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AN INTERPRETIVE BUSINESS STATISTICS COURSE ENCOMPASSING DIVERSE TEACHING AND LEARNING STYLES

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ABSTRACT

The purpose of this paper is to describe the major elements of a redesigned introductory business statistics course based on a learner-centered approach to teaching. Diverse learning styles are recognized and multiple teaching styles are incorporated to improve student learning. The redesigned course focuses on the interpretation and implications of statistical results through real business problems and data while relegating the mechanical steps of computation via formulae to the background. The philosophy that "students are responsible for their education" is embraced; thus, a mastery approach to learning was adopted utilizing pre-lecture, post-lecture and lab web quizzes all with multiple attempts allowed. Cooperative learning serves as a common thread in the course through the use of student teams in lectures, labs and two project assignments. Team projects require students to create business reports in which all statistical jargon is translated into everyday language.

INTRODUCTION

The redesigned introductory business statistics course described in this paper is a result of efforts focused on meeting the concerns of three primary constituents: students, instructors, and central administrators. Students voiced their concerns via course evaluations. Many viewed the previous course content as dull and mechanical without direct application to real business problems. Instructors teaching the course expressed concern and frustration that students spent most of their time struggling to learn the mechanics and usually not gaining mastery of basic statistical concepts and their use. Central administrators were concerned about improving student retention for various university gateway courses that included the introductory business statistics course. To address these concerns the authors adopted an interpretive, learner-centered approach and redesigned the introductory business statistics course. The major elements of the redesigned course and the interpretive approach to teaching upon which they are based are described below.

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The move to alternative approaches in introductory statistics classes is well established in mathematics and statistics departments, but little is known about how they are integrated into other disciplines including business (Moore, 1997a; Garfield, Hogg, Schau, & Whittinghill, 2002). The American Statistical Association (ASA) funded program "Guidelines for Assessment and Instruction in Statistics Education" (GAISE) created two draft reports of recommendations for introductory statistics courses at the college level and statistics education in Pre K-12 years (http://it.stlawu.edu/~rlock/gaise/). While not specifically aimed at business statistics, these draft reports contain some of the features in our redesigned course. The Making Statistics Effective in Schools and Business (MSESB) group has held conferences since 1986 (http://www.msmesb.org/). While many papers presented at these conferences encourage interaction between teachers and students as they learn, the overwhelming majority of the conference papers deal with how to best teach a specific topic. Only two articles contain individual features of our redesigned course.

Our new approach to teaching business statistics is learner-centered and focused on intuitive interpretations of computer generated statistical output with heavy emphasis on addressing real business problems. It is based on how business students actually use statistics in higher-level business courses and how they will use statistics in the business world. As noted in the heavily cited article by Felder and Silverman (1988): "Students learn in many ways . . . Teaching methods also vary . . . Mismatches exist between common learning styles of engineering students and traditional teaching styles of engineering professors." We have witnessed a similar phenomenon in teaching statistics at a business school. Felder and Silverman (1988) classify preferred learning styles into four dimensions: (1) sensory/intuitive, (2) visual/verbal, (3) active/reflective, and (4) sequential/global. These four dimensions focus, respectively, on the way people perceive the world, the way people receive information, the mental process by which perceived information is converted to knowledge, and the manner in which people understand and master the material. Teaching styles are also classified by Felder and Silverman (1988) into four dimensions according to how well they address the four corresponding learning style components. These components include: (1) content can be concrete/abstract, (2) presentation can be visual/verbal, (3) student participation can be active/passive and (4) perspective can be sequential/global. When we redesigned the course, we attempted to incorporate multiple teaching styles to match students' diverse learning styles in the hope of creating an optimal learning environment for most (if not all) students.

In an era in which knowledge has an increasingly shorter half-life, the college educational experience must encourage students to become proficient life-long learners. In a recent article, Petocz and Reid (2003) studied the relationships between students' conceptions of learning statistics and their conceptions of teaching statistics. Students' conceptions of learning are classified into "doing," "collecting, "applying," "linking," "expanding," and "changing" while their conceptions of teaching are categorized into "providing essentials," "explaining ideas," "linking concepts," "anticipating learning needs," and "catalyst for open-mindedness." Thus, students demonstrated a range of conceptions of learning from limiting to expanding. Students expressed a range of ways

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they experienced teaching, and their experience on learning and their conceptions on teaching were related. One implication of this finding for statistics pedagogy is that the design of a total learning environment must acknowledge these variations, and provide activities and assessment that encourage students to change the way they think about learning and teaching statistics toward more inclusive levels. These authors argue:

> It is easy to construct classroom activities and assessment tasks that cater for the lower levels of learning statistics and that sit well within the realm of the lowest level of teaching statistics. However, the same question set in a specific situation where students are asked to explain the *meaning* of these observations and summary statistics for the *people* involved (such as a client or a colleague) immediately shifts students' focus. This sort of question also implies a more reflective style of teaching rather than the provision of simple definitions and worked solutions in class, and technically-focused assessment questions that are so often the result of time pressures, constraints in content, and ease of marking (Petocz & Reid, 2003, pp. 50-51.)

