Enhancing Cross-Cultural Understanding Among Engineering Students:The Technology and Human Development Project

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Introduction

This paper discusses a unique curriculum unit designed to promote cross-cultural analysis and understanding in a technology-related problem-solving context. The "Technology and Human Development Project" (THDP), a five-week team-based project for 55 first-semester engineering students (12% of the entering class) at the University of Virginia, had the following objectives:

(1) Enhance students' abilities to analyze complex systemic relationships related to technology and human development in a cross-cultural context, especially the strengths and limitations of technological means for enhancing human capabilities, human development, and thus the quality of life.

(2) Introduce students to the concepts of human development, human capabilities, quality of life, and sociotechnological systems–and their significant interrelationships in different nations throughout the world.

(3) Apply analytical, statistical, and interpretive modes of reasoning and critical thinking to a specific current problem of technology and human development in a country or region of the world.

(4) Work in cooperative research teams to investigate and propose plausible solutions to the problem, taking into account technical, ethical, social, economic, political, and cultural constraints and opportunities.

(5) Present the results of a team research project and analysis in both a written report and poster-and-oral presentation, judged by UVA engineering faculty.

The paper discusses the results and an evaluation of the THDP, focusing especially on its implications for enhancing students' abilities to integrate technical-engineering and socio-cultural analysis in addressing specific global development challenges. The paper also discusses the advantages and drawbacks of using teams for this kind of project assignment. Undergraduate cooperative learning projects like the THDP respond to the educational values of the new ABET criteria and also contribute to ongoing interests in "globalizing engineering education" and revitalizing the first-year curriculum.[1, 2]

Technology and Human Development Project (THDP)

The concept of human development encompasses not only improved economic and material welfare but also access to the educational and social resources that promote the enhancement of human capabilities in the broadest sense. As part of their coursework in "Language Communication in the Technological Society," the student-engineer teams conducted in-depth background research on their topics and then developed those topics (see list below) into more focused problems of human development. Students also were required to develop a creative yet practical mix of technological and/or nontechnological solution proposals to their team's problem. They then presented their research to a panel of three faculty judges–a mechanical engineer, chemical engineer, and a communications specialist–during a one-day poster exhibition andcompetition (see Exhibit A). The oral-poster presentation was judged in terms of: (a) quality of research and analysis, (b) clarity of presentation, and (c) cogency of proposed solutions to the problem. Finally, the teams submitted a lengthy, well-documented 20-25-page report of their findings as the culminating product of the THDP.

The initial topics that student teams developed are listed below. Subsequently, the teams developed these topics into more focused research problems:

Technology and Human Development Project Topics*

1. Ultrasound technology in India
2. Three Gorges Dam project in China
3. Hand guns in the United States
4. Industrialization of the Amazon River Valley
5. The Green Revolution in Mexico
6. Controlling infectious diseases in sub-Saharan Africa
7. The Internet and inner-city American schools

*Teams of 3 or 4 students, assigned by random draw; 2 teams per topic

The background text students used was the latest annual Human Development Report 1996[3] (hereafter HDR96), compiled by the United Nations Human Development Programme. This volume is an enormous compendium of social, economic, political, and cultural data and analyses on every country in the world; the annual series, going back to 1990, has been widely praised by the international press for its careful and thorough research. Students were required to read and submit homework problem assignments on sections of the HDR96 prior to beginning focused research on their THDP topics. Afterward, and for the remainder of the project, students gathered and read extensive additional material related directly to their team's problem. Finally, instructor-generated materials, workshops, lectures, and assignments were also produced during the five-week project period.

A key emphasis of the whole project was intensive documentation and analysis of source material, including not only published articles and books on each team's topic, but also data and reports compiled by a range of national and international organizations (including the United Nations, World Watch Institute, World Bank, Planned Parenthood, U. S. Census Bureau, Agency

for International Development, World Health Organization, Oxfam, and many others). Teams also were instructed to make appropriate (but not excessive) use of newspapers and other periodicals, as well as electronic sources accessible through the Internet and World Wide Web.

