Introduction

In May 2007, I was fortunate enough to attend the United States Conference on Teaching Statistics (USCOTS) as part of their *Use It!* group. Our group's charge for the next meeting in 2009 is to implement and discuss solid activities for classroom success. At USCOTS, most of the discussion was on the best classroom practices of teaching. Some attendees were discussing a second course in statistics. A very few sessions at the conference focused on student learning of statistical concepts. The relatively new field of statistics education was born out of mathematics education research and is currently working its way through the common statistics curriculum. Beginning with student concepts of the center of a data set, the research has provided students with "telling tasks" or authentic problems to solve. As students are solving the telling tasks, researchers are able to discern patterns in problem solving approaches which reveal underlying concepts and student beliefs.

This entire project is the result of a dinner conversation. I sat at a table with colleagues from across the nation as well as an international participant from Israel. We were discussing some of the telling tasks that address student concepts of center when I began to talk about Elon's first year core math requirement. With more than 20 sections of General Statistics being taught in any given semester, we were quickly identified as the perfect laboratory for research in learning statistics. Then we began to talk about our backgrounds. While most were trained statisticians and some were mathematicians drafted into the service of teaching statistics courses, I was one of the few with a degree in mathematics education. My colleagues commented that, with my background and access to students in statistics classes, I might be the best situated to begin a research agenda into student learning of distribution, sampling, and simulation which are the next logical steps in the progression of the curriculum. My doctoral research into visualization technologies also has me poised to investigate these topics as students use statistical software and graphs.

Nature and Goals

This project sets a research agenda for investigating statistics learning in the typical statistics classroom. My goal is to create a series of "telling tasks" or authentic problems for students to attempt in the areas of distribution, sampling, and simulation. I will implement these telling tasks and report patterns in the responses as they give us insight into the beliefs and knowledge of the underlying statistical concepts. These tasks are in and of themselves creative, but the true creativity and transformative nature of this project lies in the fact that

this research is being conducted by only a few institutions. We can quickly place ourselves at the forefront of current statistics education research.

Student Involvement

With more than half of Elon's mathematics majors choosing to be teachers at the secondary level, I receive student interest in carrying out mathematics education research almost every year. We urge our majors to assist us in teaching MTH 112: General Statistics to help them better understand the classroom and to learn some statistics outside their regular course of study. My plan is to be true to Elon's model of engaged learning as I gather a small group of sophomore and junior math majors (approximately 3-4) to help me investigate distribution, sampling, and simulation. We will hit the ground running in Fall 2008 as I bring them up to speed through a few key common readings. As we meet weekly, we will then begin creating and implementing the telling tasks for distribution. I hope to have them ready for conference attendance during the first year and presentation during the second year. I would also like to have them as coauthors on all publications.

Student Learning

Individual students from randomly chosen sections of MTH 112: General Statistics will be asked to complete the telling tasks in front of a video camera. Together with my group of math majors, we will review and analyze these recordings, code responses, and look for patterns in beliefs and knowledge of the underlying concepts. The primary artifacts will be the recording along with scratch work and recorded computer work. One of our goals will be accomplished simply by creating the telling tasks which can be used by statistics teachers at all levels. We will know we have done extremely well once we begin to determine patterns in the responses.

Students' learning will be enhanced on several fronts. By better understanding the learning of statistics, we hope to inform the mathematics faculty at Elon and thus improve student learning at home. We will also inform faculty on a national stage through our presentations and publications. Finally, the students involved in the undergraduate research will have gotten first-hand knowledge of the teaching/learning process by being a part of my work.

Implications for Personal Growth

I cannot express how deeply I am anticipating the chance to restart my education research. Recently, I have been very focused on experimenting with and reporting on best practices in the classroom. My research on

teaching has overshadowed my first love of investigating the learning process. I plan to take full advantage of this support to make a presence in a national arena through presentation and publication. Working with this program would allow me both the time and initiative to reassert myself as a scholar. In addition to the benefits of scholarly work, any information gleaned from research on learning automatically informs my teaching.

