



Integration of Global Competencies in the Engineering Curriculum

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Introduction

The need for developing global competency in engineering students has received considerable attention over the past several years and a number of high-profile reports [1] [2] have highlighted this need. A variety of programs have emerged to address this need ranging from named programs like Purdue's Global Engineering Programs [3], college programs focused on the Engineering Grand Challenges (see for example [4]), at least one "global competence certificate" program [5], to individual courses and study abroad opportunities.

Many of these initiatives require significant coordination and investment of time and human resources. One of the biggest challenges college's face to incorporate new initiatives is how to authentically incorporate the content and experiences in an overly constrained curriculum.

At the University of Cincinnati, the course "The Global Technical Workforce" was introduced in 2016 to provide specific opportunities for students to develop global competencies and thus better serve the technical workforce. The course provides a needed first step to adding opportunities for students without requiring substantial investments in resources or significant changes to curricula. The course also requires students to participate in a short-term, faculty-led study abroad. The University has identified strategic global partners and seeks to foster greater ties with those partners. The travel abroad is coordinated with one of the strategic partners which increases the interaction between the partners and provides local knowledge for industry and cultural visits.

The approach taken is easily replicable at other engineering colleges and others will benefit from lessons learned from our experiences. The paper describes: the course structure and learning outcomes, pedagogical approach and changes incorporated based on lessons learned in the first two years of implementation, and the format and challenges in the study-abroad trips. Student evaluation of the course and of the study abroad trips are presented along with reflections of student learning.

Course Description

Several factors contributed to the decision to address the need for developing global competencies. Like many universities, the University of Cincinnati (UC) has made a concerted effort to increase its global interactions and colleges and units are encouraged to contribute to this global strategy. Many of the businesses that hire our graduates are global companies and they are seeking employees who are comfortable working in this global context. Finally, students are requesting these opportunities at a greater rate than they had in the past.

The College sought to provide content and experiences that met the global engineering skill set defined by the NAS [2] including:

- Cultural awareness
- Teamwork skills

- Understanding of the business and engineering cultures of other countries
- Knowledge of engineering education and practice in other countries

The College faces the same issues as most other colleges of engineering regarding how to add additional coursework to a crowded, constrained curriculum. At UC, this situation is exacerbated by the mandatory co-op program. This limits the opportunities students have to travel or to participate in activities during break periods. However the global engineering skillset articulated by the NAS clearly intersects the breadth of knowledge requirements established in the curriculum for all engineering students. Students are required to have coursework that addresses diversity and culture as well as social and ethical issues. A course focused on developing global competencies can certainly overlap with these established requirements providing an opportunity for a course that meets both sets of needs.

Downey [6] described a framework of educating globally competent engineers in terms of knowledge and abilities related to cultural and national differences as well as a developed predisposition of respect toward others. Klein-Garner and Walker [7] report on dimension of global competence that also reflect knowledge, ability and attitude, including: the ability to communicate across cultures, the ability to appreciate other cultures, the ability to understand implications of cultural differences and seeing oneself as both a citizen of a home country and a global citizen.

These three referenced studies ([2], [6], and [7]) in particular helped shape the learning outcomes and pedagogical approach we took in crafting the learning experiences for our course. The course was designed to meet required general education requirements for diversity and culture and social and ethical issues while specifically addressing the global engineering competencies. The course content and experiences are grouped into four thematic areas: teams, communication, cultural competence, and technology for collaboration. While other courses and experiences within the general engineering curriculum address some of these same topics, these were specifically addressed in the new course as described below. Figure 1 illustrates the presentation of a portion of the topics as organized in the Blackboard learning management system used by UC. Each thematic area extended over several weeks.

Teams - students work in teams multiple times throughout their academic career, most notably during senior design. Focusing on teams in this course provides the opportunity to reinforce the importance and further develop students' skill in this area. General team processes and dynamics [8], [9] are covered to make connections with students' prior learning and experiences. Material that deepens students' knowledge of teams [10] and provides content specific to global teams and virtual teams is also introduced [11]. Personality types and the influence these can have on teams [12] are also discussed.

Communication – students have multiple experiences with writing but no formal training in communication processes. Communication skills and processes [13] and [14] are presented both for basic understanding and in the context of the complexity of communicating across cultures. While languages are obviously fundamentally important, these are not part of the course content. Recognizing that many of these interactions will take place in meetings (traditional and virtual), content and discussion pertaining to communication in meetings is purposefully included.

