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Effectiveness of a Multimedia General Education Course

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Abstract

The current paper describes the design, development, and evaluation of self-paced multimedia modules that are used in an advanced General Education course at San Jose State University. The design and development cycle of these modules began in 1994 and continues to this date. The General Education course, Technology and Civilization (TECH 198), is designed to introduce students to the realm of history and usage of technology in society and to increase their awareness of both the uncertainties as well as the promises of the utilization of technology as a creative human enterprise. During the summer session 1999, the completed modules were field-tested in one section of the class with fourteen students. The students were randomly assigned to two groups: group 1 completed the multimedia module on Unit 1 (The Nature of Science and Technology) and group 2 completed the multimedia module on Unit 2 (Technology and Work). When comparing performance on pre-test and post-test measures, this study produced inconsistent results. For Unit 1, there was no difference in student performance when comparing the multimedia-based instruction with the traditional classroom instruction. In fact, the students taking the multimedia-based instruction for Unit 1 did significantly worse on the posttest ($t = 2.457$, $p = 0.022$) than those students in the traditional classroom. The results from Unit 2 differ from those of Unit 1. For Unit 2, both groups had significantly higher scores on the posttest than on the pretest. Also, Group 2 performed better overall on the posttest than did Group 1 although the difference was much less than the difference for Unit 1 (Group 1 Mean = 7.7 and Group 2 Mean = 8.4). This result would indicate that, for Unit 2 at least, the instruction by self-paced multimedia was as good as the "traditional" classroom instruction.

I. Introduction

There has been much discussion in general educational publications about the value of instructional technology, in particular multimedia or WWW-based instruction. Much of the published work thus far has described various features of multimedia systems in an anecdotal manner rather than focusing on an evaluation of multimedia and its use in the university setting[1]. In all of the discussion on multimedia, the nature of multimedia and learning using multimedia are interlinked. That is, most authors attribute positive pedagogical implications to multimedia merely because of its nature or structure. This perspective combines two aspects of learning, what is learned and how it is learned, into one entity. This pedagogical perspective has some foundation in the literature. There have been long-standing claims that students learn faster and retain more information the more they are involved in the learning process.

Therefore, the more students interact, the more they will learn. From a theoretical perspective, Hamilton[2] saw the curriculum as a process that should not separate what is learned from how it is learned. This duality is the fundamental identity of multimedia.

By its nature, multimedia-based learning is more complex than traditional lecture instruction. According to Mandl[3], there are a number of factors to consider in designing a model for complex learning. First, there must be appropriate support for complex learning; for example, the development of multimedia structure by a teacher or peer. Second, there is the need to prepare students for a new learning environment. One major problem with innovative teaching methodologies is that there is a lack of fit between the innovative instruction and the evaluative measures (i.e., tests and examinations). In order for multimedia teaching techniques to be effective, there needs to be focus placed on student applications of theoretical concepts to solve problems.

Because of the unique nature of multimedia, problems exist with the delivery of instruction. Jonassen[4] described three major problems that occur in multimedia: navigation (users get lost in the document), difficulty in integrating the presented information into personal knowledge structures, and cognitive overload. Also, he stated that a learner's interactions within a multimedia environment are not predictable and are less deterministic than other modes of instruction. Other researchers[5,6] have found that a student's learning style affects achievement on multimedia-based learning. Divergers (using Kolb's learning style preference) were found to inprove more on posttest measures than those who have other learning styles. This would lead one to state that the successful use of hypermedia requires nonlinear thinking on the part of the user--this type of thinking may not be successful for all users.

II. Design and Development of the multimedia modules

The designer of this project applied for a SJSU *Improvement of Instruction* grant and was awarded one for the 1994 calendar year. This project provided for the design and implementation of an interactive, multimedia course. The course chosen for this project was Technology & Civilization, a general education science-technology-society course. This course is required for Industrial Technology majors in the College of Engineering as well as being a popular Advanced General Education course for other majors at San Jose State.

A needs assessment for this course was done, eliciting input from faculty and experts in the field. An overall framework for the multimedia document was developed that was used as the planning document for subsequent development. This plan was evaluated for content using the expertise of many faculty members in addition to evaluation from an instructional perspective.

Before any multimedia development work was done, a faculty panel revised the course syllabus. The original content structure of the course is shown in Table 1. During the discussions of the course by the faculty, there was a general consensus that the course content was too much. So, the content of the course was revised to reduce the number of units to six (see Table 2). After the course syllabus and content were determined, the development work began on the multimedia modules.

