

## **EDUCATING FUTURE STATISTICIANS: AWARENESS, DIVERSITY, SERVICE**

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*The groundwork for broadening a future statistician's choice of and potential contribution to a workplace can be laid at the postsecondary level. Many quantitatively inclined entering undergraduates are unaware of statistics as a career, but even those with some awareness of the profession are unaware of the wide variety of venues in which statisticians can contribute and the great need for statisticians in many different settings. Our approach to attracting students to the field of statistics involves three primary principles: (1) Create an awareness among students of statistics as a career option; (2) Expose students to the diversity of uses of statistics; (3) Engage students in efforts where they can make meaningful contributions; Three different programs that have met with initial success at the undergraduate level are described: (1) a Center for Interdisciplinary Research; (2) a Practicum; and (3) a Biostatistics Interim in Geneva.*

### **INTRODUCTION**

First year undergraduate students who possess promising quantitative skills often arrive at their advisors' office with the idea that their career options are limited to "becoming a secondary school math teacher" or "an actuary." Students without pedagogical tendencies or those not immediately excited about the prospect of actuarial work may never cross the threshold of the statistics classroom. As a consequence, the preconceptions of students often limit their options in a world with a dramatically changing workplace and pose a serious challenge to attracting students to a career in statistics.

It is not that student career expectations are not changing - they are. As reported by the Association of Graduate Recruiters (2005), students indicate that they no longer think in terms of a 'job for life,' they expect to have multiple careers. Their goals now include enhancing their employability while maintaining a balanced lifestyle that includes variety and "worthwhile" work. Creating an awareness among students at an introductory level that training in statistics can meet these goals and more not only fills the ranks of card-carrying statisticians, but it enhances the skills of the workforce as a whole.

By its very nature, the field of statistics cuts across disciplines. Statistics holds the promise of unlimited variety and flexibility in its application thus providing graduates with skills transferable to multiple careers and the possibility of a lifetime of intellectual diversity. Statisticians are strategically situated to become leaders in interdisciplinary research which a US National Academies report (2004) describes as, "one of the most productive and inspiring of human pursuits—one that provides a format for conversations and connections that lead to new knowledge. As a mode of discovery and education, it has delivered much already and promises more—a sustainable environment, healthier and more prosperous lives, new discoveries and technologies to inspire young minds, and a deeper understanding of our place in space and time." This document goes on to report that "Students, especially undergraduates, are strongly attracted to interdisciplinary courses, especially those of societal relevance" (NAS, 2004, <http://www.nationalacademies.org/cosepup>).

While there are many ways in which to educate students about career choices, the approaches we present are designed to enhance awareness of the field of statistics, its interdisciplinary nature and its potential for societal relevance.

### *General Approaches*

The groundwork for broadening future statisticians' potential contributions to a workplace begins at the postsecondary level. Many quantitatively inclined entering undergraduate students are unaware of statistics as a career, but even those with some awareness of the profession are unaware of the wide variety of venues in which statisticians can contribute and the great need for statisticians in many different settings. Our approach for attracting students to the field of statistics involves creating an awareness of the field early on, underscoring the

interdisciplinary nature of statistics, and instilling notions of purpose and meaningful contribution to society through statistics.

#### *Specific Examples*

We describe three specific approaches to increasing awareness of the field of statistics, generating interest by underscoring the interdisciplinary nature of statistics, and highlighting the potential for service in the field of statistics. While there are a number of ways in which these objectives can be accomplished in a classroom setting, we focus here on three approaches that are outside the realm of the classroom and that have met with initial success at the undergraduate level.

- *CIR*: The Center for Interdisciplinary Research partners statistics students and faculty with researchers on campus.
- *Practicum*: The MSCS Practicum is an intensive, one month course that matches mathematics and statistics students with local community organizations, businesses, and government agencies to solve real world problems.
- *Biostatistics Interim in Geneva*: Students learn about global needs for statisticians through coursework, on site visits to international organizations, and work on joint data analysis projects with international organizations staff.

#### THE CENTER FOR INTERDISCIPLINARY RESEARCH

Imagine being able to choose from a vast array of potential research problems such as modeling bluebird predation, assessing place conditioning under the influence of alcohol, exploring ways in which to create phylogenetic trees, investigating how people make moral and political judgments, and characterizing how speech patterns are evolving. Imagine that you not only get to find out how statistics plays a role in such diverse settings but as an undergraduate you are able to join a research team with an ornithologist, neuroscientist, geneticist, psychologist or linguist as a collaborator on a real research problem.

