FACILITATING STUDENT ENGAGEMENT IN THE INTRODUCTORY BUSINESS STATISTICS COURSE

Charles F. Harrington, University of Southern Indiana, cfharrin@usi.edu
Timothy J. Schibik, University of Southern Indiana, tschibik@usi.edu

INTRODUCTION

The intellectual and practical engagement of students in the undergraduate business statistics curriculum posses significant challenges to faculty regardless of institutional or student body characteristics. Students often claim to find the initial experience with statistical analysis uninteresting, inapplicable, and uninspiring. The faculty-at-large whether from research universities, comprehensive colleges, or private institutions report frustration in integrating activities designed to invigorate and energize student engagement in first year statistics.

Historically, statistics curricula have favored theory over application and cursory attention over practice and competency. However, student expectation, the demand of workplace statistical competencies, and accreditation body criteria have shifted the curricular focus to the interpretation and meaning of statistics rather than on the rote memorization of abstract mathematical concepts. Providing students with opportunities to develop their skills and abilities as consumers as well as practitioners of statistics and statistical analysis is paramount if students are to be sufficiently equipped for the world of work. These understandings are significantly more important for those students taking advanced coursework in statistics or preparing for graduate level study.

The aim of this paper is to provide suggestions to create a collaborative teaching environment where active learning is the primary method used to teach statistics. Further understanding of student learning styles, the intellectual and social contributions afforded through service learning, the integration of technology into the delivery of the curriculum, and the benefit of writing-intensive assignments can each contributed significantly to improving student engagement in statistics.

HOW STUDENTS LEARN AND ITS IMPACT ON THE TEACHING OF STATISTICS

In his 1991 treatise, Teaching Statistics: More Data, Less Lecturing, George Cobb of Mount Holyoke College, commented "*lectures don't work nearly as well as many of us would like to think*". This rather discouraging assertion follows from two clusters of research results - the first shows what makes learning hard and lecturing often ineffective, the second shows what does seem to work when lecturing doesn't.

Basic statistical concepts are hard and misconceptions persistent.

Ideas of probability and statistics are very difficult for students to learn and conflict with many of their own beliefs and intuitions about chance and data. Students correct erroneous beliefs reluctantly-only when their old ideas don't work. Learning is enhanced when students are force to confront their misconceptions, a process for which lectures are not generally effective.

Learning is constructive.

To absorb the full impact of these three words, you have to push their implied metaphor to its limits; concepts are constructions, learning is building. Common sense principles of carpentry, applied to the process of teaching and learning, lead to the same conclusions as those derived from research on how students learn: to teach students to build, spend less time lecturing and spend more time on site, where you can focus your comments on the work students are actually doing. Taken together, the two sets of results lead to a third and final recommendation.

Foster active learning

As a rule, statistics faculty should rely much less on lecturing, much more on the
following alternatives:

i. Projects, either group or individual

"Real learning takes place when students buy into the course. This is best accomplished by having students design simple experiments and collect their own data." (Jack Schuenemeyer, University of Delaware)

ii. Lab exercises

"Statistics should be taught as a laboratory science, along the lines of physics and chemistry rather than traditional mathematics. Students must get their hands dirty with data." (Dick Scheaffer, University of Florida)

iii. Group problem solving and discussion

"I do not lecture at all. Instead, students are required to read the textbook guided by a handbook containing study questions and sample problems. Each day we first discuss the study questions, often arguing about issues. Students then work in small groups on activities, usually analyzing a set of data and discussing questions about these data sets." (Joan Garfield)

iv. Written and oral presentations

"Students come to us with primarily an intuitive understanding of the world.

