Developing Cultural Competency in Engineering through Active Online International Environments

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Abstract

The challenge: how can trans-national online learning be used to develop "cultural competency" and "global perspective" for engineering students

ABET Outcome H:

> "the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context"

General studies – study abroads and immersive experiences facilitate "socio-cognitive flexibility"

Cannot reach a large number of engineering students with traditional approaches (curricular limitations, etc.)

Can we teach at least basic cultural competency by using online learning for joint international experiences?

Introduction and Objectives

The challenge highlighted above raises a number of attending questions that this work is seeking to address, such as how to define "cultural competency," what effective instructional designs in an online environment would lead to students developing these competencies, how do we assess cultural competency, and can we see any measurable change over the course of one semester.

I teach a course on Engineering, Society and Contemporary Issues (STS 1500), normally offered for first-year undergraduate engineering students. This course introduces them to the role of engineers in society and develops their ability to consider societal and global issues as part of professional practice. Through my work with James Groves on the distributed learning environment he has described, I am converting this course to an online delivery format which opens the opportunity to develop and study in a new area: this fall the course has been extended into an international partnership that allows our students to not just hear terms like "global citizenship" but collaborate with peers overseas.

There are two primary learning outcomes of this innovation:

1. **develop cultural competency**, *defined as the ability to understand that there are cultural differences that influence designs and decision making and the socio-cognitive flexibility to adapt assumptions and decisions in a team project based on input from international team members.*
2. **develop 21st century communication and collaboration competencies** through the use of online and distributed communications tools as the primary vehicles for synchronous and asynchronous collaboration.

As we develop the course over time, we want to be able to assess

1. a shift in "cultural competency" along a continuum based on adaptation of a general existing instrument, as well as performance assessments on course assignments and activities
2. an increased level of comfort among students from both countries in participating in discussions and collaborative work during class, and
3. an increased level of self-directed organization using these same tools outside of class for group work or informal learning outside of the designated class period.

Developmental History of Innovation

Since April 2011, I have been working with a teaching partner in Germany, Mr. Dominik May at the Technische Universität (TU) Dortmund, to plan the course content, select and sequence content, design the activities, and design the means of assessment as well as work out the logistical challenges of offering a course with students from two different countries where the academic calendars run on dramatically different schedules. This planning has included two trips to Germany for syllabus and course development, and for technology support for the online portion as well as Skype-based bi-weekly planning meetings in between to continue pulling together the details and contents of the course.

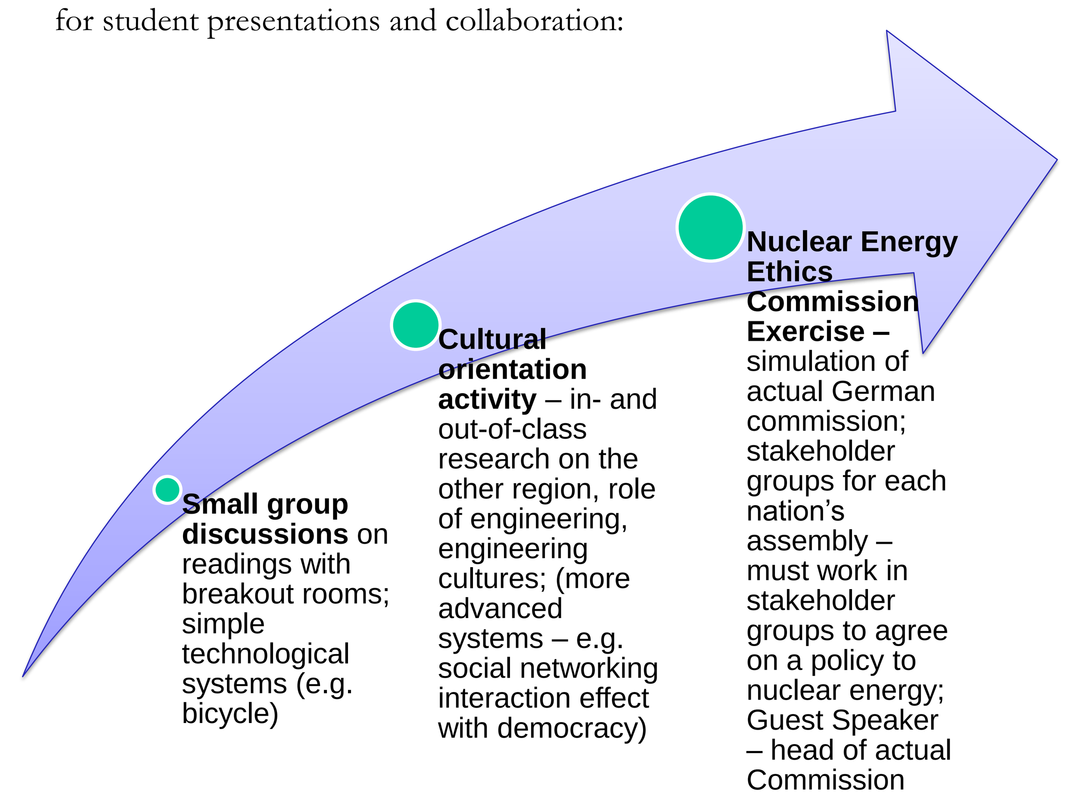
At present, we are 12 weeks through the first delivery this course. Originally, we had planned an assessment that would be given to students three times (beginning, middle, end), but we scrapped that because it relied too heavily on self-report and "likeability" was a concern in student responses. Instead, we have relied on observations and evaluations of an increased number of in-class discussions, in-class student presentations, and student performance on exams and written assignments. For the presentations and written assignments, rubrics were developed that included criteria such as cultural analysis when analyzing a socio-technical system (adapted from Neeley and Pinch & Bijker). We also administered a survey part-way through the course to assess attitudes by way of measuring "concerns" (adapted from Hal & Hord). We are still developing a coding schema for observations and a sorting schema for classifying written assignments along a continuum of cultural competency demonstrated in their analyses.

