Report on Environmental Engineering Program Curriculum Strategy for Implementing Global Learning Outcomes

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The Environmental Engineering program participated in the Implementing the Global Learning Recommendations project during summer and fall of 2010. During the course of this project, a series of reports were generated to document the considerations and concerns associated with a curriculum strategy for implementing the global learning outcomes. These reports developed an overall strategy for curriculum change as well.

This report summarizes the result of this project as of September xx, 2010. Further details beyond what is presented herein, are may be found in this report series. The summary of this project's expected outcomes and the progress toward achieving these is presented below.

Expected Outcome #1

A comprehensive approach to global learning in the major(s) that ensures that all students have substantial and multiple encounters with global perspectives (as defined in the recommendations) throughout the program of study in the major.

Status of Outcome #1

The Environmental Engineering program has evaluated its curriculum and proposes a comprehensive approach to address global learning outcomes. Although the approach proposed is considered to be best implemented as occurring through a transition in curriculum change, the basic elements of this are as follows:

- Select certain existing CENE ***required courses*** to revise their course learning outcomes to include global outcomes and modify content as needed.
- Optimize the CENE ***core course requirements to focus on those courses most relevant*** to the curriculum, eliminating or create new courses as needed.
- Develop a list of ***required and "approved"*** Liberal Studies Program courses that provide breadth toward achieving global outcomes, yet remain most relevant to our programs' educational objectives and outcomes.
- Minimum ***language requirement*** consisting of 8 credits of any first-year college level non-English language (ASL not included).
- Integrate ***international service requirement*** (such as contributions to EWB) as course credit.
- Integrate ***study abroad*** with international programs that are ***demonstrated to contribute to our program's ABET accreditation requirements***.

Expected Outcome #2

Global learning outcomes articulated in language that is relevant to the major(s) in question.

Status of Outcome #2

The program educational objectives and program outcomes presented herein represent the result of having completed one round of review by the faculty and the Department Advisory Committee.

In addition, Environmental Engineering is taking this opportunity to confirm and present its mission, values, and presents a vision that intends to guide the program into the next decade.

Mission

Environmental Engineering embraces the mission of Northern Arizona University and the University's mission statement is adopted as the mission statement.

> Mission Statement
>
> Provide an outstanding undergraduate residential education strengthened by research, and graduate and global education programs, and through innovative teaching in the classroom and methods of distance delivery.

Values

Environmental Engineering embraces and adopts the values of the College of Engineering, Forestry and Natural Sciences and as such is committed to:

- advancing individual and collaborative research and scholarship;
- integrating research and disciplinary practice into our teaching;
- exploring the interdisciplinary and multi-disciplinary nature of our scholarly and educational activities;
- cultivating the varied natural and cultural settings and heritage of our region for educational and scholarly activities;
- building the mentoring, close student-faculty interactions, and research experiences that create a supportive, nurturing environment for rigorous learning;
- sustaining our partnerships with external agencies, tribes, communities, and industrial/corporate entities, that provide opportunities for community service and application of our knowledge to societal needs and issues;
- honoring the consistent tradition of national and international recognition of our excellent faculty;
- promoting a healthy, collaborative work environment in the college, including the background, diversity and experience of our staff; and
- fostering interactions of a diverse population of students, faculty and staff.

In addition, Environmental Engineering extends these values by also being committed to:

- cultivating and advancing global experiences for students and faculty in all areas of education, research, scholarship, and the profession.

Vision

Environmental engineering has evolved into an engineering discipline that demands an ever expanding base of scientific and engineering knowledge. Environmental engineering requires that the engineer have a much broader understanding of the world's natural, cultural, social, political, and economic systems, how these systems mutually impact one another, and how to work within the context of the globally distributed technology, services, and materials of engineering. Environmental engineering is a profession that leads the effective management of multiple disciplines in the implementation of sustainable engineering design and has the ability to communicate within and between these disciplines in a way that advances humankind. In addition, while legacy environmental problems continue to be solved, the challenge of solving the emerging global problems caused by natural and human impact is also being met by environmental engineers.

The Environmental Engineering program at Northern Arizona University is recognized as preparing students for the profession, the practice, and the person of environmental engineering's future. This is possible because the Environmental Engineering program

- leads the Western United States in the innovative integration of engineering education, research, and global learning;
- provides an educational environment that exposes students to current practice and research in environmental engineering throughout their educational experience;
- provides a faculty-mentored environment that facilitates the individual's professional and personal development as a global citizen; and
- leads the university community toward a deeper understanding of engineering's and technology's role for globally sustaining the natural environment and humankind.