To promote the highest level of learning, they encourage teachers to influence students' conceptions of teaching by moving the focus of teaching efforts from the essentials toward supporting students as they learn independently, holistically, and beyond the arbitrary boundaries of the subject. This change in focus encourages students to raise their expectations of themselves and adopt a more inclusive view of their own learning. Heeding this advice, our redesigned course includes incentives to motivate students to take responsibility for their own learning. The major theme and philosophy of our redesigned course is that "Students must take responsibility for their education and instructors must assume the new role as facilitators of learning in a cooperative learning environment in addition to the traditional role as deliverers of knowledge."

STUDENT LEARNING CONCERNS

Previously the business statistics course was taught using a traditional calculation-based approach we believed contributed to our students' poor understanding of the linkages between statistics concepts and applications. Many current textbooks in business statistics rely on material that originated in the field of mathematical statistics. Thus, they place too much emphasis on calculations based on equations and formulae and not enough emphasis on interpretation and application. Business students exerted tremendous effort learning the mechanics of computing the various statistics with hand-held calculators and memorizing the recipes of the various testing and estimation techniques, but failed to internalize the concepts behind the mechanics and were unable to apply the concepts to solve real business problems. Students learned HOW to compute various

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test statistics and perform estimations but failed to understand WHY there was a need to test or estimate and WHAT implications and interpretations could be deduced from the mechanical results. Most of our students will not pursue a degree or a career in statistics. For them statistics is just a tool they will need to become effective managers in their chosen career path. Thus, knowing the WHY and WHAT in statistics is more important for them than learning the HOW.

Most business students take the introductory statistics course not because they are interested in the subject, but because it is one of the core courses required to complete their degree. Additionally, the quantitative nature of the subject imposes a high demand on students' analytical thinking ability. Our students in general are ill prepared in this area. Many of our students have minimized the number of mathematics-related courses they have taken. Adding poor self-management skills to the mix creates a recipe for high attrition. We believe high attrition is a by-product or symptom of the root problem. Students are not learning basic statistics concepts, because they do not have the skills to get beyond the formulae and equations. Attrition for this course was further compounded by the lack of an appropriate motivation scheme. Since students were assessed on their performance mainly through traditional exams, there was little or no incentive for them to go beyond learning the mechanics. They could simply memorize the formulae and the mechanics of the various testing and estimation techniques, and regurgitate them during the written exams. Applied problems in the assigned homework were treated as opportunities to refine their mechanical skills. Students made little attempt to internalize the underlying fundamental concepts and be able to solve real business problems.

REDESIGNED COURSE DESCRIPTION

Our redesigned course contains many of the components recommended by Hogg (1992) for a course designed to develop statistical thinking. Equations are introduced only for understanding of concepts. Hand calculations via formulae are not required of students. Instead, Excel® and a specific add-in, PHStat®, are utilized for all statistical computations.[1] Emphasis is placed on interpretation and application of results. This concrete teaching style based on content should help learners who prefer a sensory perception process. On the other hand, the abstract teaching style of discussing equations only for conceptual understanding should benefit learners who prefer an intuitive perception process. Additionally, our design fosters a supportive environment for cooperative learning among students as advocated by Dees (1991), Garfield (1993), Giraud (1997), Hogg (1991), Johnson & Johnson (1975, 1979, 1985), Johnson, Johnson & Smith (1991), Keeler & Steinhorst (1995), Sharan (1980), Vygotsky (1978), Webb (1982, 1983, 1991), and Wood, Bruner & Ross (1976), among others.

