Integrating Technology in a Statistics Course for a Special Program at Florida International University

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Abstract: A special undergraduate program for selected biology majors was recently inaugurated at Florida International University. The curriculum emphasizes science, mathematics, and statistics. A statistics course was implemented for this program integrating PowerPoint, statistical software (SPSS), and data from biological/biomedical studies. This didactic experience is discussed here.

Statistics is often a difficult subject for many undergraduates taking introductory courses at college. Cobb (2005) considered that although the previous twenty five years had seen an extraordinary level of research activity focused on how students learn statistics and how teachers can be more effective in helping them to learn, today's challenges are far greater than before. Thus, statistics education can still be viewed as a new and emerging discipline when compared to other areas of study (Garfield & Ben-Zvi, 2007).

Among the principles of learning statistics, Garfield (1995) includes the active involvement of students in educational activities as well as learning by practicing. Using technology can make college teaching of statistics more effective as it improves the quality of instruction, encourages students' active learning, and provides them with psychological incentives (Garfield, 1995; Higazi, 2002). In this regard, the use of PowerPoint and statistical software has been previously reported by Lock (2005) as a facilitator of learning statistics.

The traditional approach to teaching statistics at the college level consists of using a board during lectures, a textbook as a reference, and supplementary material posted on a website. This present paper describes an observational study discussing whether the integration of technology resources that included the use of PowerPoint presentations and a personal computer based statistical software (SPSS) would increase student performance and satisfaction in an introductory statistics course.

Method

Students enrolled in this introductory statistics course were undergraduates from a special program in the biological sciences implemented at Florida International University (FIU) in the fall of 2007. This program will be described below, along with the Statistics I course used for this study.

Quantifying Biology in the Classroom (QBIC)

Quantifying Biology in the Classroom (QBIC) emphasizes the use of mathematics and statistics for analyses of biological/biomedical data. The inaugural class consisted of twenty five selected students, most of them Biology majors. The selection criteria included students' SAT scores, high school GPAs, and letters of recommendation. The average SAT score, Mathematics and English combined, for these QBIC students was 1240 (Tashakkori, Reio, & Rincon, 2008).

QBIC is a pilot program that intends to expose students to a more rigorous curriculum that is both interdisciplinary and quantitative in nature. The program integrates mathematics, statistics, and computing such that: (a) data generated in biology labs are used to illustrate

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statistical concepts and teach statistical software, and (b) biological processes are modeled using mathematical techniques (Tashakkori et al., 2008).

In 2006, representatives from the Mathematics, Statistics, and Biology Departments at FIU started to design the QBIC program. Two Statistics courses were included in the program's curriculum. Sam Shapiro, now retired and Emeritus Professor at FIU, served as the representative from the Statistics Department working on the design of the QBIC project. He established the guidelines for the Statistics courses as well as a general description of their contents.

My collaboration with Shapiro and the QBIC team began in January 2007. After participating in preliminary meetings, I started working on the statistical design of several biological experiments in collaboration with Tanya Simms from the Biology Department. Simms was the instructor designated to teach Biology labs for the inaugural class in the fall of 2007. The statistically designed biological experiments were part of her course. Data generated by the QBIC students in the lab sessions would be used later during their sophomore year to teach the statistical concepts and software (SPSS).

Statistics I: Course Design

The present author was the designated instructor for the Statistics I course. During 2007 and part of 2008, I selected the textbook and prepared the detailed course description, objectives, and syllabus. Also, problems for the SPSS assignments were chosen, including data from the biology lab experiments and text exercises. The course included traditional resources and technology resources.

Traditional resources. The following traditional resources were used in the course: (a) textbook and (b) instructor's Website. The textbook, *Biostatistics: A foundation for Analysis in Health Sciences, 8th edition*, by Wayne Daniel, is intended for advanced undergraduate students. It requires mid level mathematical prerequisites and includes real data from the health sciences. This type of textbook makes the study of statistics a more enjoyable and meaningful experience. Contents from chapters 1 to 7 were covered. Handouts were prepared by the instructor for a few topics not included in the textbook such as the hypergeometric and exponential probability distributions.

Additional material posted on the instructor's Website provided valuable information to the students. The following list describes the online content: (a) course description and objectives, (b) syllabus, (c) recommended text exercises, (d) supplementary exercises, (e) SPSS assignments, and (f) vocabulary. Supplementary exercises were comprehensive in nature and also developed by the instructor. These exercises were meant to integrate different topics from the same chapter. The vocabulary file, organized by chapter, included a complete list of definitions and concepts.

A list of additional topics covered in this QBIC course, grouped by subject, is as follows: (a) descriptive statistics such as trimmed means and full discussion of the five number summary, box plots, skewness, and identification of outliers; (b) probability subjects including Bayes's rule, clinical sensitivity and specificity, clinical predictive values, Poisson, hypergeometric, and exponential distributions; and (c) tests of hypothesis about means using two samples. These topics are not included in our traditional Statistics I course at FIU and provide a more solid background to QBIC students for their Statistics II course as well as future biomedical classes.

