

## TEACHING INNOVATIONS IN INTRODUCTORY STATISTICS COURSES

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*The emphasis while teaching introductory statistics courses at university level has shifted lately from computations to a deeper discussion of statistical concepts and their association with real life problems. In this regard, the use of technology resources has been generally identified as a facilitator of students' understanding. This paper describes an innovative approach to teach introductory Statistics courses, implemented by the present author at Florida International University. This approach consists of an interactive method involving the daily use of PowerPoint presentations for lectures and the SPSS software for computations of real life data. Passing and retention rates with this method showed significantly better results compared to a more traditional approach based on a teacher-centered style and low level use of technology.*

### INTRODUCTION

Statistics is often a difficult subject for many undergraduates taking introductory (non-calculus) courses at university level. There is a general agreement among college educators that developing statistical skills is essential for a variety of majors (Dunn et. all, 2007 and Gourgeon, 2009). Hence, increasing the students' motivation and understanding is always a challenge. The emphasis in teaching introductory statistics courses has shifted lately from formulas and computations to a deeper discussion of the statistical concepts as well as their connection to the real world (De Veaux & Velleman, 2008). The appropriate use of technology has been identified as a significant contributor to that end. 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, a committee created by the American Statistical Association produced in 2005 the Guidelines for Assessment and Instruction in Statistics Education (GAISE) that recommended the use of technology for introductory statistics courses at college level.

PowerPoint has permeated all aspects of college teaching as a presentation technology resource (Hulsizer & Woolf, 2009). This success has been associated with the appropriate use of text, images and graphics. Handouts or course packs comprised of the PowerPoint slides and distributed prior to lectures have been recommended. Furthermore, the use of statistical software provides students with a tool that enhances their learning experience, by allowing them to engage the contents actively and analytically (Karp, 1995). The use of PowerPoint and statistical software in undergraduate statistics courses has been previously described by Lock (2005) and Gomez (2010; 2011; 2013) as a facilitator of learning statistics.

This paper describes an innovative approach to teach a variety of introductory Statistics courses implemented by the present author at Florida International University. This approach consists of an interactive teaching-learning method involving the use of technology resources and the application of statistical contents to real life problems with the purpose of improving student's motivation and understanding. The approach was very effective as evidenced by the students' performance and satisfaction.

### METHOD

Florida International University is a public institution located in Miami with current enrollment near 48,000 students. The Statistics for Business and Economics course (STA-2023) is a requirement for business majors and prerequisite for the 'Quantitative Methods in Business' class. The Introduction to Statistics I and II courses (STA-2122/3123) are requirements for psychology majors and prerequisites for the 'Research Methods' class. The Statistics I and II courses (STA-3111/3112) are designed for science students.

The Statistics courses STA-2023/2122/3111 cover descriptive statistics, probability and inferential statistics based on a single sample. The Statistics courses STA-3112/3123 comprise hypothesis testing based on two samples, analysis of variance, regression models, analysis of

frequency data, and non-parametric statistics. All these courses are three credit-hours classes that meet two times (75 minutes each) or three times (50 minutes each) per week over a fourteen week academic term. Classrooms are equipped with a computer projection system and a dry erase board is also available as a supplement for class discussions. No desktop or laptop computers are accessible in the classroom.

The traditional approach to teaching Statistics consists of using a board during lectures, a textbook as a reference, a calculator for computations and, more recently, supplementary material posted on a website. Two technology additions were gradually integrated into the described courses starting in the summer of 2008: the daily use of PowerPoint presentations for lectures as well as statistical software (SPSS) for data computations and analyses. This integration allows for more class time to discuss statistical concepts and subject applications. Thus, a broader conceptual understanding of the Statistics is promoted as well as students' active participation in the classroom. Consequently, an interactive teaching-learning environment is generated where students have the opportunity to develop an increased rank of statistical literacy and reasoning.

Below is a brief description of the major components for this interactive and technology based teaching-learning approach.

#### *Use of the Web*

Online material posted on the instructor's website provides valuable information to the students regarding: a) Course content and objectives, b) Syllabus, c) Recommended text book exercises, d) Supplementary exercises, and e) Vocabulary.

#### *Power Point Presentations for Lectures*

The presentations, developed by the present author, include: a) text for definitions, formulae, examples and exercises; b) tables, graphs and other pictorial representations; and c) SPSS output. These presentations are structured with the goal of increasing student participation during lectures, in addition to satisfying the needs of scholars with a more visually oriented learning style. A course pack comprising the PowerPoint slides for all lectures is made available to the students at the university bookstore, eliminating the hassle of frantic note-taking in class.