Project Context and Student Preparation

Several circumstances made such a lengthy and challenging project practicable. First, all of the students had extensive experience in small group learning earlier in the semester. (The THDP took place during the last third of the semester, and was the final course assignment, counting for 35% of the course grade.) In addition, they had received extensive instruction in writing and oral communication, including several short papers and two talks. One of their major assignments in TCC 101 was the "Engineering Career Options Project," in which students worked in eight 3-4-member teams to research and develop a team report and oral presentation on undergraduate engineering majors available at UVA. The ECOP was helpful, but probably not essential, preparation for the THDP.

Second, all students had worked in teams earlier in the semester not only in TCC 101 (the technical communication course) but also in their Engineering Design (ENGR 164) sections. A faculty colleague from chemical engineering paired his two sections of Engineering Design with the technical communication instructor's matched sections of TCC 101. Together, the aim was to provide a stronger multidisciplinary foundation for about the 55 new engineering students in the matched sections (12% of the entering class). The two instructors collaborated on course goals and assignments, emphasized cooperative learning, and developed several team projects designed to teach students how to research, analyze, and communicate about complex and open-ended problem-solving challenges.

Third, the extensive use of free and accessible networked computing greatly eased the process of locating and obtaining information for the THDP from electronic databases. Electronic mail was also a facilitator for interactions between team members and between the team and the instructor. Throughout the project, each team's coordinator was required to submit a brief weekly progress report (via e-mail) on the teams' activities, including any problems that might require the instructor's intervention.

Fourth, students were taught earlier in the semester about how to gather a range of high-quality source material. Specifically, the University's Science and Engineering Library offered two short orientation sessions devoted to learning about the range of research-related materials available through the University library. Students were required to attend both these sessions. Without that preparation, students would not have been as well equipped to conduct the basic information searching needed for the THDP.

Fifth, and finally, a great deal of careful and phased planning was crucial. Six class sessions were devoted exclusively to lectures, workshops, and/or project team meetings related to the THDP. Lecture and workshop topics included how to:

–Use background research to carve out a more focused research problem

–Structure an argument (claim, evidence, warrant, and qualifications)[4]

–Analyze interactions between technology and the larger human environment in complex sociotechnological systems (using the HDR96)

–Appreciate cross-cultural differences in attitudes toward technology (using a documentary film based on a book about the Amish of Lancaster County, Pennsylvania[5])

–Organize, design, and deliver a poster presentation

In addition, teams had to produce an initial working bibliography (10 sources) by the start of second week and a larger bibliography (25-30 sources) and detailed research problem statement by the start of the third. Despite their earlier-semester preparation and the assignments, lectures, and workshops during the THDP period, most teams needed highly individualized guidance and feedback from the instructor in developing a focused research problem and data-gathering strategy.

Project Evaluation

Evaluation of the THDP is based on two bodies of data: (1) judges' numerical ratings of the poster presentations themselves and (2) informal written feedback and course-evaluation questionnaire data from the students.

(1) Judges' Ratings of the Poster Presentations

The major purpose of the THDP was to nurture students' appreciation of cross-cultural differences and heighten their awareness of the drawbacks of ethnocentric ways of responding. Overall, the team poster presentations displayed a genuine sensitivity to cross-cultural contexts and constraints. For example, teams that focused on controlling AIDS in Sub-Saharan Africa, as well as teams that focused on regulating ultrasound technology to reduce selective female abortions in India, discovered quickly in their research that deeply ingrained cultural values that favored males over females were crucial in understanding the nature of those problems. However, their solution proposals were not always consistent with this cross-cultural understanding–emphasizing more education for men and women without recognizing why men, in particular, would probably not want or accept such a critical intervention. As one of the judges wrote in reflecting on the posters,

> ". . . [M]any presentations started out with some premise that everyone was assumed to agree with. For example, that it is our job as morally superior people to step in and "teach" these Indians or Africans the right way to behave. I imagine that one of our toughest jobs as educators is to draw attention to this kind of thinking."

