cross-functional teams on the various design, testing and commercialization / implementation aspects of their ventures. The course offers multi-disciplinary real-world integrated research and design experience, from problem formulation through assessment of performance. Students study essential theoretical constructs related to their ventures and meld them with economic, social, cultural, and other contextual considerations to develop appropriate solutions. The first few weeks of the semester are spent on understanding the social and economic objectives of the ventures, prior work, lessons learned and the goals for the Summer trip to the site. Students then formulate their plan of action to realize the goals and work collaboratively for the rest of the semester to develop the necessary materials. The deliverables might include technology prototypes, software programs, websites, user manuals, text-based or multimedia educational materials, policy documents, test plans, and assessment instruments.
5. **Venture integrated into an entire course:** A significant aspect of a social venture is integrated into a course as a semester-long project. For example, a mandatory junior-level bioengineering class (BIOE 401: Introduction to Bioengineering Research and Design) with 48 students is working on the design of the inexpensive biomedical devices for the Mashavu venture. Student teams with six members use finite element analysis and rigorous design methodologies to design the devices. They construct and test the prototypes and the students who travel to Kenya conduct field-testing. At least one student from each of the eight teams in this class serves as the context lead and attends the EDSGN 497C seminar class. Another example is a graduate-level Engineering Design class on Systems Design (EDSGN 597C) that conducted the systems design for the Mashavu venture as part of their semester-long project worth a significant portion of the final grade. These two courses facilitate a cross-section of the students getting an opportunity to develop their global competencies – something they might not have done otherwise.
6. **Course commissioned assignment:** A significant aspect of a venture is commissioned to a course. For example, the business plan for the Mashavu venture was developed by a five-member team in the BA 301H – Finance honors class as a commissioned assignment. At least one member from the team attends the seminar class to ensure that the business plan is appropriate for the context and stay current with developments from other teams working on the same venture.
7. **Independent Study:** A number of students participate in various aspects of the ventures by signing up for 1 – 3 independent study credits. They sign up for the EDSGN 497C seminar class as well.
8. **Volunteers:** Volunteers are welcome to participate in the ventures but they need to sign up for the seminar class if they want to travel. Volunteers are not allowed to lead a significant aspect of any venture but they can support members on the core venture team.

Design for Developing Communities seminar: The “EDSGN 497C – Design for Developing Communities” seminar course grounds students in EDSGN 452 and other related courses in the basics of humanitarian design, user-centered design for extreme affordability, social entrepreneurship, systems thinking, travel and fieldwork, and related issues for technology-based social ventures in developing communities outside the US. Students participate in weekly 75 minute seminars and 30 minute project management meetings with all the peripheral teams. Students write structured reflective blogs for each seminar talk and at the end of the semester make a two-minute YouTube video clip (in two-person teams) focusing on how they applied concepts from the seminar series to their ventures. The schedule for the seminar class is shown in the appendix.

eplum Model Assessment Framework

HESE is working with the Leonhard Center for the Enhancement of Engineering Education at Penn State University on the assessment of the eplum model of student engagement. A graduate research assistant funded by the Schreyer Institute for Teaching Excellence is developing the assessment instruments which will be used to conduct the more extensive assessment in Spring/Summer 2010. The goal is to understand how different forms and levels of engagement in the HESE ventures leads to global awareness, multidisciplinary teamwork and social entrepreneurial mindset development outcomes at various levels. In other words, do students who participate in the project in a less involved manner (i.e. through a class project) experience similar outcomes as those students who participate at a more involved manner (i.e. through honors theses and international travel)?

The assessment effort focuses on three outcome areas:

- Global awareness and engagement
- Multidisciplinary Teamwork
- Social entrepreneurial mindset development

The results of this study will help refine the HESE venture pedagogy and mechanics to make them more effective while maintaining a balance with creating sustainable value for partnering communities. More importantly, the assessment results will provide comparative insights into the efficacy of various models. The results will also assist administrators and other stakeholders optimize their allocation of scarce resources to enhance student’s global competencies and develop them into better multidisciplinary team players and entrepreneurial problem-solvers.

Preliminary assessment of eplum model

As the projects associated with the eplum model expand and grow, we have conducted some preliminary assessment during the Spring 2009 semester. The purpose of the assessment during this semester was to gather some baseline data about the differences associated with the outcomes at the varying levels of engagement. In addition, we wished to acquire information on the impact of service learning projects on students’ knowledge acquisition, self-perceptions, and future career plans.

Assessment Method

Because of the length of time it takes to develop sound instruments to measure the outcomes, we focused on collecting qualitative data from the students using focus groups. Collecting qualitative data from the students has a benefit in that we were able to gather information about the impact of the projects in students' own words rather than in the jargon or vocabulary of the researchers involved with the project. The focus groups also provide insight on how to guide the larger assessment project planned for the Spring 2010 semester, described further below.

Students who were working on one of the three ventures were invited to participate in a voluntary focus group. A total of three focus groups were held. Each focus group consisted of 7 to 10 students. The students came from a variety of disciplines, including both engineering and non-engineering fields (such as international affairs, information sciences, and business). The students primarily worked on the Essential Design and Mashavu ventures. The students ranged from being freshmen to graduate students and participated in the ventures at the various levels of engagement described earlier.

