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In the Wake of Darwin's Voyage: Improving International Science Study for Students of Biological and Environmental Sciences

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Introduction

V A L U E S, and problems of students interested in biological and environmental sciences have not changed much since Charles Darwin's day. At the very-undergraduate-sounding age of eighteen, Darwin had largely abandoned the career aspirations of his parents and thrown himself into the study of natural history. His primary mentor, Professor J. S. Henslow, watched Darwin develop the needed discipline to permit productive study and had helped him learn enough local species and fundamental principles of biology until Darwin was ready for his "semester abroad." When Darwin was twenty-two, both he and Henslow felt that the H.M.S. Beagle was the ideal study abroad program for the young naturalist. Planning for the trip, convincing parents both to give permission and financial assistance, and preparing field equipment were also necessary tasks sounding very familiar today.

Darwin's insight into questions of importance, his training, and fortunate timing all contributed to the result that his study abroad had the culture-changing impact that it did. Nevertheless, most of our students who study biological and environmental sciences in international settings share fundamentally the same benefits Darwin did as a result of their foreign study (see Table 1). Some similar benefits are reported by Carlson et al. (1990) in their chapter describing differences between students who study abroad and those who remain on their home campuses.

(TABLE 7. Benefits nscruing to students engaged in internationol study of biological nnd environment_/ seiences)

Content and process of subject discipline are put in larger perspective

Problems and solutions facing biologists are put in larger perspective

Greater compassion for fellow citizens of the Earth

Begin establishing international collaborations Encourage student enthusiasm

Hasten student maturity

Students who stay at their home campus may have completed more coursework in the major and related disciplines, but the benefits of international study more than amply compensate, in the long run, for the need to complete catchup coursework. The analogy of E. G. Large, reported in

his history of mycology (Large, 1940), is very appropriate to our efforts to improve undergraduate science education: "Those who commissioned investigations could never understand that the advance of knowledge was like the advance of an army, you could not reach a single objective without first occupying a good deal of adjacent territory."

In the haphazard survey conducted of 19 U.S. colleges and universities, only about 11 percent of the students studying abroad were science students, a small fraction of the science students at these institutions. If students, faculty, and parents are all agreed on the value of international science study, why do so few students go? The obvious answer is that there is not agreement on the value of international science education. Even where there is agreement, significant obstacles still must be overcome. Below, I review some of these obstacles, which in turn will suggest some solutions. I then review recent successes at St. Lawrence University followed by ideas and plans still to be implemented. This chapter closes with two more examples of the value of attempting to improve international science education opportunities for students of the biological and environmental sciences.

Problems Faced by All International Science Education Programs

1. *Lack of home-campss facglty support or understanding*

1. By far the most commonly reported problem reported by the eighteen schools surveyed for this paper was that of a lack of understanding and support of the home-campus faculty. A cynic might suggest that this lack of support is a reflection of selfish faculty and administrative interests. Clearly, if home-campus faculty do not occasionally accompany their students to teach the courses abroad, then sending more students abroad really means giving up faculty positions and capital to non-university or nondepartmental programs and people. This problem cannot be ignored during times of fiscal stress. The non-cynic would suggest that because so few faculty have study abroad experience themselves, it is not surprising that they do not appreciate the benefits given in Table 1. Our faculty need first to be reminded that the leading biological and environmental sciences journals have an international authorship. Western science is already an international activity. To not have our students and faculty study abroad is limiting their preparation and participation. I suggest that many more faculty be encouraged to spend their sabbaticals abroad and to take two week collaborative research visits abroad.

2. *General education and science requirements*

   Lack of faculty support often translates into restrictive academic policies. More than one of the survey schools suggested that students should be advised to complete their general education or distribution requirements abroad. Faculty should work to make that possible by arguing that, as far as general education courses are concerned, most real or imagined weaknesses of an academic program abroad are compensated for by the added perspective of studying in a different country. Would we prefer to see required courses in art history, geology, government, or English literature taken on our home campuses when similar courses could be taken in Australia or Austria with the concomitant learning required just to function and appreciate the international environs?

   Many graduate schools in biology and environmental sciences will admit students to master s or Ph.D. programs with three chemistry courses instead of four, or one

physics course instead of two. Our academic advisors need to be told that a semester in Russia or Ecuador may not retard student admission but instead may enhance it.

3. Major requirements and the constraints of hierarchical learning

   Biology and environmental sciences majors rarely go abroad during their first year of college. As a result, with proper academic advising the first year of coursework can be used to lay an appropriate academic foundation. If department faculty value an international perspective they need to work to remove unnecessary course prerequisites for their courses in biology and environmental sciences. Often a year of maturity as a student is as useful as only partially retained subject material of a required prerequisite course. Is it possible to honestly describe exactly what the prerequisite content and process are? Students desiring to go abroad could then have the option of summer study or independent study.

