Internationalizing our Campuses: Multinational Project–Based Approaches

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ABSTRACT: *We describe an effort underway at the University of Washington, in partnership with a number of universities around the world, on the transformation of research and education through the creation of multinational student–faculty projects in a wide variety of disciplines. Our basic approach is to build the curriculum around working in teams, with students and professors at other universities in various regions of the world, on addressing common, practical research challenges. All of the teams are multinational and interdisciplinary, and the research invokes the participation of a variety of non-academic social sectors, such as state and local government, industry and the non-profit community. In addition to engineering, our collaborations involve faculty and students from natural and physical sciences, social sciences, natural resource management, arts and humanities. For some projects, the collaboration takes place within a single course that is jointly taught at multiple sites, and for which the students interact electronically, via e-mail, the web, video-conferencing, etc. An example is our collaboration with Tohoku University, in Sendai, Japan, on first-year engineering design, a program in place since 1999. For other projects, the students' participation is of far longer duration, such as the joint, commonly-offered four-year curriculum we have created with Sichuan University, in Chengdu, on Challenges to the Environment in the US Pacific Northwest and southwest China. While our primary efforts to date have focused on undergraduate education, we have recently created a new collaborative doctoral program, working with colleagues in China, Japan, New Zealand, Vietnam, South Africa, Namibia and Mozambique. In this paper, we will describe some of the lessons learned to date in this project-based approach to integrating international research and education, and outline our directions for the future.*

1 INTRODUCTION

At the University of Washington (UW), in recent years we have been exploring new models for transforming education and research through the creation of multinational student-faculty projects across the disciplines. The central strategy of our approach is conceptually straightforward. On the one hand, it is clear that most of the big, multi-disciplinary research challenges that we face are shared across national boundaries. Examples of such challenges include environmental quality, public health, access to technology, food security and the quality of education itself. On the other hand, it is also clear that all of us are struggling with change within our own higher education institutions. Research universities around the world recognize common challenges which are vitally important to our future, including: doing a better job in integrating education and research; providing more multidisciplinary, creative opportunities for our students; linking our research more effectively to the needs of the local communities we serve; internationalizing our work more effectively; and, learning how to do a better job on evaluation and assessment of all our activities. The key strategic question we are addressing is: ***can we couple collaborative work on common research challenges with mutually supportive work on the reform of higher education itself?*** Our approach to answering this question has been to catalyze a variety of experiments in multinational project-based education, working with a small set of dedicated partner institutions around the world. Locally, we call this approach *UW Worldwide*. In this paper, we describe some of our pilot efforts, outline our progress to date, elaborate on some lessons learned, and lay out some of our plans for the future.

In the UW Worldwide approach, we bring together teams of faculty and students, both at home and at our partner institutions, to engage in common collaborative, multi-disciplinary projects. The projects are chosen such that they:

- are embedded in genuine faculty research interests on all sides;
- can take place within curricular structures which have the potential to affect *large* numbers of students on all sides, rather than a select few;
- contribute to the solution of practical regional problems, and;
- invoke deep partnerships with other allies, including industry, state and local government, NGO's, etc.

Of course it is nothing new for faculty members, particularly in science and engineering, to collaborate across national boundaries in their research. What distinguishes our approach is our commitment to involving undergraduate students (starting as early as their freshman year) in multinational research teams, and to finding ways in which to re-structure the curriculum, at UW and at partner institutions, such that participation in such teams can become the core of the undergraduate experience. There are indeed other notable international engineering programs we can learn from, such as the Global Perspectives Program at Worcester Polytechnic Institute [WPI, 2004] which has the most extensive track record in providing international project opportunities for undergraduates, and the International Engineering Program at the University of Rhode Island, which offers a five year program combining engineering, language study, and an international internship in a corporate setting [Grandin, J.M & Kim, T.J. 1998]. Our *UW Worldwide* model, while much younger than either of those programs, differs from them primarily in the degree in which it is based on a foundation of multi-university research collaborations, and in the disciplinary breadth of the activities.