It is part of our job to ferret out those intuitive processes and correct the incorrect ones. As far as I know, this can only happen by having students discuss and write about their understandings and interpretations of problems" (Dick Scheaffer)

v. Demonstrations based on class-generated data

"Even within the traditional lecture setting, it is possible to get students more actively involved." (Howard Taylor of the University of Delaware)

What does all this mean for the teaching of statistics? How can faculty enhance student learning and revitalize the undergraduate statistics curriculum by facilitating student engagement in the learning process? We offer a number of recommendations for statistics instructors:

CLASSROOM USE OF STATISTICS SOFTWARE

For several years statistics faculty have been moving away from a lecture-based course by refining active learning strategies (as defined in Bonwell & Eison, 1991). Many active learning strategies models are best met through courses which infuse statistical analysis software into the statistics curriculum. A brief examination of the available introductory statistics texts reveals a large number of text book authors and publishers combining software programs such as Excel, SPSS, and SAS into their lecture materials. As more faculty migrate their course materials to the Internet through products such as Blackboard and WebCT, statistical applications software will play an increasingly central role in the students first statistics experience.

Advanced statistical software such as SPSS allows for assignments to be introduced which require students to discover statistical principles independently. Students examine their data to estimate the means, medians, modes, and standard deviations, and they students explore the concepts of central tendency and variation by creating frequency distributions of five ratio variables using data sets provided by SPSS. Students describe the statistics' meanings and decide whether or not their results support their original estimates.

Introducing students to statistical analysis software in the introductory statistics course not only encourages student-student interactions, but also allows students to development technological competencies that can be utilized throughout the remainder of their academic tenure at their college or university, but also readily applied in their first professional field employment.

Internet - based resources

In record numbers, business faculty are migrating their introductory statistics courses to the Internet. Some courses are solely Internet-based while others, mostly the majority, are hybrid courses, combining Internet and traditional classroom lecture and laboratory work. A substantial literature is developing which posits that student intellectual and academic engagement are enhanced significantly when traditional classroom lecturing is supplemented with one or more Internet-based course components.

Course management software products such as Blackboard provide tremendous flexibility in providing students with additional course materials, providing ready access to data, solutions to homework programs, links to statistics resources and data repositories, as well as opportunities for students to engage in peer-to-peer interaction through discussion boards and chat rooms. These course management tools facilitate student learning and engagement outside of the classroom. Perhaps most importantly, providing students with access to data and information asynchronously, students can modify the course materials to match their own particular learning style.

Recent advancements in statistical graphics, particularly graphical user interface technology, provide

students with additional tools to enhance their learning. The for students to see first-hand the issues inherent in variability, sampling, and probability can significantly increase both their comprehension and retention of these and other topics.

ACTIVE LEARING STRATIGES

The introductory statistics course is the ideal academic environment in which to capitalize on active learning strategies to facilitate student engagement and enhance student learning outcomes. In the statistics course, students spend a significant portion of class time completing inductive reasoning assignments. For example, concepts such as correlation and regression can be introduced to students through realistic scatterplots created prior to class using SPSS data sets. These graphs demonstrate positive, negative, and zero correlations. By examining the graph, students describe the relationships between pairs of variables. Students are then asked how and why the graphs are different. Students write their answers and then present them to the class. This assignment allows an introduction to predictor and criterion variables, scatterplots, types of associations, Pearson correlation, and regression. Following an in-depth presentation of these statistical concepts, students then use other data sets to predict additional linear relationships. Other active learning strategies used included course periods devoted to answering open-ended student-generated questions (e.g., Why is the power of a statistical test important? When do you use the ANOVA instead of the t-test?). Instructors should avoid the tendency to immediately respond to student questions. Instead, attempt to have other students answer the question or to provide questions that guide students to the correct answer. Initially students tend to be frustrated when they do not automatically get a response. They find the questions difficult and some believe that the faculty are not teaching because they are not giving them the solution. However, over the course of the semester, students begin to enjoy the challenge of collaboratively finding the answers.

Writing Intensive Assignments

Homework and class assignments, as well as exams, should require written interpretation of data. Some of these writing assignments should require students to interpret the meaning of generated statistical data. For example, students should be asked to describe opinions regarding stock market fluctuation by presenting a variety of frequency and crosstab distributions. Other questions might ask students to explore the veracity of a hypothesis by performing the appropriate statistical operations. Students should always provide written interpretations of the data. Simply calculating the correct answer ought not be sufficient to achieve a passing grade.

