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OFF-CAMPUS STATISTICAL EXPERIENCES FOR UNDERGRADUATES

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1. Introduction

Winona State University is a public liberal arts institution with approximately 7000 undergraduate students. Its roots are as a teacher training college and its strong ties to education continue to be important. The Statistics program is in the Department of Mathematics and Statistics. Officially, it is an option within the Mathematics major, but for ease of readability, for the remainder of this paper, the program will be referred to as the Statistics major. There are approximately 110 students with majors in the department, of which approximately 20 have chosen to pursue the Statistics major. About 2/3 of those choosing the Statistics major couple it with another major and/or a minor, although completion of a minor is not a requirement for the Statistics degree.

Students who decide to pursue a Statistics major must complete four quarters of calculus (5 credits each), a quarter of discrete mathematics, a quarter of introductory linear algebra, a course in foundations of mathematics, an introductory calculus based statistics course, a quarter of probability, two quarters of mathematical statistics, two quarters of applied statistics (analysis of variance and regression), a course in a computer programming language (usually Fortran) and a statistics project (for at least two hours of credit). All courses are four credit hours unless noted otherwise. The above listed courses account for 62 credit hours. In addition, the student must complete 20 hours of electives in Mathematics and/or Statistics. Most students choose a Practicum (Internship) experience as part of these 20 hours of electives. The Practicum experience used to be a required part of the major, but was dropped as a requirement three years ago to allow more flexibility in the major. The Statistics Projects and Practicum in Statistics experiences constitute the off-campus experiences that are the focus of this paper.

2. Overview of the Statistics Projects and Practicum experiences

The Statistics Projects experiences are offered on an individual or

small group basis. This allows the faculty to tailor the projects better to the individual students' needs and to the opportunities available at the time. These experiences are usually ones where the students work on a project under the close supervision of a faculty member at the same time they are taking other courses.

The Practicum experience, on the other hand, is usually an off-campus experience where the students' daily supervision is done by an appropriate person at the Practicum site. A faculty member, however, checks with the supervisor and student at regular intervals. It is often completed as a temporary full-time job during a quarter when the student is taking no other courses or over a summer. Whenever possible, the faculty try to get the students paid for the work that they do when completing the Statistics Projects and Practicum in Statistics credits. This is not, however, always possible.

Both experiences require that the student work at least 25 hours for each credit hour elected. The students may elect between two and eight hours of credits for the Statistics Projects and between four and eight credit hours for the Practicum in Statistics. It is expected that the student write (or help to write) a report detailing a study that the student worked on for either the Statistics Projects or Practicum credits. This report usually includes an introduction, a brief literature review (where relevant), a methods of data collection section, a description of the analyses used, some important results, and a discussion of suggestions for the future. The requirements of the report are tailored somewhat to fit the individual study. In addition, they write a very short paper, of one to three pages in length, briefly describing the other activities they were involved in while completing their Statistics Projects and Practicum credits.

3. Short descriptions of some statistics projects

Survey for the friends of the Winona Public Schools

In the late summer and fall of 1988, two students and one of the faculty members became involved in what turned out to be one of the best Statistics Projects from the viewpoint of community relations and local press recognition. The students and faculty member, together with the district Superintendent, Directory of Community Education, and several parents, developed a form for use in a telephone survey. This survey had several diverse purposes that made the task of designing an unbiased survey very difficult. The students also helped to administer the survey, along with a group of parent and teacher volunteers. The students then analyzed the data. Finally, a report was written and disseminated to the media,

school district, and other interested parties.

Water conditions in a backwater region of the Mississippi River

One of the students' mothers is very active in a group that helps the U. S. Fish and Wildlife Service collect data on water conditions at 18 sites in the backwaters of a certain area of the Mississippi River located near Winona. It turned out that a lot of data had been collected, but that no one in the Fish and Wildlife Service had the time to analyze the data properly. This student asked if she could analyze part of the data. The project appeared to be too big for one person, and so she worked together on it with another student. They prepared a report for the Fish and Wildlife Service detailing the results of their analyses.

Uses of the local lake

The local lake is a major attraction in town. It has slowly been transforming itself into a swamp. The local daily newspaper wanted to study the ways in which people use the lake and its surroundings and whether the public would pay the money needed to save the lake. They wanted to include the results of the study in a series of articles about the future of the lake. One of the Statistics majors helped the editors design a telephone survey instrument, determined how to get as unbiased a sample as possible of the users of the lake, and assisted in the data collection. At that point, the news editor left the newspaper. The study was dropped but the student was allowed to do some simple data analyses.

