2006-1123: INTEGRATION OF BUSINESS APPLICATIONS AND FUNDAMENTAL SKILLS IN AN UNDERGRADUATE BUSINESS STATISTICS COURSE

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Integrating Business Applications and Teaching of Fundamental Statistics Skills in an Undergraduate Business Statistics Course

Research Problem

Motivating college of business (COB) students to enjoy learning statistics has been a major challenge for decades in many American colleges and universities. It is a widely held belief that if students enjoy what they are being taught they will strive to "own" or personalize the material and learning of it will be enhanced. Moreover the students will be less likely to forget key concepts that have been learned to the point of being "owned" by the individual [1, 6]. Unfortunately, the challenge of getting students to enjoy learning statistics has been made more difficult with the need to teach the subject in large, multiple sections. This need has been driven by budgetary and staffing constraints. The consequences of teaching statistics in large multiple sections have been a lack of enthusiasm among the students, poor class attendance, and the inability of students to transfer key concepts to other courses in the curriculum.

In recognition of the challenges facing teachers of statistics researchers have focused on creating new instructional materials to address the statistical needs of College of Business (COB) students. At the same time, educational innovators have been emphasizing how critical it is for the COB students to be exposed to business applications when learning to master the core material. Textbook writers have been reasonably successful in addressing either of these requirements; i.e., to prepare the students on statistics fundamentals or to expose them to business applications. However, instructional materials that integrate both requirements are not readily available. We worked with the Laboratory for Innovative Technology and Engineering Education (LITEE), Auburn University, that has developed award-winning instructional materials for use in engineering classrooms to adapt the instructional materials for use in business classrooms. The purpose of this paper is to report on the instructional materials that integrated methods to teach fundamental statistics skills with the introduction to business applications. We also tested these instructional materials in classrooms during summer 2005 and the results of the test are reported. The ultimate goal of this project is to develop innovative and well-tested instructional materials that help teach statistics to students in the colleges of business and engineering.

Literature Review

Contemporary business practice has undergone a drastic change in this information age where the business processes, accounting systems, and services are information technology-driven. Students are increasingly expected to use statistical tools in order to analyze data, interpret information, and make decisions in their career.

Future innovations are expected to increasingly exploit synergies between statistical tools and business disciplines[8]. The need to use statistical tools to creatively improve undergraduate education is further stressed by the Carnegie Foundation for the Advancement of Teaching[2, 3].

How has the education establishment reacted to the need for educating business students on statistical tools? The National Science Board states that the shortage of technically skilled workers is very high[4, 5]. These observations show that the education establishment is not doing

an adequate job of educating the business students on statistical tools. We derive the goals and educational objectives of the current project based on a literature review in table 1 shown below.

Project Goals (What will we do?)	**Educational Objectives (What will students achieve?)**
Develop course materials that introduce business students the complexity of real-world problems and how companies are working in the information age	*The students will be expected to:* *- learn how companies use Excel spreadsheets to analyze funding priorities among alternate projects* *- learn how companies incorporate statistical tools and methodologies to communicate their decisions; start using the software to a limited extent.* *- work on teams thereby enhancing their team building, interaction, and interdisciplinary skills.*
Develop course materials to improve higher-level cognitive-based problem solving of the students.	*The students will be expected to:* *- identify criteria to solve problems in unstructured situations* *- analyze alternatives given multiple criteria* *- differentiate between alternatives* *- evaluate alternatives* *- synthesize relevant materials into defensible solutions to problems* *- present a solution persuasively* *- be actively involved in learning situations*

Table 1: Educational Objectives to Achieve Project Goals

Selection of Instructional Materials

One of the investigators in this project is a seasoned statistics instructor. He identified the case studies that have been developed by the Laboratory for Innovative Technology and Engineering Education (LITEE) as appropriate for use in the business classes. After going through the case studies offered by LITEE (www.auburn.edu/research/litee), he identified the "Superstar Specialties" case study as a possible material for adaptation in his classroom. A brief overview of this case study is presented next.