Yet it was also apparent in the posters and reports that students had become more aware of the impracticability of prescribing solutions for others based on their own value systems or modes of

thought. For instance, one group studying the economic inequalities associated with the Green Revolution in India came to realize that transferring modern agricultural technology to lesser developed countries could do more harm than good, given the social and economic structures of the receiving society. Similarly, a team that compared approaches to controlling handgun-related crime in the U. S. and the U. K. realized that important cultural differences toward gun ownership and violence between these two closely related societies made it unfeasible for the U. S. to ban handguns. Finally, one student noted: "With ultrasound in India we found that the technology was not really the issue at hand."

Clearly, then, students broadened their cross-cultural awareness, knowledge, and understanding through the THDP. Yet it is also clear that nurturing deeper cross-culturalism among students would require more sustained classroom experiences.

The ratings of the judges can also tell us about the quality of the team projects. The three judges rated each team's poster presentation in terms of 10 criteria, using rating categories from "Weak" (1 point) to "Excellent" (5 points), as shown in Exhibit B. Judges' scores were summed and divided by three to obtain a mean score for each of the 14 team presentations. Based, then, on a total of 50 possible points, the average (mean) score was 38, with a range from 30.7 to 45.3. (Differences between the two sections are discussed below.) While the relatively unexceptional mean score may suggest that the overall quality of the presentations was not high, this would be misleading. Judges were very discriminating and disinclined to issue high scores, but they agreed that the overall quality of the team posters was exceptionally good, especially for first-semester students. As one wrote in his reflections on the competition,

> "In general, a very good exercise. It was obvious that the students took their jobs seriously. This wasn't just another homework assignment. This is good. Hopefully they will dwell on the lessons learned enough to grow some.
>
> I judged probably harder than my fellow judges. This may be because I was not comparing how they performed with how I think good first-years should perform. I figured we might as well compare them with real adults in real situations. So I tried to judge on an absolute scale. So naturally they are not going to look as good. But their audience is now the adult world."

In fact, this judge was correct in sensing that his scores were lower than those of the other two judges. This judge, interestingly, had had no previous contact with the students, and hence no baseline of specific performance expectations for any of the students or teams.

The other two judges concurred with this judge's overall assessment. In particular, it was felt that the teams had done an impressive amount of research for their projects, had assembled it generally in an effective poster design, and that the students themselves behaved in a professional manner during the presentations. The TCC 101 instructor felt that the poster competition was the best-quality class performance he had witnessed in three years of teaching that course.

(2) Student Feedback

The instructor asked his students to comment informally in writing on their experiences in the THDP, and to make suggestions for changes if the project were repeated. In general, students were extremely positive about the project, especially the poster competition phase. A sampling of favorable comments:

> "This was a good way to learn about some of the most troubling problems in the world today. It was a lot of work, but overall I think it was an intellectually rewarding and enjoyable experience."
>
> "I thought this whole project was a good experience for me since I've never done a poster presentation. The topics required in-depth research and were "useful," unlike some other research papers I've done. I think this type of project should definitely be continued."
>
> "This project is a good introduction to what is involved in a research project. It makes you see the connection between technology & society and shows you how not all technology is good in all situations."
>
> "The Human Development Project was one of the best projects I have ever done. I liked the fact that it dealt with a real problem that the leaders of the world are concerned with."
>
> "This was probably the most valuable thing I've done this semester. The group work was hard to organize, but paid off. During the presentation I had a feeling that we had really accomplished something significant."
>
> "[T]his project is worth doing again–I learned a great deal about a subject I had no knowledge of, and the entire process was beneficial."