WebCT plays a central role in the course (BA201) and allows us to provide many materials via the web that have traditionally been delivered during lecture periods. This enables us to better use the contact time during lecture periods to emphasize concepts, illustrate interpretation of

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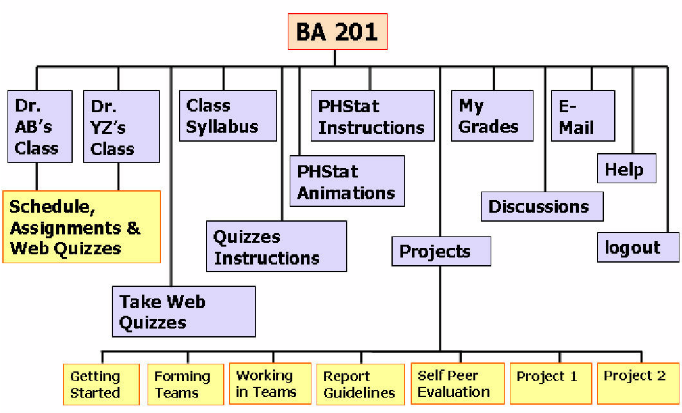
numerical results and demonstrate applications to business problems. The course site map is illustrated in Figure 1. Students meet at least once a week in lecture and once a week in a computer lab. Realistic business problems and data serve as the central connecting thread between activities in lectures and lab sessions. Lecture time is used primarily to provide motivation, discuss appropriate solutions, demonstrate related Excel skills that are needed and provide interpretations for select problems. Lab sessions provide students with hands-on experience with problem solving using Excel generated output. Teams are formed to facilitate cooperative learning both inside and outside the classroom. Teams sit together during lectures and lab sessions to facilitate interaction among members and between other teams. Our approach to teams emphasizes active student participation that benefits both active and reflective learners.

Figure 1: Course Site Map



The redesigned course consists of several major components. Multi-media learning resources with animations created by the authors are available to students 24 hours a day, 7 days a week. These resources (which include PowerPoint slides of material relevant for each lecture as well as animation movie files illustrating the associated procedures for generating the needed Excel and PHStat output) are assigned as reading and delivered to students via WebCT. Students are expected to complete these assignments before class so that they can effectively participate in discussions. Lecture sessions incorporate student-to-student interactions in addition to the traditional instructor-to-student interactions. Intense team projects utilize real data from real problems and require students to present their findings in the form of a formal business report. E-mail and discussion areas

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are heavily utilized to foster student-to-student and instructor-to-student teaching and learning outside the classroom. Discussion areas (bulletin boards) are created and organized according to their functional aspect in WebCT to foster communications among students, and between students and instructors. They are the first place students go for help with questions on quizzes, lecture materials, and team projects. Each team has its private discussion area used to coordinate activities on the team projects. E-mail is used only for private matters including the turning in of the team project reports.

Quizzes play a significant role in course design and are delivered via the web with immediate feedback to foster timely learning. Quizzes are due weekly to encourage students to take responsibility and discourage procrastination. We use three different types of quizzes. Pre-lecture quizzes are due before a lecture and serve as an incentive for students to complete the assigned reading before attending class. These quizzes contain questions that are at the "knowledge" level in Bloom's taxonomy (Bloom & Krathwohl, 1956). They only require students to be able to elaborate, encode and retrieve information from memory after completing their reading assignment. Post-lecture quizzes, on the other hand, are designed to ensure that students have internalized the fundamental concepts learned in lecture. These questions are more challenging than the pre-lecture quiz questions and address the higher order "comprehension", "application", and "analysis" levels in Bloom's taxonomy. Lab quizzes are designed to assure students are able to perform the Excel and PHStat procedures to generate output for the relevant analysis. Lab quiz questions cover not only the mechanics of how to use these procedures but also require students to use the output to answer questions associated with business problems. Students are allowed to take the pre-lecture, post-lecture and lab quizzes an unlimited number of times in WebCT®. This self-paced, self-guided mastery approach to learning, which is highly recommended by Pressley and McCormick (1995), enables students who are sensing, active and sequential learners to learn more effectively through drill exercises. The more challenging questions on abstract concepts and fundamental statistical understanding found in post-lecture quizzes, on the other hand, stimulate and challenge intuitive, reflective and global learners.

Students are required to complete two team projects. The first project deals with descriptive statistics and is assigned early in the semester. The second project is focused on confidence intervals and hypothesis tests. We ask students to perform more analysis than can be fit within a five-page business report. Thus, team members must decide what is important enough to be included in the report. The report has the following format constraints: (1) a one page executive summary, (2) five pages in the body and (3) an annotated appendix of unlimited length. Students are not allowed to use statistical jargon ("statistics speak") in the executive summary and the body of the report. Students' learning from this project is assessed based on (1) an executive summary, (2) the statistical analysis and interpretation of output, (3) intuition, (4) initiative and the overall presentation in their project reports. Self/Peer evaluations are completed by every member of the team to discourage

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free-riders while the project web quiz is used to assess the accuracy of the data analyses. A typical project grading scheme is presented in Table 1 and described below.