It is interesting to note that the type of research-based and internationalized undergraduate education we are exploring has the potential to create communities that have many of the features that have been identified as effective in the intellectual and professional development of our students. These communities are intrinsically interdisciplinary; they emphasize practical problems; they provide complex layers of mentoring; they develop students' communication abilities, and they provide experience in cross-cultural collaboration. Fortuitously, these same communities also offer an excellent platform for addressing important research questions. Thus, if structured thoughtfully, and carefully assessed, the basic approach may be useful in a quite fundamental re-formulation of how we undertake university "research" and "education".

2 THE UW-TOHOKU PROGRAM AND OTHER COLLABORATIONS WHICH TAKE PLACE WITHIN A JOINTLY-TAUGHT COURSE

Our first pilot project in integrating collaborative international research and undergraduate education was a program with Tohoku University, in Sendai, Japan, on first-year engineering design. This project builds on much of the experience with creating freshmen design programs gleaned from the US National Science Foundation's Engineering Education Coalitions program [Kalonji, G., Regan, T. & Walker, M.L. 1996] as well as with several projects linking Japanese and US engineering education reform efforts [Kalonji, G. & Ohnaka, I. 1996].

In this collaboration, teams of UW and Tohoku University students and professors work together on common engineering design projects, sharing data, designs, ideas, etc, electronically. The undergraduate students are recruited to the program in their freshman years. Their initial research experience is integrated into their core curriculum as an engineering design course. Each year, five to eight research projects are identified, based on common interests of UW and Tohoku faculty members. Each research team is binational consisting, typically, of 3 – 5 freshmen on each side, at least one professor on each side, and some graduate students, and/or advanced undergraduate students to act as "senior peers" for the freshmen. This collaboration began in 1999, and is ongoing. Each year approximately 25 students on each side join the program. Research topics have included tsunami research, piezoelectric materials, bio-MEMS, robotics, and computer simulation of defects in materials. While the required duration of the formal collaboration is only one academic quarter (during which the joint course is offered), many of the freshmen continue in their research teams throughout their freshmen year and beyond. On the UW side, the curriculum also includes a seminar in Japanese Culture, Science and Technology. There is no required language study, nor any required time to be spent at the partner university.

Evaluation of the UW-Tohoku program has taken place through a variety of methods, both qualitative and quantitative [Adams, R.S, et al. 2002]. In general, the program has been found to have a

variety of benefits for participating communities. For the freshmen students themselves, the primary benefits have included: significant professional development in engineering; increased awareness of/desire for international experiences; development of multinational teamwork skills; and enhanced confidence in their ability to contribute to science and engineering. For faculty and graduate students, benefits have included an increased respect for the ability of novices to contribute to research, and the formation of new research ties with a powerful partner university. For the two partner universities, the collaboration has proven effective in providing mutual assistance in engineering curricular reform.

Based on our experience with the UW-Tohoku program, we catalyzed a number of other *UW Worldwide* pilot projects utilizing similar joint course approaches. Some of the partner universities and topics of collaboration are listed below:
UW-University of Tokyo (international contract law)
UW-University of Port Elizabeth, South Africa (marine affairs)
UW-Tsinghua University, Beijing (art and graphic design)
UW-University of Asmara, Eritrea (the Biography Project, social work)
UW-San Andrés University, Argentina (the Global Citizen Project)
UW-Chiba University, Japan (landscape architecture and urban design)
UW-University of Auckland, New Zealand (geography, political economy)

Many of the projects above were catalyzed through a generous grant from the Hewlett Foundation. Most of them are ongoing, and it has been extremely interesting to see how the basic approach plays out in a variety of different disciplines. In parallel to continuing to explore the model employed with Tohoku, in which the formal duration of the collaboration in limited to a number of joint courses, we decided to pilot a more dramatic and extensive cooperation, which incorporates joint research, language study, extended stay at the partner university, and a full four-year collaborative undergraduate curriculum. Our partner university for the first version of the four-year model is Sichuan University.