Use of "bike" paths around the local lake

At the beginning of the Spring of 1990, the chairperson of the Lake Winona Committee telephoned one of the faculty members. The Committee wanted to do an observational study of the ways in which the bike paths around the lake were being used. One of the first things that was done was to consult with the student who did the general telephone survey of the uses of the lake. He provided the two students who were to conduct this study with information about the use of the bike paths from his study. Based on his information and the expertise of a different faculty member, the students designed, carried out, and analyzed the data from this study. They wrote a report that was given to the Lake Winona Committee and then disseminated by that group to the various branches of the city government and to the local press.

Assisting quality control personnel

Four students worked on projects with quality control personnel from different companies. One student designed a series of interactive Minitab

macros that built upon and adapted the existing Minitab commands (including control charts and other graphics) to Lake Center Industries' (a supplier for the automotive industry) needs for a particular set-up. Another student worked on a designed experiment involving some composite materials for ICI Fiberite (a composite materials manufacturer). A third student worked as a member of a quality control team at Watlow Industries (an electronic heating control supplier) that needed help with statistical analyses connected with a shelf-life problem. The experiences that these three students gained by having the opportunity to work closely with a quality control professional inside a plant were extremely worthwhile. The fourth student was already working as a full-time production worker at emd Associates (an electronic parts supplier). That company has been one of the leaders in the area of quality control in the Winona area. The student was allowed to design and run a designed experiment on one of the company's processes.

Customer Survey

One student, who was a double major in Statistics and Computer Science, helped design and pilot a mailed questionnaire dealing with customer satisfaction with the service they had received from IBM Rochester for a certain system and its associated products. She then developed a data entry program, entered the data, analyzed the data, and prepared a report. This student was already working part-time at IBM Rochester.

4. Short descriptions of some practicum experiences

Mayo Clinic

Over the past seven years, 12 students (at least one each summer) have completed their Practicum experiences by working as Interns in the Section of Biostatistics at the Mayo Clinic. Ten of these were summer interns, while two worked for one or more quarters during the academic year. As interns at the Mayo Clinic, the students receive intensive training sessions on the use of SAS as adapted by the Mayo Clinic. They are then either assigned to a single study/project or as a general data analyst. The general data analysts work on a variety of projects that are given to them by various full-time employees. One of the section of Biostatistics' master's degree statisticians supervises their day to day work and a Winona State faculty member only needs to check on things a few times a quarter.

The studies and projects that Winona State students have been involved

in over the years are varied in terms of their fields of medicine. The students have been involved in all phases of studies from design through final analyses and report writing. The statistical techniques, both descriptive and inferential, that the students have used are as varied as the studies themselves.

Besides getting experience in real-world data analysis, the students are invited to attend the seminars and social events held by the Section of Biostatistics. The students also get the opportunity to work closely with students (both undergraduate and graduate) from several different universities. They also get the opportunity to talk to Master's degree and Ph.D. level statisticians about the graduate programs they attended.

Employee satisfaction surveys

Recently, a student, along with a faculty member, helped a group of employees from the Winona site of ICI Fiberite (a composite materials manufacturer) design an extensive survey of employee satisfaction. She then aided in the data collection, analyzed the data and together with this faculty member wrote a massive final report. The report they completed for the Winona ICI Fiberite operation was shown to several people at the Tempe, Arizona, site of ICI Fiberite. This faculty member along with this student and another student then completed the data analysis and final report for a very slightly modified version of the survey form from the Winona site that was used at the Tempe site. It also should be noted that two students, in two consecutive years, worked on similar surveys of employee satisfaction for another local corporation (emd Associates - an electronic parts manufacturer), but not as part of their Statistics Projects or Practicum credits.

Quality control practica

Three students chose to do their Practicum experiences as Quality Control interns at Watlow, Inc. (an electronic controls manufacturer). They assisted the Quality Control manager on a variety of projects. One student spent a major portion of her Practicum experience trying to figure out for which types of packages each of the various commercial delivery systems (e.g., Federal Express, U. S. Postal Service) was the most efficient in terms of delivery time and cost. The other two students were involved with various projects using a variety of Statistical Process Control (SPC) procedures, design of experiments, gauge reproducibility and repeatability studies, and capability analyses.