Table 1: Project Grading Scheme.

Presentation of Results		40 %
Executive Summary	10 %	
Intuition	10 %	
Recommendations	10 %	
Sample Description	5 %	
Charts, PHStat and Appendix	5 %	
Statistical Analysis		40 %
Formulation of variables	10 %	
Analysis of Excel output	10 %	
Interpretation of the Excel output	20 %	
Points for Initiative and Overall Presentation		20 %
Total Project Report Score		100 %

Presentation of Results includes an Executive Summary. This one page project overview includes identification of who wrote the report, who the intended audience is, a brief description of the background and the sample, the major findings (usually involving interpretation of Excel output) and recommendations. Points are given for intuition if the report contains insights about the problem that are not obvious from the questions asked. Report recommendations should be useful and valuable for the intended audience. What is being sampled and the sample size must be clear. Students are to minimize the use of charts and PHStat output in the body of their report. Relevant charts and PHStat output are to be presented in the appendix. The appendix should be annotated to explain the included chart or PHStat output. References in the body of the report are made to the more detailed material in the appendix. Statistical jargon may be used in the appendix. Statistical analysis includes the results of the analysis. The relevant numbers and statistics generated must be identified and analyzed. Students must interpret the output generated by Excel using layman language. Points are given for initiative if the report contains relevant analysis beyond what is required. Our requirement of no statistical jargon is more challenging with the second project, but students rise to the task since they have already had practice in doing so with the first project.

At the end of the semester, we expect students to be able to demonstrate the learning objectives listed in Table 2.

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Table 2: Course Learning Objectives	
1.	have a sound understanding of the relationship between a population and a sample, and the stochastic (random) nature of various test statistics
2.	feel comfortable about applying the various statistical techniques learned in the class to real problems
3.	be competent in performing statistical analysis in EXCEL
4.	have become an effective self-learner
5.	have acquired skills needed to work effectively in a team environment
6.	have learned good business report writing skills
7.	demonstrate an understanding of why there is a need to test or estimate
8.	interpret mechanical results from Excel and communicate the implications of results in non-technical everyday language.

REOCCURRING COURSE THEMES

In addition to the major course components described above we continuously emphasize three themes throughout the new course to address our concerns regarding student learning. We believe we serve our students best when we focus our efforts on teaching basic concepts, using real world data and problems to illustrate these concepts and creating mechanisms that encourage students to take more responsibility for their own learning. These three themes are discussed in more detail below.

Basic Concepts

In a business situation, our graduates are more likely to either (a) generate statistics and make inferences using a spreadsheet or statistical package, or (b) be given the results of such analysis to interpret. They are not likely to use the equations and formulae found in business statistics textbooks. While Excel®, SAS®, Minitab® and other such output are increasingly found in statistics texts, equations and formulae still dominate. Texts for business statistics courses increasingly include case studies and real data sets. In our approach, Excel and PHStat are used but not as ends in themselves. We rely on in-class and lab demonstrations to help our students understand how to use these tools. We still introduce conceptual equations to students in order to develop an intuitive understanding of the fundamental concepts, but we never show the actual computation involving the equations. We do not expect our students to be able to perform hand calculations. We do expect them to know what the output means and be able to provide intuitive explanations related to actual problems. This de-emphasis on formulae and heightened emphasis on interpretation attempts to provide a better balance of concrete information (facts, data, results)

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and abstract concepts (theories, mathematical models) and works in favor of students with both the sensing and intuitive learning styles.

Given the way our graduates will actually use statistics in business situations, it is more important for them to be able to translate abstract statistical concepts into daily non-technical language rather than to use "statistics speak" or statistical jargon. We believe students are more likely to learn and internalize the underlying abstract concepts when they are able to communicate their findings in simple everyday language instead of regurgitation with jargon. Thus, our lectures emphasize the interpretation of the results rather than the process of obtaining the numerical results.