Learning Activities and Materials

I am designing an active, fully online learning environment that blends students together from the U.S. and Germany into one class that is designed to have them work in teams on complex engineering topics and generate a co-developed soft product (e.g. policy recommendation or joint decision) by the end through on-going collaboration and discussion both in and out of the classroom.

Course Design *(more detail in handout)*

- Learning activities and strategies beyond readings and listening to lecture - want the students to work in groups on projects that will highlight culturally different approaches to a complex technological system
- Scaffolded activities that go from basic to more complex both in terms of complexity of technological systems and role of culture as well as expectations for student presentations and collaboration:



Technical Setup

- Entire course, office hours, and out-of-class student group meetings occur using UVa's platform for online learning
  - Use of Collab - Resources, course schedule, student created meetings
  - Use of Elluminate / Blackboard Collaborate - Live class sessions with lecture, discussion, break-out groups and quizzes; students self-organize group working meetings using Elluminate Bridge tool
  - Other tools – wiki for Nuclear Energy Commission exercise

Learner Population

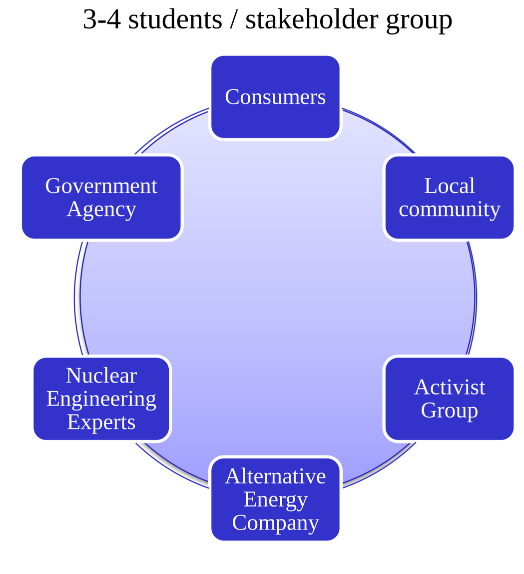
- 22 from UVA, 19 from Dortmund (pilot; student interest much higher)

Course includes weekly readings that provide theoretical frameworks, historical readings and examples, and cross-cultural examples. While I was the main lecturer and facilitator, Mr. May from TU led on several occasions as well.

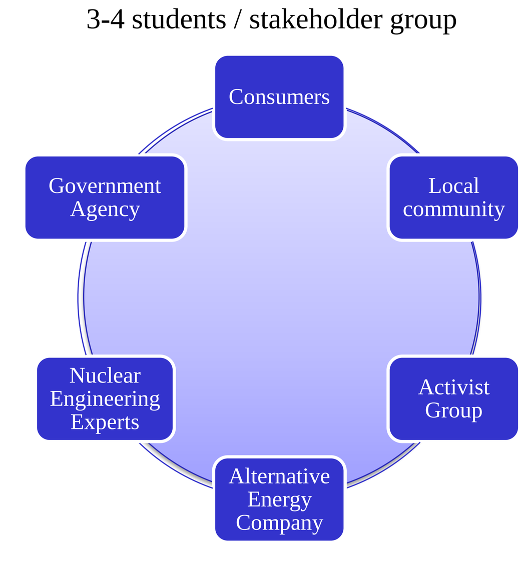
UVA students had to write three papers (socio-technical systems analysis, engineering as a vision of the future, and engineering as a global endeavor), complete two exams, and give a total of three graded presentations plus several in-class discussion reports. TU students had to write the final paper and take the final exam and gave one graded presentation (the Nuclear Energy exercise) plus several in-class discussion reports.

