

Taking HEED within the Context of Peace Education

Grand Challenges Scholars Program's Curricular Focus for Peace

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Abstract— Millions of people contend with considerable challenges due to limited essential resources that humanitarian engineering addresses. From drinking straws that protect against waterborne diseases to solar-powered incubators to assistive educational technology to environmentally-safe temporary housing for hurricane survivors, humanitarian engineering experiences and designs are prime examples of interventions which act locally to create possibilities of life-changing opportunities by: (a) breaking cycles of poverty and inequities through education, (b) ameliorating detrimental health conditions and addressing issues of limited food and access to clean water, (c) creating alternatives to inadequate shelter, (d) and reconsidering innovative alternatives for deficient energy conditions all of which citizens of the world have endured for hundreds of years. Engineering students need to be effective as 21st century learners and leaders who explore technical solutions as well as complex aspects of community development and co-created designs that pertain to peace. This paper aims to provide insight into understanding approaches to teaching Peace Education within the context of humanitarian engineering that can be integrated into current engineering curricula via the Grand Challenges Scholars Program.

Keywords—humanitarian; peace; curricular design; Grand Challenges; interdisciplinary

I. INTRODUCTION

Professional engineers have played an important role in infrastructure, sanitation, and energy sources necessary to meet human need; they have also contributed to the modern history of power, wealth, economic development, war, and industrialization. The changing role of the engineer in history puts into context the call for a more balanced, community-centered engineering curriculum, including engineering education within the contexts of humanitarian and peace initiatives. Effective curriculum design includes teaching technical skills in conjunction with deep exploration of issues of social justice, social location, cultural awareness, root causes of marginalization, a broader understanding of technology, and unlearning many elements about the role of the engineer and the dominant economic/political ideology.

As world citizens, we all face issues and problems involving the sciences including those pertaining to the energy, education, water, and shelter. Humanitarian engineering experiences and design (HEED) can provide people with some of the tools to responsibly address these

pressing problems. Two main ways that thought leaders from around the world support this call for change is through the adoption of the United Nations Sustainable Development Goals (SDG) and also by the Chinese Academy of Engineering, Royal Academy of Engineering, and National Academy of Engineering creating and implementing Grand Challenges Scholars Programs (GCSP) in universities around the world.

In 2009, shortly after the NAE identified the Grand Challenges, academic leaders designed a co-curricular framework to integrate into engineering programs so that students and educators could engage in effective ways to explore and potentially solve the Grand Challenges. To make strides in solving these complex issues, NAE Grand Challenges Scholars Programs (GCSP) have started in a wide range of universities. All students who are recognized as Scholars apply five key components of the GCSP to face the Grand Challenges with (1) entrepreneurship and (2) service-learning by understanding (3) global dimensions through (4) hands-on research and (5) interdisciplinary curriculum [1-8].

More recently, world leaders came together in a historic United Nations Summit and adopted Sustainable Development Goals (SDG). The SDG build on the foundation and success of the Millennium Development Goals and aim to go further to ameliorate poverty. These SDG call for action by all countries and all income levels to promote prosperity while protecting the planet by considering issues of sustainability and resilience. They recognize that the goal of ending poverty must incorporate strategies that build economic growth while addressing a range of social needs including education, health, social protection, and job opportunities, while tackling climate change and environmental protection. Indeed, Grand Challenges and the Sustainable Development Goals have common stakeholders that engage in and are impacted by university-based strategic thrusts that align strongly with Peace Education.

This paper is part of a larger research project exploring curricular and program design of the GCSP. Embarking on the seventh year of our interdisciplinary course for the Grand Challenges, a team of two full Mechanical Engineering professors, an EdD who is directing the NAE GCSP at this university, a Mechanical Engineering doctoral

candidate, along with 15 new university first year students research and co-design a semester of rigorous and meaningful learning. Our data for the large, longitudinal study incorporates reflections about curriculum and teaching from the students and instructors, an array of pedagogical practices, recognition of varied and shifting learning and teaching styles and preferences, and multiple literacies practices. In the larger study, our mixed-methods analysis offers insights into ways to address complex ecology of engineering education by representing learning from many vantage points. Our research is a tool that engineering educators and other scholars can apply in designing their own curriculum about innovation and as a model of co-teaching.

