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Impact of Screen-Capture Based Instruction on Student Comprehension of Computer Aided Design (CAD) Software Principles

By Dr. James E. Folkestad & Dr. Michael A. De Miranda

Introduction

The prevalence and importance of computer applications within high-tech industry is undeniable. Companies are looking to hire graduates with software knowledge and computer-based competencies. It is important that industrial technology (IT) graduates enter the workplace with a solid foundation in both theory and function of industrial computer applications. With the proliferation of new software, teaching these technologies is a rapidly changing and technology intensive part of the faculty member's responsibilities; demands that continue to increase in complexity (Boettcher, 1999, Hedberg, 2000, Raval, 2000).

Evidence of these demands can be found throughout higher education. For example, many faculty are familiar with the feeling of teaching a class only to find that the software will not function properly or cooperate. It is not uncommon to hear an instructor complain that a software application was not working or a student remark on how an instructor doesn't know how to use the software. Henceforth, many instructors avoid teaching or demonstrating computer applications altogether (Zhao & Cziko, 2001 and Dawson, 1996).

For example, Computer-Aided Design (CAD) software is changing and being upgraded so frequently that it is difficult for practitioners, let alone educators, to remain current and proficient in their use. This leads to a situation where instructors are often

learning the CAD software just prior to providing in-class demonstrations. Furthermore, each student has their own pace of learning making it difficult to teach CAD related technologies in a stand-and-deliver format, where some students excel and subsequently are waiting on the instructor, and others lag behind and may never grasp the intended learning objectives.

Instructors need an easy and quick-to-use instructional technique for teaching software applications. The technique should allow them to meet the following objectives:

1. Develop prerecorded software presentations that can be used for in-class demonstrations and run by students for further review.
2. Share prerecorded software presentations with colleagues who are working with the same software to reduce development time.
3. Help instructors keep up with the pace of changing software.
4. Develop prerecorded software presentations in a similar time frame to what they would typically have spent preparing for in class demonstrations.

This study examines the use of screen-capture software toward meeting the above-mentioned objectives. Screen-capture software provides an easy-to-use process for developing movie segments of any movements that appear on a computer screen, including any "click" or selections made by the instructor.

These movie segments can then be played back by either the instructor (in-class demonstrations) or the student (self-paced demonstrations). In addition, screen-capture software has the capability of capturing audio messages for verbal explanation. Prerecorded movies (video) of computer-based steps have proven to be an effective means of showing how software works (Allen, Channac, Stephane, Trilling, and Laurent, 2000, Cavalier, 1998, Hampe, 1999, Schwier & Misanchuk, 1993).

This study used screen-capture software to create movie segments for demonstrating CAD software and delivering lab-based lessons. A distributed web-based methodology was used to deliver these screen-capture movies to students. The movies were applied to a treatment group within an introductory graphic communication course at Colorado State University (CSU). Results of this pretest posttest control-group study are presented and implications of the findings are discussed. Recommendations for further study are also provided.

Purpose

The competitive nature of the software industry requires that software companies make improvements to their product on a frequent and consistent basis. Even a minor software update may require relearning for instructors who are teaching these applications in their classes. Furthermore, major software revisions may require a significant amount of retraining, which can take a considerable amount of time.

Add to this the demands of providing a stand-and-deliver software demonstration and many instructors simply do not feel confident or comfortable in front of their class. Instructors need a tool that will assist them in delivering learning objectives and help them with the demands of software demonstrations. Screen-capture software appears to be one tool for developing prerecorded presentations that can be used to assist instructors with software demonstrations. The following study was conducted using screen-capture software to develop tutorial

movies that were used at Colorado State University within a pretest-posttest control-group design to answer four predetermined research questions. These research questions include:

1. Are posttest scores higher for those students who received the screen-capture instruction versus the control group (whom received the written tutorial)?
2. Is there a significant difference between the mean posttest scores of college students who receive software instructional material in a screen-capture format compared to those who receive the same information in a traditional software tutorial book format?
3. What amount of development time will be required to create the instructional material for the screen-capture format compared to the traditional instructional format?
4. Do college-level students respond more favorably on an attitudinal questionnaire to software tutorials presented in a screen-capture format than to material presented in a traditional written textbook format?