Sanjeev Kumar, CEO of Superstar Specialties, Inc., was faced with the decision to allocate resources among the 15 proposed R&D projects slated to start in August 2005. The board had allocated him $4.91 million to spend on R&D for the next budget year. As the CEO of a $400 million company with five business units (energy, food, construction, personal care, and transportation units), Sanjeev had to decide among the different R&D projects. He contacted Earl Wagener of The Chemquest Group, Inc. a consulting firm that specializes in using Business/Project Analysis tools to help companies choose among multiple R&D projects. Earl had worked in many chemical industries during the past 30 years and been a Vice President for R&D at a large chemical company. As a Director of the Chemquest group, he was available to work with Superstar Specialties, Inc.

The board of Superstar Specialties had agreed that they needed to grow the company's gross profit by 25% aggregate over the next three years. Sanjeev called for a five-day retreat session hosted by Dr. Wagener where he and his top management (Marketing, R&D, Sales, Finance, five units, and Manufacturing) would participate. The objective of this retreat was to come up with a prioritized list of R&D projects that would be funded by the company. He wanted to ensure that the final choices were arrived at after careful analysis, were the appropriate ones for the company to achieve its profit objectives, and acceptable to most of the top management team. At the end of day two of the retreat, Sanjeev and his team came up with a list of critical success factors and their respective weights (Table 2).

With the allocation of funds to some of the projects in energy, food, personal care, transportation, and construction, Sanjeev, had to decide which projects to fund that will give him a high probability of making his profit goals. Also, he had to decide if any or all of the segments are achieving their profit goals of the Chemquest Group and how to categorize these segments into "grow", "maintain" or "harvest" categories. He had to choose five high rated projects from fifteen projects or one project in each segment, to keep his company growing (Figure 1). He contacted Dr. Wagener who was a pioneer in the field of prioritizing R & D projects from earlier records and current research. The objective of this retreat was to come up with a prioritized list of R&D projects that would be funded by the company. He wanted to ensure that the final choices were arrived at after careful analysis, were the appropriate ones for the company to achieve its profit objectives, and acceptable to most of the top management team.

	Critical success factor	**Weight**
1	% Profit Growth ($ to $) 2002 – 2004	20%
2	Value to Customer (End User)	15%
3	Competitive Advantage	10%
4	% Profit last full year	10%
5	Technical / Commercial Feasibility	10%
6	Total sales last full year	10%
7	Market Attractiveness	10%
8	Total Profit last full year	5%
9	Current Development Costs	5%
10	Strategic Fit	5%
	TOTALS	**100%**

Table 2: Critical success factors with Weights specified

The original "Superstar Specialties" case was designed for showing engineering students the importance of selection process among multiple R&D projects[7]. Analysis tools were designed and incorporated in an Excel spreadsheet for use by the students.

