Work in Progress — Developing Multi-Country, Multi-Team, Multi-Term Projects for a Large, Introductory Engineering-Design Course

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Abstract — This paper describes our efforts at the University of Michigan in addressing globalization in project-centered engineering design courses at the first-year level. The additional challenges that come from doing engineering design over multiple countries tend to be social. We have subsequently engineered social network motifs that allow a class to adapt to such projects and their associated clients/stakeholders. Emphasis has been on the transmission of artifacts from one team to the next, one term to the next, one country to the next that afford the creation of realizable designs that work for the people / culture for which such designs are intended. From Spring 2006 to Fall 2007, approximately 630 students in the United States and China have participated in this course. Data suggests that this network-based, artifact-centric method can have a positive impact on a student’s learning about globalization and engineering.

Index Terms — globalization, learning structures, project-centered learning, social networks.

INTRODUCTION

There are many methods for engaging students in the globalization of engineering. Lecture-based methods can expose students to its concepts and consequences. Methods with asynchronous learning networks can afford students from different countries an exposure to international teaming. Study-abroad methods can immerse students in a foreign culture to help them understand its nuances.

While these methods exist, there are difficulties in implementing them at the first-year level, particularly if project-centered learning becomes a curricular focal point. For a variety of reasons, projects are local. They are local to a room (e.g., projects are tied to a lab). They are local to a team (e.g., projects require a team to interact often). They are local to a time (e.g., projects are scheduled tightly). “Being local” can and has helped to foster the kind of affective learning environments needed at a first-year level. “Being local,” however, is often at odds with “doing global.”

This paper briefly describes the means by which we cultivate “being local” while “doing global.” It furthermore describes some of the preliminary results of our work.

BACKGROUND

ENGR 100 Introduction to Engineering is a four-unit (5-hr / wk) project course taken during either the Fall or Winter 13-wk terms at the University of Michigan. Approximately 1,200 first-year students take this course per year.

The course is divided into sections that range in size from 40 students (for a pilot section) to 140 students (multi-disciplinary). Sections represent different “flavors” that are designed around a common set of learning objectives. Most sections are disciplinary. The particular section that is the focus of this paper is a multidisciplinary one and does a systems approach to engineering.

Agreements between U-M and Shanghai Jiao Tong University (SJTU) have resulted in U-M faculty traveling to SJTU to teach U-M courses. Our section was the first first-year U-M engineering course taught at SJTU.

Our course now pilots asynchronous design projects in partnership with SJTU. A scale-up of this course occurred in Fall 2007, where projects extended to China, Jamaica, and Malawi.

Altogether, our section has involved a total of 631 students from Spring 2006 to Fall 2007. This period includes two terms at SJTU (Spring 2006, 89 students; Spring-Summer 2007, 195 students) and three terms at U-M (Fall 2006, 100 students; Winter 2007, 109 students; Fall 2007, 138 students). Our students participated in over 120 projects spread over 20 different categories.

SOCIAL NETWORK STRUCTURES

To implement our curriculum, we intentionally engineered six different network motifs and incorporated methods and approaches from networks (physics and complex systems) [1], as well as social network analysis [2]. These motifs are considered as building blocks for a complex network that encompasses our section, clients, and projects. Each motif is associated with a particular scale (i.e., in personnel and in time). Collectively, the motifs allow for “being local” while “doing global.” The motifs are:

- **Team.** A team typically consists of 4-5 students. The duration of a team is for an entire term. Students are assigned to a team by a discussion faculty. A team represents the base unit for project grading.
Meta-Team. A meta-team typically consists of 2–3 teams. The duration of a meta-team is typically for a third to a half of a term. Meta-teams are voluntary and can be transient. Meta-teams are trading collectives, which use “currencies” of skills, data, and manpower.