Table 1. Original Content of the course, Technology and Civilization

Unit	*Title*
1	The nature of science and technology
2	Technology and work
3	Technology: Gender and cultural issues
4	Technology assessment and management
5	Technology transfer
6	Quality of life issues
7	Technology ethics and society
8	Prospects for our technological future

Table 2. Revised Content of the course, Technology and Civilization

Unit	*Title*
1	The nature of science and technology
2	Technology and work
3	Technology and gender issues
4	Technology transfer
5	Quality of life issues
6	Technology ethics and society

The first decision in the multimedia development process was the choice of authoring environment, Authorware for Windows. In addition, other planning decisions included discussions with Information Systems and Computing related to the use of EMAIL by students and the most effective way to manage the EMAIL interactions among students and with the faculty coordinator; and determination of the best way to include videotaped materials: on videotapes, videodisks, or as a part of the multimedia environment using CD-ROM.

The primary outcome of this project was self-paced modules on CD-ROMs that allow students to explore the topics presented in this class on their own corresponding with other students and faculty by EMAIL. The primary instruction for these modules is by a multimedia-based document that provides an organizational structure for the course. In addition, textbooks, readings, and videotapes are required for the class. Each unit is divided into multiple sections--at the end of each section, students are required to complete a class activity and submit the activity to their professor by email.

The multimedia document developed linked the text, video materials, discussion questions, exercises, and Quicktime and Video For Windows (VFW) movies. The type of structure in this multimedia was a modified hierarchical hypermedia. This is a more structured hypertext and

assumed to be more consistent. The movement within hierarchical hypertext can only be up, down, forward, backward, without jumping. A problem with this type of structure is that it can be too restrictive. As this course required the student to be exposed to the topics mostly in a sequential manner, this structure was chosen in order that the student could understand the continuity of the material presented.

Each unit in this course was developed as a series of files under Authorware, with each unit having an introductory section (file) followed by four to eight sections (files) in each unit. The individual files were linked by hypertext commands so that the student would not have to run the individual files separately. The remaining units in this course had the same overall structure, nested Authorware files. The multimedia was converted to an executable version for student use.

The design and development phase of this multimedia course began in June 1994 and continues. The first version of Units 1 and 2 were used in Fall 1994 and Spring 1995 lecture courses as presentation modules although the entire hypermedia course was not finished. The students and faculty in the course evaluated the modules in order to further refine these multimedia documents. In 1996, Backer[7] presented the development and design of the first version of these multimedia modules to an international meeting on educational multimedia to obtain comments and feedback on the structure of the multimedia modules.

After gathering several semesters of data on version 1 of the multimedia documents for Units 1 and 2, version 2 of the multimedia was created in 1999. The most significant differences between version 1 and 2 relate to the navigational structure. The original structure of these multimedia modules was a modified hierarchical hypermedia. For version 2, the structure was revised to reduce the amount of hyperlinks in the document. Many students reported problems with navigating (getting lost in the document) through the modules--this, according to Jonassen[4], is one of the three major problems that occur in multimedia.

III. Methodology

During the summer session 1999, the revised modules were field-tested in one section of the class with fourteen students. The students were randomly assigned to two groups: group 1 completed the multimedia module on Unit 1 (The Nature of Science and Technology) and group 2 completed the multimedia module on Unit 2 (Technology and Work).

The summer session was organized into a one-week class with eight hours of class each day. Day 1 of the class was devoted to Unit 1 and Day 2 of the class was devoted to Unit 2. On the randomly assigned multimedia day, the students were sent to a computer laboratory where each student was assigned a computer and given a CD-ROM with their module. Instead of attending class, they stayed in the computer laboratory and completed the multimedia. In lieu of their "regular" classwork, they completed the online class activities at the end of each section of the multimedia.

The class consisted of nine women and five men. All but two of the students were in their 20s and all but one used computers daily for either work, school, or recreational purposes. The students encompassed a wide range of majors: child development, psychology, photography, industrial technology, English literature, computer science, administration of justice, industrial design, mathematics, and aviation. As this course regularly attracts students from throughout the campus, this class seemed representative of the students who normally take this class.

On the first day of class, the students were given a demographic student profile that asked their age, experience and time spent daily on a computer, and major. Also, the students were given two computer attitude questionnaires. The first was an open-ended survey with three questions designed to find out (a) how they defined computers and (b) their love-hate relationship with computers. This survey was developed by Morse and Daiute[8] and was field-tested by this researcher[9] in a previous study. The second survey was a revised version of Oetting's Computer Anxiety Scale [COMPAS][10]. These two computer surveys were given to control for any variability in the computer anxiety and/or attitudes of the two treatment groups.

