2006-1223: ENVIRONMENTAL HEALTH FOR DEVELOPING COMMUNITIES PILOT COURSE

Angela Bielefeldt, University of Colorado-Boulder

Dr. Bielefeldt is an Associate Professor and a licensed P.E. in the State of Colorado. She teaches Civil and Environmental Engineering courses for freshman, seniors, and graduate students on topics including design, hazardous waste management, solid waste management, and bioremediation. She is a co-faculty advisor for the Engineers Without Borders student chapter at the University of Colorado at Boulder (CU) and is working with other faculty at CU to start a new emphasis in Engineering for Developing Communities at both the graduate and undergraduate levels.

Diana Shannon, University of Colorado-Denver

Diana Shannon has worked over 27 years in the areas of environmental health and environmental protection. She has worked for the U.S. Environmental Protection Agency, Colorado Department of Public Health and Environment, Boulder County Health Department, City and County of Denver. She co-developed and co-taught the Environmental Health for Developing Communities course. She currently serves as Assistant Chair in the Department of Planning and Design, College of Architecture and Planning, at CU Denver.

Jay Shah, University of Colorado-Boulder

Jay Shah is earning his M.S. degree in Civil Engineering in the EDC program. Jay was a Research Assistant funded by the NSF grant on Department Level Reform to create an EDC program at the undergraduate level. Jay served in the Peace Corps in Nepal from 2000 to 2002. In 2005, Shah was awarded the Franklin H. Williams Award; the award pays tribute to returned Peace Corps volunteers of color who show an ongoing commitment to community service and who support the agency's third goal of promoting a better understanding of other countries and peoples to Americans.

R. Scott Summers, University of Colorado-Boulder

Professor Summers is the director of the Center for Drinking Water Optimization. His research areas include drinking water quality and treatment, natural organic matter, disinfection by-products, organic and inorganic contaminants and physical, chemical and biological drinking water treatment processes. He is one of the three faculty in the Department of Civil, Environmental, and Architectural Engineering at CU leading the Engineering for Developing Communities program at both the graduate and undergraduate levels.

Jim Ruttenber, University of Colorado

Dr. Ruttenber, M.D., Ph.D., co-developed and co-taught the Environmental Health for Developing Communities course in 2005 and 2006. He is an Associate Professor in the University of Colorado at Denver's Health Science Program. His research focuses on occupational and environmental health, risk assessment, and environmental epidemiology.

Environmental Health for Developing Communities Pilot Course

Abstract

Public health is an increasingly important issue for environmental engineers, as indicated by the ABET 2005-2006 accreditation guidelines. An *Environmental Health for Developing Communities* course was developed as part of the new Engineering for Developing Communities (EDC) option for Environmental / Civil Engineering students at the University of Colorado at Boulder (CU). This course provides students with a basic understanding of environmental health issues, methods, and practices through an emphasis on their application in developing communities worldwide. The course emphasizes sustainable approaches for improving public health and the importance of interdisciplinary collaboration between practitioners of public health, the environmental sciences, and engineering. The course was piloted for the first time in Spring 2005 to eight graduate students. Semester-long team projects were associated with existing Engineers Without Borders (EWB) - CU projects in Peru, Mali, and Rwanda. The students identified the major health problems in the community, indicated engineering solutions that would improve these, and prioritized the health problems and solutions with regards to costs and benefits. Feedback from the students and instructors was gathered via a mid-term questionnaire, end of semester surveys, and the traditional Faculty Course Questionnaire (FCQ) administered by CU. In the future, the course will be cross-listed as an undergraduate course and dual-listed for Environmental Studies majors.

Background

Historically, a key driver for environmental engineering activities was the prevention of negative public health impacts. While this is still true today, engineering courses often focus more on regulatory compliance than the public health drivers behind U.S. regulations. In developing countries that lack significant environmental regulations or enforcement, an understanding of public health is critical to the design and implementation of appropriate facilities for water treatment and waste management. The ABET 2005-2006 accreditation guidelines for Environmental Engineering degrees states that: "The program must demonstrate the graduates have introductory level knowledge of environmental issues associated with air, land, and water systems and associated environmental health impacts."[1] Other entities are also trying to reform engineering education, such as the National Academy of Engineering's "The Engineering of 2020" report which notes that engineers must "develop and implement more ecologically sustainable practices… in industrialized countries and developing countries alike" using "systems-based strategies and holistic approaches that embed social and cultural objectives."[2]