Methodology

Toward this effort a pretest-posttest control-group design was used. Borg and Gall (1989) stated that, the pretest-posttest control group design is among the most commonly used experimental designs in educational research. When properly carried out, the pretest-posttest study effectively controls for the eight threats to internal validity identified including history, maturation, testing, instrumentation, regression, selection, mortality, and interaction effects. In addition, an opinion survey was administered to gather information on student attitudes toward the screen-capture instructional method.

Population and Sampling Design

The target population for this study was students in Graphics Communications/CAD (MC131) inclusively. During the spring semester (1999) Graphic Communication/CAD (MC131)

was comprised of one 50-minute lecture and three one-hour and forty-minute applied computer labs (each lab included approximately 25 students). The lecture was structured to cover the fundamental principles and practices of basic technical graphics, with identical material being covered in each lab by the same instructor. The course is required within the Manufacturing Technology and Construction Management (MTCM) Program and study participants consisted of freshman and sophomore level college students working on a baccalaureate degree in manufacturing technology, construction management, or technology education and training. All students registered for the course attended the single lecture, while students were divided evenly among the three lab sections. During registration students had the choice, on a first-come first-serve basis, of lab sections based on the lab times that met their schedule. The treatment was administered based on these lab-section breakdowns and each student was randomly assigned to either the treatment or control group within these labs.

The students were informed that they were being invited to participate in a study and required to complete a consent form. This study required students to participate in three lab sessions involving the application of the instruction (treatment), practice using the treatment method, and testing. Those under age requiring parental consent to participant in this study were excluded from the participant pool and were required to follow the book tutorial instructional format and excused from taking the posttest.

Research Design – Description of Treatment.

Pretest: Prior to delivery of the screen-capture-based instruction (treatment) students were given a pretest. This pretest was designed to assess student knowledge pertaining to CAD and specifically those CAD-based learning objectives that were to be delivered during the study. The same test was used in a post-test format following the treatment.

Book tutorial instructional format (control group): Students in Graphic Communication (MC131) were required to purchase the book, "A Tutorial Guide to AutoCAD Release 14" by Shawna D. Lockhart. The book was chosen for the class because it consists of tutorials that provide step-by-step instructions on how to complete each AutoCAD exercise and at the same time cover drafting principles and content that is directly related to the course learning objectives. Each lesson has specific learning objectives that are listed at the beginning of each chapter providing focus for that lab.

After the initial presentation, described above, the instructor (the same instructor teaches all labs) directed the students to read the assigned chapter (Chapter 6), complete the AutoCAD tutorials, and complete the assigned computer aided drawing tasks. After giving this directive the instructor was available to assist but relied on the students to follow the tutorial (book) and learn from the self-paced lesson.

Screen-capture-based instructional format (treatment): The book tutorial instructional method (described above) was modified to become the treatment instructional format. In preparation, screen-capture movies (actual movies of movements on the computer screen) were made using Lotus ScreenCam™ (<http://www.lotus.com/home.nsf/welcome/screencam>). ScreenCam™ is a simple application that can be purchased directly from Lotus at (<http://www.lotus.com>). A novice can install ScreenCam™ and be making movies within ten minutes.

ScreenCam™ movies consisted of a series of screen-captures that illustrated a step-by-step method for completing the CAD assignment (an example Lotus ScreenCam™ movie can be viewed by visiting the following web address – <http://lamar.colostate.edu/~jfolkst/lab6/mc131.htm>). The steps illustrated via these movies were designed following the learning objectives and more specifically the information that was presented in chapter six of the Lockhart textbook. To index these movies, a web page was created with hyperlinks to

each movie and a description of each associated step. An example of this indexed (cataloged) web page has been provided in Figure 1. This provided the student with an easy to use catalog for finding the information.

Application of Treatment: The treatment was administered during the sixth CAD-lab lesson. Subject matter for the sixth CAD lab included that pertaining to 2D orthographic drawings in AutoCAD (e.g., 2D orthographic views, Ortho command, construction lines, hidden lines, projection lines, center lines, miter lines, Ltscale command, ellipses and center marks). Three lab periods were used to administer the pretest, treatment, and post-test. These labs were taught over a three-week period. The following describes these lab sessions.