Focus Group Results

Perceptions of global awareness and engagement: Students were specifically asked whether they felt that their skills related to internationalization, such as global awareness and engagement, were impacted by participating in these ventures. One of the most frequently discussed themes concerned the need to be culturally sensitive when designing a product. For example, one student from the Mashavu team mentioned that when designing a stethoscope for the project, the team members needed to pay attention to where the stethoscope would be placed (i.e. under or over the clothes) in order for the design to be appropriate in the Kenyan culture. Another student said that engineers need to think about “what is needed” versus “what is wanted” and check their biases and assumptions before starting work on a project. One student said that he was “amazed” at his own “ignorance” as he had not been taught to think about cultural issues before beginning a design project. Students mentioned that if they wanted to work efficiently in a global workplace, they need to be open, willing to compromise, considerate of ethical issues, and sensitive to individual differences. It is important to note that there were a few students, in the minority, who said that certain disciplines do not require global awareness. For example, an agricultural engineering student said that skills related to internationalization will not help his future career.

Perceptions of multidisciplinary teamwork skills: Students were also asked questions about how they felt about the impact of their work on the ventures on their multidisciplinary teamwork skills. Students' comments tended to focus on working with a diverse group of students, in terms of their year in school and major. For example, one freshmen student expressed that she learned a lot from working with upper class students. Students acknowledged that this multidisciplinary work provided important benefits. For example, another student stated the project gave her teamwork experience similar to that in a real company where everyone is working to create a real product by a certain time. She expressed that in order to accomplish this, the team members need to depend on and learn from people with different backgrounds and skills. Students commented on the importance of communication across disciplines and majors even though this also presented a challenge. For example, several students stated that it was important to understand

the role and responsibilities that each person had on the project in order to be successful. The students also acknowledged that communication could sometimes be a challenge in that students from non-technical majors sometimes could not understand the technical jargon from engineering students. Engineering students realized that they needed to communicate in a manner that non-technical students could understand. Overall students shared that participating in multidisciplinary teams helped to build confidence and patience. In addition, they felt that working within the multidisciplinary team helped them to generate more ideas and better ideas for the project solution.

Perceptions of social entrepreneurship: During the preliminary assessment, the students were not yet asked about the perceived impact of participation on their abilities related to social entrepreneurship. Rather, we asked the students questions about public scholarship and the need to help people around the world. Students focused on the need to help with the world's greatest challenges, such as health care, water, and energy. One student said that she believed in the "power of one" philosophy, meaning that one individual can make a difference. Students seemed to be impacted by the fact that they could see real benefits to participating in the ventures and that it was actually helping people. When asked whether the students would continue to work on public scholarship projects in their career, some said that they would while others said no. Some students said they probably wouldn't work on public scholarship problems in their careers, but might in spare time or as a hobby. Overall the focus groups agreed that the most significant impact the course had was that it inspired them to get involved more globally and work towards a common goal. An individual student said that he can use the skills he learned in the class "to work, travel, and teach."

Qualitative data garnered from the focus groups is currently being used to formulate new assessment instruments and data collection strategies.

Future Assessment Plans

Based on the results of the focus groups, we have developed a rating scale instrument. The goal of this instrument is to measure internationalization, multidisciplinary teamwork, and social entrepreneurial mindset of the students. Data will be collected to determine how the mindset of the students changed from the beginning through the end of the course related to the three constructs. In addition the results of the three surveys (beginning, mid and end of semester) will be compared and analyzed. In the Spring 2010 semester, this survey was administered to approximately 150 students at the start of the semester, end of the semester and end of the three-week trip to Kenya. Preliminary data analysis is currently being conducted. In addition, we will examine how these scores improve when we consider the level of engagement with the project. We hypothesize that all students will improve on the scores, although students who are more engaged in the project will see greater increases. In addition to the rating scales, we also plan to collect qualitative data from students at each level of engagement through their reflective blogs, focus groups and exit interviews. We believe that the qualitative data will help us determine and articulate the various features and levels of achievement for the three outcome areas for the various levels of engagement. Finally, we also intend to conduct observation-based research in Kenya during the Summer 2010 trip.

Conclusion

This paper discussed the eplum model of student engagement that weaves innovation, global awareness and engagement, multidisciplinary teamwork, and social entrepreneurship education into a number of courses and formal programs to reach a larger number of students. A number of other courses are participating in the eplum model in the Spring 2010 semester with the rigorous assessment effort expected to provide more insights into the efficacy of the model and the desired levels of achievement for the cross-section of the students in the college of engineering as well as other colleges. The humanitarian focus of the ventures serves as a motivating factor to develop the technical and professional skills necessary to prepare students for modern engineering practice and metamorphose them into social problem-solvers and entrepreneurial global citizens.

