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Aller au sommaire du numéro

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Résumé de l'article

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Issues in Canadian Geoscience

Why Canada Needs REUs

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SUMMARY

Problems of earth science involve not only questions of physical science and engineering, but also of the social sciences and humanities. As a fourth-year geo-environmental engineering student, I am increasingly concerned that issues of philosophy and public policy are being neglected in earth science classrooms. Realizing that my scholastic career was narrowing, I sought an opportunity to alleviate this concern and expand my horizon. This summer I participated in just such an opportunity: the Global Climate Change and Society Program, a Research Experience for Undergraduates (REU) sponsored by the National Science Foundation and held in Boulder, Colorado. Throughout the program, students were encouraged to collaborate with peers from around the country, exposed to an outstanding roster of guest speakers, and inspired to reap practical knowledge in disciplines outside their area of specialization. Canadian undergraduates in Earth science would greatly benefit from participating in educational programs of a similar nature. Canada's closest analogue of the National Science Foundation, the Natural Sciences and Engineering Research Council, needs to expand its outreach programs and spearhead a campaign to develop Research Experiences for Undergraduates in Canada.

INTRODUCTION

This summer I journeyed to Boulder, Colorado to participate in Global Climate Change and Society (GCCS) – a Research Experience for Undergraduates (REU) sponsored by the National Science Foundation (NSF). GCCS is billed as a forum for students to collaborate in an attempt to analyze issues simultaneously from scientific, philosophical, and political angles, an interdisciplinary think-tank if you will, using global climate change as its case study. It was that and more: eight weeks of intense intellectual toil hurtled by like a locomotive. The passengers – twelve American students and one Canadian – emerged elated and exhausted from the ride. As I trekked northward at summer's end my thoughts converged on one notion: other students need to share similar experiences, but the opportunities in our country are few. Canada *needs* REUs.

AN UNUSUAL CIRCUMSTANCE

It should be emphasized that my participation in the GCCS program would never have happened without the generosity of others, diligence on my part, and sheer good fortune. American REUs are not publicized north of the border and do not include a funding component for international students. My discovery of the existence of GCCS took a most circuitous route and I am not surprised to hear that Canadian undergraduates (or faculty, for that matter) have never heard of the NSF's REU initiative.

I am grateful that Dr. Robert Frodeman, the program director, was willing to accept my application (as he could have easily rejected it on the spot) and welcome me as his student. Only later did I learn that Dr. Frodeman was eager to introduce an international perspective: he not only admitted me as a Canadian student; he hired Alison Shaw, a Canadian resident and PhD candidate at the University of British Columbia, as the program's coordinator and teaching assistant.

American students are granted stipends for their contribution to a research experience and, often, financial assistance with travel and accommodation is provided. The National Science Foundation welcomes REU proposals with an international dimension; however, foreign participants are ineligible for remuneration. Thus I had to seek out funding from an alternative source. Fortunately, Dr. Jean Hutchinson, my research supervisor at Queen's University, was eager to support me. If not for her commitment to excellence in engineering teaching and her interdisciplinary vision, I would not have been able to partake in my summer experience.

So it can be seen that my involvement in an American REU represents an extremely unusual circumstance – one that cannot be easily repeated by my peers. This is precisely the impetus for this article. Canadian undergraduates should be vying for enrollment in our own nation's well-publicized, equitably funded research experiences.

GLOBAL CLIMATE CHANGE AND SOCIETY

The Global Climate Change and Society program is the current incarnation of a Research Experience for Undergraduates directed by Dr. Robert Frodeman, a lover of interdisciplinarity and a man of

many talents (he holds a PhD in philosophy and a master's degree in geology). He is joined by co-directors Dr. Mark Bullock, a planetary physicist at Southwest Research Institute, and Roger Pielke Jr., the Director of the University of Colorado's Center for Science and Technology Policy Research. Frodeman previously orchestrated The Southwest Earth Studies Program, a REU that united five earth science students with five philosophy students to examine issues surrounding acid mine drainage in Colorado. GCCS followed a similar tack, this time bringing together thirteen students with a wider variety of academic histories. Though global climate change was the issue at hand, topics of discussion run the gamut, fueled by readings ranging from ancient philosophy to modern planetary science.

Global Climate Change and Society was, as I experienced it, composed of three parts: two formal and one informal. One of the formal sections was academic – a series of lectures delivered by the program's three directors, the program coordinator, and guest speakers. The other was applied – a unique internship, tailored to the talents of individual students or drawing on the skills and dynamics of a small group. The informal section raged on whenever formal activities were not in session – during group hikes, Frisbee games, and potluck dinners – as students eagerly and incessantly debated the issues of the day.

The three program directors each wove a thread into the GCCS tapestry, as we delved into issues of global climate change and explored the nature and pertinence of knowledge in the 21st century. Bullock bolstered our knowledge of atmospheric science, providing us with a firm background in order to understand and better assess scientists' interpretations of global climate change. Pielke presented us with ways to better frame policy issues while lending insight on the political process underscoring the global climate change debate, describing the roles of state and non-state actors. Frodeman stressed that global climate change, like any issue, is not for science alone to solve. He guided us through a whirlwind of philosophy, always emphasizing the importance of the oft-ignored humanities in problem solving.

The lecture series exposed me to a highly diverse group of inspiring guest speakers. Atmospheric scientists and philosophers, an environmental sociologist and an economist, a historian and a policy analyst – even the esteemed mayor of Boulder (who holds a PhD in physics) came to speak. What students may have ordinarily regarded as stale academic papers were lifted off the page as the authors themselves spoke to us, sharing their enthusiasm and peppering their speech with revealing tales of past experience. It was a delightful experience to meet a host of passionate scholars and learn experientially about their lives.

