TEACHING AN UNDERGRADUATE STATISTICS CLASS WITH TECHNOLOGY

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Abstract

Technology plays a vital role in teaching and learning statistics. Over the years the development of technology has changed the way of thinking and teaching a statistics class. In this paper an overview is given on variety of ways in which technology can be involved in the teaching of an undergraduate statistics class and how technology will foster deep understanding of statistical concepts and statistical thinking among undergraduate students. The paper will provide instructional technologies available and will give some insights about the undergraduate statistics course at our institution, where we incorporate technology as a vital part in the course. The specific course under consideration in this paper is a lab based introductory class which is student centered and technology enhanced. This can enrich students' learning experience in the statistics class.

Introduction

In today's world decision making and learning from data are increasingly dependent on evidence from data. The rapid growth of the technological tools available in today's world has changed the landscape of teaching and learning statistics. In the field of statistics there is a great attention on how we as academics make students understand and know how to apply statistics. Introducing lab based undergraduate statistics class is one effective way to make students improve their statistical knowledge and statistical thinking skills. Use of technology in the lab classes allows utilizing variety of relevant data and providing students with valuable experience. The lab based class is structured according to the fundamental principles articulated by Cobb (1992) on behalf of the American Statistical Association/Mathematical Association of America joint committee: 1). the need for data and concepts, 2). emphasize statistical thinking, and 3). foster active learning. The students will have a better understanding about how to deal with data, uncertainty and its effect on decision making, ability to think statistically, finally "the big picture", which will be useful and important above and beyond towards their future careers.

Background

In the recent years there have been a loud and urgent calls for reform in statistics education in all levels of the education system in the US as well as internationally (Binnie, 2002; Jacobbe, 2010). Statistics is used in a wide range of disciplines. With the complexity of today's world and the increase use of statistical analysis, educators are very much interested in providing sound conceptual knowledge of statistics and how to apply them correctly. On the other hand teaching and learning statistics is changing tremendously with the development of new technology. Integrating technology into the introductory statistics course at the undergraduate level can be used to develop student's statistical thinking skills. Statistical thinking has a broad meaning and the essential elements of statistical thinking have been discussed by several people, and to name a few: Moore (1990), Cobb (1992), Snee (1999) and Wild & Pfannkuch (1999). In summary all definitions and statements on statistical thinking address how to make sense of data.

Many introductory statistics courses contain too much material. There is a growing recognition that we need to change the way undergraduate statistics is taught. Usually in a traditional undergraduate statistics class, with the load of material being covered, it is difficult to motivate students and develop statistical thinking. Cobb (1991) in his treatise, Teaching Statistics: More Data, Less Lecturing, commented: "*lectures don't work nearly as well as many of us would like to think".* If students don't understand concepts, there's little value in knowing procedures. We need to walk away from the traditional overview of statistics as a discipline that relies just upon formulae and procedures. Major emphasis should be on students understanding of statistics, use and its value. Also it is essential to present statistics as an interdisciplinary approach that allows the students to use statistics to answer real world situations and communicate statistically.

Many successful reforms have been made to the traditional algebra-based, introductory statistics course which leads to new emphasis on the incorporation of collaborative projects, conceptual understanding, genuine data sets, activity-based learning, and use of technology (Kuiper 2010). Richard Schaeffer (Moore, 1997) states that "with regard to the content of an introductory statistics course, statisticians are in closer agreement today than at any previous time in my career." Garfield, Hogg, Schau, and Whittinghill (2002), in their paper presents the impact of reform efforts on the teaching of statistics. Also they provide suggestions and guidelines for teaching these courses.

Statistics should be taught as a laboratory science (Cobb, 1992). Nolan & Speed (1999) explored in depth a model for developing case studies/labs for the use of the undergraduate mathematical statistics class. In this approach the students were exposed to the concepts of statistics and probability through case studies/ labs. In our approach, we first teach the theory in a lecture format to the students and then let the students perform the relevant lab. This will help the students learn all aspects and extensions of the statistics and probability concepts and be prepared with the tools needed for the lab portion of the class. In this lab based lecture class students learn the fundamental ideas of statistics and probability in the context of current real world situations. Also great

importance and attempt have been made to incorporate technology to these classes inorder to have a positive impact on the students' statistical thinking skills.