In spite of these important indicators of the importance of training our students in issues related to society and public health, most undergraduate environmental engineering programs lack a required course in public health. A survey of ABET accredited B.S. degrees in Environmental Engineering (http://www.abet.org/schoolareaeac.asp) using curriculum published on each university's website revealed that of 47 programs: 12 require a course in public health, environmental toxicology, or industrial hygiene at the junior or senior level; and an additional four programs include one of these courses on a list of recommended technical electives (note that at six programs a clearly defined curriculum could not be located on the web). Six other

programs had graduate-level courses related to public health, which presumably could be taken as technical electives by undergraduate students. Some specific examples are listed in Table 1. Southern Methodist University has the most health-related courses taught from within engineering, including ENCE 3451 Principles of Industrial Hygiene and Environmental Control (required junior course), ENCE 3353/5351 Introduction to Environmental Toxicology, ENCE 5312 Risk Assessment and Health Effects, and ENCE 5353 Environmental Epidemiology (http://engr.smu.edu/ence/courses_undergraduate.html).

Table 1. Examples of Public Health Courses in Engineering Programs

University	Course Number and Name	Notes	Web site
California Polytechnic State, San Luis Obispo	ENVE 455 Environmental Health and Safety	required for BS	ceenve.calpoly.edu/files/enve0507.pdf www.calpoly.edu/~acadprog/2005depts/cengr/ce_dept/envecrs2005.html
Humboldt State	ENGR 353 Environmental Health Engineering	required for BS	www.humboldt.edu/~catalog/programs/engr.html
Massachusetts Institute of Technol (MIT); Cambridge	1.083 Environmental Health; 1.081J Chem in Environ: Toxicology & Public Health	required for BS; elective	http://web.mit.edu/catalogue/degre.engin.ch1e.shtml
Old Dominion	CEE 356 Public Health Engineering	required for BS EVEN	www.cee.odu.edu/abet/ee356.php
Tufts University	ES 27 Env Health & Safety; CEE 137 Public Health	req'd BS; elective	ase.tufts.edu/cee/undergraduate/bseve-degchk.pdf ase.tufts.edu/cee/courses/graduate.asp#137
Virginia Tech, Blackburg	4114 Fundamentals of Public Health Engineering	MS elective	www.cee.vt.edu/course.php ?cat=0&action=view&id=50

Curriculum at University of Colorado - Boulder

An *Environmental Health for Developing Communities* course was developed as part of the new Engineering for Developing Communities (EDC) option for Environmental / Civil Engineering students at the University of Colorado at Boulder (CU). At present, graduate students can emphasize EDC in their environmental engineering degree, with this new course part of the required core courses (http://bechtel.colorado.edu/web/grad/ environ/ms-guide.htm). The new EDC graduate program began in January 2004. (http://www.edc-cu.org/)

An EDC emphasis is also under development for undergraduate students. Within the ABET-accredited B.S. degree in Environmental Engineering (EVEN), students select an emphasis area that dictates approximately 3 upper division technical electives. The EVEN degree is cross-departmental, comprised primarily of courses from civil, chemical, and mechanical engineering. An EDC emphasis may be added to existing emphasis topics of air pollution, chemical processing, ecology, remediation/soil, and water/wastewater. The new *Environmental Health* course (a cross-listed undergraduate version) would be required for students selecting the EDC emphasis track as part of their EVEN degree. (http://www.colorado.edu/engineering/EnvEng/)

An undergraduate certificate in EDC that would be open to any engineering student is also being considered and developed. This would join other certificates available in the College of Engineering & Applied Science, such as the International Engineering Certificate in German (http://engineering.colorado.edu/academics/german.htm). Offering an *Environmental Health* course that doesn't require significant pre-requisite knowledge would enable students college-wide to take the course to fulfill requirements of the certificate program.

Public Health Courses in Other Programs

The course being considered would be somewhat unique in that in a single course engineering students would become familiar with key public health issues relevant in developing communities. In contrast, most existing public health programs have multiple courses which provide in-depth coverage of important sub-topics. In addition, most programs focus on "first world" type of public health issues. In order to better define the CU course objectives and purpose, courses in the Public Health programs at other universities were examined, including Harvard, Johns Hopkins, the University of North Carolina's and the University of Michigan. The goal was to distill the most important content from these various courses into a single course at the University of Colorado.

