Statistics instructors know that interesting, real-world problems are crucial to motivate student learning. As an extension of our efforts to build student interest and ownership in applications, we recently incorporated service learning into our statistics courses. Service learning provides an active-learning experience associated with a community service application. In this article we describe our experiences using service learning in our statistics courses. We give examples of projects used at the University of Minnesota–Morris, a public, liberal arts college.

KEY WORDS: Active learning; Service learning; Statistical education.

1. INTRODUCTION

In recent years many of us have incorporated more “active learning” experiences and content into our statistics courses. Service learning might initially be thought of as tutoring other students, or providing services for the elderly, but it is also a valuable, active-learning approach for statistical education. In this context we define service learning as community service that relates to student involvement and appreciation within a given course. That is, students are involved in statistical analyses that will benefit the community. Service learning is especially well suited to statistics courses because almost every type of group or organization has data that needs summarization and analysis. In this article we present some motivation for service learning as an educational approach, and give some examples of how we have used service learning in both introductory and advanced courses. We conclude by providing some comments and advice for those considering service learning in their courses.

2. MOTIVATION FOR SERVICE LEARNING

Using service learning in our courses evolved as a natural extension of the active-learning philosophy described by Cobb (1992) and Garfield (1995), and subsequently developed into books by Schaeffer, Gnanadesikan, Watkins, and Witmer (1996) and Rossman (1996). We were looking for longer term active learning applications. Service learning has successfully provided this dimension to our courses. In this section we briefly describe the benefits of this approach for the three most important groups in this process: students, faculty members, and community organizations.

The primary benefit of service learning for students is that they are analyzing real data in a local context. Because the project comes from a local source, student interest and ownership of the project is strong. This approach also provides consulting and statistical communication opportunities. Because students are motivated with an application, we believe they are more receptive to the methodological content of the course.

Many faculty members have three job components: research, teaching, and service (outreach). However, there is an increasing tendency for faculty members to be faced with higher expectations in all of these components. We believe that service learning provides a way to become more efficient and effective by combining efforts on these components. The effort on a service-learning project obviously contributes to our outreach component and, as we have mentioned, we believe it greatly benefits teaching. In addition, a service learning project may also provide research, consulting, and grant opportunities for faculty.

The community organization benefits from service learning by obtaining answers and information that would otherwise not be available due to financial or expertise difficulties. The organization can also benefit in the future from the establishment of this contact.

The website for the National Society for Experiential Education (www.nsee.org) is a helpful source of further information about service learning. We also recommend the periodicals NSEE Quarterly and The Michigan Journal of Community Service Learning.

3. IMPLEMENTATION ISSUES

The process began in 1995 with the preparation of the 10-year Comprehensive Plan for the City of Morris. As part of this plan, the city invited citizens to participate in focus groups on specific areas of town planning that interested them. These focus groups produced a report that reflected the desires and needs of the city. However, the City of Morris did not have the resources to obtain analysis of most of the issues important to citizens, such as demographics, the local economy, land use, housing, transportation systems, and many others. We decided that we could address some of the Comprehensive Plan issues in our courses. Our experience with the City of Morris led us to consider other community agencies that might benefit from our services. In subsequent courses we have been able to implement projects for the Morris Wetland Management District, the Morris Soil and Water Conservation District, and the University of Minnesota, Morris.

Our first attempts at incorporating service learning were supported by a grant from Minnesota Campus Compact. This grant was crucial to the early development of these
projects. It enabled us to hire an advanced undergraduate student to coordinate activities, contact agencies, organize data, and meet with faculty members. If grant funding is not available, we suggest using teaching assistants and/or students with strong community ties. In our experience it is not difficult to find such students. An individual faculty member could implement service learning through careful, advanced planning. Faculty members can also have groups of students initiate and develop contacts with community organizations. These students could be from any statistics course. For example, introductory students could be involved in this process to show them statistical applications in the community. The successive implementation of this approach will produce an information base of datasets and contacts that can be used in a variety of courses in the future. A model for our service learning process is given in Figure 1. This figure shows the participants and the interactions between them. It also summarizes the stages of the process leading to outcomes.

The process starts with identifying organizations in the community with limited resources that also need statistical help. Such organizations are often not aware of the need for statistics in their operations, or are unable to formulate a statistical question. In our experience, students, faculty, and other colleagues will often be aware of such needs in the community. The areas in Figure 1 called “Data & Information Transfer” and “Problem Formulation” represent these activities. The next stage of the process involves matching the organization’s statistical needs with the specific educational goals of the course. The area “Integration with the Course” in Figure 1 represents this stage. Implementing the project in a course follows this. The final stage of the process involves preparation of research reports and presentations to the organization. The right side of Figure 1 labeled “Outcomes” shows that the process is expected to produce student outcomes such as: increased interest and motivation, increased statistical content knowledge, consulting experience where the student uses statistical communication skills, increased awareness of community service and citizenship. The connection in Figure 1 between the “Research Reports & Presentations” and the organizations represents information transfer to the organization and the subsequent interactions that have been initiated.