<p><u>Week 1</u></p> <p>This is an in-person session On January 9.</p>
<p><u>Week 2</u></p> <p>Communication</p>
<p><u>Week 3</u></p> <p>Culture</p>
<p><u>Week 4</u></p> <p>In-person session discussing diversity and cultural competence.</p>
<p><u>Week 5</u></p> <p>Personality types and teams - part 1</p>
<p><u>Week 6</u></p> <p>Continue looking at teams and global teams</p>
<p><u>Week 7</u></p> <p>More on global teams and communication across cultures</p>

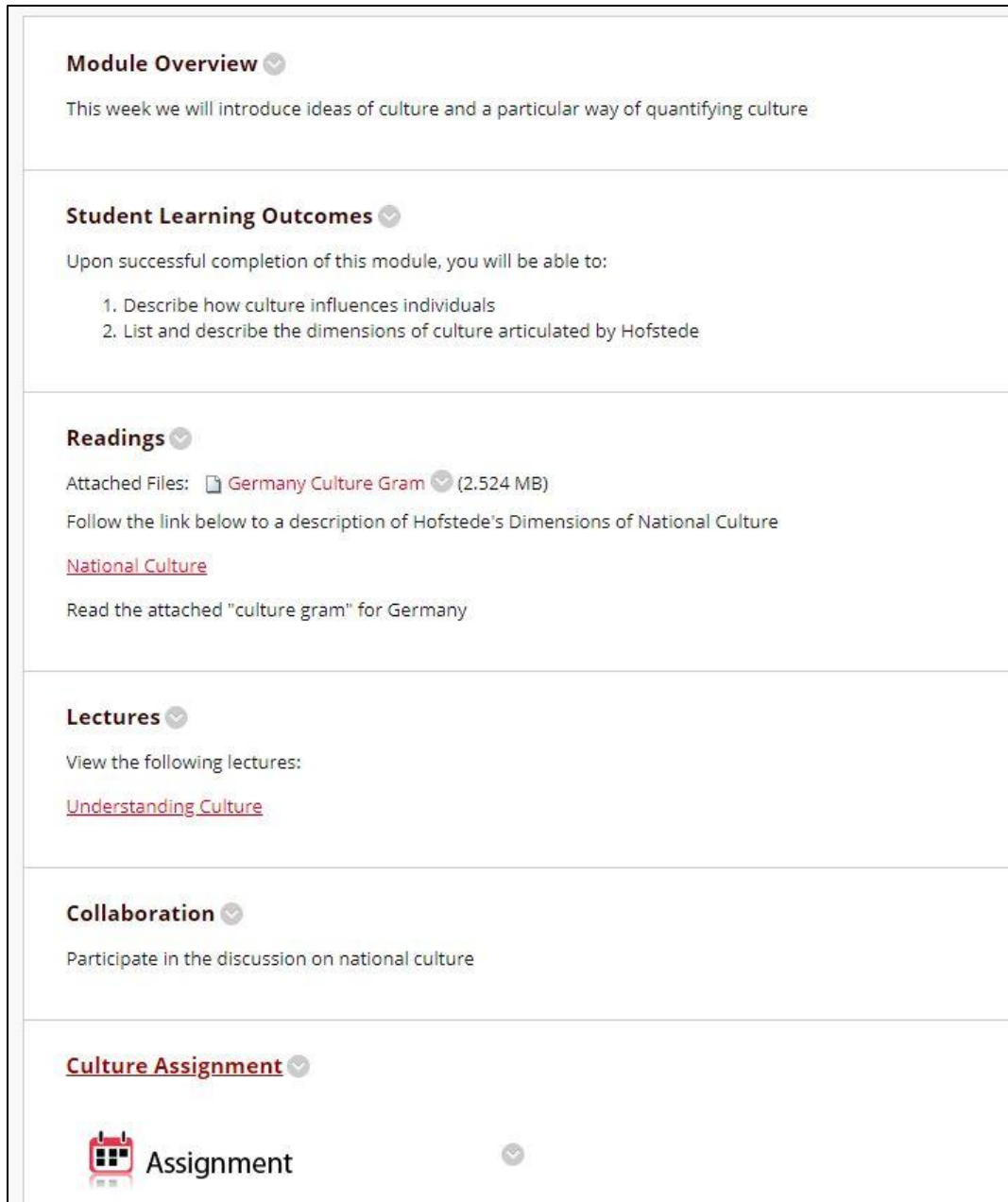
Figure 1 Course Layout (partial)

Cultural competence - students have little to no formal instruction in this area and it is vital to developing these competencies [15]. For the course, students are first introduced to levels of diversity [16] and the importance of diversity [17]. Students are introduced to the concepts of culture described by Hofstede [18] and given several assignments which require them to analyze and discuss national culture comparisons using these concepts [19]. Students are then provided some instruction in the complexity of communicating across cultures [20].

Technology for collaboration – students have a great deal of familiarity with many of the tools used for collaboration. Student have not however developed skills at differentiating among technologies for particular purposes. A structured comparison of technologies to accomplish

specific outcomes is presented [21] and students are provided opportunities to practice with several of the tools.