Course Purpose, Objectives, and Format

The purpose of the course was to provide students in engineering and environmental studies with a basic understanding of environmental health issues, methods, and practices through an emphasis on their application in developing communities worldwide. The course emphasized sustainable approaches for improving public health and the importance of interdisciplinary collaboration between practitioners of public health, the environmental sciences, and engineering. Topic areas covered included an international overview of public health and environmental health practice; common toxic agents and environmental diseases in developing communities; health effects of air and water pollution; environmental emergency and disaster response; practical methods of epidemiologic analysis; and sustainable engineering for health communities.

The course objectives were defined as:

1. Understand environmental public health policies and programs and the core public health functions
2. Understand important public health issues, in particular those confronting developing communities
3. Understand the inextricable linkage of public and environmental health issues and appropriate treatment technologies
4. Know and use the language of environmental public health, including public health assessment, assurance, and surveillance; epidemiology; vector transmission; disease agents, etc.
5. Gain basic skill using assessment, monitoring and surveillance tools and techniques
6. Gain basic skill to effectively involve stakeholders, interested organizations, and the public

7. Ability to present public health-related information in an effective manner (in writing and orally)

The course was set up to meet twice a week for 90 minutes each, with a total of 30 meeting days. The course was capped at enrollment of 20 students and advertised with the above purpose and objectives to the engineering school and environmental studies students. Eight students enrolled for credit and one student enrolled to audit the course. The format of the course was lecture, group discussion, small assignments, and a semester project. The required text for the course was the *Control of Communicable Disease* manual[3]. A number of other excerpts from papers and other textbooks were assigned readings (see Table 2), and were made available to students via WebCT.

Table 2. Course Topics, Readings, and Assignments

Lectures	Topics	Required Readings	Assignments
1-5	*Course Overview and Sustainability*	Krizek[4] - Sustainability Public Affairs Television[5] – Sustainability Video Walley[6] Public Health Overview Koop[7] Regional Health Overview UNEP[8] – Socioeconomic Overview	1: Concepts of Sustainability 2: Mongolian Grasslands 3: International Regional Health
6-9	*Determinants of Environmental Health*	UNEP[8] – Atmosphere and Health; Freshwater; and Land Burke[9] – Monitoring Methods WHO[10] Agriculture and Vector-borne Diseases	4: Earth's Atmosphere and Health – Region Specific 5: Land Degradation and Health – Region Specific 6: Midterm Review
10-18	*Diseases and Epidemiology*	Heymann[3] - Principles of Medicine; Malaria; Pneumonias, Respiratory Infection; Diarrhea; Gordis[11] – Epidemiology Overview; Estimating Risk; Disease Transmission; Case Control; and Case Studies	Developing Community Project
19-28	*Assessment, Public Involvement, Behavior Change, and Governance*	UNEP[8] – Urban Areas; Disasters Basch[12] - International Health Organization Lautz[13] - Complex Emergencies Merson[14] and WHO- Community Participation	7: International & Gov'l Health Agencies 8: Contemporary Public Health Issues 9: Disasters and War 10: Health Behavior Change
29-30	*Developing Country Project, Course Evaluation, Wrap-up*		Developing Country Project Presentations and Reports

Feedback on the course identified two general themes relating to the course content: decrease the focus on sustainability as a topic as students already had enough background and increase the focus on actual public health topics, specifically a focus diseases, surveillance, and transmission. There were also comments that some of the readings covering the environmental determinants should be more in-depth More detail on the course feedback is presented in the latter part of this paper.

Eight guest speakers were utilized during the semester in order to draw upon the wealth of knowledge and experience outside of the University. Some of the speakers had significant public health experience in Africa and Asia, with the Peace Corps and other organizations. Others held various public health positions with the local counties, cities, and the State of Colorado.

Students completed semester-long group projects. The purposes of the project were:

1. To learn how to assess the needs for engineering solutions that will improve public health in developing communities.
2. To understand the public health implications of engineering projects in developing communities.
3. To recognize the benefits of sustainable engineering solutions to public health problems.