Another effective writing assignment is called the "one page press release" (Beins, 1993). Periodically students should read a peer-reviewed and refereed journal article. To maximize the effectiveness of this particular exercise, the article must include statistical analyses currently being taught in the class. Students summarize the article into a one-page press release using no statistical terminology. The assignment helps to develop students' reading, writing, and critical thinking skills, as well as their understanding of professional literature.

Another form of writing assignment consists of a learning assessment journal (Qualters & Dolinsky, 1995). The journal assignment asks students to monitor their own learning processes. About every two weeks, students are assigned a general topic on which to write. Topics include their feelings toward statistics, experience with computers, strategies to solve problems, and studying strategies. The journal entries typically range in length from 100 to 250 words. The entries are to be evaluative and demonstrate perceptions of learning in the course. Faculty read and then comment on the student entries. The purpose of the journal is to allow students to develop self-knowledge of their learning, not only in the statistics course but other courses as well. From a learning outcomes perspective, the journal is also helpful in monitoring student mastery of topics. It allows faculty to advise students on effective learning strategies and to act as a motivator for students who admit to having frustrations and difficulties.

Case Study Methods

Case study method has long been held as an effective tool for increasing student engagement in statistics. The practice of bringing realistic applications and cases into statistics education is growing in general. Improved statistical computer packages and the dilation of Internet-based access to data sets have expanded significantly the opportunity for statistical applications to business problems, particularly those germane to economics. Reports from a number of authors confirm the importance of active student involvement in the learning process. Students regularly report that the case projects require considerable effort but are a key component in the contribution to their learning.

Case studies are particularly well-suited for the business majors because they are interested primarily in the study of business (economic) problems and not mathematical statistics. Students are presented with situations that require statistical and economic analysis to solve a realistic problem. In the cases, students must first apply economic and business analysis to identify key issues and formulate the analysis. Written and oral reports (addressed to policy makers) are particularly powerful teaching and learning strategies when used with the case study.

Service learning experiences

Service-learning programs provide educational experiences through which students learn and develop statistical analysis competencies through active participation in thoughtfully organized service experiences that meet actual community needs and that are coordinated in collaboration with their colleges and community. These activities are integrated into the students' academic curriculum and provide structured time for a student to think, talk, and write about what the student did and saw during the actual service activity. They also provide students with opportunities to use newly-acquired statistics skills and knowledge in real-life situations in business and industry and enhance what is taught by extending student learning beyond the classroom and into the business environment.

Projects such as the American Association for Higher Education's Service Learning in the Disciplines provide examples of service learning activities in eleven different academic disciplines including Economics. Service learning projects require significant thought and preparation in order to be effective.

Team-based projects

Rarely in business and industry are projects done in isolation. When incorporated into the curriculum, team-based approaches to problem solving and project development serve two fundamental and important roles; engaging students more fully into the subject matter by making the projects interesting and applicable, and preparing them for the joint accountability and collaboration that will be hallmarks of their early professional experiences. Team-based projects can be related to service learning, but more general – team-based projects can be related to case studies, and include written and oral presentations.

Supplemental Instruction

The goal of Supplemental Instruction (SI) is to help students learn how to succeed. Working with faculty in traditionally difficult classes, such as introductory statistics, SI seeks to help students learn to solve problems, organize classroom materials, develop effective study strategies, and meet their own and faculty's expectations. It offers content-based discussion sections attached to large entry-level courses. The discussion sections are offered in two ways: some are optional and announced the first week of classes. Others are integrated into the course as a required discussion section. SI discussions are led by undergraduate teaching assistants and are designed to reinforce the content of the course and at the same time offer course-specific study, problem-solving and test-preparation strategies. Research has shown SI to be effective in helping students be more successful in the course. Gains from between 0.5 and 1.0 grade point have been documented when SI students are compared to non-SI students.

Guest speakers and 'statisticians in residence'

Quite often business programs have "Executive in Residence" programs. However, rarely do these individuals address or demonstrate the quantitative competencies required in their respective professions. Programs that are sincere in their efforts to reform their undergraduate statistics curriculum and desire to impart to students an understanding of the importance, role, and scope of statistical analysis should consider opportunities to bring to campus professional who have demonstrated high levels of competency and proficiency in statistical analysis.

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