#### *Scientific Calculator*

A basic scientific calculator with statistical capabilities like the TI-30xa is required for some in-class computations, such as the sample mean and standard deviation of small/medium data sets, as well as Binomial and Poisson probabilities.

#### *SPSS for Computations*

Cryer (2005) has indicated the importance of using not only scientific calculators but also statistical software at college level. The integration of SPSS in these introductory statistics courses involved the use of computer output to illustrate a variety of topics such as frequency graphs, box plots, control charts, areas under normal curves, sampling distributions, confidence intervals, and tests of significance. For second courses, like STA-3112/3123, the execution of SPSS procedures becomes an additional objective and to that end SPSS team assignments are scheduled.

#### *Application of Statistical Contents to Real Life Problems*

The textbook used for STA-2023 is "Statistics for Business and Economics" by McClave, Benson and Sincich (2011). For the other courses "Statistics" by McClave and Sincich (2013) is used. These books emphasize inference methods and stress the development of statistical thinking. They include many proposed exercises for which data is utilized to illustrate statistical and subject applications. In addition, the present author has created supplementary exercises, posted on his website, that provide real life data for statistical analysis.

#### *Students' Active Learning*

The Instructor's style for lectures consists of projecting slides from a presenter device and discussing their content with the students while moving around the classroom. This approach allows a more direct interaction with learners. Students are asked in multiple occasions to complete

statistical tables and procedures shown on the screen and contained in the PowerPoint course pack. They are also asked numerous questions regarding the interpretation of statistical results. Homework from the text book and online supplementary exercises is regularly assigned at the end of lectures, and their solution discussed during the next class.

## RESULTS

This technology based interactive method was gradually implemented starting in the summer of 2008. Before that, the present author had taught some of the courses using traditional resources and a more teacher centered approach several times. Table 1 shows combined data regarding students' motivation and performance for all groups taking the STA-2023, STA-2122 and STA-3123 courses with the two different approaches. The indicators used to measure motivation and performance were the retention and passing rates, calculated as the number of non-dropped and passing students relative to enrollment, respectively. Periods of time associated with each method comprise 3-4 years. Since the present author had taught the STA-3111 and STA-3112 courses with the more traditional approach just occasionally, Table 2 shows only the results with the interactive method between the fall of 2009 and summer of 2013. It can be observed that passing and retentions rates are outstanding during this period.

Table 1. STA-2023/2122/3123 Combined Results for Method Comparison

<i>Method</i>	<i>Students Enrolled</i>	<i>Students Dropped</i>	<i>% Retention</i>	<i>Students Passing</i>	<i>% Passing</i>
Traditional	798	66	91.7%	456	57.1%
Interactive with Technology	768	27	96.5%	588	76.6%

Table 2. STA-3111/3112 results with the Interactive Method

<i>Course</i>	<i>Students Enrolled</i>	<i>Students Dropped</i>	<i>% Retention</i>	<i>Students Passing</i>	<i>% Passing</i>
STA-3111	627	10	98.4%	534	85.2%
STA-3112	211	5	97.6%	190	90.0%

## DISCUSSION

The use of Power Point where text was presented in conjunction with graphs and other pictorial representations effectively assisted students, particularly those with a more visually oriented learning style. The course pack comprised of PowerPoint slides helped students to focus on class discussions by minimizing the note-taking process. Furthermore, the integration of computational technology provided an effective teaching tool for this type of course by generating more time for data analysis and conceptual understanding. The scientific calculator expedited the computation of sample means and standard deviations as well as binomial and Poisson probabilities; whereas the presentation of SPSS output for statistical graphs and procedures led to a deeper problem understanding. Instructor's mobility in the classroom, granted by the use of a presenter device, also facilitated interaction with the students.

To assess the effectiveness of this interactive approach based on technology resources, data from Table 1 was used to compare the performance and motivation of students taking the STA-2023/2122/3123 courses to groups of the same courses taught by the present author with a more traditional approach that excluded Power Point and SPSS. Some statistical comparisons provide useful information about the effectiveness of this technology based interactive approach. The passing rate was almost 20 points of percentage higher and the retention rate increased from 91.7%

to 96.5% while using the interactive approach. Despite possible limitations, tests of significance using data from Table 1 indicate that the greater retention and passing rates for groups with the technology additions are highly significant ( $p$ -values  $< 0.00005$ ). Moreover, students' satisfaction with the interactive method was high, demonstrated by the near 90% of excellent/very good opinions about the overall quality of instruction, as assessed by the official university surveys.

These results indicate that the integration of technology resources into an interactive approach provided a highly effective teaching-learning method for undergraduate students taking introductory statistics courses.

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