Professional and Intercultural Engineering Competencies

Learning across borders

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Abstract— The ability to live and work in a contemporary global community is an important requirement for engineering professionals. They need to have broad engineering skills and know-how, be flexible and mobile, and be able to live and work internationally. In a graduate-level course, jointly organized by The Pennsylvania State University (US) and KU Leuven (Belgium), cultural differences and the impact on business practices, communications, and team dynamics when solving engineering problems in global contexts is more broadly and deeply explored. The course takes the students on a journey from personal professional skills introspection and development towards intercultural and team competencies development. The course consists of synchronous videoconference lectures by faculty from both institutions and by guest speakers from the corporate and academic world, complemented by readings, case studies, individual assignments, group discussions and a major experiential learning project, in which the students tackle a concrete engineering problem in the global world in mixed teams across the ocean. A first edition of the course was offered in the Fall 2015 term, with a limited number of students (6 at both sides of the ocean). It was considered as a success by all actors. With the student feedback and the teachers' own reflections, a new, improved version of the course is now under development.

Keywords—intercultural engineering competences, professional skills, learning across borders, videoconferencing

I. INTRODUCTION

The ability to live and work in a contemporary global community is an important requirement for engineering professionals. They need to have broad engineering skills and know-how, be flexible and mobile, and be able to live and work internationally. In today's global marketplace, successful engineers must combine technical expertise with an understanding of how professionals in different cultures define problems and develop solutions.

The need for today's engineer to possess not only technical skills, but also professional, and global competencies has been well described in recent studies [1]. These skills and experiences have evolved into a critical part of the undergraduate minor in the Engineering Leadership Development program at The Pennsylvania State University. Founded in 1995, the ELD program is one of the oldest university-based engineering leadership programs in the world, and was initially focused on providing that second dimension, the professional skills, such as teamwork, motivation, communication.

In 2009, the program was identified by a global study as the first of four case studies of university-based engineering leadership development [2]. One of the key attributes that distinguished the program was the active pursuit of the third dimension, the development of international, cross-cultural skills. For the past 12 years, virtual teams of students have been created as part of the program, with participants from Corvinus University (Hungary), and more recently from Taibah University (Saudi Arabia), the University of Sydney (Australia), and The Belgium Campus (South Africa).

Over the past two years, the ELD program at Penn State has been developing a Master of Engineering program to provide a graduate degree in Engineering Leadership and Innovation Management. The program developers recognize the importance of these global competencies at the graduate level as well as the undergraduate levels, and decided to incorporate an international virtual teaming course as a requirement in the program. They contacted KU Leuven (Belgium) to establish a partnership in this endeavor.

At KU Leuven the Faculty of Engineering Technology is organizing an annual Postgraduate Program on Innovation and Entrepreneurship in Engineering. This one-year program aims at developing entrepreneurial, managerial and innovation skills and offers the students an opportunity to gain a unique work experience through innovative projects in a stimulating working and learning environment The match with the ambitions of the Penn State ELD program was obvious, and this led to the development of the course we present here.

II. COURSE DESCRIPTION

A. Course general outline

In a graduate-level course, jointly organized by the Pennsylvania State University and KU Leuven, cultural differences and the impact on business practices,

communications, and team dynamics when solving engineering problems in global contexts is more broadly and deeply explored. The course takes the students on a journey from personal professional skills introspection and development towards intercultural and team competencies development.

B. Learning objectives

As learning outcomes of the course, students will be able to:

- Demonstrate a proficiency in engineering team-building, leadership and service.

- Construct creative solutions to engineering problems incorporating cultural differences among team members and external stakeholders.

- Critically analyze personal and engineering team-member competencies and biases.

- Formulate and apply strategies to improve engineering team dynamics.

- Provide effective feedback, recognition, motivation and corrective guidance for engineering team members with various cultural and national backgrounds.

- Evaluate engineering business opportunities in the context of international and cross-cultural markets.