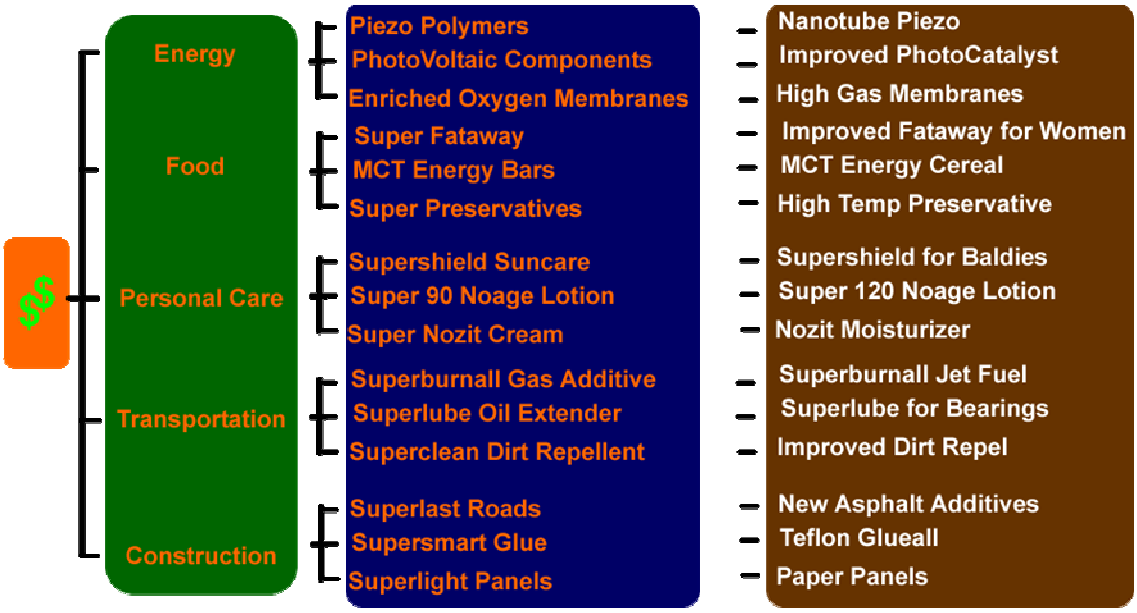

Figure 1: Overview of Superstar Specialties Inc.

Adaptation of the Case Study for Use in Statistics Class

We had to make changes to the case so that it could be used in a business classroom for use by sophomore level students. This involved the following steps. First, students were asked to focus on just one of the five business units and in particular analyze only one product to find out whether it was a good candidate for growing the company's gross profits. The Personal Care business unit was chosen since it was felt that the products were easily understandable to non-engineering students. The possibility of selecting the Super 120 Noage Lotion for funding was considered. Next, the case was shortened for use in the class and the following scenario was created.

Ms. Baldwin met with each of her assistants to layout plans for the data analysis and resulting report that she would then present to the CEO in the next retreat session, to be held in 5 weeks. As instructed, each assistant must prepare a thorough report of the analysis of Super Noage 90 and Super Noage 120. To be specific, the assistants must conduct a thorough comparison of Super Noage 90 and Super Noage 120 lotions on the basis of the following critical success factors:

- *Value to Customer*
- *Market Attractiveness*
- *Profit Growth*
  - *For profit growth, each assistant will need to examine several factors affecting profit, such as the use of rebates, difference in price versus competitors' prices, production costs, advertising costs, and similar factors to be determined.*
- *Other Factors Requested*
  - *These may be additional factors that Ms. Baldwin determines are necessary for her report to the CEO.*

Ms. Baldwin indicated that she would be gathering any data to support the remaining critical success factors of the company and will insert those into the final report before her presentation to the CEO.

In addition to the analysis of the two lotions, each assistant will also need to collect and analyze preliminary data for the cellular phone service project. Each will be primarily responsible for looking at the importance of various features and calling plans, the frequency of cell phone use for their potential customers, and other data necessary to make initial recommendations to the CEO. The report will be due to Ms. Baldwin no later than the final day of class in its completed form. Ms. Baldwin will give additional details regarding the report and the required data analysis in the coming days. However, the report should be a comprehensive accumulation of analysis completed over the next 4 to 5 weeks.

Statistical data for this product was developed so that many of the statistical concepts could be explained when the students analyzed these data. An excerpt from the data provided is shown below.

> *This is survey data collected from 115 consumers chosen at random, 62 females and 53 males. Each was asked to rate his/her perceptions of Super Noage 120 Lotion based on texture, smell, color, price, and oiliness. In particular, on a scale of 1 (definitely will not buy) to 10 (definitely will buy), each participant was asked to rate the likelihood that he/she would purchase Super Noage 120 Lotion based on the characteristics listed.*

In addition, a report was provided that showed the demand for Super Noage 90 Lotion. The report showed data on the sales of Noage 120 for a number of regions over a 4 week sale periods. The report showed the following elements:

- The Demand refers to the number tubes of Noage sold measured in tens of thousands.
- Price refers to the price (in dollars) per tube of Noage.
- IndPrice refers to the average price (in dollars) for Noage's competitors.
- PriceDif is how much lower Noage's price was compared to the avg. competitors' (in dollars) for a given region and 4 week period.
- AdvExp is the amount spent on advertising Noage 120 in the given region for a 4 week period.
- Coupon is the face value of coupons used to promote sales of Noage 120.
- Profit is the profit realized from Noage 120 sales in a given region for a 4 week period.
- Mail_in is a "dummy" variable that equals 1 if the coupon is a "mail-in rebate" type and 0 if redeemable for cash.