This paper focuses on the pedagogy and curricular design of the GCSP that nurtures understanding and action-oriented learning experiences to promote social justice and peace. This paper includes an overview of our GCSP curricular design as it pertains to taking HEED with Peace Education and a qualitative narrative from one of the GC Scholars who helped co-design the course and conducted action research as a means to inform curricular design and learning.

II. PEDAGOGICAL UNDERPINNINGS

As an educator committed to the building of a culture of peace by taking HEED, I am especially encouraged by the inclusion, within the goal of promoting inclusive and quality education for all, of the specific target United Nations SDG 4.7:

By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development [10].

This target recognizes and affirms the expanding work of educators in diverse fields of transformative education. While promoting specific purposes, these fields share many common principles and pedagogical strategies as well as the overall goal of educating citizens toward the building of peaceful societies. They include, for example, social justice or development education; intercultural and multicultural education; education for sustainable development or futures; global citizenship education; and values education.

Many schools have begun offering “Cultural Competency and Global Engagement” leadership courses,

which center around what it means to be a global citizen. These courses are thematically organized to follow the UN model of presentation and debate – meaning it uses technologies best suited to reach a global audience. These experiential and elective courses aim to provide students with the knowledge, tools, and skills to address the challenges of a global community. We integrate the pedagogical approaches and topics into our Grand Challenges course. Highlights of peace education include:

- Socratic discussion of the problems that society faces today
- Virtual collaboration to problem solve world issues creatively
- Developing the technological skills to research, record, and reveal to our community today’s relevant global issues
- Experiential learning through Model UN competitions
- Project-based and design-based curricula
- Student leadership and facilitation in educating school communities on global problems
- Student leadership trips to collaborate with other students on global issues
- Opportunities to contribute locally and globally to have a meaningful impact on our interconnected society.

III. PEACE-FOCUSED CURRICULAR DESIGN FOR GRAND CHALLENGES SCHOLARS PROGRAM

A. Taking HEED of Nature and Human Values in Peace Education: Outcomes-based Curriculum

To guide the development of the curriculum and assessment in terms of Peace Education, student learning outcomes were needed for the GCSP at our university-wide program. The first three outcomes are consistent with ABET’s criterion 3h and are initially addressed through the curricular design [9-13]. Below is a list of these outcomes.

All GCSP students will be able to:

1. explain how engineering solutions can be used to support the basic human needs of the world’s population.
2. explain how engineering solutions are impacted by the surrounding economic, environmental, and societal context.
3. explain how engineering solutions may impact global society.
4. explain how culture and political philosophies impact the appropriateness and sustainability of engineering solutions.
5. explain the influence that a given culture has had on the engineering solutions that are used in that culture
6. design and implement and engineering solutions that addresses the needs, both from a practical and

cultural perspective, of a range of communities including those that are currently disadvantaged.

B. *Peace-Focused Curricular Components of GCSP*

Each GC Scholar Candidate must develop a Program Plan which satisfactorily addresses each component through (1) entrepreneurship and (2) service-learning by understanding (3) global dimensions through (4) hands-on research and (5) interdisciplinary curriculum. By engaging in these components, we aim to develop students in the GCSP that are competent in talent, multidisciplinary, entrepreneurship, multicultural, and social consciousness.

For this paper, the curricular components of our GCSP program that are peace-focused are highlighted below. In an effort to enrich Peace Education, GC Scholars will have:

1) GC Themed Projects and Research Experience – GC themed projects and research experience must explicitly be framed within one of the fourteen identified NAE GCs.