While few students offered strong or explicit criticisms, those who did tended to focus on the project's relevance to engineering, problems related to time constraints and deadlines (especially for the team report), under-performing team members, or difficulty coordinating team members' work schedules:

> "There were times that I didn't see how it related to engineering, but by the end I realized the purpose and how it related."
>
> "Project was hard to do in a group. Project didn't seem to relate to engineering."
>
> "It was hard to make such a large paper flow nicely since four different people wrote it."
>
> "I guess my only complaint is the time [constraint], but there's really nothing that can be done about that."

"The only complaint was that we had put so much effort into the entire [poster] presentation that when we had to do the paper there seemed to be an attitude of 'let's just get it done'."

"I don't like having teams assigned. Yes, it is a learning experience to work with all kinds of people, but when a few high-quality workers are working with one who doesn't care, the hard workers must work overtime to make the low-quality work better."

In their final progress report to the instructor, coordinators in three of the 14 teams reported significant problems with one team member, while another coordinator reported problems with two team members. In every case, the problems focused on team members who had missed more than one scheduled team meeting, produced low-quality work, and/or failed to meet key deadlines. In addition, most of the problem reports concerned the final report, not the poster. Finally, all four of the team problem reports came from one section.
Despite these problems of team dynamics–ccommon to most team projects–students in both sections gave high marks to team writing and the THDP (especially the poster presentations) in the final course evaluation:

"Please indicate the importance of each of these course components to what you learned in TCC 101:"

1=Very Important 2=Important 3= Somewhat Important 4=Not Important

	Students' Ratings of THDP*	
	Section 1 (n=26)	Section 2 (n=27)
Technology and Human Development Project (THDP)	2.12	1.78
THDP Poster Exhibition and Competition	2.04	1.30
Team writing assignments/reports	1.92	1.59

*Mean scores; standard deviations do not exceed 1.0.

In interpreting differences between the sections, it should be noted that Section 2 performed significantly better on every assignment throughout the semester, including the THDP. A comparison of between-section differences in mean scores on the THDP posters and reports reveals the following:

Mean Scores for THDP Posters and Reports

	Section 1 (n=27)	Section 2 (n=28)	Combined (n=55)
Poster (max. = 50)	34.2	41.7	38.0
Report (max. = 20)	16.4	18.3	17.4

Discussion

What are the important lessons from this project for instructors at other engineering schools? First, bear in mind that students in both sections of the course had worked extensively in teams earlier in the semester–not only in the technical communication course (TCC 101) but also in their Engineering Design (ENGR 164) sections. The semester-long pairing between and cooperative teaching of the two courses, built around an explicit model of professional development described elsewhere,[6] probably had a significant positive impact on the success of the THDP. Further assessment of the THDP and other assignments in the paired courses may help to clarify this impact. Nevertheless, while the benefits of course-pairing were an added plus in this context, projects like the THDP could clearly be accomplished successfully in appropriately designed stand-alone courses. Such courses clearly would need to devote significant time to providing students with experiences in team-based assignments, developing their technical research and communication skills, and offering them substantive cross-cultural materials and instruction.

Perhaps the chief drawback of the THDP was the amount of time it required for both the students and the instructor: about most of five weeks in a 14-15-week semester. One can imagine devoting somewhat less time to such a project. However, the multiple learning benefits were clearly cumulative; indeed, students felt that more time, not less, would have enhanced the quality of the written report especially. Thus, it seems unlikely that this sort of project could be successfully implemented in fewer than 3-4 weeks, especially given students' total course loads. Moreover, cross-cultural knowledge and understanding cannot be nurtured effectively in a rushed or ad hoc manner.

