USING BUSINESS-STYLE CASES IN AN INTRODUCTORY STATISTICS COURSE

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Most institutions of higher learning in the United States offer introductory statistics courses in a variety of flavors. Integration of the subject-specific concepts with the basic applied statistical techniques should be the primary goal of these flavored courses. Solely lecture-based traditional instruction method is not suitable to satisfying this objective. We argue for the incorporation of business-style cases into the introductory statistics curriculum using Constructivist learning theory and the notion of the "liberal arts" education. A typical business case setup is presented and its compatibility with an introductory statistics course is assessed. Finally, a sample business-style case for the application of the simple linear regression is provided.

INTRODUCTION

Most institutions of higher learning in the United States that provide liberal arts education to their undergraduates offer introductory statistics courses in a variety of flavors. The most popular choices include, but are not limited to, psychology, political science, economics, and business (finance). Unfortunately, little data is available to evaluate how these courses differ in their approaches to instruction and whether the students have a chance to apply their newly acquired statistical knowledge to the unique problems arising in their chosen fields of study. Integration of the subject-specific concepts with the basic applied statistical techniques should be a primary goal of these flavored courses, and a solely lecture-based traditional instruction method is not best suitable to satisfy this objective. The arguments for incorporating business-style cases in a traditional lecture-based introductory statistics course are presented, then a typical business-case setup and example case are described and compatibility with a basic statistics course evaluated.

BENEFITS OF USING CASES

The inclusion of cases into the introductory statistics curriculum is usually met with reluctance by instructors, who are uncertain whether theory can be effectively conveyed through cases and whether there are tangible benefits from the inclusion. Instructors are also discouraged by the time and resources required to update the traditional lecture-based lesson plans (Parr and Smith, 1998). Parr and Smith focus on an implementation of a solely case-based intermediary or advanced statistics course. We present arguments for the inclusion of cases as supplements in an introductory course. To argue for the added benefits of incorporating cases in any introductory statistics course, we rely on the Constructivist learning theory. Constructivists believe that students understand the material only after they have constructed their own meaning for what they are learning because they approach the class material with significant prior knowledge; hence any introductory instruction is done most effectively through a hands-on approach (Garfield and Ahlgren, 1988). As a consequence, students with a mismatch between their own *a priori* cognitive framework and that of an instructor will have difficulties learning in an exclusively lecture-based course (Kennedy, 1998). Also, since cases require non-traditional problem-solving and self-discovery, students might retain theoretical concepts longer (Parr and Smith, 1998).

Another line of reasoning lends support for the inclusion of cases in an introductory statistics course taught at a liberal arts institution. Since liberal arts education is modeled to supply the students with general knowledge and intellectual skills, rather than specialized occupational or professional skills, cases would allow instructors to illustrate broad concepts instead of just conveying technical content in lectures (Moore, 1998). Cases also require a complete presentation and interpretation of results in the context of the data either through a thorough written report or an oral presentation; hence they meet the number one requirement of teaching the reasoning of statistical inference (Rossman and Chance, 1999; Sharpe *et al*., 2001). A promising paradigm for statistical problem solving in line with the "liberal arts" notion was

proposed by Stuart (1995) and should adhere to the following sequence: problem formulation, statistical design, data collection, data analysis, and interpretation. The last step may raise questions about the assumptions in the problem formulation stage, hence students might redefine the problem and choose supplementary data or different (and sometimes new) statistical techniques to tackle the problem presented in the case. Cases point to real world experiences as the sources for statistical theory, instead of relying on teaching the mathematical abstraction of statistical concepts that takes them out of their original applied setting, transforms them and then attempts to reapply the results (Chatfield, 1988). While few studies have been conducted to assess the benefits of adding business-style cases to introductory statistics courses, Smith (1998) reports that examination scores improved when projects were included as a part of curriculum, not just lectures; McCarthy and Anderson observe that students who engaged in collaborative applied projects did better on subsequent standard evaluations than their traditionally instructed peers (2000). Moreover, students who consider themselves active or visual learners are more likely to prefer non-traditional method of instruction than their counterparts, where "non-traditional" encompasses discussion, group activity and Internet aided classes (Johnson, 2005).

RELEVANCE OF BUSINESS-STYLE CASE STRUCTURE

It can be argued that the history of case-based teaching dates back to Socrates, who is renowned for his didactical method of inquiry. Case-based learning was employed in law schools as early as the late nineteenth century; it also became a staple of business school instruction in the early twentieth century (Merseth, 1991). Cases can be tailored to suit various objectives: "tools" cases are very structured and aim to make students familiar with a single application, "decision" cases combine a few applications together and require students to choose the most appropriate one, and finally "open-end" cases are extremely unstructured and students are expected to supply the relevant questions and possible solutions. Most contemporary business cases are built using the following general guidelines (Nunnally and Evans, 2001):

- A case should present a narrative about an event that has (supposedly) happened. The narrative should contain both relevant and irrelevant information so that students develop the ability to differentiate between the two.
- Case objectives should be stated clearly in the form of questions and/or tasks.
- There should be a research component in every case.
- The case should require the utilization of concepts learnt in class.
- Familiarity with the subject matter and/or data used is desired.
- The cases should integrate skills learnt in other (non-statistics) courses.