- Examine moral, ethical, and legal dilemmas in cross-cultural environments.

- Apply course concepts in an international team-based engineering project.

C. Course content

The goal of this course was to develop global competence to enable students to be successful in a global engineering environment. As reported by Parkinson (2009), the top five most important attributes identified by industry leaders and engineering educators for global competence in engineering graduates are: 1) An appreciation of other cultures, 2) Proficiency working in or directing a team of ethnic and cultural diversity, 3) Able to communicate across cultures, 4) Experience practicing engineering in a global context, whether through an international internship, a service learning opportunity, a virtual global engineering project or some other form of experience. 5) Effectively deal with ethical issues arising from cultural or national differences [3]. In addition, the qualities of an inter-culturally competent person include an open minded attitude, the acquisition of culture sensitive knowledge, and appropriate and effective interaction skills [4]. Course readings, in class activities, and assignments were selected/developed to foster these important attributes and qualities in our students. The course was structured to present culture knowledge content throughout the semester utilizing two required texts: *Cultures and Organizations*, by Hofstede, Hofstede, and Minkov provides knowledge content on dimensions of culture, cultures and organizations, and the evolution of culture [5] and *Kiss, Bow, or Shake Hands* by Morrison and Conaway provides additional content related to conducting business in 60 countries and serves as a reference book for future travel [6].

Knowledge content was supplemented through additional online and journal article readings, in class activities, and assignments. These additional activities and assignments were structured around five themes: Understanding Yourself and Others, Developing Effective Teams, Cultural Differences, Dealing with Conflict & Team Motivation, and Cultures in Organizations.

1. Understanding Yourself and Others: This module set the groundwork for developing intercultural competencies. It provided an overview of individual differences that can affect team dynamics and performance and emphasized the need for understanding yourself and the influence you have on others based on your own personality type preferences. Several common personality/temperament/skills inventories were discussed and utilized by students. Students were required to reflect on their own personal assessment results, describing how they can capitalize on their strengths and address potential challenges when interacting with others.

2. Developing Effective Teams: This module introduced students to the need for global engineering teaming, the synergies and potential obstacles when working on diverse teams, and the challenges of working on global virtual teams. Students examined their own personal dimensions of diversity and biases based on their own diversity filters. Student teams then assessed the diversity and values of their project teams, identified synergies and potential areas of conflict and developed a plan to capitalize on the synergies while recognizing individual differences to ensure each team member participates fully. Students were then introduced to the communication challenges that are expected in virtual teaming settings, importance of understanding collective mental processes in teams was emphasized. They were given an overview of knowledge sharing and the development of global interconnectedness, as well as the phenomenon of global consciousness, as examples of ever growing spread of information. Students experienced these concepts and practiced the needed skills within their semester long project teams.

3. Cultural Differences: As mentioned previously, students were introduced to knowledge content on cultural dimensions and differences from required text readings throughout the semester. This module supplemented the main content with an in depth look at cultural evolution and students were introduced to the concept of 'memes' as a unit of cultural transmission. Student pairs (PSU and KUL) presented on cultural dichotomies between their own culture and a select culture from Brazil, Russia, India, China, or Saudi Arabia. Students also reflected on the persistence and evolution of cultural attitudes and were required to develop a 'meme' map illustrating the needed adaptation of ideas for their course project to be adopted in their project's host country.

4. Dealing with Conflict & Team Motivation: This module included an individual assessment of each student's preferred conflict management style. In-class activities included opportunities for students to observe these styles in action with a discussion on the benefits and potential obstacles that can arise during teamwork interactions. Students also participated in a mock negotiation and follow up discussions covered cultural differences in business negotiations. Students were required to

reflect on their personal conflict management style with a focus on how their style might negatively impact their team and how they will strengthen their ability to deal with team conflict. The conflict module coincided with the mid-project peer evaluation, giving students a chance to reflect on any problems their team is experiencing and how they will work to resolve them.