The students self-organized into groups of three to four. Then they selected a developing community that is need of, is implementing, or has implemented a sustainable engineering solution to improve public health. All of the students worked on projects for communities associated with the University of Colorado Engineers Without Borders chapter (EWB-CU):

Developing Community Assessment Project, San Leon, Peru
Maternal Health Clinic: Zambougou, Mali, West Africa
Public Health Assessment, Increasing Water Availability, Muramba, Rwanda

Next, the teams identified an expert with first-hand experience with the project who served as a consultant to the group. The written report generated for each project included:

1. Description of the physical environment and ecology of the community, and the ways they relate to the priority health problems (as identified in part 3 below) and how they affect the engineering solution.
2. Description of the demographic and socioeconomic features of the community, and how these affect the engineering solution.
3. Identification of the major health problems in the community and indications of engineering solutions that would improve these. Prioritized the health problems and the basis for the priorities system. Prioritized the solutions with regard to their benefits and costs.
4. Discussion of the reasons for selecting the engineering solution instead of the others listed in section 3 above.
5. Describe the engineering solution in detail. Indicate the different options for the solution and discuss them in terms of sustainability. Justify the selection of the solution.
6. Estimate the specific public health improvements that will result from the engineering solution.

The student teams delivered a 15-minute oral report on their project to the class.

Course Evaluation

A variety of assessment tools were employed during this pilot course, including a mid-term questionnaire, end of semester surveys, feedback from the instructors, and the traditional Faculty Course Questionnaire (FCQ) administered by CU. Overall the feedback identified two general themes relating to the course content: decrease the focus on sustainability and increase the focus on actual public health topics. There were a number of other comments about the course, including the effectiveness of the lectures and discussion, guest speakers, semester project, and course prerequisites. A summary of evaluation feedback is presented in Table 3 and the recommendations developed in response to this feedback appear at the end of this paper.

Table 3. Course Evaluation Summary

Course Component	Strengths	Recommended Changes
Course Content	Diseases, disease transmission, and epidemiology, and behavior change topics were very effective Focus on international issues was effective Focus on public health was effective, as well as integrating health issues with environmental, social, cultural, and economic issues in developing countries	Less emphasis on sustainability concepts and environmental issues (such as air and water pollution) More emphasis on public health; go into more depth on disease transmission, public health assessments, health risk assessments, and specific diseases (e.g., HIV/AIDS); and increase focus on issues in developing countries
Lectures and Class Discussion	Generally considered to be effective learning tools	In general, increase pace and rigor of course
Course Readings	Generally readings were effective learning tools	Switch some supplemental readings with required readings to go deeper into selected topics. Include The Spirit Catches You and You Fall Down[11] as a required reading for the Public Involvement/Behavior Change topics
Guest Speakers	Guest speakers were generally effective; those with relevant international experience were most effective	Use medical students to teach disease topics and to assist with project. Add a guest speaker on children's health issues
Semester Project	Project was an effective learning tool	Include a broader range of project options (i.e., don't restrict to Engineers Without Borders projects)
Course Prerequisites	Generally students had previously taken biology/microbiology, environmental or environmental policy, and sustainability concept courses	Prerequisites should include environmental issues, sustainability concepts, and environmental microbiology, (or biology). If these prerequisites can't be met, then the course should include overviews of these topics

Future Recommendations

This *Environmental Health for Developing Communities* course was intended to provide students with a basic understanding of environmental health issues, methods, and practices through an emphasis on their application in developing communities. Overall this pilot course met the intended purpose and course objectives. Given the performance of the sole undergraduate in the pilot course offering, student feedback, and a discussion among the faculty, no significant changes should be needed to offer the course as a senior-level undergraduate elective. The recommended changes that will be implemented in future course offerings include changing the course topics to focus more on disease, disease transmission, and epidemiology, specifying prerequisites, changing some of the guest speakers, switching required and supplemental readings, and shifting towards more focus on diseases and epidemiology topics.

Specific to the prerequisites, students should take several courses before this environmental health course, including environmental microbiology (or biology if microbiology is unavailable), environmental issues, and sustainability courses. These courses should provide the students with sufficient background. Microbiology, which is required for all undergraduate Environmental Engineering students, should be a prerequisite for this course. With this pre-requisite content in mind, undergraduate Environmental Engineering students could take the course the last semester of their senior year. Students earning a degree in Environmental Studies don't typically have all of these courses, so some changes would need to be made to accommodate cross-listing. An engineering treatment technology course focused on solutions in developing communities is now being taught (first offered in Fall 2005), and fits well with this health-focused course.