3 A JOINT FOUR-YEAR PROJECT-BASED CURRICULUM: THE UW–SICHUAN UNIVERSITY JOINT PROGRAM ON CHALLENGES TO THE ENVIRONMENT

Building on the some of the lessons learned from our collaboration with Tohoku University, we designed a four-year model, which:

- allows deeper research experiences for students;
- promotes stronger institutional partnerships;
- opens up a richer domain of project topics;
- allows time for language instruction, humanities and social sciences, and;
- includes a year at the partner university.

The over-arching research theme for our collaboration is “Scientific, Engineering and Social Challenges to the Environment in the US Pacific Northwest and Southwest China”. Within this broad theme, we have several research groups working on five topics: 1) water resource management and waste water treatment; 2) “eco-materials”, i.e. reducing the environmental impact of materials processing and use; 3) forest ecology; 4) biodiversity; and 5) environmental social sciences, focusing on the effects of humans on the environment (and vice versa) in our two regions. UW and Sichuan University (SU) faculty chose these research topics together, based on common interests and based on our assessment of topics that are of particular importance both to Washington State and to Sichuan Province.

The curricular structure of our program with Sichuan University is the following. Each year, we admit 25 first-year undergraduate students on each side, clustered into five teams to focus on the five project topics. Each team is binational, consisting, in addition to the first-year students, of at least one faculty member on each side, and at least one graduate student or senior undergraduate. For the first two years of their curriculum, the binational student teams work on their projects in their home countries, sharing ideas, data and designs with their counterpart teams electronically. In parallel, the students in Washington undertake intensive Chinese language study (typically 2 years, or 30 credits) and a year-long seminar on Chinese Society, Science and Culture. In their third year, the UW students travel to Chengdu, and the Sichuan University students come to Seattle, staggering the travel such that they can work together in Sichuan during the first summer and together in Washington State during the second summer

of their junior year. This differs from more traditional "junior-year abroad" programs in that the focus is on continuation of their research, in collaboration with academic, industrial and local government partners. In the fourth year, the students return to their home countries to complete a senior thesis/design project, based on the collaborative research. The status of our program with Sichuan University is the following. We admitted our first group of students in the fall of 2000. The 2002-2003 academic year was the first year that the undergraduate student exchange took place. The 2003-2004 academic year is the first year in which our program benefits from the presence on our campuses of the students who have returned from their international research experience. While the SARS crisis had a serious impact on our ability to send students to China, we have sent 37 UW students for a year of research at Sichuan University in the first two years of the exchange, and received 51 SU students in our programs at UW. Please note that in steady-state our program is designed to have 100 students enrolled in the program on each campus at any given time: 50 freshmen and sophomores preparing for their year abroad, 25 juniors from the partner university, and 25 seniors, returned from their experience abroad and completing a senior thesis on their work. This permanent physical presence on each others' campuses is a vitally important aspect of our program design.

The undergraduate students in the program have a wide variety of academic majors and career aspirations. Undergraduate majors include: civil and environmental engineering, materials science, mechanical engineering, industrial engineering, computer science and engineering, bioengineering, botany, biochemistry, sustainable resource sciences, forestry, conservation of wildland resources, anthropology, international studies, Chinese language, business and art. What unites the students is a strong commitment to working on environmental issues and a deep interest in international experience. Faculty members are also drawn from many departments, and 12 – 15 professors are actively participating on each side at any given time. In addition to the faculty members, graduate students on both sides are active and invaluable members of each of the five research teams.