4. PROJECT DESCRIPTIONS

In this section we will describe three service learning projects implemented over the past two years at the University of Minnesota, Morris. We are a four-year, public, liberal arts college located in a community of about 5,000 people in west-central Minnesota. The projects described in this section were implemented in advanced courses (second courses, only introductory statistics as prerequisite) on a 10-week quarter system. However, both authors have incorporated smaller parts of these projects into our introductory courses. The projects there are smaller in scope, but still provide many of the same benefits as the projects in the advanced courses.

4.1 Economic Data Analysis

Our Data Analysis course is a second course in statistics that focuses on regression and analysis of variance methods. The students tend to be advanced students in mathematics, economics, biology, and psychology. The students analyzed employment and unemployment trends using Stevens
County data from the Minnesota Department of Jobs and Training (Morris is the county seat). Students also analyzed food stamp and AFDC usage trends for Stevens County. Local industry conditions were analyzed using wage, employment, and number of establishments data from the Minnesota Department of Jobs and Training. The students in the course were able to use plots and simple statistical models to examine the behavior of Stevens County economic data over time. They were able to see seasonal employment fluctuations in certain industries, as well as evaluating trends in these data. The written student reports were presented to the City of Morris Planning and Zoning Commission for use in the Comprehensive Plan and in other planning activities. An oral presentation by the instructor was also given to the Planning and Zoning Commission to summarize the report and respond to questions from the commission.

4.2 UMM Student Admission Data

After experiencing beneficial results from the analysis of regional data in other courses, students in the Multivariate Statistical Analysis and Categorical Data Analysis courses analyzed data for a different community, our campus community. These courses are both second courses in statistics taken by students primarily in mathematics, economics, biology, and psychology. With the cooperation of university administrators we were able to obtain and analyze student admission and retention data from 1991 to the present. The students used logistic regression, classification and regression trees, and other multivariate methods to identify characteristics of incoming freshmen that are related to student retention three to four years later. The findings were presented to our administrators in oral and written forms. The students were excited to have an opportunity to use their talents to give assistance to their university. The students were also exposed to the problem of how to communicate their findings to an audience with less statistical training. They found that our administrators could easily understand the results of our classification tree analysis, but the logistic regression results were best understood by constructing example student profiles that showed the various predicted probabilities of students staying at UMM. The admissions office now uses this information to focus recruitment efforts.

<table>
<thead>
<tr>
<th>Period</th>
<th>Activity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary stage</td>
<td>1. Meet with city officials and community organizations.</td>
<td>This phase was completed by the project coordinator and professor.</td>
</tr>
<tr>
<td>Feb. 29 to Mar. 12, 1996</td>
<td>2. Attend focus groups to address issues and define problems.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Data collection and organization.</td>
<td></td>
</tr>
<tr>
<td>Course integration</td>
<td>1. Check the appropriateness of the research questions to the course objectives.</td>
<td>This phase was completed by the project coordinator and faculty.</td>
</tr>
<tr>
<td></td>
<td>3. Assign data sets to groups.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Prepare handouts and data disks.</td>
<td></td>
</tr>
<tr>
<td>Course implementation</td>
<td>1. Administer pre-service learning survey.</td>
<td>This phase was completed by students, faculty, the project coordinator, and community officials.</td>
</tr>
<tr>
<td>Mar. 25 to May 20, 1996</td>
<td>2. Carry out exploratory analysis of the data and formulate questions to the organization officials.</td>
<td></td>
</tr>
<tr>
<td>(Quarter began on March 25, 1996)</td>
<td>3. Meet with the organization and get information on data collection procedures, and observe the process in the field.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Carry out confirmatory analysis of the data (model selection, building, checking).</td>
<td></td>
</tr>
<tr>
<td>Report generation</td>
<td>1. Students, in conjunction with the faculty, report on their findings concerning community problems, data summarization and analysis, model building, and interpretation to the community organization.</td>
<td>This phase was completed by the students.</td>
</tr>
<tr>
<td>May 21 to May 31, 1996</td>
<td>2. During this period, the standard post-test evaluation forms from Campus Compact were used for assessment.</td>
<td>This phase was completed by the project coordinator, students, and faculty.</td>
</tr>
<tr>
<td>Post-service learning reflection period</td>
<td>3. Publication and presentation of the academic and community benefits of service learning.</td>
<td>This phase was completed by the project coordinator and faculty.</td>
</tr>
<tr>
<td>June 1 to June 6, 1996 (Quarter ended on June 6, 1996)</td>
<td>2. Publication and presentation of the academic and community benefits of service learning.</td>
<td>This phase was completed by the project coordinator and faculty.</td>
</tr>
<tr>
<td>Summer, 1996</td>
<td>3. Follow-up visit and presentation.</td>
<td></td>
</tr>
</tbody>
</table>
4.3 Migratory Bird Data