Given the need for engineers to be well-rounded individuals who can truly be global citizens, universities must find innovative ways to provide both travel and non-travel based experiences intended to expose students to international issues. The eplum model provides one example that universities can follow, by allowing students to participate in international humanitarian endeavors at various levels. Ongoing assessment will help to determine whether the less intensive, non-travel based levels of engagement can have a significant impact on students' perceptions and understanding of global awareness, social entrepreneurship, and multidisciplinary teamwork.

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Bibliography:

1. Marginson, S. 1999. "After Globalization: The Emerging Politics of Education." *Journal of Education Policy*, 14(1):19-31.
2. Albrow, Martin. 1990. *Globalization, Knowledge and Society*. London: Sage Publications.
3. Hanvey, R. (1976). *An attainable global perspective*. New York: Global Perspectives in Education. Retrieved February 22nd, 2010 from: [http://www.globaled.org/An Att Glob Persp 04 11 29.pdf](http://www.globaled.org/An_Att_Glob_Persp_04_11_29.pdf)
4. Case, R. (1993). Key elements of a global perspective. *Social Education*, 57 (6), 318-325.
5. Merryfield, M. M. (1997). A framework for teacher education. In M. M. Merryfield, E. Jarchow, and S. Pickert (Eds.), *Preparing teachers to teach global perspectives: A handbook for teacher educators* (pp. 1-24). Thousand Oaks, California: Corwin Press.
6. Battiste, M. & Henderson, J (2000). *Protecting indigenous knowledge and heritage*. Saskatoon, SK: Purich Publishing Ltd.
7. Kirkwood, T. F. (2001). Our global age requires global education: Clarifying definitional ambiguities. *The Social Studies*, 92 (1), 10-15.
8. National Academy of Engineering. 2004. *The Engineer of 2020*. Washington, DC: National Academies Press.
9. Mehta, Khanjan, and Thomas Colledge. 2010. *Humanitarian Engineering and Social Entrepreneurship*. Retrieved from <http://www.engr.psu.edu/hese/> (available as of January, 2010).

10. World Health Organization. 2008. *WHO Statistical Information System*. Retrieved from <http://www.who.int/whosis/en> (available as of January, 2010).
11. Mashavu Team. 2009. *Mashavu: Networked Health Solutions for the Developing World*. Retrieved from <http://www.mashavu.com> (available as of January, 2010).
12. Fleishman, Aaron, Julia Wittig, Jennifer Moreau, Andrew Baxter, Jason Milnes, and Khanjan Mehta. "Validation Process for a Social Entrepreneurial Telemedicine Venture in East Africa: A Case Study." *International Journal for Service Learning in Engineering*, 2010
13. BBC. *Mobile Phones Boom in Tanzania*. 2005. Retrieved from http://news.bbc.co.uk/1/hi/programmes/click_online/4706437.stm (available as of January, 2010).
14. Mehta, Khanjan, and Ladislaus Semali. 2009. "WishVast: Building Trust and Social Capital using Cellphones." *Proceedings of the International Multiconference on Computer Science and Information Technology*. Mragowo, Poland, 375 – 381.

Appendix: Schedule for the “Design for Developing Communities” Seminar Course

Week Number	Topic
Week 1	Program orientation <ul style="list-style-type: none"> • Introduction to HESE • Introduction to the various ventures • Program Mechanics • Travel logistics and planning
Week 2	Jambo Kenya! <ul style="list-style-type: none"> • History, Politics, Culture, Religion • Economy, Geography, Education • Important recent events
Week 3	Cultural Issues that affect Design <ul style="list-style-type: none"> • Sticky information and social deconstruction • Cultural issues that affect technology design • Real stories about cultural issues
Week 4	Design Process I <ul style="list-style-type: none"> • Engineering design process • Customer Needs/Resource Assessment • Verification and Validation • Developing test plans
Week 5	Circle of Life (Design Process II) <ul style="list-style-type: none"> • Sustainable Development • Biomimicry • Cradle to Cradle Design • Indigenous Knowledge Systems
Week 6	Leadership and project management <ul style="list-style-type: none"> • Philosophy of “championing” tasks • Leading harmoniously in Kenya • Consensus building
Week 7	User-centered Design <ul style="list-style-type: none"> • Design for extreme affordability • Designing User Experiences

	<ul style="list-style-type: none"> • Systems Thinking
Week 8	Technology Entrepreneurship <ul style="list-style-type: none"> • Art of the Start • Social Innovation • Triple Bottom Line Philosophy
Week 9	Critical Design Reviews for the ventures <ul style="list-style-type: none"> • WishVast • Mashavu • EssentialDesign
Week 10	Social Entrepreneurship <ul style="list-style-type: none"> • Definition & discussion • Case studies of successful (and failed) social ventures • Business models for social ventures
Week 11	Working with communities <ul style="list-style-type: none"> • Ethical issues • Human subjects & IRB • Stakeholder Education
Week 12	Travel issues <ul style="list-style-type: none"> • Systems of Privilege • Traveling in Africa • Travel Preparations
Week 13	No Class
Week 14	YouTube video viewing
Week 15	Final Design Reviews for the ventures <ul style="list-style-type: none"> • WishVast • Mashavu • EssentialDesign