Statistical Technology

Technology has become a part of our daily life. At the rate the technology is changing, incorporating technology into teaching continues to be an evolving task. Technology strongly influences both what we teach and how we teach a statistics class (Moore, Cobb, Garfield, & Meeker, 1995). Technology provides the opportunity to create an entirely new learning environment, which is beneficial in teaching undergraduate statistics. There is a variety of technology tools that can be used to improve student learning in an undergraduate statistics course.

As Kemp, Kissane and Bradley (1998) points out, the hand held graphics calculators provide students with an easily accessible experience of inferential statistics. Though these calculators would not perform major analyses, it can play an important role in a student's first learning experiences with statistical analyses. Instructors have the choice between many quality statistical software packages; SAS (http://www.sas.com), MINITAB (http://www.minitab.com), SPSS (http://www.spss.com), R (http://www.r-project.org), etc. Continuing upgrades of the software has led to menu-driven packages making it easy for the student. Also Excel is available for easy computations. Another great tool for the students to visualize the statistical concepts is the use of applets. In the recent years there is a tremendous growth in the development of applets. Other valuable fact is the availability of the text books with the inclusion of technology commands and instructions (statistical software, Excel, StatCrunch, etc.).

Depending on the course learning outcomes, instructors should seek appropriate technology necessary to meet the teaching goals of the course. Also the technology should be accessible for the students and it is important to be able to provide adequate computer time for the course structure. Another concern is the expense for licensing, and the level and need of students. In the lab based class discussed in this paper we use MINITAB as it is the most appropriate for our students and we use Excel as the students have easy access. Also we use TI 84 plus calculator for simple and quick calculations.

The purpose of the course is to teach the students statistical concepts and analytic techniques using technology as a tool. Also it is worth to note that technology is not a substitute for understanding statistical theory and concepts. Today's world decision making is based on statistical analysis where statistical software is used. Students having access to technology in the class are likely to use it in their own research or future careers (Bradley & Kemp, 2002).

Course Description

Elementary statistical methods course (STAT 301) is a basic introductory statistics course offered at our institution. The course content includes descriptive statistics, probability, random variables, sampling distributions, inferential statistics and regression analysis. After completing the course, students should be able to recognize and apply these concepts in specific cases. Although no statistics or calculus class is required or assumed of students who take this course, the pre-request for this course is College Algebra (MA 152) or Algebra & Trigonometry 1(MA 153). The undergraduate students enrolled in the elementary statistical methods course are usually Liberal Arts, Business, Nursing, and Engineering & Technology majors. The STAT 301 course is offered in different formats: traditional lecture, hybrid, online and lab based lecture class. All class formats use TI84-plus and MyStatLab program from Pearson Education/Addison Wesley. The course draws material from the text Statistics – Informed Decisions Using data by Sullivan published by Pearson (3rd edition). The specific class under consideration in this paper is one large lab based lecture class offered for our students in the university, and we have around sixty students enrolled every semester. Student work is evaluated through in class exams, lab assignments and homework using MyStatLab.

The lab based class meets one hour and fifty minutes on Wednesday of the week for traditional lecture and fifty minutes on Friday in the lab for the project session. All of the students enrolled will meet in a large lecture hall on Wednesday and split between three lab sections on Friday. The lab based lecture class is developed to introduce students to the necessary concepts and theory in statistics in the lecture portion of the class and application of these are integrated via the lab portion of the class. The labs are central to this elementary statistics course. Depending on the material covered in the lecture, in the lab the students do related projects which serve to motivate and provide hands on experience in using the concepts and theory learned. The intervention involves 50 minutes activities conducted every Friday of the week. Students work individually and/or in small groups of two or three students where each group had to perform certain tasks. The lab class mainly use the statistical software MINITAB, spreadsheet package Excel and the TI84-plus calculator to analyze data, conduct simulations and to explore ideas. Instructor provides hints; MINITAB and Excel instructions and suggestions to carry out the lab. The projects are thoughtfully designed to cover the main ideas and related theory. While the statistical topics vary for each lab, students will be following a thoughtful process as 1). data collection and /or literature review, 2). perform descriptive analysis, 3). integrate technology, 4). perform statistical analysis, 5). make inferences, 6). discussion and conclusion, 7). report writing and/or presentation.

In this lab based lecture class the emphasis is on the collection and analysis of real data and provide students with the initial exposure to the discipline of statistics. Further students gain statistical knowledge, versed in using statistical software, active learning, and finally develop statistical thinking.

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