Research Methodology

The project comprised of testing the adapted instructional material in a section of a sophomore level statistics class taught during a five week summer session. A control group was created with another section of the class where the case study was not used. We had no control over the size of the classes. However we chose the smaller class of 25 students to represent the "experimental" group and the larger class of 55 to represent the "control" group. Both classes were taught by the same instructor and operated under the same basic syllabus with common topics and course deliverables such as exams and term projects.

To add a data collection dimension to the case we also required students in the experimental class to survey local residents on their attitude towards cell phone plans. The cell phone proposal was deemed as another project under the "Personal Care" business unit being offered to management to achieve the profit growth target. The computer generated data for the Noage Lotion comparison and "real" survey data collected by the students together provided bountiful opportunities for students to practice the type of statistical analysis needed to achieve the course objectives.

Beyond this commonality between group treatments there was difference in the teaching method applied to each group. The control group was taught concepts using the traditional Power-point slides in a regular lecture hall. In contrast the experimental group's classes were held in a computer lab and all the key concepts were taught via class discussions driven by the data. In this hands-on approach each student had the data on their own computer and they were able to mimic the instructor's keystrokes which were projected on the classroom's large screen. In this way students quickly learned how to use software to manipulate and analyze data and the instructor was able to pass on many "tricks of the trade" and shortcuts to the students. Thereby, the students needed to use help menus and manuals to a lesser extent.

A non-lecture component was incorporated in both classes. For the experimental group the component focused on the "Superstar Specialties" case and the cell phone project. For the control group a regular project that had been used in the course during previous semesters was used. The project was based on a fictitious scenario and computer generated data was created with all the attributes necessary for the students to implement the data analysis tools taught in the course.

In order to compare the performance and perception between the students in the two classes, the following procedures were used.

(a) The graduate student assistant developed a daily log and made notes on the experimental class.

(b) A questionnaire that had been developed earlier was used to evaluate the perception of the students to the use of the case study in the class. We collected data from a questionnaire on students' perception towards effectiveness of the "non-lecture" component of their course in conveying the key concepts stated in the syllabus.

(c) A new questionnaire was developed to compare the perception of the students to the use of the case study. A faculty member visited both classes during the final week of the classes and interacted with the students to obtain feedback from them about use of the case study and collected responses to open-ended questions.

(d) To measure the effectiveness of the case approach we administered a pre- and post-test to each group. For convenience the final exam for the course was chosen as the pre/post-test instrument. The increase in scores, based on posttest – pretest, was compared between the experimental and control groups. A straightforward two sample t-test was used to find statistically significant difference between the increased scores.

Results

Three of the original 30 students in the experimental group and four of the original control group did not complete the course and so their pre-test scores were discarded.
At the beginning of the course these students did not express any concern about being taught the material not only through cases but also via a "hands on" approach in the computer lab. However, it soon became apparent that students were struggling to keep up, not because of the

case study approach but mainly because of their inexperience with using Excel, the chosen analysis software. It took more than five days of classes before students figured out they were better off focusing on mimicking the instructor's keyboard manipulations than attempting to write notes. Another noteworthy observation, which was more a consequence of the laboratory setting than of the case study approach, was the tendency for some students to be engaged in non-class activities such as surfing the internet, checking email, and doing homework. Of course, off-task behavior is possible in traditional lecture room settings. But students may find it easier to disguise their non-learning activity when sitting behind a computer terminal.

A trace of the daily logs (details available from the authors) showed that the students in the experimental class eventually became very comfortable in using Excel for performing statistical analysis. In general, and especially at the beginning of the course, they did not participate actively in classroom discussions. On the positive side, they tended to use their computers intensely. But on the negative side, this led to isolated work sessions during the lab sessions. However, it was encouraging that some of the students who were asked questions repeatedly became more comfortable with statistical terms and became active contributors toward the end of the class.

The responses to the open-ended questions and class visit by an external faculty member showed that the students in the experimental class exhibited more comfort with statistical terms. They showed enthusiasm in discussing as to why statistics was a valuable tool in business. Some of the students discussed statistical concepts in depth and impressed the visiting faculty member with the depth of their knowledge. The students in the control class were irritated with the feedback session and exhibited hostility toward the external faculty member and the instructor. Some of them stated that the class was a waste of time since they can learn all the material from books. Very few of them argued for use of statistics in the classroom and did not exhibit mastery of the subject matter. They were more interested in the final grade and the questions that will be asked in the final examination.