In the fall of 2004 such an opportunity become available for St. Olaf College students studying statistics with the establishment of the Center for Interdisciplinary Research (CIR). The CIR was created under the auspices of the National Science Foundation as part of a nationwide effort to enhance the mathematical sciences workforce in the US (NSF #0354308). The CIR now serves as a focal point of all interdisciplinary activity involving statistics on the St. Olaf campus. Its physical space creates an awareness of statistics among students and faculty from across the disciplines on campus. Its intellectual activities are so varied that it is difficult to imagine a discipline that could not field a CIR research team. Although there was some uncertainty at the outset of the need for such a program on campus, the overwhelming demand for its services confirms that the CIR is providing a necessary and valued service for the community.

#### *Preparation*

Students who have successfully completed an applied regression course and declare their intentions to pursue a statistics concentration are recruited to participate in the CIR. During the academic year, these Undergraduate Fellows in Statistics have an opportunity to attend a weekly seminar series to receive training in research and collaboration skills including literature searching, reference management, and oral and written communication. Practicing statisticians and graduate school faculty are invited to present during the series to expose students to the breadth of career options involving statistics. In addition to some direct enhancement of students' knowledge of careers in statistics, this weekly gathering of the CIR Statistics Fellows has created a camaraderie among the students involved which has, in turn, sparked the curiosity of younger, incoming students to find out more about the study of statistics.

Far from being passive recipients of information, the CIR students studying statistics learn first-hand through the CIR how to function in a collaborative, interdisciplinary setting. CIR Fellows' primary activity is participation in a long term collaborative research project as a member of a research team. To compile a set of potential projects, faculty statisticians attend division and department meetings to describe the CIR and solicit ideas for collaborations. An

amazing assortment of potential projects have been identified and as the word gets around more proposals come in. (See <http://www.stolaf.edu/academics/cir/CIRPotentialProjects2005-06.html>.) Recent proposals such as modeling Norwegian Immigration Patterns in the US and analyzing the stylistic differences in the translation of Norwegian literature attest to the endless possibilities for applying statistical methods. (St. Olaf College is an institution in the US with a Norwegian heritage.)

At the time a student applies to become a CIR Fellow, s/he selects the project(s) of interest to them. Projects are selected and research teams are formed based on student interest and faculty availability and expertise. The CIR program allows students to participate during the academic year for 0.5 credit per semester or full time during the summer. Teams meet weekly with their faculty mentors and students work together through the remainder of the week. At the end of a project, students present their work orally during the seminar series, write up reports or papers with collaborators and present posters with their results at the St. Olaf College Science Symposiums as well as at other venues locally and nationally.

The CIR Team Projects address all three of our goals. First, it makes faculty aware of the potential value of collaborating with statisticians in their work and both faculty and students across campus become more aware of the role of statistics in research. The dissemination of results locally at the Seminar Series and the Science Symposium are additional mechanisms for increasing student awareness of the field. Second, having a wide range of problems from a variety of disciplines helps to impress students, current and potential, of the broad utility and numerous settings in which statistics is useful. Third, the CIR Team projects are clearly providing a service to researchers on campus.

#### THE MATHEMATICS, STATISTICS, AND COMPUTER SCIENCE (MSCS) DEPARTMENT PRACTICUM

Students have the opportunity to provide community service on a larger scale through the Mathematics, Statistics, and Computer Science (MSCS) Department Practicum. Modeled on an offering at Harvey Mudd in the 1970s, the MSCS Practicum has been offered at St. Olaf College every January since 1980. In turn, it was the Practicum which provided the inspiration for the CIR research teams. The goal of the practicum, offered during our January interim session, is to give our students experience working in teams while addressing mathematical and statistical problems from the “real world.” At the end of the January term each group visits the workplace of the problem’s proposer in order to give an hour-long group presentation of their results. The groups also produce a written version of their work which is provided to the company or organization. This final presentation is the culmination of the course, giving the students a chance to communicate all they have learned while providing an excellent opportunity for public speaking.

Through the years, we have worked with many Minnesota businesses, government agencies and non-profit organizations. In the recent past we have worked with Rosemont Inc., the Mayo Clinic, Cargill, Pillsbury, Honeywell, CP/Soo Line Railroad, Control Data Corp., Northwest Airlines, and the Saint Paul Companies. We have also worked with smaller firms such as E.W. Blanch Reinsurance Brokers, Fairway Foods and government agencies like the Minnesota Department of Public Health and the Minnesota Pollution Control Agency.

Students taking the practicum are normally junior and senior mathematics majors, often with double majors in other areas such as physics, chemistry, or economics. Small groups of four or five students are formed, with each group working on a separate project. The work is done almost exclusively by the students. The role of the faculty is to mentor and advise; they do not work on the mathematics of the problems. This sense of student ownership of the project is a critical element of the practicum. It is also critical that the problem be unsolved and open to creative efforts.