Program Educational Objectives (Proposed for fall 2011)

ABET defines program educational objectives as follows:

> *Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.*

The Environmental Engineering Program Educational Objectives below are shared with those of the Civil Engineering program. Within three to five years of obtaining a bachelor's degree in Environmental Engineering from Northern Arizona University, a graduate is expected to achieve the following,

1. Promote implementation and awareness of sustainable development and the sustainability of the global environment, and improve the quality and diversity of life through engineering practice or graduate study pursuit.

2. Commitment to life-long learning by participating in activities for the mentoring and professional development of self and others.
3. Professional engineering licensure or in the process of becoming a licensed professional engineer.
4. Demonstrates competence and leadership through increasing professional responsibility and participates in discussions and decisions that help shape local and global sustainability and environmental policy.
5. Engagement in community and/or professional organizations that contribute to the well-being and sustainability of the natural environment and humankind.

Program Learning Outcomes (Proposed for fall 2011)

Program learning outcomes are the knowledge and skills that students have upon graduation. In addition, in order to become a relevant asset to a profession that is now international in scope, graduates must also acquire a disposition that values the diverse approaches to environmental engineering that cultures both near and around the globe have to offer. It is by having been equipped with these outcomes that they are then able to achieve our program educational objectives. Graduates receiving a bachelor's degree in Environmental Engineering

1. Possess foundational skills in mathematics and in the chemical, physical, and biological processes of the earth's atmosphere, biosphere, hydrosphere, and lithosphere, as well as the ability to apply these skills to advanced topics and problems appropriate to environmental engineering.
2. Properly apply tools and methods of design, experimentation, modeling or simulation, and analysis to inform decisions throughout the process of design.
3. Define and analyze complex local and global environmental engineering problems, and devise and document sustainable engineering design solutions that are globally and culturally appropriate.
4. Effectively communicate, both written and orally, within multi- and interdisciplinary teams, have a disposition for collaborating with indigenous or other global cultures, and possess skill in more than one language.
5. Understand relationships between professional engineering and public and private organizations, and the mutual impacts that global environments and diverse societal and political systems of the world can have on one another.
6. Understand the importance of and be motivated to continually learn about emerging global and professional issues that will improve professional skills and abilities, and that adhere to and promote the standards and ethics of engineering practice in local, indigenous, and global contexts.

Expected Outcome #3

Evidence that the themes of global learning (diversity, environmental sustainability and global engagement) will be infused in an intentional way in the major(s), not as add-ons, but deeply embedded in the curricular content of the major.

Status of Outcome #3

Diversity: Intentionally infusing diversity into our curriculum becomes necessary because of our ABET accreditation requirements. The program's outcome #5 as it is

currently revised, specifically addresses "diverse societal and political systems of the world" and the program inherently considers that the "global environment" is rich in diversity with regard to its ecosystems and mutual interdependence with diverse social and political systems. Additionally this outcome maps to ABET Criterion 3 outcome (h) and our accreditation requires we demonstrate that students attain

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

This is done through assessment of these outcomes, which demands that content relevant to the program is embedded in the curriculum and that the program use the assessment results to improve the program by improving course content and content delivery.

In addition, a Liberal Studies Program course sub-list is being developed to focus on those courses considered to be more relevant to the program and already approved for diversity credit. These courses would also be included in the assessment described above.

Environmental Sustainability: Similarly, our accreditation will require that sustainability is intentionally infused into our curriculum. Sustainability development and sustainable engineering are important aspects of our program's educational objectives, as well as within our revised outcomes. In order to provide opportunity for students to attain this aspect of global learning, sustainability must be introduced in the CENE 150 Introduction to Environmental Engineering course. Although sustainability has been a module topic in this course for the many years, this semester marks the first semester where will begin to intentionally collect assessment data on the student's understanding of sustainability issues. Sustainability will also be reinforced in other CENE courses, but must be more deliberately incorporated into design project requirements for the senior capstone course.

As with diversity, sustainability in Liberal Studies Program and other campus-wide courses will be evaluated for their relevance to our program and used to supplement our curriculum's Liberal Studies requirements and non-CENE technical elective requirements with sustainability taught outside of engineering.

Global Engagement: The idea that our graduates will be globally engaged is reflected in two of our program educational objectives (objectives 4 and 5). In order to foster attainment of these objectives, this has been reinforced in our revised outcomes 3 through 6. As above, we are required to assess these outcomes and to use the assessment information to improve our program. It is anticipated that transitioning from global education to full global engagement will take some time and a good deal of patience.