Introductory statistics students can benefit greatly from using cases structured in the aforementioned way. Many statistics instructors complain that even the most accomplished undergraduate statistics students cannot do more than mechanically apply standard statistical procedures (Kennedy, 1998). Instead of providing a few numbers and a question to be answered (for example, find a 95% confidence interval), cases present students with an opportunity to articulate the effects of their statistical inference on real world phenomena. Moreover, rarely do homework exercises in textbooks provide irrelevant data, leading students to believe that statistical problems in practice are always clearly defined and the method(s) to be applied obvious. The research component is also often lacking in a basic statistics course: computer assignments given by instructors usually come with ready-to-use data and a set of meticulous instructions outlining every step. Data collection is an essential part of the practice of statistics (Moore and McCabe, 2002), hence students would benefit greatly if they were given incomplete data that they would have to augment. A very general outline of the methods that are applicable to the data in a case should be favored over an overtly specific one; this enables students to understand that there are multiple approaches to a particular problem type. Likewise, cases allow students in subject-specific sections to appreciate the impact of statistical inference on decision making in their respective fields, transforming statistics from an abstract math-type course into a valuable tool. If cases are used, students experience the dynamics of working in a small group, which benefit the learning process and build relationships among students (Jones, 1991).

SAMPLE CASE

The following "decision" case has been written by the authors adhering to the general guidelines for a contemporary business-style case presented in Section III.

Sandra O'Connor will be starting her freshman year at American University, Washington, DC, in the Fall of 2006. Recently, she has read in the U.S. News and World Report magazine that tuition increases at the private universities have been rampant. Her family employs you as their personal financial planner; hence, Ms. O'Connor has come to you for help understanding which variables contribute to the rise in tuition costs. She has suggested you find the time series data for the variables in Table 1. Your client expects you to pick a single variable that predicts the changes in the tuition increases the "best" and would to receive a 3-5 page written report that includes both qualitative and quantitative analyses that guided your choice.

Table 1: Variables suggested as likely predictors by Ms. O'Connor

Variable
Annual % Increase in National Rents
Annual % Increase in Higher Education Costs (dependent variable)
Annual % Increase in Consumer Price Index
Annual Unemployment Level in % of Active Labor Force
Annual % Increase in Crude Oil Price Per Barrel
Annual % Increase in Violent Crimes in the State of Illinois

This "decision" case contains a narrative informing the students about Ms. O'Connor's concerns about the rising education costs. There is a piece of irrelevant information incorporated into the case: the annual increase in violent crimes in Illinois can hardly be considered a contributing factor. The case objective is clearly stated: a student should recommend the "best" predictor of increases in education costs. Note that the case does not provide the actual data; students should be encouraged to become active collectors of data. There are also no method(s) explicitly listed that could be applied to solving the case: such a setup provides an instructor with a chance to ask students to think in class about the various ways the problem could be tackled (i.e. scatterplots, correlation or regression). While the case does not contain a description of the grading policy, it does state that a 3-5 page written report is required. The written component in an introductory statistics course if often lacking, even though its usefulness has been suggested by numerous authors (Beins, 1993). Moreover, the case states that the client expects a presentation; hence, instructors could assign students into groups of 3 to 4, and ask one of the groups to present their findings in front of their peers. Not only do the presenting group members have an opportunity to develop their public speaking skills, but also the students in the audience are more likely to be critical of the presented material. If the solution to the case is presented by the instructor, students are not likely to voice any differing opinions or suggest alternative solutions.

CONCLUSION

We assert that a basic statistics course that mixes theoretical lectures with applied business-style cases would better aid the learning process of students in flavored introductory statistics courses. Through the integration of subject-specific topics, cases would allow students to approach statistical theory from a more personal reference point and to recognize statistical applications as flexible and immediately useful. A secondary goal for many instructors of basic statistics courses intended for non-majors is to convert talented students to majors or minors in statistics and adding cases to the curriculum would make the subject more appealing. We also hypothesize that such a hands-on approach would produce longer retention rates of statistical concepts. Further study is needed to assess the current state of introductory statistics education, which has increasingly been offered as a course meeting a general mathematics requirement, as well as to quantify the effectiveness of non-traditional methods of instruction, with the measure of interest being the long-term retention of statistical concepts rather than the exam scores.

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