Another aspect of problem selection for the Practicum is the value of collaboration for the client. The intense attention and effort these very bright and talented students can bring to bear on the problem is a luxury most companies and agencies cannot afford and therefore it represents a real gift to the client. This perspective encourages faculty to seek out and select Practicum problems that can provide a service. For example, often one of the three problems will be drawn

from the small town, Northfield, where the college is located. Projects for the Minnesota Department of Public Health and the Minnesota Pollution Control Agency also provided these understaffed agencies with much needed manpower for important, but lower priority problems.

A couple of years ago, at the request of an Assistant Commissioner of the Minnesota State Department of Human Services, a practicum group performed an analysis to investigate racial disparities in the child protection system. Students used logistic regression analyses and a survival analysis to investigate and compare the amount of time children spent in the system waiting for reunification with their caregivers. At the end of the month, the group of five students presented their findings to a meeting of approximately 40 State Welfare officials. Results from this work were included in testimony to the State Legislature on this issue and the report is published on the State of Minnesota's web site: [www.dhs.state.mn.us/CFS/programs/ChildProtection](http://www.dhs.state.mn.us/CFS/programs/ChildProtection). Following this presentation and the formal conclusion of the course, this group of students continued to meet on their own to produce a manuscript that was accepted for publication in the Child Welfare Journal.

The practicum is one of the experiences MSCS graduates praise most frequently. It provides one of their first connections of their mathematics and statistics training to the workplace. Lessons learned by students in the Practicum are translated to the workplace following graduation and employment. Alumni in the workplace are among those clients who request the chance to work with a St. Olaf Practicum group. Besides knowing that the caliber of the students and the quality of their work will be high and contribute to their own efforts, companies also assist in enhancing students' awareness of the possible application of statistical methods in the workplace.

#### BIostatISTICS INTERIM IN GENEVA

In addition to providing service to campus colleagues and service to local and state groups, one of the goals of the Biostatistics Interim in Geneva is to increase student awareness of the role of and great need for statisticians to provide service in the global arena. The Biostatistics Interim focuses on investigating issues in global public health from a quantitative, research-oriented perspective. Students study biostatistical methods in a seminar setting and visit international organizations with major roles in global public health such as the World Health Organization, Doctors Without Borders, the International Red Cross, and the UN Commission on Human Refugees. A visit to the International Cancer Research Center (IARC) in Lyon, France provides an international perspective of issues associated with cancer research. Students receive hands-on experience working on projects with researchers from the World Health Organization in Geneva, Switzerland, where they learn about the global burden of disease and how statisticians and epidemiologists can contribute to finding. A visit to Montpellier acquaints students with the kind of work statisticians do in a health care system that deals with unique international health problems such as those associated with French nationals going to and returning from assignments in Africa. Students also have the opportunity to tour the UN, the WHO facility, meet WHO researchers, and learn about the work of statisticians and epidemiologists there. Students who participated in this seminar in January of 2005 wrote an article describing some of their experiences and insights related to this trip that was accepted for publication in *Chance* magazine. This transition from using statistics to perform research with campus colleagues to using statistics to assist with international concerns is a natural one when one considers the familiarity of today's students with communities all over the globe either virtually or through travel. Linking the growing interest in global health with what statisticians can offer provides a powerful message for quantitatively adept students who are looking for ways in which to apply their skills to transform their world.

#### DISCUSSION

We have described three programs that seek to attract students to the field of statistics by increasing their awareness of careers in statistics, underscoring the diversity of areas of application and the flexibility of statistics training in career transitioning, and highlighting the potential for statistics as a form of community service. These efforts were inspired by and build upon the many years of dedication and hard work by the statistics educators to enhance the

quality and ubiquity of introductory statistics courses, to promote active problem-based approaches to learning statistics, and to involve statistics in the community service learning movement. Benefits of these programs include casting a wider net in search of future statisticians, motivating service-oriented students to enter the field, and increasing the general awareness of statistics as a vital science with wide ranging impact.

Challenges to the continuation and propagation of these efforts are not inconsequential. Successful implementation of these programs requires faculty and institutional support. Faculty support must include adequate resources for faculty development to help faculty members keep current and feel competent in the decidedly un-classroom like settings of these programs. Institutional support must encompass commitments to hire and support statisticians as well as recognizing that these types of programs are a valuable form of pedagogy and should be formally incorporated into the college administratively. Lastly, collaborators must be willing to take the risk of investing and partnering in these efforts. In our experience, collaborators may initially be hesitant to become involved, but the benefits are quickly realized as evidenced by the consistent demand for interdisciplinary collaborations on our campus and annual, repeated request by former clients of the Practicum. To accomplish this kind of success on an international level remains more challenging but also holds greater opportunity for contributions at many levels. Recognizing that collaborating institutions and agencies also provide a service by working with supervised students could eventually pay dividends in the long term by serving to help create a more responsive and competent workforce. We would like to see IASE and the ASA's newly created special interest group on volunteerism take a lead in these efforts.

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