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Hypertutorial and Conventional Web-Based Lessons Evaluated Similarly by Dental Postgraduates in Health Informatics Statistics Course

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ABSTRACT

Twenty-seven dental postgraduate students, enrolled in a Web-based Statistical Methods in Health Informatics course at the University of Texas Health Science Center at Houston and given no training in computer or Web use were randomly assigned to Hypertutorial versus "conventional" Web-based instructional methodologies for the first of 22 Web-based statistics lessons. Students then switched methodologies for each succeeding lesson, alternating methodologies, lesson by lesson, as they proceeded according to syllabus schedule through the remaining 21 Web-based lessons making up the course. Students evaluated both instructional methodologies similarly. No significant differences were found between the two methods of instruction on any of three end-of-lesson, student evaluation of instruction subscales. This result contrasts with previous studies in more controlled environments in which hypertutorial lessons using similarly sized samples consistently demonstrated significant superiority on a variety of measures. Students working with lessons in ways, times and places of their own choosing in an unsupervised field setting may not properly follow study guidelines. The study illustrates some of the difficulties inherent in conducting rigorous randomized controlled studies in open Web-based field settings.

INTRODUCTION

Hypertutorials[1] implement five features: Presentation, learner control, practice, feedback, and elaborative learning resources. Previous research[1] demonstrates that each feature, by itself, typically facilitates learning. Hypertutorial learning environments optimally integrate all five. In previous randomized studies, where students worked in controlled classroom or computer lab environments, Hypertutorial lessons using sample sizes similar to those of the present study consistently demonstrated significant superiority over conventional "Book-on-the-Web" lessons on a variety of measures[2,3,4,5]. Previous research also showed graduate students significantly and overwhelmingly preferred Web-based hypertutorials[2,5]. The primary question for the present investigation was whether hypertutorial lesson superiority could be demonstrated when conducting randomized comparisons in an open Web-based course field environment where students worked unsupervised with lessons in ways, times and places of their own choosing. This report describes that randomized comparison of hypertutorial and conventional "Book-on-the-Web" instruction.

METHODS

Subjects. Twenty-seven dental postgraduate students, enrolled in Web-based Statistical Methods in Health Informatics course at the University of Texas Health Science Center at Houston participated in the study. Students were given no training in computer or Web use. Students attended a brief introductory orientation class session where students were informed how to access the course materials including the course homepage and its associated hyperlinks, the syllabus, and the Web-based tutorial lessons. All 27 students who registered for the course volunteered to participate in the research. Five students were excluded from the data analysis due to missing data.

Procedure. Students used either Netscape version 3.0 or above or Microsoft Internet Explorer version 4.0 or above to access, study and respond to the Web-based tutorial lessons given a schedule recommended in the course syllabus. All lessons were completed by all students by the end of the course. At the end of each lesson, students responded to a five-item quiz and a 22- item end-of-lesson student evaluation of instructional effectiveness.

Student responses to embedded practice exercises, quiz, and end-of-lesson student evaluation items were stored immediately as they were entered, using a small, client-side, JDBC applet, into a Microsoft SQL Server database and also logged redundantly via automated E-mail from within the browser. No Java servlets or CGI code were employed.. Students used the browser of their choice in ways, times and places of their own choosing, and were not limited to lesson access from School computer labs or classrooms as in previous studies conducted by the first author.

Instruments. A five-item cognitive achievement lesson quiz and a 22-item end-of-lesson student evaluation of instructional effectiveness appeared at

the end of each lesson. The lesson quizzes were individually designed to assess achievement of each lesson's objectives. On the other hand, the same 22 items were used for all 22 lessons' end-of-lesson student evaluation of instructional effectiveness.

Included among the 22 student evaluation of instruction items were 15, 5-point Likert type items distributed into 3 subscales. The 3 subscales assessed specific instructional, hypertutorial and outcome objectives, respectively. On most of the 15 5-point Likert type items the scale descriptors ranged from "Much better than the typical lecture" (rating = 5) to "Much worse than the typical lecture" (rating = 1) with "Same as the typical lecture" as the middle rating.

Items forming the 3 subscales were generated from a data source by objectives matrix using a standard top-down, goal/task analysis methodology for achieving content validity: First, the three subscale goals were identified. Second specific behavioral objectives were identified for each subscale goal. Third, items were written to measure degree of achievement of each objective for each subscale. The use of a data source by objectives matrix together with the top-down methodology assures that the instrument contains a representative sampling of the objectives, resulting in high content validity. Reliability of the subscales was 0.90, 0.82 and 0.85, respectively.

Lessons. Each of the 22 tutorial lessons was written entirely in a combination of HTML and JavaScript and each referenced one and the same small JDBC applet via an "applet" tag. Each HTML lesson document delivered instruction, included embedded forms elements, and included JavaScript functions that implemented feedback, collected, scored, formatted and transmitted via E-mail all student data (including timing information). All of these processes were implemented on the client without CGI programs or servlets. Data was redundantly stored by the Java JDBC applet whose methods were called from JavaScript on the client to transmit the data to a Microsoft SQL Server database on the server.