Technology resources. The two primary additions to the traditional approach were the daily use of PowerPoint presentations for lectures as well as the statistical software SPSS for data computations and analyses. Students used SPSS during classes for statistical computation and analyses of the following course subjects: (a) descriptive statistics, (b) sampling distributions, (c) estimation with confidence intervals, and (d) hypothesis testing. SPSS was also required for solving take-home assignments. The PowerPoint presentations, created by the instructor for this course, included: (a) definitions, concepts, formulas, examples and exercises, (b) tables and graphs, (c) SPSS instructions, and (d) SPSS output.

Course Organization

The Statistics I course started in August 2008 during QBIC students' sophomore year. It included twenty eight class meetings, two per week, for seventy five minutes each. The classroom setting consisted of a fully equipped computer lab with twenty five seats. Out of the twenty five freshman students from the inaugural class, eighteen remained in the QBIC program for the sophomore year. Each of these eighteen students had access to a desktop personal computer and the QBIC program provided flash memory drives for data storage. SPSS data files from textbook exercises and biology labs were loaded into the students' flash memory drives. A computer connected projector and an eighty inch screen were used for the PowerPoint presentations. A dry erase board was also used as a supplement for class discussions.

Students were required to bring the text book to class as well as a folder including the vocabulary and supplementary exercises from the instructor's Website. Hence, limited notes were needed during classes, allowing students to focus on the discussion of statistical concepts, exercises, and SPSS execution.

Course Assessment

Student evaluations consisted of three tests (300 points), three SPSS take-home assignments (100 points), and a cumulative final exam (100 points), for a total of 500 points. Approximately 30% of the content of partial tests and the final exam was directly related to the use of SPSS. The inclusion of statistical software in the evaluation system, as reported by Higazi (2002), was expected to contribute to the success of this technology based teaching-learning model.

Student progress was monitored and discussed during biweekly multidisciplinary faculty meetings. A journal, developed along the course by the instructor, detailed the students' learning process and the use of various didactic resources, lecture by lecture. This information was intended for future refinement of the course. A short questionnaire developed by the instructor was also given to the students at the end of the course asking them to share their views regarding different components of the teaching-learning model used. Opinions were quantified using a Likert scale with ratings between 1 and 5, with higher values indicating greater levels of helpfulness in learning the material.

Results

QBIC Students' Performance

Table 1 shows grouped statistics summarizing the QBIC students' performance for this course. The results are expressed as percentages of the 500 points, covering the totality of evaluations. Since the passing result was established as 70 in the syllabus, the table indicates that 100% of the eighteen students passed the class. The median and mean results were 90 and 88 respectively, with nine students in the range of 90 or above.

Table 1
QBIC Students' Performance

Score Interval	No. of students	% of students
90.0 or above	9	50.0%
80.0 - 89.9	5	27.8%
70.0 – 79.9	4	22.2%
Below 70.0	0	0.0%
Total	18	100.0%

Performance Comparison

It may be useful to compare the QBIC students' performance against a traditional Statistics I class, taught simultaneously by the present author during the fall of 2008. This traditional course incorporated only typical non-technology resources, such as a textbook, online material and a board for lectures. Given the nature of this study, the traditional Statistics class cannot be considered a true control group; however, it is used here as a valuable comparative reference. Table 2 presents the comparison of several relevant parameters.

Table 2
Performance Comparison

Parameter	QBIC Statistics I	Traditional Statistics I
Students enrolled	18	50
Passing rate	100%	84%
Median score	90.1	84.3
Mean score	87.9	81.7
Standard deviation	8.4	14.2

A statistical comparison of the two groups, with the understanding of its limitations, showed that QBIC students had a higher passing rate (p-value = .0354) and mean score (p-value = .0165) than the traditional Statistics I students. The less powerful Wilcoxon test for a comparison of the medians revealed a one-tailed p-value of .0605.

QBIC Students' Opinions

Table 3 shows grouped statistics summarizing the opinions of QBIC students about the helpfulness of different components of the teaching-learning model used.

Discussion

Measured by any standards, the QBIC students' performance, shown in Table 1, can be considered outstanding for a first-level university statistics course. Even though there was no baseline or true control group available for a more reliable comparison, the results of Table 2 support the success of technology integration into the traditional teaching-learning model for this type of course. Furthermore, the use of technology was identified by the QBIC students as a very positive factor in their learning process, as shown in Table 3. More than 50% of them gave the

Table 3
QBIC Students' Opinions

Component	Avg. Rate	No. of students rating 4 or 5	No. of students rating 5
Textbook	3.44	11	3
Instructor's Website	4.50	16	11
SPSS	4.00	12	10
PowerPoint	4.39	15	12

highest rating of helpfulness to the use of SPSS and PowerPoint, with an average rating of at least 4.00 for both technology resources out a maximum of five. QBIC students' satisfaction was also reflected in the FIU student assessment of instruction where 100% of them rated the instructor's job as excellent or very good with average of 3.88 out of a maximum of four.

While using the teaching-learning model described here, QBIC students were able to learn statistics more quickly and effectively. This was evidenced by the number of extra topics covered, the acquired knowledge of statistical software, and the students' overall performance, all of this with high student satisfaction. This study suggests that the integration of technology into other traditional resources provides a more effective teaching-learning model for this type of introductory statistics course.

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