Thus far, direct global engagement has been limited with the exception of EWB, a co-curricular activity that is does not involve all of our students. One proposal being considered this semester is that we incorporate project development and project support research activity into a required course that would actually be able to include elements of diversity, sustainability, and global engagement/education. Although global education is covered in several of our courses, we have not assessed this. Once again, CENE 150 is beginning this semester to assess global education relevant to our program. This course will serve as an assessment pilot that can be used to demonstrate how other courses can begin to embed these assessments.

As with both diversity and sustainability, the Liberal Studies Program and its preapproved global diversity course will be evaluated for program relevancy and used to supplement global education in the curriculum.

As the program seeks to transition toward a more flexible curriculum that can allow study or other experiences abroad, a curriculum mapping project is being conducted this semester to better identify opportunities to streamline our curriculum to help create room for these opportunities. Ultimately the idea if a fully integrated international program of study will be evaluated and considered.

Expected Outcome #4

Describe which courses are likely to be involved in implementing the global learning objectives, and how the academic unit will coordinate with Liberal Studies and the co-curriculum to accomplish these objectives.

Status of Outcome #4

Those courses that are most likely to be involved with any proposed implementation of global learning objectives are summarized below.

Course	R/E	LS	G	S	D
CENE 150 Introduction to Environmental Engineering	R		✓	✓	
EGR 186 Introduction to Engineering Design	R		✓	✓	
CENE 330 Air Quality Engineering	R		✓	✓	
CENE 332 Solid and Hazardous Waste Management	R		✓	✓	
CENE 386W Engineering Design: The Methods	R		✓		
CENE 476/486C Capstone Prep & Design	R		✓	✓	
CENE 535 Sustainability of Environ. Biotech. (New)	E		✓	✓	✓
CENE 484 Undergraduate Research in Engineering (New)	R		✓	✓	✓
XXX 101/102 First year Language	R	✓	✓		✓
LS Global Diversity (from course list focused on contributing to program outcomes)	R	✓	✓		
LS Ethnic Diversity (from course list focused on contributing to program outcomes)	R	✓			✓
PHI 331 Environmental Ethics	R	✓		✓	
Ex: ENV 495 Global Environmental and Climate Change/Other interdisciplinary courses relevant to program outcomes	E		✓	✓	✓

R = Required, E = Elective, LS = Liberal Studies Program, G = Global, S = Sustainability, D = Diversity

Coordination with the Liberal Studies Program and its course requirements will be conducted primarily through the program's evaluation of all approved Liberal Studies course with the aim to develop a list of courses that best support the achievement of program outcomes. This courses list will be reevaluated as part of the regular assessment process, and the program's list will be updated as necessary.

Similarly, interdisciplinary courses that can contribute toward achieving program outcomes will also be identified to so that a separate list of course to be used as on-CENE technical electives can be developed.

One initial co-curriculum activity that is being proposed to more broadly contribute to achieving program outcomes that have incorporated NAU's Global Learning outcomes is Engineers Without Boarders (EWB). The proposal is that all program students would be required to take CENE 484 Undergraduate Engineering Research. This new course (actually intended at this time to be open to other disciplines as well) would then not only serve to reinforce skills required for research and life-long learning and understanding of professional and ethical responsibility, but also facilitate gathering information or data that would support on-going or new EWB project (or other similar type project) needs. Students would be heavily exposed to a real-world situation demonstrating engineering's significance and impact in the context of each global learning outcome. In addition to broadening the knowledge of all students in these outcome areas, this approach is expected to also increase interest and participation in EWB's important co-curricular activities, and thus increase the ability to sustain EWB activities into the future.

Expected Outcome #5

A strategy to assess whether students have achieved the global learning outcomes identified.

Status of Outcome #5

The program currently is required to assess outcomes for ABET accreditation. Once the revised program objectives are approved the incorporated elements of the NAU Global Learning outcomes will be assessed much in the same way that we assess our other program outcomes. Many of our outcomes are directly assessed by having assessment methods directly embedded into our courses. In this way, we are able to collect quantitative data that can be used to show the degree that outcomes are achieved, improvement trends or identify areas of concern where more improvement may be needed. In addition, a new assessment tool that will allow us to evaluate any course's content for contributing to the attributes of global learning is being developed. This assessment tool has actually already been created and is currently being reviewed.

Expected Outcome #6

Requiring the active participation and support of the majority of faculty in the department to ensure the success of the curriculum strategy.

Status of Outcome #6

Although faculty participation up to this point in time has been limited, new program objectives and outcomes that incorporate NAU's Global Learning outcomes are moving forward with the process of being revised and approved. This is a requirement of our accreditation. Simultaneously, a curriculum redesign project is underway this semester (fall 2010). This redesign project will serve to implement changes in the curriculum that not only address the global learning curriculum strategy but other curriculum issues as well. This is occurring with the participation of the faculty.