   Most educators in biology value the upward spiral of hierarchical learning. Students should be challenged to understand our educational objectives and then given great flexibility to meet those objectives by alternate means. As a professional ecologist, I will always be grateful that I was permitted to replace one usually required ecology course with independent text study, a research internship, journal club participation, extra courses in statistics, and extra work in an advanced ecology course.

   Several of the schools surveyed for this study recommended more involvement with established programs such as Organization for Tropical Studies and School for Field Studies. As we become more involved, we will have more influence over the course content and faculty selection associated with these programs. It should be mentioned here again that if more of our students attend these programs our schools will probably suffer financially unless additional students are admitted to our home institutions.

4. Transportation (for field cogrses)

   Most study abroad programs are located in large metropolitan areas. Securing adequate vehicles and drivers adds expense to already tight budgets. It requires an hour just to exit many larger cities reducing field-trip time. Program administrators need to reserve large blocks of time and modest amounts of program funds if we are to keep field trips as an integral part of some courses.

5. Student maturity level

   Perhaps one of the most daunting challenges faced by all programs is the group of personal behaviors that are accepted as the norm by many U.S. college students today. Many of our students regularly drink large quantities of alcohol. U.S. student culture condones drunkenness much more than most people in Europe and Asia. Promiscuous sex and late-night parties are also considered unseemly or disruptive by many non-U.S. host families and institutions. Illegal drug use is often prosecuted much more vigorously abroad than on our college campuses. Much more aggressive communication of program standards needs to be given to prospective students of our abroad programs as well as vigorous enforcement of these policies.

6. Language challenge (optional)

All non-English programs face similar challenges with respect to language preparation and assimilation. By and large, most non-English language programs abroad require at least two full years of college-level language preparation. This restricts participation of many first-year and second-year students. Furthermore, even after week-long intensive orientation sessions in the foreign country, most students still require language immersion of one to two months before they will be effective students in another language. Program schedules should reflect these realities, encouraging or providing a variety of activities in the foreign country before the formal classwork begins. Entering first-year students should be encouraged to continue foreign language training begun in high school or to start new language study. We must work to break the unspoken assumption that since English is the language of intemational study, only knowing English is sufficient. If we correctly note in the examples we use in the classroom of current research, we will help students to see that leading-edge research is conducted all over the globe.

7. Health concerns and expense I cannot add any new insight to these challenges which are common to all programs.

Problems Faced as a Result of Institutional Choices

Some problems faced by programs are a direct result of program choices. The most important choice is that of program ownership and control. Most U.S. universities do not take fiscal and academic responsibility for the programs that their students attend. If a student chooses to study in England, Australia, or France, the student is advised to select an institution offering appropriate course work. Several of the schools in the study group reported here take great pride in their advising system that attempts to match student interest with foreign program offerings. These universities point out the large course variety potentially available to the students. What is not mentioned is the difficulty that our students have in courses where often the academic culture is entirely different. For example, in some places it is expected that one-third of the students will fail-not just receive a mediocre grade, but fail. Knowing course prerequisites and academic standards at so many foreign universities is very difficult and requires efforts at our home campuses to establish and maintain an institutional memory. As is the case at our U.S. universities, many faculty tenured at foreign universities offer courses that look attractive in a catalog but are poorly taught. When our students are visitors in foreign programs we have very little influence on faculty selection or supervision. Schools who maintain fiscal and academic responsibility for their programs abroad do not have as many of the problems given above but instead have their own set of challenges.

When programs teach courses abroad just for their own schools or in combination with other members of smaller consortia, there are often much-reduced course offerings available for students of biological and environmental sciences. This is particularly true of science course offerings because of the historically small percentage of science students in programs abroad. Faculty who staff small programs abroad are often parttime instructors seeking to supplement their normal professorships. As a result, even though these faculty can be hired and supervised more easily, they are often overworked and little institutional loyalty develops. St. Lawrence University has attempted to improve this situation somewhat by having an annual two-day faculty retreat with all program faculty and administrators. Subjects covered include grading standards, understanding North American student culture, sharing faculty teaching successes, and so on. St. Lawrence has begun a modest program of bringing faculty from the foreign campuses to teach for a period of time at the home U.S. campus. Much more could be done in this regard. The faculty at an institution could truly become an international faculty.