A typical week is illustrated in Figure 2.



Module Overview ▾


This week we will introduce ideas of culture and a particular way of quantifying culture

Student Learning Outcomes ▾

Upon successful completion of this module, you will be able to:

1. Describe how culture influences individuals
2. List and describe the dimensions of culture articulated by Hofstede

Readings ▾

Attached Files:  [Germany Culture Gram](#) ▾ (2,524 MB)

Follow the link below to a description of Hofstede's Dimensions of National Culture

[National Culture](#)

Read the attached "culture gram" for Germany

Lectures ▾

View the following lectures:

[Understanding Culture](#)

Collaboration ▾

Participate in the discussion on national culture

Culture Assignment ▾


 Assignment ▾

Figure 2 Typical Layout of Module

Based around these four thematic areas, the student learning outcomes for the course are, at the completion of the course students will:

1. List the steps needed to develop effective teams
2. Describe and discuss the attributes needed to be an effective team member, including a global team

3. Describe and apply Hofstede's Dimensions of Culture to particular national cultures
4. Describe and demonstrate the skills needed to function on a virtual team
5. Describe the complexities of global work teams

To authentically address the knowledge and skills associated with other cultures and nationalities, a faculty-led study abroad was incorporated as a mandatory component of the course. The trip was taken over the students' spring break (plus two additional days prior) so as to minimize conflicts with academic schedules. The trip included an essentially equal focus on visits to businesses, visits to universities, and cultural visits. The trip was an integral aspect of the content and interactions that allowed students to meet the learning outcomes. The trip is described more fully in the next section.

Certain attributes of the course design and presentation are worth noting:

- While a single faculty member presented most of the content, guest speakers who could authentically address particular elements of cultural competence also presented some content. For example, the leader of the local Hispanic Chamber of Commerce addressed the class to compare and contrast Hispanic culture to that prevalent in the local community.
- The fundamental pedagogical approach is derived from reflective learning / reflective practice (see for example [22] and [23]) and typically followed this pattern: introduce content, student reflection regarding the concepts and their experience with the concepts (often through writing), group discussion of concepts (either in-person or via an online discussion board), experience with the concept during the study abroad trip, and further group reflection regarding the concepts and the experience.
- Content and interactions were provided both in-person and on-line. A portion of the content was easily formatted for web-based presentation and on-line discussion boards allow for sustained examination of a topic. This hybrid approach also allowed greater flexibility in scheduling the course.

Trip Description

Each year, trips to two or three distinct destinations are offered and students select one trip to participate in. Each trip was coordinated with one of the University's international partners with the partner school providing some logistical help in arranging visits to regional industry and cultural activities. Unlike some programs, the partner school is not asked to provide teaching content during the visit. Rather the partner hosts a visit to the university, provides an opportunity for interaction with students and faculty, and provides a tour and discussions around the structure of degree programs in that country.

Students typically visit 3-4 business organizations in the country. A typical visit consists of a tour of the facility to learn the scope of what is done at that location, discussions with technical professionals on their contribution to the business, and discussions with business leaders to hear the local perspective on issues in the global economy. On the best visits, concepts from the course such as cross cultural communication and virtual teams are explicitly addressed by individuals from the business.

Cultural visits were included to provide opportunities for students to see and experience sites and places important to the region or nation and to interact with individuals from the region. These visits also provide a necessary level of excitement and motivation for the trip. Some characteristics of the trip worth noting include:

- Leave the Thursday evening before spring break and return the Friday or Saturday at the conclusion of spring break.
- Most days are structured with visits to industry, university or cultural sites. Most evenings nothing is scheduled.
- Students have at least one free day during the trip to choose activities and visits they want to pursue.
- Typically three group dinners are scheduled to provide time for debriefing events and guided reflection to relate course topics to activities that took place during the trip.
- A faculty member leads the trip accompanied by another faculty or member of college staff. Student fees pay for these expenses.

To date trips have been taken to Germany, France, the UK and Guatemala. Additional destinations will be added.

Student Evaluation and Reflections

The college uses a common student evaluation for all courses and the student responses to selected evaluation questions are shown in Table 1 for the spring term of 2016 and 2017. The responses are in the form of a modified Likert scale with 1 being strongly disagree or very poor to 5 being strongly agree or excellent.

Some comments students provided on the evaluations include:

“I feel like I am better prepared for the workforce both nationally and internationally.”

“This class was great because we actually learned things applicable to the real world and our professional lives.”

“I was not a fan of the course itself overall, but the reason I took it was for the travel component.”