Grand Challenge themed research projects in at least one of the following courses that relate to Peace:

- ASE, BME, CE, CHE, EE, ME, PGE 333T: Engineering Communication
- CHE 341: Design for the Environment
- ARE 465: Integrated Design Project

2) Interdisciplinary Curriculum – Interdisciplinary curriculum incorporates learning experiences about the GCs from new perspectives outside of GC Scholar Candidate's traditional field of study. This will foster understandings about different and new ways of thinking, communicating, and viewing the complexities of the GCs. Peace-focused courses that connect to the GCs are:

- ANT 324L/URB 354: Urban Anthropology
- TC 357: 1962: Year of Creativity/Cultures/Crisis
- ANT 324L/R S 373M: Biomedicine, Ethics & Culture
- FR 374D/ANT 324L: Science, Technology & Race
- ALD 327: Sociocultural Influences on Learning
- ANT 324L: Activist Research Practicum
- CTI 303: Competing Visions of Good Life
- HDF 340: Ethics/Philosophy/Professional Development Issues

3) Entrepreneurship – GC Scholar Candidates must engage in entrepreneurship experiences that connect directly to the GCs so that s/he is able to contextualize within local, national, and global economies in consideration for the viability of an innovative solution. The following entrepreneurship component that relates to Peace Education is:

- MAN 337: Strategic Change & Innovation;

4) Global Dimension – This component is meant to cultivate an enhanced global awareness, foster sensitivity to

multiple perspectives, improve communication skills, and facilitate community development. For each of these options, students must submit a justification for how their proposed study program/internship/research experience/courses will help them incorporate global dimension into her/his GC scholarship and how Peace Education is fostered through the following:

- A Study Abroad Program;
- An internship with a significant global focus;
- An NGO experience with international travel;
- ANS 372/ANT 324L: Global Markets & Local Cultures
- TC 357: Energy and Society
- MAN 337: Global Strategy & Translational Management;

5) Service-Learning – Service-learning is a teaching and learning strategy that integrates meaningful experiences that emphasizes both community service AND learning by integrating thoughtful planning and guided reflections. These service-learning experiences: enrich learning, teach civic responsibility, and strengthens communities. The GC Scholar Candidate service-learning experiences will be framed within the Grand Challenges. Each GC Scholar Candidate must satisfactorily participate in programs such as: Projects for Underserved Communities, Engineers for a Sustainable World, Student Engineers Educating Kids, Engineers Without Borders, Habitat for Humanity, GC-aligned projects within the Volunteer & Service Learning Center.

C. *Integration of the Arts to Explore Peace*

In addition to the courses and co-curricular opportunities described above, it is of high value to integrate Arts and aesthetic experiences into our GCSP course. The Arts are critically important to integrate into curriculum in Peace Education. Arts education is conducted through various methods including visual arts, novels, performing arts, cinema, and music and provides different methods for reconceptualizing our world. Therefore, the role of the Arts for understandability of the truth about peace cannot be neglected. Art as content becomes the mediator for understanding and nurturing peace. John Dewey considered imagination and the Arts important. In *The Public and Its Problems*, Dewey wrote: "The function of art has always been to break through the crust of conventionalized and routine consciousness. Artists have always been the real purveyors of the news, for it is not the outward happening in itself which is new, but the kindling by it of emotion, perception and appreciation." Because of the profound potential of the Arts to evoke empathy, cause understandings of things from a new vantage point, and develop a sense of community towards peace, it was key to integrate opportunities for aesthetic experiences with Arts in our Grand Challenges course curricula.