Lab session one (week 1): The lab instructor led the lessons in both the treatment and the control group by presenting identical information including an overview and brief explanation of the lab objectives (this was typical procedure and consistent with previous labs). After presenting this identical preliminary information

the study groups were given their respective treatments. The control group was asked to work through the textbook tutorials (Lockhart's chapter six) and the treatment group was presented with a brief explanation of how to access the screen-capture instruction (through the web) and how to work to complete the on-line demonstrations/movies. After this initial instruction students were directed to follow each screen-capture step (movie) and to complete the assigned computer aided drawing tasks. After giving this directive the instructor was available to assist but relied on the students to follow the screen-capture movies and to learn from this self-paced lesson.

Lab session two (week 2): During lab number two (week two), all students were given the opportunity to practice what they had learned by completing two applied CAD problems. These CAD problems were designed as a review for the key points of the lab lesson (treatment and control). During these practice sessions, students were only allowed to use their textbooks if they were in the control group and the



Figure 1. Web page used to catalog ScreenCam demonstrations (movies).

screen-capture movies if they were in the treatment group.

Lab session three (week 3): During the third lab session the students were given a posttest. This posttest was designed to assess student knowledge pertaining to CAD and specifically those CAD-based learning objectives that were to be delivered during the study.

Instrumentation

The posttest included the following sections: seven CAD-based questions (section one), three applied CAD-based exercises (section two), and seven student opinion questions (section three). The test questions were selected from a pool of questions created using content from the course textbook. Furthermore, the test questions were generated based on the objectives for the chapter being presented. After evaluation, it was concluded that a high level of content validity existed because, a) the test questions covered all the different content areas presented during the study, and b) the number of test questions were proportional to the amount of time spent covering each content area.

Findings

Four questions framed this study and provided structure for the findings. The answer to these research questions are provide below.

1. *Are posttest scores higher for those students who received the screen-capture instruction versus the control group?*

Pretest and posttest means were calculated for both the experimental (treatment) group and the control group. Table 1 provides these non-adjusted means. These descriptive statistics provide inconclusive evidence on whether the treatment or control group scored higher on the posttest scores. These means appear to indicate very little difference between the two groups performance on the posttest evaluation. An analysis of covariance (ANCOVA) was calculated to adjust the posttest

scores for differences between the experimental and control group on the corresponding pretest (see question 2).

2. *Is there a significant difference between the mean posttest scores of college students who received software instructional material in a screen-capture format compared to those who received the same information in a traditional software tutorial book format?*

An ANCOVA was calculated to adjust the posttest scores for differences between the experimental and control group on the corresponding pretest. Table 2 provides both pretest and instructional F values. The ANCOVA yielded a significant F value for the pretest (covariate) but not for the instructional method (independent variable). This analysis indicates that the use of the screen-capture instruction, as applied in this study, did not result in an improved performance on the posttest measure.

3. *What amount of development time will be required to create the instructional material for the screen-capture format?*

Development time was tracked and tabulated for each instructional method. The time required preparing for each lab varied between the instructional/treatment methods. These development times were recorded as follows:

Development time for screen-capture: A development log was maintained as the screen-capture movies were created. Over the course of four days nine hours were spent developing the screen-capture moves and linking them to the web-based catalog. This included the time to upload the files to the server and preparing them for use within the student-computer lab.

Development time for textbook-based tutorials: Typically preparation consisted of reviewing the computer-based processes and reviewing the textbook-based tutorial. Preparation for the textbook instruction took three hours. Textbook-based preparation took one-third the development time. This development time will vary between instructors including their individual learning pace.

Table 1: Pretest and Posttest Mean scores for each treatment (average on a 5 point scale).

Measure	Experimental Group (Screen-capture)	Control Group (Textbook tutorial)
Chapter 6 test.		
Pretest Mean	2.92	2.41
Posttest Mean	4.08	4.30

Table 2: Analysis of Covariance (ANCOVA)

Measure	Type III Sum of Squares	df	F	Sig.
Chapter 6 test.				
Pretest	11.005	1	6.237	.016
Instruction	1.886	1	1.069	.306

Although the screen-capture movies were more time consuming to develop, in-class demonstration were simplified. Students could watch each movie segment individually at their own pace. The movies can be paused and restarted based on need. Therefore, the instructor was not required to pace demonstrations or repeat the information based on the speed of individual students. The instructor would simply inform the student to watch the movie segment again.