Culminating activity: Nuclear Energy Ethics Commission *(see handout)*

US Assembly
Equal mix of UVa and TU students
12 UVa + 9 TU = 21 students
3-4 students / stakeholder group



German Assembly
Equal mix of UVa and TU students
10 UVa + 10 TU = 20 students
3-4 students / stakeholder group



Two products from each group:

1. Stakeholder presentations
2. Joint recommendations for national policy

Execution

We are currently in the middle of implementing our first run of this course. Thus far, we have observed that students do struggle with understanding "culture" and the cultural aspects of socio-technical systems. They are provided a very basic definition of a socio-technical system early on that includes the Technical, Organizational, and Cultural (TOC) aspects (with definitions of each). We present a host of examples that we analyze using the TOC. The students then have to work in pairs to select a socio-technical system in their local communities and give a joint presentation in-class with a slide on each of the aspects. Based on these presentations, it was clear that most students did not understand "culture" as many defined this primarily in economic terms (culture equated to impact on jobs, impact on economy, maybe impact on environment).

The first paper students had to submit also required them to analyze a socio-technical system including cultural aspects. In most papers, this part was the weakest. A significant number of students clearly viewed culture as a "problem" to be "managed," often depicting "culture" as being at odds with engineering and technology (for example, "anti-technologists" equal "culture" and the problems with "culture" would simply be resolved if people were just more educated about any given technological system.

This suggests we should spend more time defining "culture" and perhaps incorporate some concepts from anthropology or sociology that would aid the students in developing a rich understanding of what constitutes "culture."

We are too early in the Nuclear Energy Exercise to know what has resulted from this. Early indications are that students are beginning to understand how culture shapes technological decisions more, but it is too early to draw any clear conclusions. I am also considering integrating an energy grid simulation that I am developing with colleagues for a separate project into this course because it may assist us in highlighting systemic relationships and differences in resources around the globe in a more direct manner.

Major Issues to Resolve

What We Want to Know & How You Can Help

First, we want to know what other professionals in engineering believe are cultural competencies *specifically* for engineers. As opposed to generic definition that could apply to any discipline, what are the competencies engineering professionals should possess, or how to cultural competencies relate to design and innovation development. **When you think of cultural competencies for engineers, what does this mean in your mind that engineers should be able to do or should demonstrate?** When you see a professional in action with strong cultural competencies, what is different (or excellent) about that individual's performance? What does he or she do? How does he or she approach problem solving, design, management, or implementation?

Second, we want to know how you would define "global perspective" for engineers. This is a very loose term in the literature and has been bandied about quite a bit. Outcome H states that engineering students should receive "the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context." While definitions of economic, environmental, and even societal contexts and impact can be meaningfully defined, the "global" part of this outcome remains vague despite growing emphasis on themes like "engineering as a global endeavor" and a "global perspective" for engineers. So, **in your words, as a professional in the field, what is *your* definition of a global perspective for engineering?**

Third, you are most welcome to provide **feedback** on the activities and Nuclear Energy Ethics Commission exercise and the reflections on what we have found so far.

Finally, we would like your **reactions to the following specific learning objectives** we have been developing and recommendations for any additional we should consider:

- Identify the cultural components of a socio-technical system
- Explain the relationship between culture and technological systems using "mutual shaping" as a framework
- Identify the different "relevant social groups" for a given socio-technical system and explain how they have influenced or could influence the development and implementation
- Articulate a technological definition of progress and a societal definition of progress for a given socio-technical system; explain the relationship between these two definitions of progress
- Describe the role engineering plays in shaping a society over time
- Explain your definition of what the phrase "engineering as a global endeavor" means (using ideas presented from this course)
- Identify and describe the professional responsibilities and/or skills that relate to having a "global perspective"

For any feedback, thoughts, reflections after the symposium, feel free to email me at **stephanie.moore@virginia.edu**.

Discussion

Thus far, we have identified several ideas and terms that still require further clarification. I plan to add some course readings and lecture notes in the future to provide a grounded definition of "culture" to the students and have them identify examples. In addition, I want to share with the students definitions of "cultural competencies" and "global perspective" that come *from engineering professionals*. Definitions that come from within the field tend to resonate more deeply with the students than those that feel like they are "externally imposed" definitions.

In addition, while the Nuclear Energy Ethics Commission exercise appears to have worked well enough for how it was designed, there clearly are a far broader set of opportunities to be explored here. Specifically, we are considering incorporating a simulation/game that is being developed with other colleagues on the energy grid. Depending on the conditions we specify or can change in that simulation and the instructional design that engages students in specific ways with that simulation, we could use one simulation environment throughout the course to give the students opportunities to look at the same context but in different ways.

What remains to be learned is whether we can derive an operational definition of cultural competency, how we can assess student learning in this area, and how to assess their performance on activities. This project takes a learning and performance orientation to a construct that has traditionally been defined in attitudinal or affective terms. By looking at "cultural competency" as a cognitive activity and a performance skill that can be learned, this could more greatly facilitate the development of instructional strategies for teaching such a competency as well as assessment strategies and instruments with clearly defined criteria. I do plan to submit an NSF proposal on the further development of this course specifically for developing the instructional aspects of the simulation described above and development of assessment techniques in this area.

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