Design. Two different versions (Hypertutorial vs. Conventional) of each lesson were created that contained identical presentation text and graphics, but differed in the presence or absence of hypertutorial features. For the Hypertutorial versions of the lessons, hyperlinks operationalized the elaborative learning resources feature while increasing learner control, as well. Embedded practice exercises with immediate feedback (correct, incorrect) operationalized the practice and feedback features while also increasing learner control. Together, the hyperlinks and embedded practice exercises with immediate feedback operationalized the only differences between the Hypertutorial and Conventional lessons. Both versions contained identical presentation text and graphics and differed only in the presence or absence of elaborative learning resources, practice, feedback, and degree of learner control. Hypertutorial lessons contained the hypertutorial features. Conventional lessons did not.

All students taking the course were randomly assigned to two groups at the beginning of their participation in the study. After deleting the five students due to missing data, Group 1 contained 10 students; Group 2 contained 12 students. Students in Group 1 started the course using the Hypertutorial (H) version of Lesson One. Students in Group 2 began with the conventional (C) version of Lesson One. Lesson versions then alternated for each student lesson by lesson as students progressed through each of the 22 successive Web-based lessons at times and places of their own choosing.

The complete research design consequently presents three factors (See Table 1): One between-subjects factor (Group - 2 levels; HCHC…HC vs. CHCH…CH) and two within-subjects factors (Odd vs. Even Numbered Lessons – 2 levels) and (Lesson Number – 22 levels). As can be seen from Table 1, the 22 levels of Lesson Number are nested within the two levels of the Odd vs. Even Numbered Lesson factor. The three scores for the three student evaluation of instruction subscales constituted the dependent variables tested for the study.

Data analysis. Repeated measures data analysis employed the SPSS 11.01 MANOVA procedure for the three factor design having one between-subjects factor (Group) and two within-subjects factors, with the first within-subjects factor (Odd vs. Even Numbered Lessons) having the second within-subjects factor (Lesson Number) nested within its two levels. The three subscales (instructional, hypertutorial, outcomes) constituted the dependent variables for the 3 univariate repeated measures analyses conducted by MANOVA. For each univariate analysis the omnibus Group by Odd vs. Even Numbered Lessons interaction test constituted the critical test (alpha = .05) for significant presence of a differential Hypertutorial vs. Conventional lessons effect. This is so because Hypertutorial superiority would appear in the form of Group 1 superiority to Group 2 on the Odd Numbered Lessons with simultaneous Group 2 superiority to Group 1 on the Even Numbered Lessons (See Table 1). As noted earlier, 5 students were deleted from the analysis

because of missing data. For each of the 22 remaining students, regression estimates based on their other scores replaced any relevant remaining blanks or erroneous responses.

RESULTS

Student evaluations of the Web-based instruction were high overall, with ratings for all three subscales (instruction, hypertutorial and outcomes) averaging in the range of "Better than the typical lecture" (rating = 4) for both methodologies (See Table 1). The results of the three interaction tests were not significant for instruction ($F_{1,20} = 1.70$, $p < .207$), for hypertutorial ($F_{1,20} = 0.69$, $p < .417$) and for outcomes ($F_{1,20} = 2.19$, $p < .154$) subscales, respectively. While most of the cell means for Hypertutorial lessons exceeded those of the Conventional lessons, the study found no significant (alpha = .05) differences between the two Web-based methods of instruction on any of the three subscales of the student evaluations of instruction.

Group	Odd Lessons											Even Lessons										
	1	3	5	7	9	11	13	15	17	19	21	2	4	6	8	10	12	14	16	18	20	22
1	H	H	H	H	H	H	H	H	H	H	H	C	C	C	C	C	C	C	C	C	C	C
	Instruction Mean = 3.97											Instruction Mean = 3.97										
	Hypertutorial Mean = 4.11											Hypertutorial Mean = 4.14										
	Outcomes Mean = 3.80											Outcomes Mean = 3.78										
2	C	C	C	C	C	C	C	C	C	C	C	H	H	H	H	H	H	H	H	H	H	H
	Instruction Mean = 3.88											Instruction Mean = 4.03										
	Hypertutorial Mean = 4.01											Hypertutorial Mean = 4.12										
	Outcomes Mean = 3.72											Outcomes Mean = 3.80										

Table 1: Design diagram and means of hypertutorial subscale.

DISCUSSION

Dental Postgraduate students enrolled in a Statistical Methods for Health Informatics course gave high ratings to both Web-based hypertutorial lessons and Web-based conventional "Book-on-the-Web" lessons in Web-based student evaluations of the two instructional methodologies. Ratings averaged in the range of from "Better than the typical lecture" to the "Much better than the typical lecture" for both methodologies.

The present study found no significant differences between the two methods of instruction on any of the three subscales of the Web-based evaluation instrument. This result contrasts with all previous studies in more controlled classroom or computer lab environments. In these prior studies hypertutorial lessons using similarly sized samples demonstrated significant superiority on a variety of measures[2,3,4,5].

A plausible reason for the difference in results between this and previous studies is that students, unsupervised and working with lessons in ways, times and places of their own choosing, may not properly follow study guidelines. In fact, anecdotal reports from students indicated that some students did not follow guidelines while the investigation was under way. For example, some students shared hardcopies of their hypertutorial versions of lessons versions with students who were assigned to the conventional versions of lessons.

The present study illustrates some of the problems and difficulties that can occur when investigators attempt Web-based randomized controlled studies in the uncontrolled environments of typical open field settings. Further research may produce methodologies and technologies for improving experimental control in open unsupervised Web-based settings as more is learned about conducting such research.

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