The curriculum was designed to include museum trips with guided reflections, novels with reflections and discussions, and film viewing with critical review. For example, we would go as a class to the Blanton Museum on campus to GC-related exhibits and also view the Cooper-Hewitt Smithsonian Design with the Other 90% exhibit online. *Design with the Other 90%: CITIES* features sixty projects, proposals, and solutions that address the complex issues arising from the unprecedented rise of informal settlements in emerging and developing economies. Divided into six themes—Exchange, Reveal, Adapt, Include, Prosper and Access—the exhibition shines the spotlight on communities, designers, architects, and private, civic, and public organizations that are working together to formulate innovative approaches to urban planning, affordable housing, entrepreneurship, non-formal education, public health, and more. The United Nations offers an ideal setting to examine these complex issues and connect with stakeholders who can impart real change [15].

Viewing films is a meaningful way to prompt deep thinking and promote critical discussion. Some of the films that relate to peace and that we integrate into our curricula are: *When the Levees Broke: A Requiem in Four Acts*, a 2006 documentary film directed by Spike Lee about the devastation of New Orleans, Louisiana following the failure of the levees during Hurricane Katrina; *Water*, a 2005 film written and directed by Deepa Mehta; “*Emmanuel’s Gift*,” an Oprah Narrated Film, *Tells of Paraplegic’s Life-Changing Bike Ride* directed by Lisa Lax and Nancy Stern and written by Lisa Lax and Elizabeth Massie; *Crash* is a 2004 American drama film produced, directed, and co-written by Paul Haggis; and *Universal Declaration of Human Rights* by the Human Rights Action Center, created by Seth Brau and produced by Amy Poncher [16-19].

We also conducted a whole class book club where we read, critically reflected, and discussed *The Immortal Life of Henrietta Lacks* by Rebecca Skloot and *Earth Democracy: Justice, Sustainability, and Peace* by Vandana Shiva. These books provided deep insight into ethics, power structures, cultural differences, sustainability, social justice, and human research. In addition to that, students chose their own book to read and present to the class [20-21].

One of the GC Scholars that is doing action research on the course design wrote a narrative as a form of qualitative data. Her reflection, included in the next section, highlights all of the curricular and pedagogical designs previously described while also indicating a depth of competency in Peace Education.

IV. GC SCHOLAR’S NARRATIVE REFLECTION

...A single person cannot address these underlying causes with a single set of skills. A well-rounded and interdisciplinary approach is required. This concept is not unique to public health challenges; the world’s Grand Challenges are complex and require the same unique, multi-faceted approach.

Engineering ambitions to improve access to clean water require a set of skills in students that reach beyond mathematical equations, flow rates and impersonal data. Even the brightest engineer will barely make a dent if he or she has no competency in public policy, human behaviors, or ethics. How can you introduce an engineering innovation into a country if you do not understand the cultures or values? Can you ensure they will maintain or embrace your innovation if it does not fit into their way of life? The answer is clearly that you cannot.

Throughout the course we have had the opportunity to look at engineering through several different perspectives to become well-rounded scholars. In one of our first experiences as a cohort, we visited the Blanton Museum. We analyzed Luis Jimenez’s Progress Suite. This four-piece lithograph series features a progression through time in the old American West. The series begins with a Native American riding a horse bareback while spearing a bison, shifts to a depiction of a Western gaucho riding alongside a longhorn, to a rattling carriage racing across the plains amidst a vivid gunfight, and finally a depiction of a speeding automobile and train without any natural or human elements visible to the viewer. In the clouds above the subjects of each lithograph there are letters that spell out the word “progress” when traced through the whole series.

This piece evoked a discussion on the place of technology in progress, and our hopes to include a more human element into our work. We hope not to allow technology to replace emotion or humanity. As I look back on the experience and apply it to my current work to improve access to clean water, I recognize the value in keeping the human element in mind in my work as a scholar. I am not designing or implementing water systems or technology just to improve statistics, I am doing it for people.