Real World

Felder and Silverman (1988, p. 678) argue the majority of students are inductive learners who "need motivation for learning. They do not feel comfortable with the "Trust me – this stuff will be useful to you some day approach: like sensors, they need to see the phenomenon before they can understand and appreciate the underlying theory." We have found students are motivated to learn to the extent they see a clear linkage between course material and their potential careers after graduation. It is for this reason that data sets and problems encountered by real businesses play a central role in our course. The use of real data demonstrates to students how data are used in the context of solving a business problem. Real data and real business problems are integrated into all aspects of our course including lectures, labs, quizzes, exams and team projects. Data analysis becomes just one step in the process of solving business problems. The mechanical skill of data analysis is of no value to business students unless they gain intuitive insights of the type of analysis that must be performed and can make non-technical interpretations of the results of the analysis.

In our typical lecture, once the facts for an example problem are presented and studied we ask student teams to collectively determine intuitive approaches to solving the problem and decide what statistical methods are most suitable for the analysis. After consensus is reached on the statistical analysis, we demonstrate how the relevant Excel output can be generated. Teams are then asked how the output can be used to intuitively explain the solution to the problem. At this point, students are expected to explain the solution with and without the use of statistical jargon in order to practice looking at technical statistical output and then translating it into everyday language. The combination of fact, real data, result presentation with emphasis on problem-solving methods and in-class discussions and brain-storming allows sensing, active and sequential learners to better perceive and process the knowledge while still challenging intuitive, reflective and global learners.

Responsibility

In our previous "traditionally" taught business statistics course, students held the view that the professor should teach them everything necessary for the course as they sat as isolated

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individuals not actively connected to the current material or the class. Students percolated their conceptions, learning and expectations of teaching to the lowest level of Petocz and Reid's (2003) classification. Additionally, procrastination in completing all aspects of the course was a major obstacle to learning and retention. The redesigned course attempts to minimize both types of problems by emphasizing active student participation.

We encourage students to become active stake-holders in the course by allocating one half of the course grade to activities entirely under their control via web quizzes and team projects. Web quizzes make up twenty percent of the course grade. Multiple attempts are allowed on these quizzes (but not on major exams) to encourage students to take responsibility for their education by mastering the material. While multiple attempts are allowed, a new set of questions is presented each time a student takes a quiz. Feedback is given on each question to lead the student to the correct answer without revealing it. Importantly, students are more likely to have read the assigned material before lectures since the pre-lecture quizzes must be completed prior to the associated lecture. Rolling deadlines are used for all quiz types to encourage students to be actively connected to the current lecture material when it is being presented, reduce procrastination and achieve just-in-time learning. Thirty percent of the course grade is tied to team projects. Using the self-peer evaluation system, student team members are able to exert both individual and group control over the quality of team projects and the class participation of their teammates.

Class attendance is required. A name card system is used to track attendance. Such a system helps the instructor know the names of the students, and it helps the student to learn and use the names of their team members. Required attendance helps to assure that the class teams can function.

Thus, our students take responsibility for their own education by mastering material found in web quizzes associated with lecture material, by being an active member of a team and by attending and actively participating in class.

SUMMARY

We view our biggest challenge as training students to translate abstract business statistic concepts into daily business language and to understand how these concepts are applied to solve real business problems. Clearly, this challenge requires a more interpretive approach than is traditionally employed to teach business statistics. In redesigning our course, we created new assessment components and used them in addition to the traditional assess-through-exams model. This helps students succeed through continuous input of their efforts from day one. The redesigned course emphasizes cooperative learning because we believe students learn better when they are able to receive help from and provide help to their classmates. Importantly, cooperative learning closely emulates the life-long learning environment in today's work place.

We took an interpretive learned-centered approach since business students will not become statisticians and the traditional method of teaching business statistics relied too heavily on equations

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and formulae. Our approach emphasizes why a need for a test or estimate existed and what the implications and interpretations are for real business problems.

Student evaluations now indicate an increased appreciation for the course and its use of real world problems and data. They are not spending their time struggling to learn the mechanics and have an improved understanding of why there is a need to test or estimate and what implications and interpretations can be deduced from the mechanical results. Administrators concerns regarding student attrition have also been addressed. The course instructors are now actively engaged in a method of teaching which better fits the expectations of their students, the business community and the instructors of courses which use business statistics as a tool.

ENDNOTES

1 In its position paper to endorse the Mathematical Association of America (MAA) "Guidelines for the Programs and Departments in Undergraduate Mathematical Sciences", the American Statistical Association commented that "Generic packages such as Excel are not sufficient even for the teaching of statistics, let alone for research and consulting."

2 (http://www.amstat.org/education/index.cfm?pf=ASAendorsement&fuseaction=ASAendorsement) Since Excel will be the most readily available software the majority of our students will have access to when they start working, we have decided that using Excel and its add-in is a small price to pay for the convenience it provides.

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