5. Cultures in Organizations: This module examined the influence of national culture on organizational mission, vision, strategy, and values. The development of personal values was examined in relation to national culture, professional culture, corporate culture, and corporate values. In addition, the examples of how technological developments influence cultural practices were studied. Students examined a multinational company reporting on how their values were defined and aligned to their action. Students also reflected on how their personal values would fit with the values of the company.

D. Course format

The course consists of synchronous videoconference lectures twice a week given by faculty from both institutions and by guest speakers from the corporate and academic world, complemented by readings, case studies, individual assignments and group discussions.

The course incorporates a major experiential learning project, in which the students tackle a concrete engineering problem in the global world: the students, in mixed teams across the ocean, encounter virtual, cross-cultural challenges and resolve them while applying several course concepts. In this interdisciplinary project students combine their engineering knowledge and entrepreneurial spirit with their professional and intercultural skills in order to find innovative and feasible business opportunities.

The international student teams were engaged in the following project assignments:

1. Suggest solutions to water scarcity in South America, especially in rural mining communities, by recommending a wastewater treatment solution that is both customized for the region and its specific geological and industrial characteristics, and practical for the usually impoverished communities of these regions.

2. Look for appropriate CRT Plastics recycling methods in sub-Saharan countries of Africa, in pursuance of goals by WorldLoop international non-profit company. The lack of a sustainable e-waste management infrastructure means that harmful waste is collected and recycled by crude methods, causing the release of toxic chemicals into the environment and putting population at risk.

3. Research possible ways of recycling discarded printer cartridges, specifically in certain countries of Western Africa. One of the biggest challenges in implementing a solution for recycling printer cartridges in developing nations is the lack of systems or infrastructure for recycling in general. This makes it difficult to execute a recycling plan or method since there may be significant barriers (e.g., capital, political, social) to building systems from the ground up.

In another assignment Belgian-US pairs of students are tasked to conduct interviews with engineers (including students, professors and entrepreneurs) from selected countries to assess their opinion on how their culture is perceived and on what potential obstacles or synergies might exist when working on a team with someone from other culture.

To build awareness of globalization, students were required to present news presentations on current events related to global economies/markets impacting the engineering industry.

E. Course language

As it is widely accepted throughout the world in international business practice the common language in our joint class was English. This worked very well in social and work interactions for students in the joint class. In addition, during the semester KU Leuven students were tasked to give several basic lessons in Flemish language to PSU students. This was meant to emphasize the importance of nuances in international communications.

III. FIRST EDITION

A. First Run

A first edition of the course was offered in the Fall 2015 term, with a limited number of students (6 at both sides of the ocean).

Graduate students at Penn State came from the departments of Mechanical (1), Civil (1), Industrial (1), and Agricultural and Biological Engineering (3). Three of the students were in M.S. programs and three were in Ph.D. programs.

The postgraduate students from KU Leuven had a background in Bio-engineering (3), and in Electrical Engineering (3). Three were already graduated and three were still in a M.S. program.

A team of experienced instructors was assembled to deliver the course, consisting of Wim Van Petegem, Expert in Multicampus and Engineering Education from KU Leuven, Michael Erdman, Walter L. Robb Director of Engineering Leadership Development, Dena Lang, Associate Director of Engineering Leadership Research, and Andras Gordon, Engineering Design Program, from Penn State. All had been involved in virtual teaming experiences, many in an international educational setting.

B. Student Experiences

Mid-semester student feedback (from 11/12 students) indicated that 100% of students felt that the course material was relevant to their future work as an engineer. 100% of students felt that the assessment methods were fair and 91% felt that the course material (textbook, workbook, lesson notes, and online materials) helped them understand the new material. Mid-semester feedback also indicated that we could have done a better job organizing and presenting the material. Only 55% of students thought the material was well organized and that the presentation of material in class enhanced their learning.