The Grand Challenges Scholars course also gave us the opportunity to read and reflect on a novel of choice that tied back to the Grand Challenges. While my own novel did not provide the depth in understanding I hoped for, the presentations from fellow classmates did. A classmate’s discussion of the British Petroleum oil spill with his presentation of “Drilling down: The Gulf Oil debacle and our energy dilemma” reiterated the idea that our world’s challenges can have many intricate elements. He described how it was not a single person or single component failure that meant disaster for British Petroleum. It was a combination of mechanical, managerial and other failures that ultimately led to the spill. Another classmate’s discussion of “Banker to the Poor” described the ability of microfinance to improve the socio-economic status and health status of women in India. It highlighted the need for innovative solutions for our modern world problems.

The non-traditional readings and museum visits gave me a better understanding of the scope of our world’s Grand Challenges, and guided me to learn more about my own Grand Challenge: improving access to clean water. I am beginning to grasp the scope of this challenge, the current solutions available, and some opportunities for innovation. I

understand that a lack of clean water is responsible for more deaths in the world than war, that about 1 out of every 6 people living today do not have adequate access to water and more than double that lack basic sanitation for which water is needed. At the same time, there is no true global shortage of water. Water is abundant. However, the distribution is not uniform; some countries have more than they need. Even when the distribution favors a particular country, political and economic barriers may prevent access to water in areas where it is otherwise available ("World Water Access").

These barriers were witnessed first-hand in my past trip to Honduras. Flying into the country, I saw brown, polluted rivers etched across the entire rural landscape. I think about how these rivers provided abundant, but polluted water to the rural villages. The basic technology exists to allow for this water to be used in farming or households. However, many families in rural Honduras survive off of sustenance farming, have no source of income, little to no education, and virtually live invisible to the government; the technology and infrastructure is not truly available without the assistance of outside funding and efforts because of these barriers.

Some current solutions for the improving clean water access include desalination, technologies to recycle wastewater for agricultural or industrial purposes, and technologies to reduce water use. In my current involvement with the Tibetan Village Project, I have been looking at technologies that may be relevant in Tibet. I have discovered several water management innovations that have been evolved by a group called Pragya. These include snow harvesting and glacier melt collecting installations, solar water pumps, and adapted filtering systems that can withstand the high silt load of Himalayan rivers ("Water and Sanitation").

My personal research in the future will involve more on water management and purification systems that are tailored to Tibet. I will also tap into existing resources like the Global Brigades network to incorporate the successful elements of their water and sanitation projects. Cultural research will also be important because we need to also be concerned with the social determinants of health that develop from the cultural beliefs of Tibetans. My informal research so far has included Ted Talks featuring Tibetan perspectives on technologies that incorporate aspects of Buddhism like "His Holiness the Karmapa: The technology of the heart". Through Ted Talks, I have also learned from Anupam Mishra about the ingenuity of ancient and culturally relevant water system, and about human centered technology from David Kelley.

My informal research overlaps with the global component of the scholar's program by providing views from leaders in various countries and cultures and reminding me of the cultural differences that impact our ability to solve global challenges. My personal experience in El Canton, Honduras as a public health volunteer allowed for me to see the impact of these cultural differences along with environmental, economic, and geo-political factors that affect access to clean water.

This past summer I traveled to El Canton, Honduras. This village is isolated in the mountains surrounding

Tegucigalpa. I worked with a young man Wilson, and his family. Wilson, 16, lived with his parents, brothers, and his 15-year-old wife who would within the year deliver his first child. The highest level of education achieved in the family was by the youngest child Moises, who had graduated from the fifth grade. Wilson's family lived off of the land, growing enough maize and fruits to meet their nutritional needs. Any efforts to profit from their excess crops were thwarted by their poor education; visitors coined "Coyotes" often tricked the uneducated families in El Canton to sell their corn way below the cost of production. Not surprisingly, the family also lacked access to clean water.

There was a river nearby the home of Wilson and his family, but it was one of the many polluted, brown waterways tainted with run-off feces due to lack of latrines, consumer waste from far away cities, and other pollutants. Wilson's family bathed and drank from its water until our organization was able to provide them with an alternative latrine, and water filtering system.