Perhaps the most significant problem associated with maintaining ownership of international programs is the problem of limited space, and capital equipment. Biological and environmental sciences are usually laboratory centered, often involving limited use of live organisms. Securing permits to do field work and lab work can be very costly. Renting additional space for labs and secure space for storage for equipment is also daunting. I believe home campus administrators would find that in this case, a small investment can yield a large return. It has been my experience that foreign campuses are even more pressed for equipment than they are for space. As a result, if a program director can count on a very modest amount of reliable funds for purchasing equipment, arrangements for shared space and equipment are often possible. This has the result of forging ties that often involve more interaction with students, and sometimes faculty, from the host and visitor schools.

Students attending programs as visitors of other universities are forced to interact with their peers at those institutions more than they would if they have their own programs staffed by faculty hired to teach just them. However, not all students are able to be so gregarious, and coping with language and cultural differences may present enough challenge without the added pressure of having to break into already established foreign friendship circles. Once again, the problems become solutions, or solutions become problems depending on the initial choice to send students into small, North American-run programs abroad or to have North American students attend independent foreign universities.

It is amazing to me how little communication there is among U.S. universities concerning programs abroad. Word of mouth does not travel that quickly here in the United States. Each school seems intent on inventing the wheel de novo. Not only do we need more communication between our faculty and administrators here, but we need more groups like the one active in Spain, APUNE (the translated Spanish acronym corresponds to Association of North American University Programs in Spain). Member schools meet several times a year to help each other with legal, social, and academic issues.

It should be obvious that many of the challenges and suggestions given above are not specific just to foreign courses in biological and environmental sciences. At St. Lawrence University (SLU), any student may elect to study abroad, with the only real change in their comprehensive fee being that the student must provide round-trip airfare to the foreign program. Even with this ease of access, it is all too common for students to elect to stay in the comfortable environs of the home campus. To break this pattern the above challenges must be addressed. If more science faculty get involved, I believe changes can be made.

Recent Successes at St. Lawrence University

St. Lawrence University has attempted to improve science education in the biological and environmental sciences in both their own programs abroad and in selective use and strengthening of programs from other schools. Our programs in France and Spain were changed from year-long programs to include the option of semester-long programs. The benefits of increased curricular flexibility for all students are somewhat offset by additional expense to the programs as well as the result that those students who do not elect to stay the entire year do not progress as far in language skills and understanding of the culture. The programs at SLU all include orientation sessions on the home campus, extensive orientation sessions at the beginning of each new semester in the foreign country, student placement in individual homes with native families, five-week internships in organizations related to the student's interests (e.g., a hospital, a medical clinic, the city zoo, or a government recycling agency), and courses taught just for our students, by faculty we hire to work parttime for our programs. SLU also works to encourage course work prior to the semester abroad and follow-up course work upon

return as a means to integrate the study abroad experience. SLU faculty have worked to design research projects for students going to our program in Kenya. This involvement adds continuity not only for the students but for the faculty as well.

St. Lawrence University has worked to find a limited subset of nonSLU programs abroad that faculty advisors can recommend from year to year. If the number of programs is limited, then an institutional memory in faculty and students begins to accrue. This targeting of specific programs for limited groups of students seems to be a strength reported by several of the schools surveyed for this study. SLU has programs in Denmark and Costa Rica that are targeted especially for students in biological and environmental sciences. In our program in Costa Rica, our participation over a number of years has permitted us to change the course offerings and faculty, thereby improving the quality of science experiences for our students.

Goodwin and Nacht (1988) report that the University of Massachusetts in Amherst and the University of East Anglia (Norwich) have forged so many extensive links between their universities that students can cross-register with ease. Several benefits to science students are reported. We do not think twice about extensive academic partnerships such as the Bryn Mawr-Haverford-Swarthmore-University of Pennsylvania. Why are we so slow to form stronger multinational educational partnerships?

A Broader View of What We Could Be Attempting Despite the ease with which we can publicize programs and quantify program output, good programs are always staffed by good people. Even though a program may be in an attractive setting, have a formidable reputation, and have a history of solid curricular success, good programs turn mediocre or poor when staffed by mediocre or poor people. Our first priority should be to select, strengthen, and retain the best faculty. Courageous administrators at every level should survey their faculty for strengths and interests, challenge them to prepare proposals for involvement at their highest personal level, and then support them with discretionary funds as commitments are undertaken and completed.