Peer Mentors. Peer mentors are this class’s alumni who have been invited to join this network. They serve for one term, for which they receive course credit and training. One peer mentor serves 4–5 teams. An additional informal peer network now includes SJTU course alumni, who also help to advise the U-M students on the SJTU/U-M joint designs.

Marketplace. The “marketplace” consists of all student teams and clients/stakeholders. The marketplace extends over at least two terms. Students review work from previous terms and can choose to build on projects from previous terms, do new project offerings in the current term, or opt to start a new project not listed. In the marketplace, students can also choose their meta-teams. This is the structure by which international, asynchronous projects have been introduced to the students. All students are exposed, but only those who truly want to do so opt in for the international projects.

Consultancy. Our section is run as a consultancy, where client/stakeholders interact with the class. Our consultancy is the means by which a client/stakeholder can maintain projects over several terms. Consequently, multiple teams over multiple terms can work for a single client/stakeholder. International clients/stakeholders like SJTU are managed in this structure.

Bootstrap. Our section currently serves as a bootstrap for two student organizations: BLUElab and MPowered Entrepreneurship. Students in our section have the option to continue their projects after they leave the course in these organizations. They can remain with these projects for as long as they are at U-M. In particular, BLUElab is the conduit through which our students have access to the Jamaica and Malawi projects in sustainable engineering.

ARTIFACT DEVELOPMENT AND MANAGEMENT

The main artifact by which a project carries forward into the next term, as well as serving as the main deliverable to a client, is a team’s final report. Consequently, there are two additional structures that needed to be engineered:

Communications. For the students to create a final report that can be used by future teams, a fair amount of staffing and course time has been devoted to technical communications. Students meet in discussion sections of about 25 students each, 1-hr / wk. Technical communications staffing ranges 1.0 – 1.5 Full Time Equivalent (FTE) / term.

Repository. Students have access to nearly all of our section’s U-M final reports since Fall 2001. The management of 345 final reports, as well as managing lecture notes and clients is done via a MediaWiki server.

PRELIMINARY RESULTS

All students receive some level of exposure to issues of globalization during the lecture portion of the course. However, only some choose to go further. This is because projects are given in the context of a marketplace and global type projects like SJTU joint designs represent only one of several categories from which students can choose.

The following preliminary results are for the period Spring 2006 to Fall 2007:

Scalability. The course was flexible enough to be transplanted in its entirety from U-M to SJTU and to accommodate almost twice the number of students. The scale-up occurred over consecutive terms (i.e., 109 students in Winter 2007 to 195 students in Spring-Summer 2007). The number of FTEs over the scale-up remained constant at the cost of tripling the amount of space needed to do the course.

Global awareness and participation. For three terms (Fall 2006, Winter 2007, Fall 2007), U-M students voluntarily opted into projects or assignments with an international component at increasing rates of 15%, 24%, and 48%, respectively.

Predictors. Whether a U-M team would decide opt for an SJTU final project is anti-correlated with whether that team’s students opted to review any of SJTU final reports. (Students are asked to review previous final reports before starting their final projects.) In other words, if a student reviewed an SJTU project, that student’s team was likely not to opt for an SJTU joint design. Out of 10 students in the Fall 2006 term who reviewed SJTU projects, none subsequently opted for doing an SJTU joint design for their final project. Likewise, out of the 22 students in the Winter 2008 term, none subsequently opted for doing an SJTU joint design. However, 9 of those 22 opted to a final project associated with either Malawi or Jamaica.

Examples. Examples of student projects are highlighted in our section’s website:
http://lattice.engin.umich.edu/wiki100/index.php/Welcome

CONCLUSIONS

This paper describes our section of an introductory engineering design course at U-M. We developed structures for social networks and for artifact development, which have allowed us to incorporate a global experience into our project-based curriculum. Furthermore, these structures have allowed us to transplant and scale the course at SJTU, as well as to extend some of these networks back to U-M. While data suggests that the overall impact is positive, there have been findings that indicate further study.

REFERENCES
