The Transition from Electronic Quizzes to Electronic Cases a Work in Progress

Rybolt, William
Babson College, Mathematics and Science Division
231 Forest Street
Babson Park, MA 02457-0310, USA
rybolt@babson.edu

Case studies are widely used in business schools in the United States. A typical business case describes a situation faced by a company, often disguised, which requires sorting through information, extracting the important elements, analyzing that information and making a recommendation about what the company should do. Generally there is no one correct answer.

It is not uncommon for statistics textbooks to also contain cases. For example, Basic Business Statistics Concepts and Applications by Berenson (2006) has what they call a Running Case Managing the Springville Herald. In chapter 10 on Two-Sample Tests, they ask the students to "Analyze the data in Table Sh10.1 and write a report to the marketing department that indicates your findings." There are also casebooks that contain multiple cases and are often designed to supplement conventional textbooks. For example, Casebook for Statistics and Data Analysis by Chartterjee (1997)

At Babson College, we are currently developing and using short randomized electronic quizzes in several sections of our introduction to applied probability and statistics course. Each quiz presents a typical statistical problem with small set of randomly generated data which the students are asked to analyze and enter their results on a web form. Here is an example of an electronic quiz with ten parts.

> An employee of Consolidated Industries has been instructed to authorize payment for a shipment of peaches if he finds evidence with 99 % confidence that the average weight of the peaches in the shipment is greater than 170 grams. A random sample of 5 peaches is selected from the truck load of peaches. The weights are normally distributed with a known standard deviation of 17 grams. The mean weight of the 5 peaches in the sample is 183.76 grams.
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> 1) Formulate the null hypothesis Ho
> 2) Formulate the alternative hypothesis Ha
> 3) Identify the rejection region and determine the critical value of Xbar
> 4) Find the observed value of Xbar
> 5) Determine the critical value of Z
> 6) Determine the observed value of Z
> 7) Determine the probability, p, that we will get a value as extreme as the test statistic, assuming that Ho is true
> 8) The significance level, alpha, is
> 9) The correct conclusion concerning Ho is
> 10) The correct conclusion concerning authorization is that the shipment

This type of quiz provides a great deal of structure which guides the students through the steps in answering the question. Each time a student takes the quiz they are given different information but the same structure. Some instructors believe that the electronic quizzes provide too much structure. Currently the structure is necessary in order to generate questions that can be automatically graded by the computer.

An electronic case differs in the following aspects. It asks a simple question, possibly embedded in related but unneeded information. It provides almost no structure, and each time a new case is generated the solution may require a very different approach. A significant percentage of time, the data contains invalid entrees and requires cleaning. The need to clean data is a major problem in real life that is almost never given adequate attention in textbooks. Sometimes the data violates the assumptions required for the type of

analysis that the students have learned and no solution are possible.

After analyzing a case, students summarize their work and write a brief report which is collected on a web form. Currently we are uncertain how to have the computer grade an unstructured solution. The program needs to generate a sample solution as it generated the case. Thus the instructor has a guide to assist in grading each student solution. As we become more proficient in generating the cases, we hope to enable the computer to play a greater role in assisting the instructor in grading unstructured solutions.

Let illustrate these ideas with a fanciful trivial example. A group called the Alliance for Enhancing the Quality of Student Life has presented the administration Acme College with a demand that students with high SAT scores be given special guidance. AEQSL claims that those students are getting less sleep than other students and need help. They have presented the dean with a data set that they claim supports their position. Their data set consists of two columns of data. Column one contains the SAT math scores and column two contains the amount of sleep that students are reporting they get each night. Your job is to analyze the data and make a recommendation to the dean.

If we do a simple correlation calculation for real data from students at Babson College, we get

Pearson correlation of SATmath and Sleep = 0.205 with a P-Value = 0.230

meaning that there is no relationship, and the claims of AEQSL are bogus.

When a data set is generated for an electronic case, we might have the following changes.

Each random variable could be either quantitative or categorical. If reasonable values are generated, the students would need to use either a two sample t-test, a chi-square test, or a correlation analysis to determine if there was a relationship before they could report their results. Of course the vocabulary would change in each situation.

If the data set contains inappropriate values, then the students would get invalid results if they did not first examine the data set and use common sense. For example if one row of data were altered we could get

Pearson correlation of SATmath and Sleep = 0.973 with P-Value = 0.000

meaning that there is a very strong relationship and the claims of AEQSL need to given serious attention. The difference between the two data sets is that the pair of values of 750 and 4.5 was changed to 7500 and 45. These values of course are not valid, and the students should realize this before taking the analysis seriously.

There are many other bogus data situations that can be generated for electronic cases. For example if we have categorical data we could generate a data set which would yield the table shown below.

	High SATmath	Low SATmath
Above Average Sleep	47	1
Below Average Sleep	1	47

A naïve chi-square analysis would yield Chi-Sq = 88.167, DF = 1, P-Value = 0.000, but common sense would say that something is not correct and the analysis should not be taken seriously.

There are many other examples that we could give but let us summarize the key idea. We believe that generating an artificial but relevant data set in conjunction with simple electronic cases provides a number of advantages. Students are required to clean data, check fundamental assumptions, and decide on the appropriate statistical approach for solving a problem given a certain type of data set. They can be given a multitude of similar cases to analyze and reach a different conclusion each time. Students benefit from needing to think about all aspects of their work. Instructors benefit from having summary solutions to each generated case as a convenient aid in checking student work. We hope to demo a working prototype at the ISI conference in August.

REFERENCES

Berenson, M., Levine D., and Krehbiel T. (2006), *Basic Business Statistics: Concepts and Applications*. Tenth Edition, Upper Saddle River, NJ: Prentice Hall

Chartterjee, S., Handcock, M., and Simonoff, J. (1997), *A Casebook for a First Course in Statistics and Data Analysis*, New York, New York: John Wiley & Sons, Inc.

ABSTRACT

We have been using electronic quizzes in our introduction to applied probability and statistics for several years at Babson College, a small business oriented college. Because such quizzes use randomly generated data, we encourage the students to take each quiz several times to help in the mastery of the material. The students are also encouraged to help each other with the concepts behind the quiz. Each quiz has slightly different answers, thus each student must work their own quiz. This inhibits passive reading of the quiz and casual copying of answers which give the illusion of understanding.

The use of cases is a very common way of teaching in business schools. Because cases have always emphasized real data, this presents a dilemma when constructing an electronic case. We believe that students can benefit from being able to work the same case multiple times with different results. When a conventional case is reused, students are tempted to search for solutions from the past.

Our solution to this problem is to use realistic data that is artificially generated, but consistent with the spirit of the case. In a typical case one goes through a series of steps to solve the problem. When generating artificial data, each step is an opportunity to generate a data set which requires a different approach to solve the problem. Examples include data sets that require cleaning, data sets that are categorical instead of numerical, and data sets that violate fundamental assumptions such as normality. A more subtle approach is make only changes to the data to alter the final result in such a manner as to require a different conclusion. This paper describes our basic approach to designing and implementing such electronic cases, and gives a simple example.