Another student worked for Lake Center Industries (an automotive industry supplier) a few hours a week over the course of an academic year helping to design and then analyze the data from a questionnaire

concerning people's opinions of electronic heating control systems in automobiles. Another student began work several months ago as a full-time employee in quality control at Ashley Furniture. When hired, it was the company's intention to continue to employ her after graduation, not just for the Practicum experience. Recently, two students have completed full-time internships in quality control at emd Associates. These last three students have applied the concepts learned in the statistical process control and industrial design of experiments courses to a variety of processes.

Attitudes toward homework survey

One non-traditional student, who felt that she needed a Practicum experience that did not have set hours, decided to help the Curriculum Committee of the Winona Public Schools carry out a survey of the attitudes of parents, students, and teachers toward homework. The student, with only minimal supervision from the Curriculum Director and a faculty member, designed the three surveys (one for parents, one for students, and one for teachers), designed the methods of data collection for each group, analyzed the data, and prepared a written report for the school district.

5. Lessons learned

1. Care must be exercised continually that the students are doing meaningful activities. For example, it is important that students get some experience on data coding and data entry, but having them do only data entry and data coding is not a meaningful experience.
2. One must be very careful that the students do NOT spend too much time on their projects and Practica. The students get so involved in their projects that they sometimes do not put the effort needed into their other courses and their work quality in other courses is adversely affected.
3. Although the students are not happy about it at the time, the requirement of having to complete a scholarly written report is important. It gives the students practice in technical writing and gives the employer/recipient and Winona State University an excellent record of what the student did. Several students have commented one or more years after graduation that having to do these written reports was very helpful to them in graduate school or employment.
4. Finding good projects for weak students is hard. Also, the weak

Students take more faculty time in terms of supervision than the stronger students. Finding off-campus Practica for these students has also been very hard. Allowing the students to find their own projects and Practicum sites helps. But, it is important that a faculty member still approve the projects and Practicum site.

5. It is important to have some form of written contract between the student and faculty member before the Statistics Project or Practicum is begun. The form used at Winona State is very simple. It has a projected date of completion, the number of credit hours being elected, and space for the student and faculty member to fill in responses to the following:

THE STUDENT AGREES TO:

THE FACULTY MEMBER AGREES TO:

METHOD OF EVALUATION:

Filling in such a form protects both the student and faculty member in case of a disagreement over the completion of the Project or Practicum.

6. Having two experiences, both a closely supervised one such as Statistics Projects, and a loosely supervised one, such as the Practicum, is the ideal. Every attempt should be made to have these experiences either build on one another or cover very different areas.

7. Although having two experiences is the ideal, having the Practicum in Statistics as optional rather than required has worked well. It allows the faculty the option of refusing to place weaker students in Practicum experiences and allows students pursuing a variety of goals to meet their goals in the way that is most meaningful to them.

8. Off-campus Projects and Practica are far superior to on-campus Projects and Practica for several reasons. First, they expose the students to the real-world work environment. The students also often form close working relationships with adults other than the Statistics faculty. It is our impression that the letters written by the off-campus contacts for these Projects and Practica are just as important, if not more important, to future employers and even to many graduate programs than those written by faculty members.

9. Supervising these Projects and Practica takes up a great deal of faculty time. It is time well spent. The faculty must be careful NOT to allow the Projects and Practica to take too much of their time and detract from their other activities.

10. The students should be free to choose which faculty member they want to supervise their Project or Practicum. Faculty members also should have the freedom, when necessary, to refuse to work with a student. There should, however, be a mechanism in place, either formal or informal, to make sure that every student can complete any Projects or Practicum credits required for the degree.

6. Acknowledgements

This paper is a shortened version, with some minor additions, of a paper of the same title presented at the 1992 Joint Statistical Meetings in Boston, MA and appearing in the *American Statistical Association 1992 Proceedings of the Statistical Education Section*. The author wishes to thank the students who have done Statistics Projects and Practica in Statistics over the last five years. Their wonderfully written reports were invaluable in the writing of this paper. All the projects and practica done by these students are not discussed in this paper. Apologies are given to the students whose projects and/or practica are not included. The choice of what to include was a difficult one. There were also some extremely valuable experiences done on-campus. Some of these experiences are described in the paper appearing in the *1992 Proceedings*.