My internship was spent working at the Southwest Research Institute's Department of Space Studies. Guided by my mentor Dr. Clark Chapman, I researched the hazard presented by potential Earth impacts due to asteroids and comets. As a geo-environmental engineering student, I initially felt completely out of my element. However, I learned much by working in a field outside my own, meeting numerous bright and generous researchers who assisted me along the way. Most importantly, I relished the opportunity to learn from the wisdom and anecdotes of Dr. Chapman. Even though astronomy is not in my career plans, I gained valuable insight from immersing myself in a new discipline and experiencing, for the first time, research in motion.

The other students were equally satisfied, excitedly treating their internships as prisms through which to refract program themes concerning the nature and pertinence of knowledge. Project titles included:

- Understanding Energy in the American West
- Philosophical Critiques of Scientific Modeling
- Urban Garden Indicators for Community Health
- Integrating Scientific Information with Societal Needs: Citizen Involvement at Rocky Flats
- Carbon Sequestration Methods: the State of the Art
- Prediction and Yucca Mountain
- Ground-based Sampling of Pyrogenic Emissions from the Big Elk Fire, Estes Park
- A Quantification of Groundwater Seepage During Drought and Its Importance for Water Quality Modeling in the St. Vrain Watershed
- Global climate Change Mitigation Policy in Japan and the US: The Role of the State and Economic Structure

Interacting with students of a variety of disciplines broadened my knowledge base immensely. My intellect was stimulated in new and exciting ways as I became aware of and explored linkages between all modes of inquiry – geological engineering included. Where else could a geo-environmental engineering student, a math/philosophy student, a political science student and an environmental studies/english/women's studies student gather and discuss global issues? GCCS united students from across the continent, providing a forum for much needed conversation across the disciplines. The program demonstrated interdisciplinarity in action, something that begs to be mirrored in Canada.

MONEY MATTERS: NSERC VS. NSF

Dr. Frodeman's summer schemes, The Southwest Earth Studies Program and Global Climate Change and Society, may be considered outliers as far as conventional REUs are concerned. Descriptions of typical REUs in the Earth sciences include: "geologic mapping in the field with mentors from the state geologic surveys", "precision structural mapping using global positioning system, total stations and geographic information systems: the search for Norumbega shearing", and "integrated field and laboratory research on the geological evolution of the Southern Blue Ridge" (*http://www.nsf.gov/home/crssprgm/reu/reu98atm.htm*). The integration of public policy and the humanities to an institution established to foster science, mathematics, and engineering remains novel to say the least. But Frodeman's programs share more than his panache and an interdisciplinary mission – as with all REUs, they rely on NSF funding.

The Natural Sciences and Engineering Research Council of Canada (NSERC) plans to invest $678 million in 2002-2003 (*http://www.nserc.ca/fact_e.htm*). The NSF's budget for Fiscal Year 2002 was $4.796 billion and $5.036 billion is being requested for FY 2003 (*http://www.nsf.gov/home/budget/start.htm*) – nearly 7.5 times the amount to be spent on "university-based research and training in all the natural sciences and engineering" (*http://www.nserc.ca/fact_e.htm*) in Canada. Of course, Americans outnumber Canadians by more than nine times. A cursory examination of these facts by any Canadian yields apparently positive results: NSERC seems to dole out more dollars per capita on science and engineering than its border-mate, the NSF. However, the two bodies allocate their resources differently and, by creating and supporting REUs, the NSF does so more effectively in an important area. In fact, REUs and NSERC grants are incommensurable. Opportunities to collaborate with students from around the country, to be exposed to an outstanding roster of guest speakers, and to garner practical knowledge in a host of disciplines outside a student's area of specialization are not available in Canada. But this can change.

NSERC's mission is to "[invest] in people, discovery, and innovation to build a strong Canadian economy and to improve the quality of life of all Canadians" and to "[promote] excellence in intellectual creativity in both the generation and use of new knowledge". This is fulfilled by "awarding scholarships and research grants through peer-reviewed competition, and by building partnerships among universities, colleges, governments and the private sector" (*http://www.nserc.ca/about/inbrief.htm*). For NSERC to realize its goals, it needs to expand beyond individual grants and develop an instrument akin to the NSF's REU program. Today's Canadian undergraduate in the Earth sciences must be prepared to tackle complex problems requiring interdisciplinary solutions. To do this they need to acquire tools, such as sympathetic understanding of varying viewpoints, the ability to communicate with specialists and the public, and the skill of recognizing and synthesizing philosophical, political, and scientific facets of an issue. These tools can only be developed through dynamic collaboration with students in other disciplines from other geographic locales (Canadian or otherwise) and through creative instruction by passionate educators.

CONCLUSION

As we vault into the 21st century, problems in Earth science appear increasingly complex. We are developing awareness that social and environmental issues are multidimensional and globally pervasive; they cannot be addressed by disciplinarians with their heads in the sand. It is time to encourage opportunities for specialists to collaborate and converse with those outside their disciplines as well as with the public. We need to develop interdisciplinary mediators who can span knowledge gaps, establish new linkages between fields, and treat multifaceted issues with multifaceted approaches. Canada must become a global leader in Earth science education. Establishing programs at home that reflect the benefits of Research Experiences for Undergraduates can do this. Canada *needs* REUs.

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