The two sample t-test conducted on the increase in performance scores between the two groups is summarized in the Table 3.

Hypothesis Test: Independent Groups (t-test, unequal variance)

	Experimental Group	Control Group
Number of Students	22	51
Mean	39.1	37.9
Standard Deviation	11.7	16.6

Table 3. Results of Hypothesis Test

The t-value measuring the significance of the difference between the two groups was 0.35 and the p-value (two-tailed) was 0.73. The result shows that while the students in the experimental group showed a slightly greater increase in scores than that of the control group, the difference was not statistically significant. Even though this result was not strong, we are not sure whether the use of the typical final examination questions was the appropriate instrument for testing the improvement in knowledge. This result indicates that there is insufficient evidence that teaching statistical concepts with the "hands on" approach and a real world case

study results in significant improvement in student performance compared to teaching with traditional lectures and term project. However it is an open question whether similar results would have been obtained if the control group were not required to do a term project in addition to listening to course lectures. It is our opinion (without proof of a survey) that the approach of using pure lectures in statistics courses without any opportunity for the students to analyze fictitious data using a computer is quite prevalent in colleges and universities today.

An interesting outcome from the daily logs of observing student activity and attitudes in the experimental group is the noticeable improvement in the students' use of statistical software in data analysis. Students were observed to be much more willing and able to carry out complex manipulations with Excel as the course progressed. By the end of the course these students' comfort level with using software was so high that they even showed great enthusiasm when analyzing data and were confident in discussions over their findings arising from the analyses. In contrast, though not observed on a daily basis throughout the course, students in the control group seemed to be less comfortable with using statistical tools by the end of the course and did not show marked enthusiasm for the concepts taught.

Adaptation to Engineering

Although the research focused on development of an undergraduate business statistics course, the approach and methodology that was developed could be applied to the introductory statistics course in any other field. We believe that regardless of the field of study, the core topics in a one-semester introductory statistics course should comprise descriptive statistics, minimal probability concepts, inference, and simple regression modeling. The Superstar case used in this study provided an excellent setting to discuss and investigate all these core topics. It is interesting to note that the Superstar case was originally created to expose engineering students to the importance of the profit motive in decision making within large corporations. Therefore we would not recommend any changes to our adaptation methodology when using these materials to teach engineering students. However, to inject some traditional engineering principles into the course we would recommend using a different second case. One could substitute our case on cell phone usage with a case centered on a key concept such as maximizing throughput in a manufacturing plant or design of a product.

Future Research

One weakness with this research is the lack of daily logs of activity and attitudes of the control group. Although the experimental group showed marked improvements in ability to use software and participation in class discussion there is no way of knowing how different these improvements would have been under the treatment experienced by the control group. Another point of weakness is the use of open ended questionnaires instead of objective multiple-choice types during the wrap-up sessions to assess students' perceptions at the end of the course. By comparing scores on an objective questionnaire we would have been better able to measure differences in perceptions between the control and experimental groups. We believe that a replication of this study with the correction for the above mentioned points of weakness will yield useful results. Also, expanding the experimental design to include a group in which no term project is given as a course deliverable should provide an interesting comparison. Finally, in addition to comparing pre- and post-test performances on the final exam, we could develop an

instrument to test students' ability to draw conclusions about an unfamiliar case based on relevant outputs from statistical software analyses.

Conclusions

This paper reports on the results of an experiment that compared the use of case study from a real-world project in contrast to teaching using traditional lecture sessions and a term project. The results indicate that the case study approach provided a more in-depth experience to the students and increased their interest in use of excel spreadsheet to perform statistical analysis improved. In contrast, the control group exhibited a neutral interest in using statistics in their future business courses. It is critical to replicate the experiment with the suggestions mentioned in the future research section.

We believe use of innovative instructional materials to improve teaching of statistics is an important endeavor in the colleges of business and engineering. This project has motivated the researchers to pursue the experiment further.

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