Table 3. Pre- and posttest scores for students taking the class

Student	Group	Pre-test Unit 1		Post-test Unit 1		Pre-test Unit 2		Post-test Unit 2	
		Score	Percent Correct	Score	Percent Correct	Score	Percent Correct	Score	Percent Correct
1	2	3	37.5	5	62.5	7	63.6	11	100.0
2	2	1	12.5	8	100	4	36.4	7	63.6
3	2	3	37.5	3	37.5	2	18.2	6	54.5
4	2	1	12.5	7	87.5	3	27.3	8	72.7
5	2	5	62.5	8	100	9	81.8	11	100.0
6	2	2	25	7	87.5	3	27.3	9	81.8
7	2	5	62.5	3	37.5	4	36.4	7	63.6
8	1	4	50	7	87.5	2	18.2	10	90.9
9	1	0	0	1	12.5	1	9.1	6	54.5
10	1	2	25	4	50	2	18.2	8	72.7
11	1	0	0	4	50	0	0.0	8	72.7
12	1	0	0	4	50	1	9.1	7	63.6
13	1	1	12.5	3	37.5	4	36.4	9	81.8
14	1	1	12.5	4	50	5	45.5	6	54.5

In addition to the computer anxiety/attitudes surveys, all the students were given pretests for both Units 1 and 2 before either class instruction or multimedia instruction began. On the last day of class, the students were given the posttests for both units. The pretest and posttest for Unit 1 (The Nature of Science and Technology) had eight questions that were selected by faculty teaching the course as representative of the information covered in the unit. The pretest and posttest for Unit 2 (Technology and Work) had eleven questions also selected by faculty.

Table 3 below shows the results of the pretest and posttest scores for both Units 1 and 2. (Students in Group 1 completed the multimedia for Unit 1 and students in Group 2 completed the multimedia for Unit 2.)

IV. Results

A. Comparison of Groups

Students in the two treatment groups had an equivalent mean age (27 years); and similar amounts of time reported as spent on computers each day (3.09 hours/day for Group 1 versus 2.95 hours/day for Group 2). In addition, both groups showed a wide range of computer anxiety on the COMPAS; however, the mean computer anxiety score for each group was equivalent (mean score of 108 for Group 1 versus a mean score of 107 for Group 2).

In performance, the two treatment groups appeared to be distinctly different. An Analysis of Variance (ANOVA) comparing the results from the pretests and posttests for both Unit 1 and 2, indicated that there was a significant difference between the two treatment groups. On both posttests, the students in Group 1 scored lower, on average, then students in Group 2. These lower scores for Group 1 persisted across the entire class. On the final exam, students in Group 2 scored significantly higher on both the Unit 1 section of the final exam and the total grade on their final exams than did students in Group 1 ($t = 2.15$, $p = 0.03$). Therefore, it appeared that these two groups were not the same in ability (or motivation).

B. Comparison of multimedia versus traditional instruction

Based upon the ANOVA for Unit 1, there was no difference in student performance when comparing the multimedia-based instruction with the traditional classroom instruction. The students taking the multimedia-based instruction for Unit 1, in fact, did worse on the posttest than those students in the traditional classroom. In fact, the posttest results for Unit 1 were significantly different for the two groups ($t = 2.46$, $p = .04$). However, since the students in Group 1 had consistently worse overall performance than students in Group 2, this result is inconclusive.

The results from Unit 2 are different than those of Unit 1. The results showed that both groups had significantly higher scores on the posttest than on the pretest. An ANOVA comparing the pre- and posttest scores shows an F value of 39.84 ($p < .001$). As for Unit 1, Group 2 performed better on the posttest than did Group 1 although the difference was much less (Group 1 Mean = 7.7 and Group 2 Mean = 8.4).

C. Qualitative Evaluation of Multimedia

Ten of the fourteen students completed a qualitative evaluation of the multimedia modules. All ten students liked the multimedia modules for the class. As one student stated, "I liked the video interactions, they [sic] allowed me to comprehend the material better." Another student noted "I found the multimedia portion of this class to be very impressive. I really enjoyed the

freedom and convenience of the CD ROM. The content allowed me to gain specific knowledge on specific subjects that I would not have otherwise known about [sic]."

V. Summary

This paper provided a description of the development process of multimedia modules for a General Education course at San Jose State University. In addition, an evaluation of these modules, completed in the summer 1999 session, was discussed.

When comparing performance on pre-test and post-test measures, this study produced inconsistent results. Based upon their performance both on the posttests and the final exam, the students in Group 2 consistently outperformed the students in Group 1. The effectiveness of the multimedia modules, as compared to classroom instruction, was not demonstrated conclusively.

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