Implications for Statistics Education

The project's implications beyond Elon are what really excite me about this opportunity. As my dinner companions expressed, my background as a mathematics educator together with access to multiple sections of statistics in any given semester and the current emergence of research in statistics education represents the perfect confluence of ability, opportunity, and national interest. The products we create will serve teachers at all levels. The insight we gain into students' attitudes, beliefs, and knowledge will inform the entire discipline. Plus, the process of becoming a CATL scholar, assembling a team of undergraduate mathematics majors, conducting the research, and presenting on a national stage may serve as an appealing model to other institutions.

Timeline and Budget

Academic Year 2007 – 2008 (before CATL Scholar work begins) - I have already begun a large chunk of background reading into the current state of statistics education that will continue during spring and summer 2008. My preliminary reading focuses predominantly on the telling tasks that have been created for studying student concepts of center.

Fall 2008 – As part of the *Use It!* group, I will be implementing several classroom tasks deemed "best practices" by my colleagues. I will lead my student investigators through the background readings and get them involved in creating and implementing telling tasks for the concept of distribution.

Winter 2009 – Complete the work of the *Use It!* group and work with student group to write up preliminary findings on telling tasks in distribution for spring presentation at USCOTS.

Spring 2009 – (*2 Presentations at USCOTS*) Present as part of the *Use It!* group and present (alone or possibly with students) the preliminary telling tasks in distribution with a preview of the work to come as part of the CATL Scholars program. Continue creating and implementing new telling tasks with student group.

Summer 2009 – (*1 Publication*) Write up findings on distribution for a national journal such as the Journal of Statistical Research or the Journal of Statistical Computation and Simulation.

Fall 2009 – (*1 Presentation at JSM*) Present at national Joint Statistical Meetings (JSM) which is the largest gathering of statisticians held in North America held jointly by the American Statistical Association, the International Biometric Society, the Institute of Mathematical Statistics, and the Statistical Society of Canada. The conference is to be held in Washington, DC and I definitely want the students to be a part of this presentation focusing on the project and findings to this point. Back on campus, we will be continuing to implement telling tasks of sampling and simulation.

Winter 2010 – (*1 Presentation at Joint Math Meetings*) The 2010 Joint Math Meetings to be held in San Francisco, CA is held jointly by the Mathematics Association of America and the American Mathematical Society. This presentation will be focused for mathematicians who might be asked to teach introductory statistics.

Spring 2010 – (*1 Publication*) Write up findings from telling tasks in sampling for national journal. (*1 Presentation at NCTM*) Present at the National Council of Teachers of Mathematics (NCTM) meeting to be held in San Diego, CA. This presentation will be specifically designed for educators.

Spring 2011 (after CATL Scholar work completed) – (*Presentations at USCOTS*) Present findings from entire project at USCOTS, promote the CATL Scholar model, and investigate further research in statistics education.

The budget for both years will go to conference travel. We will be presenting at USCOTS (location unknown) in the first year and would like to attend the JSM and NCTM conferences as far as the budget allows. In the second year, we will be presenting in Washington, San Francisco, and San Diego. If we cannot get funds to supplement, I may have to choose only two of the three. Oddly enough, the mathematics conference in San Francisco is last on the list of priorities. I do not foresee any other expenses related to this research agenda and its dissemination. Hopefully the students will seek 499 credit for their work on the project and be able to use undergraduate research for their experiential learning requirement. My only concern is relying on volunteers from MTH 112 for the core research rather than offering some incentive like small gift cards which have

become quite popular. If we can find additional resources for student travel, I might be able to divert funds for this aspect of the research. I heartily request any insights the committee can offer in this matter.

Conclusion

When I have served on committees similar to the selection committee for CATL Scholars, I always tried to get the maximum benefit out of the available resources. While I have already been drafted as a member of the *Use It!* group to attend USCOTS in 2009, there is no way I can take up the rest of this full research agenda "as time allows" by resorting to departmental reassigned time. This high level of student engagement in research is going to take extended time and resources that only CATL can provide. I also find myself refreshingly available for the next two years; however this seems to be the only period of availability I will have for some time to come.

When I think of the confluence of factors and the specific timing of this research agenda, I hope you will agree that this is a wonderful and unique opportunity for me to work with students and help Elon move to the forefront of statistics education research. If events unfold as I have laid out in this proposal, there will be substantive benefit for students and faculty at Elon, at other institutions, and the entire field of statistics education.