In addition to the university participants, we have created some deep partnerships with the local government, trade, non-profit, and industrial sectors, which greatly expand the scope of projects we can undertake. On the Washington side, the primary partners outside the university are: the Washington State Office of Trade and Economic Development (OTED): a cabinet-level state agency created in 1994 to assist companies to export their products, and promote the expansion of Washington's businesses internationally; the Washington State China Relations Council (WSCRC): a non-profit trade association dedicated to promoting stronger commercial, educational and cultural relations between the state of Washington and the People's Republic of China; the Northwest Environmental Business Council (NEBC): the trade association representing the environmental industry of the state of Washington, a sector which comprises over 600 mostly small firms (2 – 25 employees); EarthTech, a large environmental technology firm; and the Washington State – Sichuan Province Friendship Association, a non-profit organization dedicated to strengthening educational, artistic and commercial ties between the two regions, which have been linked through a formal sister state-province relationship since 1982. Support from the US National Science Foundation's Partnerships for Innovation program has been of great assistance in strengthening these natural alliances. All of these partners mentioned above are heavily involved in the planning and implementation of the program, and on the Sichuan side there is a similar set of partnerships in place. These partnerships are particularly important in maximizing the probability that the research of the student-faculty teams will actually be implemented in real products and services that can benefit our regions.

What follows is a brief description of some of the research directions of the students in our program. This is very much a work in progress; for continuing developments please consult the project website [UW Worldwide. 2004]. It is interesting to note that while the faculty on both sides designed some initial research directions, many of the projects that have evolved are now student-designed and led. By taking the program in new and unexpected directions, the students themselves have, in turn, brought new faculty into the program. In addition to research that takes place in Seattle and Chengdu, a lot of fieldwork takes place in remote areas. In China, a cluster of projects in the fields of anthropology, forestry and biodiversity are located in a site in a Chinese minority area – Yangjuan Village, in the Liangshan Autonomous Prefecture. Organized by research theme, here are brief descriptions of some of the projects undertaken to date by Chinese and US students.

Biodiversity: understanding biodiversity in our two regions, and the relationships between speciation and geography. UW and SU students have focused on: biogeography and the evolutionary relationships of plants in the Pacific Northwest and Southwestern China; compiling a complete herbarium collection of the flora surrounding Yangjuan Village; an ethnobotany study of the traditional uses of plants by local Nuosu minority people; using DNA analysis to determine the phylogeny among species of various genera including rhododendron and passiflora; a survey of botanical biodiversity in Wang Long Nature Reserve; techniques for the statistical estimation of giant panda populations; and snow leopard population dynamics.

Eco-Materials: reducing the environmental cost of materials processing and use.
UW and SU students are working together on the design of industrial ecology models for the effect of the materials processing industry on the environment in the Sichuan Basin and the Puget Sound. Other materials-related research projects include: synthesis and photocatalytic properties of nanocrystalline TiO_2; design and synthesis of lead-free piezoelectrics ceramics; thermoelectric materials and devices; and materials for solid oxide fuel cells. Support for this portion of our effort comes from the NSF's new MUSES initiative (Materials Uses: Science, Engineering and Society), and from the Natural Science Foundation of China.

Environmental Social Sciences: understanding the complex interactions between humans and the environment in our two regions. Chinese students at UW have worked on Northwest Native American culture and art, in conjunction with an exhibit at the UW Burke Museum. They collaborated with UW freshmen to produce a video and teaching materials in Chinese, to introduce this topic to academic and general audiences in China. UW students in China have worked on a variety of projects, including: a study of the apple industry in Sichuan Province, investigating the reasons for market collapse and possible solutions, emphasizing finding new markets, and; a nutritional and health survey of the rural Nuosu minority group in Yangjuan, focusing on nutritional deficiencies in children and women.

Forest Ecology: understanding the dynamics of forest ecosystems and the balance between environment and development needs. UW and SU students are focusing on: the natural history of the Olympic Pennisula, and the relation between vegetation and soil erosion; in Yangjuan Village, constructing the natural history of forest stands; assessing the currently existing ecosystem; researching human uses of and impacts on forest resources, including surveys of fuelwood use; and, developing recommendations for future ecosystem management.

Water: understanding river systems in Sichuan and Washington, and investigating waste water treatment strategies. UW and SU student projects include: Using low-cost and effective biofluidized bed reactors to treat domestic waste water in Luzhou City, Sichuan (partners include Luzhou municipal government and local companies); mathematical modeling of water quality; research on the White River and the effects of water quality on endangered salmon populations; and working with the partners on the NSF Partnerships for Innovation grant to help environmental companies in Washington identify opportunities in the area of waste water treatment in Sichuan.