I asked Wilson why they remained in El Canton when it ensured life-long poverty. He told me that his grandfathers had built their home by hand and it is all he has ever known. His cultural connection to the village anchors him in El Canton, where his poverty and rural location will mean limited water access in the future.

Wilson and his family are some of the 1.1 billion people on Earth who lack access to clean water, but these billions of people are not a realistic target for the system we plan to design and implement with the Tibetan Village Project ("World Water Access"). Many of the 1.1 billion people who lack access to water are like Wilson's family, without access to income or education. There is no way to pitch our product directly to these populations; there is not a media outlet to pursue, no funding to attain, and we would not have the resources to reach them. If we attempt to market the system developed through The Tibetan Village Project, we will most likely be targeting NGO's and other organizations focusing on improving water access. One example is the student run Global Brigades network which has two branches involving clean water access: Water Brigades and Public Health Brigades. This organization seeks for outside innovations regularly and often adopts student- created improvements.

If our system includes features that are adapted to the unique physical and social environment of Tibet, we will have to consider organizations that work with communities sharing similar characteristics. A true market analysis at this point would be difficult because the actual product for the project has not yet been designed, but we can plan to look for opportunities in the NGO realm and learn from the in-class analysis of the Big Belly product when we get to that point in the project.

Beyond using marketing and entrepreneurship to push our product, it is also an important to remember that entrepreneurship on the part of those suffering from limited access can be a key to creating sustainable change. As a classmate's presentation on "Banker to the Poor" demonstrated, financial investment in those struggling with

poverty and limited resources is key in changing their situation permanently. The service-learning component of our project could incorporate this understanding of entrepreneurship as a key to rise from poverty. I recently watched a Ted Talk featuring Renee Botta, who works on water sanitation projects with the University of Nairobi. While the technologies and infrastructure she has implemented for sanitation are sound, she finds poor sanitation persists due to the extreme poverty in the communities she works with. Renee now works with the local women in the village to teach them how to make soap and market it in the community. This provides women with the income to support a more sanitary lifestyle. We might be able to incorporate a similar service-learning component into our project in Tibet.

Another service-learning idea involves staying here in Austin. We could work on teaching the youth here about the importance of water access worldwide, and work on small-scale water sanitation projects that mimic the worldwide access issues. As a public health major I could bring in knowledge of the health impact these issues have on communities, while the engineers in the group could provide more information on the engineering tools that address the challenge. By fostering an understanding of the issue in the local youth and introducing them to the current techniques for improving access, we can encourage the next generation to help us tackle to grand challenges. I have been tutoring here in Austin for Webb Middle School for almost 3 years and feel I could utilize my connections with the middle school to undergo this type of project with the students of Webb.

My work on improving access to clean water is in its beginning stages, but my semester's work in the Grand Challenges course has given me some basic tools to pursue a greater impact. In my application to this program I described my hope to eventually combine entrepreneurship, public health, and medicine in the future to impact health on a large scale. I believe my work this semester has pushed me further down that path, now with the appreciation of how innovative engineering can be an important tool towards health and peace for our world's citizens. I look forward to working on the Tibetan Village project to fine-tune the skills I need to make my future goals a possibility, and to making a dent in one of the world's Grand Challenges.

DISCUSSION

For those of us striving to develop globally competent citizens and towards peace through innovative engineering curriculum, understanding how a wide range of disciplines engages in Peace Education is key. The goal sharing the curricular objectives and specific Peace Education components as well as examples of Arts integration is to add to the discourse of a community of practitioners. As educators, hearing the voices of our students reflect and apply their learning can be the best indicator of effective curricular design and pedagogy. From my perspective, this GC Scholar's narrative reflection created rich data from which to understand the deep learning as it relates to peace, HEED, and becoming a globally competent citizen. Future research will include

longitudinal analysis of curricular design, pedagogy, and the impact of co-creating a GCSP course and program.

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