Efficacy of Computer Tutorials for an Introduction to Statistics course

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Abstract

Tutorials are a form of computer-based instruction that is becoming more prolific in higher education. For this study, some key issues of student understanding of scientific methodology and student usage of Excel's statistics functions were addressed by writing computer tutorials as PowerPoint macro-enabled shows. While one section of Statistics for Bioscience used the newly developed computer tutorials, another section of the same course used the paper-based tutorials that had been developed previously. Comparing learning between the two sections yields a measure of the efficacy of the computer work. This presentation describes the basic principles used in developing the tutorials and the results of the comparison.

Key Words: Tutorials, Computer Aided Instruction, Powerpoint

1. Introduction

Good Samaritan College's Introduction to Statistics course includes a significant number of students who have not had a math course in more than a decade. Teaching the course assuming prerequisite calculator skills does not meet the needs of these students, while at the same time teaching basic math skills is equally unacceptable. Online and paper based tutorials were used but with limited success. For instance few students could carry out the step-by-step process used for finding a standard deviation as described in the textbook. When asked about their inability to complete the step-by-step process, students were unable to pinpoint the problem and usually just said, "I don't understand." Further probing indicated that different students were failing at different points and for different reasons – from a lack of understanding of the sum symbol to an inability to recognize the algebraic hierarchy in the final standard deviation formula to an inability to go from a superscript format for square in the formula to a ^ or y^x format on the calculator.

Computer tutorials are ideally suited to meet the instructional needs of these students because the computer tutorials' immediate feedback insures student mastery of each step separately before attempting mastery of the overall process. Large institutions have successfully designed computer tutorials and have integrated them into classroom instruction. Massachusetts Institute of Technology created the myCyberTutor, a homework delivery tool that engages students actively both in the logical process of working through physics homework problems, and requires them to analyze and assess the significance of the solution they achieve (Morote and Pritchard 2009). Carnegie Mellon developed the Cognitive Tutor over a period of twenty years for use with

psychology students, in conjunction with classroom learning and face-to-face tutoring (Viadero 2007).

Besides requiring mastery each step or idea before further analysis, Wang (2010) found two other key values of computer tutorials. Wang found that a self-paced computer assisted learning environment decreases student anxiety and supplies the student with a sense of control over the learning process. Wang also concluded that multimedia environments appeal to a variety of learning styles and break some of the tedium of learning, allowing longer engagement with material.

Educators at higher education institutions often view the development of these types of sophisticated computer tutorials as expensive, time intensive, or technically out of reach for all but those individuals with advanced knowledge of computer programming. The computer tutorials designed for this study were built by one instructor over the course of a year to address students' ability to perform common statistical calculation and computer activities. This study required little technical support and no special software beyond Microsoft Office. The development and subsequent use of these tutorials revealed several key principles for the educator who develops computer-based instructional strategies.

2. Results of Comparison between Paper and Computer tutorials

One section of Introduction to Statistics was given traditional lectures and paper based tutorials to work on either alone or in groups as per student preference. This section is called the "paper" section for this study. Another section, during class, used four computer tutorials written in Powerpoint to work on alone or in groups as per student preference. This is the "computer" section.

Three objectives were included in this study:

Objective 1 was "The student will use the average and stdev (standard deviation) functions in Excel." The computer section of introductory statistics did interactive computer tutorials while paper section worked through paper based tutorials. Both sections had a homework assignment requiring use of Excel's average and stdev functions on a set of data. The exam which included this material was one week after the homework assignment was due. All the students using the computer tutorials successfully met this objective, while only 12 of 17 using the paper tutorials were successful.

Objective 2 was "The student will tabulate data and calculate the average and standard deviation of a set of data." Both computer and paper tutorials followed the textbook's (Blair 2008) methodology. Two homework sets focussed on this objective. Because the exam involving this objective was open book, both sections were primarily successful, with the section doing the paper tutorial performing slightly better. (See Table 1.)

Objective 3 was "The student will recognize common poor experimental techniques." Some topics covered were lack of experiment controls (including blindness), patient safety and review boards, measures of success, reproducibility, correlation implying causality, conflict of interest and paying test subjects, and stating that failure to reject a hypothesis implies proof of the hypothesis. For example: A test question discussed this

study and asked about the experimental flaw that the students and instructor knew which group was doing which tutorial set. For this objective, the same Powerpoint was done as a lecture without interactive questions to the paper section and was done as an interactive tutorial to the computer section. For a study aid, both sections had digital access to the respective Powerpoint.

Table 1: Comparison of students success between the section using computer tutorials with the section using paper tutorials.

		Proportion of students that obtained the correct stdev		*Experimental design quiz % Average ± stdev*
	# of students	*Using Excel Objective 1*	*On paper. Objective 2*	*Objective 3*
Paper	17	12/17	15/17	72 ± 11
Computer	16	16/16	13/16	82 ± 6
p		0.007	0.58	0.002

* average ± stdev

3. Conclusion

Computer tutorials were efficacious in this study. The authors believe that the primary reason for this is the immediate feedback available to the students. Feedback can be used to ensure student mastery of each item of learning or process step before learning the overall process; the key criterion for an effective tutorial (whether on paper or on computer) is the comprehensiveness with which the tutorial covers all of the necessary building blocks of learning.

A last, but crucial comment: No matter what new sort of teaching style a teacher is considering, if the teacher goes too far beyond his/her comfort zone (whether in trying new software, like vba enhanced Powerpoint, or new techniques, like merging multimedia into the learning environment), success will be unlikely. In the end, all teaching is teacher-centered in the sense that the teacher must be comfortable with what he/she is doing. But, at the same time, an end of all teaching methods is to be student-centered, in the sense that the student must be engaged with the material.

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