Our Design of Experiments course is another second course in statistics taken primarily by advanced juniors and seniors. In this course students worked with officials at the Morris Wetland Management District Office to help them understand the nongame migratory bird data they had collected over the past few years. This is one of many ongoing data collection projects in the district. The district office has access to a regional analysis team, but because the region is large, it may take years for the data to be analyzed, if at all. This situation proved to be ideal for implementing service learning. The district office officials wanted the data summarized, but also wanted to know if these data could help answer management questions. The data included year (1993–1995), waterfowl production area (12 areas), county (6 counties), habitat type (native prairie, woodland, farm grove/shelter belt), and number of birds from various species that were heard or seen. Within a waterfowl production area, data were collected at locations from an experimental design. Each waterfowl production area was either managed by periodic controlled burning (a treatment of interest), or not (control).

Wetland office officials Bernie Angus and Donna Rieckmann met with the students and explained their mission and gave a walking tour of their facilities. They also visited a data-collection site and the officials discussed how they collected the data. At this point in the course the students were able to ask very detailed questions about the data collection procedures because they had already been exposed to data collection issues in the design course and previous experience from their introductory statistics course. The students were immediately worried that the season, time of day, and observation duration within a day might not be consistent enough across sites. Through examining the data and data collection logs, Bernie was eventually able to convince them that this variation was adequately controlled in the data collection process.

The wetlands officials did not really know what kinds of questions could be addressed with these data, but during our meeting we agreed to pursue several data analysis goals: data summarization, analysis of trends in species diversity, and determining factors that could explain the changes in the diversity of bird species in different locations. The response variable in this study was a species diversity index. The students found many things in their examination of the data. They were especially happy to find and correct some data recording errors. The students concluded that there was evidence for species diversity trends and for effects of controlled burning. Both of these findings had strong implications for management decisions, and they also prompted experimental design discussions for studying the impact of agricultural practices and controlled burning in the future. These results were presented to the Morris Wetland Management District Office at a meeting. In this process, students learned ways to handle the challenge of communicating results of complicated statistical methods to an audience. A detailed chart of activities is given in Table 1.

5. CONCLUSION

We give an enthusiastic recommendation for others to try this approach. Service learning can be applied to a variety of “communities,” and we anticipate new and exciting ways to mix community service and student education in courses. For example, we hope to integrate projects involving local social service agencies and possibly local industries into our other courses. This would represent community service in an even broader sense.

We have identified several benefits of this approach:
1. The students are analyzing real data.
2. Service learning provides an active-learning environment that stimulates inquiry-based learning. Students formulate questions and learn how to solve them.
3. The students are able to experience the role of statistician as a valuable member of a research team. This is especially valuable at smaller institutions that do not have many statistical consulting experiences for students.
4. The students are given an opportunity to realize that the statistical skills learned in the classroom are truly valuable in the “real world.”
5. The projects provide a rich source of examples for classroom instruction.
6. The students and faculty have a potentially rewarding experience that serves the community.
7. The service learning projects can give positive public exposure for the college or university and for statistics in our community.
8. The projects encourage future partnerships and collaboration with groups outside the university.

Some drawbacks of service learning are:
1. It can be time consuming if it is not carefully planned and organized. Faculty must supervise and integrate service learning into the course, and early on it took us more time than we anticipated.
2. Service learning is often not a neatly packaged part of the course in the initial implementation. Timing of projects may not be convenient. Community organizations have needs and deadlines that may not fit neatly into an academic calendar. Faculty members may need to adjust the course if difficulties emerge. Faculty personalities are important, the more adaptable the better.
3. It can be a challenge to match the data analysis needs of a project with the learning objectives of the course. There is often a strong temptation to force a project to fit a given course, but it is best to resist this temptation and use a project with a natural fit to the course. This can be accomplished by using service learning in many courses to increase the likelihood of finding an appropriate project-course match. We integrated service learning projects over all of the higher level statistics courses, offered by two instructors, for an entire academic year on the quarter system. Most of the project-course matching was done early in the academic year. Many projects did not match our course objectives for the upcoming academic year. These projects were either postponed or not implemented. If service learning is used over a period of time, an information base of
datasets and contacts will make this project-course matching challenge gradually easier.

In conclusion, we believe that the benefits of service learning far outweigh the drawbacks, and we encourage others to consider this approach to improve statistical education at their institutions.

[Received May 1997. Revised September 1998.]

REFERENCES