Our basic program structure, in which the undergraduate curriculum is so strongly research–based, has enabled us to be successful in broadening the base of financial support for the program. Both universities have committed local resources to the project, on the UW side through a grant from our Tools for Transformation fund to launch the *UW Worldwide* program. We have also been successful on both sides in garnering significant external support from the US National Science Foundation and from the Natural Science Foundation of China. On the US side, we also receive support through the Fund for Improvement of Post-Secondary Education (FIPSE) of the US Department of Education. Analogously, Sichuan University receives support for the project as a whole through the Chinese Ministry of Education, which has designated our project as a "national key project in higher education reform".

4 LESSONS LEARNED IN THE EFFORTS TO DATE

The evaluation of the various *UW Worldwide* projects has been undertaken by a variety of organizations and individuals, including UW's Office of Educational Assessment (OEA), the Center for Engineering Learning and Teaching (CELT), and an external evaluator, Dr. Susan Millar, of the

University of Wisconsin, Madison. A full–time doctoral student in education, Ms. Chia-lin Huang, who is fluent in Chinese and English, has worked extensively on the evaluation of the UW–Sichuan project. The evaluation is both formative and summative, including a variety of methods for triangulation purposes. Methods employed include: surveys, peer assessment, performance-based tasks, monitoring of research accomplishments, interviews, observations, focus groups, and longitudinal tracking of students. While the evaluation process is led at UW, to the greatest degree possible we try to implement similar activities at the partner institutions.

While the project is still in its early stages, we have learned a great deal about the benefits and challenges of the approaches we have undertaken. The research and professional development of the students is quite extraordinary, and exceeds the expectations of most faculty members involved. The program does serve as a motivation for continued international experience; many of the US the students are already planning to continue to their careers in China; others are anxious to explore other international opportunities in graduate school. The program has also proved to be a powerful platform for faculty and graduate student professional development. For the faculty, it provides increased international dimensions to their work, as well as greater experience in working with multidisciplinary, cross-cultural teams of students. For the graduate students, new opportunities for international research and collaboration are opened up, and they get valuable experience in management of research teams.

A key challenge for our integrated approach is to get the faculty on both sides to collaborate beforehand on a coherent, yet flexible, four-year plan. We have found face-to-face meetings to be indispensable in this matter, though costly. Another challenge is the effective incorporation of the industrial, governmental and non-profit sectors in our work. It is vitally important, but many professors have little experience in that regard, and all of us are stressed for time. On the US side, a very challenging matter is recruiting students who will agree to spend the time needed on Chinese language studies and on study abroad. Particularly for engineering students, who have no language requirement in their curriculum, we have to expend a great deal of energy to help them understand how valuable such a commitment might prove for their professional futures. On the financial side, the biggest problem is raising the money to support the room and board for the Chinese students during their year in Seattle. Because the universities in our program share home tuition exchange agreements, the tuition is not a burden, but the differential cost of living is a challenge. We have managed so far with a combination of loans and grants, but need to continue to involve additional partners to make sure the approach can be sustainable in the long run. Another serious challenge to overcome has been the cultural differences between disciplines. In our program, we have botanists working closely with engineers, anthropologists, forestry professors, etc., and the cultures of the ways we do research and teach our students are very different – at least as challenging as understanding the cultural differences in the higher education communities in our two countries, which are certainly significant.

The biggest challenge to overcome on both sides has proven to be curricular constraints. One thing that unites professors across national boundaries is the deep underlying assumption that education for students is synonymous with the completion of a set of courses in which all the required materials are "covered". With our model's heavy emphasis on research, and with the very extensive time needed for language and other studies, it is extremely difficult to continue to fit in all the required courses for all the majors in the program, themselves extremely diverse, without unreasonably extending the duration of the undergraduate program. It is an ongoing challenge on both sides to determine what can be cut out, what among truly essential sets of knowledge and skills can be acquired and assessed through alternate routes, and what really has to remain as formal coursework requirements. And, of course, all this has to be negotiated within a complex set of institutional frameworks on both sides. Nevertheless, the progress in addressing these curricular constraints has a very large potential pay-off; if we can come to grips with some of these fundamental issues we can free up the energies of faculty and students for many other creative pursuits in the future.