Because of the nature of the course as a service level course, there is little that needs to be done to the course as a modification to use it as a senior level undergraduate course. However, as a cross listed course a distinction must be made between graduate and undergraduate credit. First, keep the project for both levels, but add an additional paper for the graduate students. This paper could be a comprehensive study of a specific disease, due earlier in the semester and presented so the whole class has a better background for the rest of the course. In addition, the graduate students could take a final exam, since the 2005 course did not have one.

Another important recommendation for this course is to continue to incorporate guest speakers into future courses. Where possible, speakers with experience in developing communities should be sought out. More of the course readings should delve deeper into the specific topic. This recommendation is particularly important for students that already have a broad understanding of environmental challenges and the concepts of sustainability. Since the feedback on the course readings was generally positive, future reading lists should include several of the more in-depth supplemental readings as required readings. For example, Fadiman's book is highly recommended.[15] The broader readings, listed in Table 2, should be retained as supplemental readings. Lastly, future courses should place more emphasis on specific diseases and epidemiology topics, and less focus on the concepts of sustainability and broad environmental issues. The environmental determinants of health topics should be retained but linked more closely to the relevant diseases.

2006 Course Offering

The Environmental Health in Developing Communities course is being offered again in Spring 2006, with a current enrollment of 12 students. The 2006 course will be team-taught by Dr. Jim Ruttenber, M.D., three M.D.s with experience in the developing world (Barry Bialek, David Silver, and Louis Perrinjacot), Barry Karlin (see experience above), and R. Moreno with experience in geographic information systems (GIS). Key topics include: participatory community development; community assessment (self-assessment and GIS); public health; epidemiology; and tropical medicine. Team projects related to a real engineering project in a developing community are being retained as a large component of the course. A significant assessment component will be executed with the revised course.

Acknowledgments

This material is partially based upon work supported by the National Science Foundation under Grant No. 0431947. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Bibliography

1. ABET. 2004. Criteria for Accrediting Engineering Programs 2005-2006 Accreditation Cycle. Engineering Accreditation Commission ABET, Inc. Baltimore, MD. Website: www.abet.org
2. National Academy of Engineering. 2004. The Engineer of 2020: Visions of Engineering in the New Century. Washington DC. National Academies Press.
3. Heymann, David.L., ed. 2004. Control of Communicable Disease Control Manual, 18th Edition, American Public Health Association.
4. Krizek, Kevin J. and J. Power. 1996. A Planners Guide to Sustainable Development. American Planning Association. Planning Advisory Service Report No. 467. Chicago, IL.
5. Public Affairs Television, Inc. (2001). Bill Moyers Report: "Earth on Edge"
6. Walley, John; John Wright; John Hubley; eds. 2001. Public Health: An Action Guide to Improving Health in Developing Countries. 1st edition. Oxford Press.
7. Koop, C. Everett, Clarence E. Pearson, M. Roy Schwarz; eds. 2001. Critical Issues in Global Health. Jossey-Bass, San Francisco
8. UNEP (United Nations Environmental Program) Reports: State of the Environment and Policy Retrospective 1972 – 2002.
9. Burke, Gwendolyn, Ben Singh, and Louis Theodore (2000). Handbook of Environmental Management and Technology. Wiley-Interscience, New York
10. WHO, World Health Organization (1996). Agricultural Development and Vector-Borne Diseases
11. Gordis, Leon. 2004. Epidemiology, Third Edition. Johns Hopkins University.
12. Basch, Paul F. 1999.Textbook of International Health. 2nd Edition. Oxford University Press.
13. Lautze, Sue, Jennifer Leaning, Angela Raven-Roberts, Randolph Kent, and Dyan Mazurana (2004). Assistance, Protection, and Governance Networks in Complex Emergencies. Lancet
14. Merson, Michael H., Robert E. Black, Anne J. Mills; eds. 2001. International Public Health : Diseases, Programs, Systems, and Policies. 1st edition. Publisher: Jones & Bartlett Pub. ISBN: 0834212285
15. Fadiman, Anne. The Spirit Catches You and You Fall Down: A Hmong Child, Her American Doctors, and the Collision of Two Cultures.