One advantage that programs in Europe have in comparison with programs in Japan and Australia, is that of the time difference. Current teleconferencing technology makes it possible with a modest capital investment to have real-time interactive video classrooms. I do not mean movies or tapes of famous lecturers giving entertaining presentations that amount to not much more than very entertaining but slow books. Rather, using existing technology, students in Europe can schedule their evenings to attend one of our morning classes or afternoon labs, including the possibility of asking questions, taking notes, and participating in discussions with students here in North America. Transmission of only thirty frames per second ensures interactive video and audio. The three routes that provide such capability (satellite uplink/downlink, leased telephone lines, and the Internet) are all changing so rapidly that price and performance recommendations that I might offer now will be largely out of date by the time this volume is published. Teleconferencing classrooms will help solve some of the problems of curricular requirements and hierarchical learning. The biggest challenge will probably be that of having lab equipment and space on campuses abroad. I would expect that given the homogenization of Western science, if faculty and administrators do not shy away from the true costs of teaching laboratory science to undergraduates, a modest investment of capital and personal contact at foreign institutions will make global classrooms feasible.

One future initiative in biological and environmental sciences should be to add more and better courses utilizing the local environment of our programs abroad. Ecology and environmental sciences have a core of fundamental principles which could be taught with examples in areas near our programs in Kenya, Spain, Australia, and Denmark. Cell biology and physiology courses could be taught with examples more relevant to health concerns in France, England, or Japan.

Internships and research projects like those encouraged by Worcester Polytechnic Institute (Rubin, 1995) may be very important to energizing international science education. Goodwin and Nacht (1988) also report that coordinated internships between MIT and Japanese laboratories have been very successful.

Perhaps the most encouraging example reported by Goodwin and Nacht (1988) was that of the successes of the University of Illinois in convincing their students that to become well educated and competitive in a global economy required international training in the sciences. Once again internships seemed to be the key, but they also report that students did not shy away from proper language training when they understood the importance of the educational objective.

Because of the hegemony of Western science, we often fail to recognize that some of our best teaching of biological and environmental sciences can happen when we implement learning experiences and courses that attempt to understand these disciplines from the non-Western perspective. For example, if our students learn physiology and health career-related subjects from Chinese, Indian, or Kenyan scientists, will they learn entirely different ways of approaching the discipline? There are farmers who have successfully harvested crops from the same fields in Portuguese valleys for over two thousand years, without a loss in soil fertility. What can our ecology and environmental science students learn there that is difficult to learn in North America?

As someone who relishes hot showers I have often wondered if an ecologically sustainable future includes enough energy consumption to include hot water. On my first trip to Spain, I was surprised to find that even the poorest village homes had on-demand water heaters (small gasfired water heaters next to the kitchen sink or bathtub). Water is heated only as needed, and it is heated adjacent to where it will be used; no big storage tanks or long pipes from the basement to the second floor. The energy and water savings are modest but continuous and widespread. Perhaps more striking were the toilets.

Spanish toilets look similar to U.S. toilets from the outside but have a different internal bowl shape and plumbing. Very little water is stored in the bowl compared with the large pool of water found in North Armerican toilets. The strategy of Spanish toilets seems to be to store in the bowl the smallest amount of water possible necessary to facilitate immediate cleaning of the bowl after each use (with a toilet bowl brush stored in a holder next to the toilet). The American toilet strategy seems to be to store in the bowl the amount of water necessary to minimize the bowl's getting "dirty" for the maximum length of time, then clean the bowl when the bacteria have finally established a colony as a ring around the pool of water. Ecologically and energetically these are very different strategies. The cost to the local and global environment depends on the strategy. Furthermore, with toilets of the more affluent Spanish homes, the amount of water that enters the bowl when discharging wastes is variable, dependent, on how hard you push the lever or button. Almost all American toilets discharge the same amount of water on each flush, no matter if I push the lever hard or soft, no matter if I urinate or defecate. Water-use savings in Spain are continuous and widespread. As an instructor of ecology attempting to integrate useful examples in my courses wherever possible, I could not have predicted before I went to Spain that such superior, contrasting water and gas consumption strategies would be found in the most ordinary of places. Our students learn similar powerful lessons. We must work to provide them with the best opportunities we can in international science education because we may find that many of the solutions that will make life pleasant or even possible in the next century are found abroad.

My last example is one of encouragement. The American mass media, government, and educational establishment seem to have adopted the "sky is falling" attitude with respect to

solving the ecological and educational challenges facing us today. We are surrounded by doomsday predictions, mounting deficits, and data telling us that our resources are already stretched beyond the limit. Much of what we are told is true. We do have cause for concern and action. The tight budgets facing us as we work to improve international science education do make our work harder; however, we all need to drive across France. I drove from England through France at the beginning of the year directing our program in Spain. At the end of my year in Spain I slowly drove back through France to England. Spain is not blessed with a favorable ecology suited to agriculture. Spain has real problems, but France could feed all of Europe and have enough to spare. Ohio, Nebraska, and California could feed all of the United States and have plenty tO spare. Our problems are solvable. Ecologically and educationally we have an abundance to work with, if we will only apply ourselves.

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