5 NEW COLLABORATIONS ON DOCTORAL EDUCATION

The *UW Worldwide* program was originally designed as an effort to focus on the transformation of undergraduate education. As our work evolved, though, we became increasingly aware of the importance of including a focus on doctoral education in our collaborative efforts. On the one hand, graduate

students on all sides proved to be the important “glue” that held our multinational research teams together. On the other hand, the collaborative, integrated multinational research and educational communities we have created provide an extraordinarily powerful platform for graduate education. Together with the partner universities mentioned above, each of which is committed to further expansion of our project-based undergraduate collaborations, we have designed a new collaborative doctoral level program. We have maintained the five environmentally-related research themes of the UW-Sichuan program, but added additional partner universities and expanded the program to include an explicit focus on the transformation of graduate education. The partner universities in this new graduate effort include: Tohoku University (Japan), the University of Auckland (New Zealand), the Polytechnic of Namibia (Namibia), the University of KwaZulu-Natal (South Africa), Eduardo Mondlane University (Mozambique), Can Tho University (Vietnam), Sichuan University and Tsinghua University (both in China). We also work closely with Pacific Northwest National Laboratory (PNNL), our region's major governmental research lab. The UW has recently received a $3.36 million award from the US National Science Foundation’s IGERT (Integrated Graduate Education and Research Traineeships) program to launch this new multinational model for interdisciplinary graduate education and research.

Our educational program for the doctoral students incorporates: 1) participation in one or more of the 5 interdisciplinary environmental research clusters; 2) a year-long, project-based course on Coupled Human, Natural and Materials Systems, which brings together faculty and students from all of the 5 research themes, and which will be offered at multiple sites; 3) a required research internship at one of the partner institutions (6 - 12 months) under the supervision of a local co-advisor; 4) an internship working either at the K-12 or undergraduate level on a project related to international educational reform in science and engineering; 5) an on-going weekly IGERT seminar; 6) two "dissertation workshops"; and 7) activities focused on career awareness, ethics, and professional development, with a particular emphasis on the international dimensions of these issues. This program is particularly appropriate for students who are interested in combining rigorous scientific and technical training with extensive international experience . Because it builds on existing collaborations on the undergraduate level, we feel that our program will provide an outstanding professional development environment for the Ph.D. students at all of the participating institutions, especially for those students who are preparing themselves for future academic careers.

6 FUTURE DIRECTIONS FOR THE UW WORLDWIDE PROGRAM

We are currently pursuing several parallel directions with the UW Worldwide program. We are deeply committed to continuing to strengthen the collaboration with Sichuan, and to making it a sustainable one that has a significant role in building ties between our universities and regions. In addition, we are continuing to launch new pilot projects on the undergraduate level, with a number of new partner institutions and on new topical areas. Some support for expanding the basic approach comes from the NSF’s Distinguished Teaching Scholar Award. The second major direction we are pursuing is to greatly enhance our focus on internationalizing graduate education, through the IGERT program outlined above. Lastly, we will continue to work on mechanisms to more effectively involve the broader community, with the goal of making these challenging approaches to education sustainable in the long run.

7 CONCLUSIONS

We have initiated an ambitious set of projects with partner institutions around the world, projects that share the common distinguishing feature of integrating collaborative multinational research into undergraduate and graduate curricula. Though the results are promising to date, a great deal more information needs to be gathered to enable a scholarly assessment of the benefits and drawbacks of the approaches we have piloted. We are committed to scholarly assessment of the results of our work, and to reporting the insights we have gained to the broader educational community. We welcome questions from other universities or potential collaborators in the private sector that would be interested in joining us in some of these activities.

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