Table 1 Student Evaluations

Questions	Responses	
	2016	2017
This course helps me develop:		
An ability to function as a team member	4.3	4.1
An understanding of professional and ethical responsibility	4.5	4.5
An ability to communicate effectively (orally)	4.5	4.2
An ability to communicate effectively (written)	4.5	4.5
An ability to understand the impact of engineering solutions in a broad context	4.2	3.8
The course was well planned	4.2	4.6
The professor was approachable to discuss problems	4.5	5.0
Overall, how do you rate this course	4.2	4.9
Overall, how do you rate this professor	4.5	4.8

As part of the course, students are asked to reflect on how the trip informed them regarding concepts taught during the course. Several typical responses are presented below (paraphrased from student reflections).

- When I heard the title of the course, I thought it was pretty explanatory as far as what would be covered. I originally thought it would be about what to do and what not to do when you are working in a different country and how best to go about it. However, by the end of the semester I realized it was so much more complex than that. The trip to France was fundamental in getting that across to me. Through interactions with students, company visits, even cultural tours, I discovered that working across global barriers is more subtle and involves taking time to understand the other culture.
- Seeing a French company and how they operate daily was eye opening. We received presentations from different departments in the company, then got to see the machines. We also got a tour of the manufacturing floor, which was my favorite part. Being able to observe the workplace culture at the company reinforced my knowledge of culture in France. I now have a better understanding and how I can work better as a member of a global team.
- I'm not afraid to admit that being fully immersed in another culture and language was difficult and frustrating at times, but I also realized how enriching and fruitful a diverse group of minds can be when put together.
- We quickly learned that several of the core communication skills were especially important when communicating with someone whose first language is not English. Understanding the context of the individual was important. It was also important to communicate sufficiently; the English language as we know is full of slang and confusing sayings. This gave me firsthand experience with some of the challenges that come in communicating across cultures.

Lessons Learned

Our experience with developing and offering the course has provided a number of lessons that could benefit other colleges.

Course design

The requirement that most institutions have for breadth of knowledge type courses, and even the ABET criteria themselves, provide ample “space” for inclusion of the global competencies in a course. If there is opportunity to develop and teach such a course out of a college of engineering it provides an opportunity to better tailor examples and activities to an engineering student audience.

Most students do not have courses that include as much reflection as this course was designed to include. Students benefit from structured opportunities for reflection particularly in the context of developing skills to be more effective in the workplace. Some faculty however, will consider such a course inappropriate for inclusion in the curriculum.

This course was designed to have multiple sections, each section representing a different destination for the study abroad component. All sections met together for the teaching

component. This arrangement provides an efficient use of instructor resources (one instructor rather than multiple instructors) but limits some specificity in topics (all examples did not deal with one specific country). In general this arrangement proved appropriate as faculty were willing to lead study abroad but did not have time to add another teaching assignment.

Course Implementation

Despite purposeful design and good intentions, it can be difficult to get students to engage in robust discussions. Faculty need to be purposeful and persistent in facilitating these discussions. Some early activities that students find enjoyable can help create a better atmosphere for more challenging discussions later in the course.

Guest presenters who can authentically speak about cultural challenges are very helpful. They are most helpful when their presentations also clearly connect with the learning outcomes for the course.

Since a portion of the content could be presented well in an online format, having a mix of in-person and online content and work was well received by the students.

Instructors may need to be more explicit than expected in helping students make connection between concepts and students' experiences. Even when a student had experience through co-op employment with a topic, they seemed to lack sophistication with the concept that would help them make connections. At other times students simply seemed unwilling to initially articulate the ideas until the instructor first discussed these.

Study-Abroad

The trips have been very effective at helping students more fully understand and engage with many of the concepts. Even though the time abroad is short, it provides an appropriate learning experience.

Participation in the course and trip is restricted and it has been helpful to interview students prior to accepting them into the class and study abroad trip. If a student is obviously only interested in the trip and not the learning outcomes of the course, they are not given permission to register.

There are third party providers that can help with many aspects of logistics of the time abroad. Unfortunately we have not found the services to provide appropriate experiences commensurate with the learning outcomes of the course. In our experience it has been better to work with an international partner university to recommend and help with local arrangements.

Cost is a significant issue that will limit participation.

It is important to purposely de-brief and discuss trip activities and how they relate to course concepts. Having a structured time for these discussions helps students to process what they have experienced and learned and provides a forum for students to learn that others may process these items differently.

Conclusions

The course “The Global Technical Workforce” has provided authentic opportunities for students to begin to develop global competencies. While engineering curriculum is constrained, formulating the course to meet breadth of knowledge and appropriate ABET criteria provides an opportunity for inclusion of such a course at most institutions. Working with international partners provides an opportunity to develop deeper collaborations and lessens the burden on faculty leading the study-abroad trips. The course is becoming an integral part of the curriculum with students seeking an opportunity for an international experience.

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