Time constraints, however, must be seen in light of pedagogical outcomes. Based on both informal observation and formal course evaluation data, the THDP was a rich, demanding, and informative educational experience for these first-semester engineering students. It accomplished its primary goal: to enhance students' abilities to analyze complex systemic relationships related to technology and human development in a cross-cultural context. In particular, students learned that technological solutions alone to major social problems are not always the most feasible or effective, but rather must be considered relative to specific cultural circumstances. The project also provided students with intensive and challenging team-work experiences well beyond what is typical in the first-year curriculum. Finally, the THDP gave students an opportunity to develop

and practice their technical communication skills, through both the oral-poster presentations and the final reports. Not only are these outcomes beneficial for students' professional development in the first year,[6] they also provide a platform that students can build upon throughout their academic and professional lives.

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Exhibit A

Technology and Human Development Poster Exhibition and Competition
Thursday, November 21, 1996, University of Virginia Chemistry Building Lobby
Participating Students, Project Titles, and Presentation Schedule

11:00-11:15: Ultrasound Technology–Accomplice to Gendercide?
Paul Conti, Michael Homenick, Jason Mayer, Delicia Tucker

11:15-11:30: Damming the People? The Three Gorges Dam Project
Matt Ipri, Nakia Eckley, Edward Hurley, Byung-Wook Lee

11:30-11:45: Different Cultures: Comparing Handgun Control in England and America
Frank DeRosa, Lorna Robertshaw, Kris Van Atten, Meredith Whibley

11:45-12:00: Amanaka'a: Fighting for Life [Amazon Rain Forest]
Jerome Boschulte, Jessica Dante, Royce Kunze, Nick Soonthornchai

12:30-12:45: "Spend 500 Rupees Today or 50,000 Rupees Tomorrow"
[Ultrasound Technology in India]
Chris Mehler, Chris Nute, Corey Schwartz, Alex Sirois

12:45-1:00: The Three Gorges Dam: Flood Protection or Flood Creation?
Bradley Easterlin, Tan Le, Mike Morabito, Christi Settlage

1:00-1:15: Handguns and Homicide in America
Irene Greenberger, Totran Nyugen, Dean Rafferty

1:15-1:30: Uncivilized Development: Brazil's Neglect of its Lower Classes
Rob Koehl, Keith Moores, Tom Peddicord, Jon Sia

2:00-2:15: Socioeconomic Inequality and the Green Revolution in Mexico
Mike Autuoro, Kelly Cush, Sarah Dondero, Atsuro Kagawa

2:15-2:30: Blood at the Root: Controlling AIDS in Sub-Saharan Africa
Emily Bennett, Charity Carpenter, Brian Robbins, Matt Walsh

2:30-2:45: CyberEducation: Learning At The Speed Of Light
Kevin Berger, Mark Goodman, Mauricio Herbas, Justin Spagnoli

3:30-3:45: The Green Revolution in India: The Plight of the Small Farmer
Scott Chapman, Carlton Fraley, Wali Sulaiman, Felix Tan

3:45-4:00: Silent Killer: The AIDS Epidemic in Sub-Saharan Africa

Keith Karem, Daniel Milner, Drew Price, Patrice Washington

4:00-4:15: The Internet: Closing the Educational Gap in America
Shaun Burroughs, Couch Payne, Ray Yin

Exhibit B

Technology and Human Development Project
Judges' Evaluation Form
November 21, 1996

Poster Title:

Team Members:

Poster Component	1=Weak	2=OK	3=Good	4=Very Good	5=Excellent
How well did this team:					
research the topic?	1	2	3	4	5
use high-quality sources?	1	2	3	4	5
design the poster display?	1	2	3	4	5
organize the information?	1	2	3	4	5
develop its argument(s)?	1	2	3	4	5
use visuals, graphics clearly?	1	2	3	4	5

Total Poster Points (max. = 30):

Comments:

Oral Component	1=Weak	2=OK	3=Good	4=Very Good	5=Excellent
How well did this team:					
organize the presentation?	1	2	3	4	5
deliver it (i.e., style)?	1	2	3	4	5
engage your interest?	1	2	3	4	5
answer your questions?	1	2	3	4	5

Total Oral Points (max. = 20):

Comments:

TOTAL POINTS (max. = 50): _____