4. Do college-level students respond more favorably on an attitudinal questionnaire to software tutorials presented in a screen-capture format than to material presented in a traditional written textbook format?

Opinions varied between those who used the screen-capture based (treatment) instructional format. Eighty percent of those in the treatment group agreed that the screen-capture tutorials were well organized. Similarly 75 percent agreed that the screen-capture tutorials were easy to follow and understand. However, reaction was split related to preference of instruction format. Sixty percent preferred the book tutorial (control method) to the screen-capture format, while 40% preferred the screen-capture instruction.

Student comments that were recorded included the following:

- It takes too long to switch between the program [screen-capture] and the AutoCAD screen.
- It was frustrating to have to move back and forth between screen-capture and AutoCAD.
- I liked the idea of the screen-capture but it took longer than the book.
- Screen-capture was a slower process, but I felt like I under-

stood things better.

- I liked the book more because I could read up on the assignment before class.
- Screen-capture confused me more than anything.
- More computer stuff [screen-capture] is not good.

Implications

As educators look toward the future of instructional delivery they need to begin to assess the appropriate nature of instructional technology. Distance delivery, online instruction, multimedia presentations, and computer-based instruction are options that are available for use. However, what is appropriate to use in the classroom? And, more specifically what is appropriate to use for CAD instruction? Appropriate instructional technology should provide an improved method of delivering learning objectives to the students and it should assist the instructor in preparation for the course. The use of screen-capture technology was studied to assess its effectiveness within the CAD classroom as a teaching tool. The following implications were drawing from the data collected during this investigation.

Screen-capture applications are easy to learn and use. Most applications can be installed and the user can be recording video segments within ten minutes. Development is simple, requiring the instructor to set the screen-capture application to record, work through the software activity on the computer, and stop the recording. Despite how simple these applications are to use, it is time consuming to develop screen-capture movies, which require additional scripting and planning. As indicated in the findings of this study it took three times as long to develop screen-capture tutorials compared to the typical preparation (see book tutorial instructional format). If instructors are going to prepare screen-capture movies – as described in this study – they should prepare for this added development time.

Additional development time may be offset by improvements in student learning. However, findings from this

study were mixed, indicating that the effects of the treatment were insignificant when adjustments were made for pre-test differences. This information is significant for educators who are using or considering the use of screen-capture movies (see screen-capture instructional format). Findings indicate that the use of screen-capture movies, as used in this study, resulted in similar student performance on exams, as did the traditional book tutorial format.

Results indicate that the treatment (screen-capture presentations) had little effect on improving student comprehension of CAD software principles as related to the control group (textbook tutorial). Although these results were insignificant, the means between the treatment and control group were similar, indicating that the screen-capture format was as effective as an instructional tool as the textbook approach. These results were not unpredictable considering that student groups have different learning styles and some will prefer a written (textbook) to a visual (screen-capture) approach.

Furthermore, students' opinions regarding the use of screen-capture tutorials were mixed. Some students enjoyed following the screen-capture instructional format and agreed that these tutorials helped them understand the assigned activities, while others did not like the screen-capture activities stating that these screen-capture movies confused them further. The opinion questions exposed the disparate learning styles with some learning very well from visual movies and others learning well from the textbook tutorial. Considering these findings, screen-capture instruction may best be used as a supplement to the book tutorial instruction, and should not be substituted in whole as an improved teaching pedagogy.

In conclusion, screen-capture movies appear to provide a valuable teaching tool for CAD related instruction. However, this teaching tool should only be used as a supplement to a textbook approach. Various students with different learning styles learned best using one or both teaching

methods. Additional research should be conducted studying an instructional format that combines both the textbook and screen-capture movies and comparing that to the textbook tutorial format in isolation. This study would provide information as to how a screen-capture movie in conjunction with the textbook improves the overall learning process of a cross section of students.

As was indicated in these findings it takes additional time to develop screen-capture movies. An effort should be made to leverage NAIT constituents in an effort to reduce this development time. This could be done through a collaboration of developers. For example, if several instructors from NAIT accredited schools worked together to develop screen-capture instruction for specific CAD software (i.e., AutoCAD), development time would be cut proportionally. Other options may include requesting that CAD textbook publishers develop screen-capture movies that would accompany their CAD tutorials. The findings from this study and other similar studies will provide valuable information as we look to the future of CAD instruction including the appropriate use of similar technology.

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