Despite some organizational issues, overall indications were that the students loved it, when asked 'What helped you learn in

this course?' one student response indicated: "The interaction between the two universities made the class a great learning environment. By far the best experience.", an intensive, but rewarding 'real life' experience across several borders.

Although occasionally we experienced delays connecting through Polycom video conferencing portal, students enjoyed having the combined (KU Leuven & Penn State) class periods. Based on end of semester feedback, students indicated that there was a need for less material covered in class, more time for discussion, and frustrations trying to do group work virtually within the class period.

C. Teacher Experiences

Not only the students, but also the teaching team had to cope with intercultural challenges due to different educational settings and paradigms. Some of the challenges were as would be expected – dealing with staggered time-zones and academic calendars. In some cases the start and end of the semesters were misaligned by 4 weeks. The solution adopted was to postpone the start of the teaming experience at Penn State by 2 weeks and starting the semester at KU Leuven 2 weeks earlier, a daunting task when recruiting students to participate.

Another challenge was in how to assess students on a level playing field. Graduate students at Penn State were used to seeing acceptable grades in the 80 to 100 (e.g. B- to A) range, and a C being a poor grade. In contrast, the graduate students at KU Leuven typically encountered a wider variation of acceptable grades (e.g. ranging from 60 to 100, with a C being acceptable). Differences also appeared in the peer and self-assessments, with Belgium students being "harsher" graders.

One of the actions that helped the instructor team to overcome some of these difficulties was a face-to-face meeting prior to the start of the semester. While a face-to-face meeting of the student teams would have been quite desirable, the funding was not available. We did however meet with the instructor team to work out the schedule, lecture content and leads, and other administrative items. A similar meeting is scheduled to be held prior to the next offering of the class to incorporate lessons learned. These face-to-face meetings were supplemented (and will continue to be) with virtual meetings of the instructor team.

IV. FUTURE DEVELOPMENTS

With the student feedback and the teachers' own reflections, a new, improved version of the course is now under development.

Course Logistics: With any new venture, prototypes are invaluable to the design process. The same is true for course development. The pilot offering provided a great opportunity to get our feet wet without drowning ourselves. We were able to test topic areas, delivery, and assessments and gauge interest and value to students. Based on this experience during the pilot run of the course, followed by student feedback, a number of significant improvements are planned for future offerings. To allow for more in-class activities and discussion, the majority of the supplemental content delivered during class will be provided online (flipped), freeing up class time during future offerings.

Despite the students' suggestions to eliminate group activities in class, the instructors feel strongly that the in class group activities (with groups composed of students from KU Leuven and PSU) were important part of the course. To address the difficulty with connecting virtually with groups, it might be necessary to hold specific class sessions in a computer lab to provide more reliable virtual connections.

Course Activities / Assignments: Course activities and assignments will be tied more closely with the course project to help tie lesson objectives together. For example, the student news presentations will still focus on global economies/markets but will be required to be tied to the host country of their team project. In addition, the cultural difference dichotomy presentations will also be tied to the team project host country. Students will also be presenting role playing scenarios depicting potential challenges related to business etiquette behavior in the team project host country followed by appropriate and effective responses. In addition, the conflict management reflection assignment will be modified to require students to reflect not only on how their own conflict management style might impact their team but to also examine how it might impact working on projects in their host country. These changes will help to focus the activities in a more meaningful way while allowing all students to benefit from each team's work during end of course project presentations.

Content Topics: Related to topic area and depth, more emphasis will be placed on globalization, expanding this to 3 modules (weeks) and focused on globalization and the impact on engineering industries, globalization and engineering practices, globalization and the impact on communication & knowledge sharing.

More emphasis will also be placed on examining differences between stereotypes and generalizations applied to personality type as well as cultural dimensions. During the pilot course this became an important discussion topic and it will be explored in a more formal way in future offerings.

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