Optimization in the Balance between the Production Effort of E-learning Tutorials and their related Learning Outcome.

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The question in the development of e-learning tutorials becomes a strategic one when we are called to reach a level of optimization between producing a package that can accommodate the students' learning requirements and also our production efforts. This paper provides evidence on the level of media richness that may be cost effective in the development of e-learning tutorials for teaching and learning computer techniques for design visualization. The author assumes that due to considerations regarding the cognitive theory of multimedia learning and learning style of students, audio-visually rich e-learning tutorials for teaching computer techniques to design students will tend to have a positive impact on their learning outcomes. The paper describes the results of an experiment that supports this assumption by comparing the use of two different multimedia combinations for delivering the same instructional content in terms of learning outcomes and the effort or cost invested in their development.

I.Background

Circa twenty years of R&D of multimedia and hypermedia applications for instruction have demonstrated the benefits of transferring relevant information to learners using engaging media. There are several studies reporting about multimedia components that can be integrated into online courses to enhance, engage, and extend the students' ability in understanding course content and materials (Mayer, 2001; 2001; Ryan & Kasturi, 2002; Roblyer, 2006).

Encouraged by this evidence, we have assumed that due to considerations regarding the cognitive theory of multimedia learning and learning style of students, audio-visually rich e-learning tutorials for teaching computer techniques to design students will tend to have a positive impact on their learning outcomes. In order to confirm this hypothesis and propose a relevant balance between media and learning effectiveness, we undertook an experiment in the use of two e-learning tutorials using different media modalities for delivering instructions for the production of computer animations for design visualization.

On the design of these tutorials, we began by assuming that available media technologies would make the development of e-learning tutorials feasible and apparently the logical way to implement our instructional packages. However, the question in the development of e-learning tutorials becomes a more strategic one when we are called to reach a certain level of optimization between producing a package with a basic standard, namely; static written text & still-image based tutorials, or a state-of-the-art package that is based on dynamic audio-visual demonstrations that can accommodate the students' learning requirements and also our production costs. The key question is: What is good enough, and what is clearly superfluous?

2.Designing the E-Learning Tutorials

We developed the two multimedia packages taking into account educational strategies applied to the learning task, the students' learning style, and cognitive theories of multimedia learning. The task consisted in the learning of procedures for the design of a digital animation. The suitable educational strategy for this design task consisted on the step-by-step demonstration and parallel hands-on practice in the production of a general animation case, and then the testing in the preparation of a unique solution. Most of the design students have been regarded as spatial ability learners and therefore we have assumed they will benefit

more from visual displays because they are able of extracting meaning from pictures (Mayer & Sims, 1994).

For this study we followed Mayer's well-established cognitive theory of multimedia learning that depicts a learner-centered approach which begins with an understanding of how human cognition works (cognitive load theory) and then attempts to use multimedia to enhance human learning. Based on the characteristics of the learning task, the chosen educational strategies, and the learner's style, these are some of our design considerations regarding the multimedia modality to be used:

•Students learn better when corresponding information is presented simultaneously in space and time (Mayer 2001).

•Spoken narration combined with on-screen visual guide does not split the attention of the learner, but in fact can enhance the learning experience (Mayer 2001). When texts are presented together with visual displays, it is better to present text auditorily because the efficiency of information processing in working memory will be enhanced.

•Mayer and Moreno (2002) indicated that students learn more deeply from animation and narration than from narration alone or by animation and on-screen texts.

•According to Ryan & Kasturi (2002) the utilization of animation, video, and audio in online courses can be effective in enhancing understanding of vital concepts and particularly significant for courses that have a strong emphasis on visual aspects.

•Rieber and Kini (1991) argued that complex cognitive tasks involving motion and trajectory attributes become easier and concrete to understand because animations trigger the automatic ability of the visual system to induce apparent motion.

There are four alternatives in the design of multimedia packages that represent different combinations in the use of text and images (Guan, 2006): written text/static image, written text/animated image, spoken text/static image, spoken text/animated image. We chose the lowest and highest end of the ranking (static content: written/static and dynamic content: spoken/animated) as the two multimedia options to be tested.

3.The Experiment

The main purpose of this experiment was to investigate what kind of online multimedia presentation can promote better learning outcomes when teaching to design an animation using computer techniques. The target group was represented by 10 novice design students learning Computer Techniques for Design Visualization (ENDS170-200) in the Honors section. In general terms, they learn to apply digital visualization techniques to perform diverse design tasks as drawing, painting, modeling, rendering, and animating with computer techniques. In this particular experiment, they learned to use digital imaging techniques to create a walkthrough animation [Figure 1]. The online tutorials of this experiment were utilized in support of in-class lectures and demonstrations. The tutorials were intended to complement and enhance other animation techniques employed in class, to allow the instructor to expand in other areas of design interest and offer more attention to not communicated to students upon their individual projects. The nature of the experiment as such was the students; they only knew this was a graded practice test. The achievement of a good grade was an overall goal that provided motivation for students to complete not only the design task during the test but also to follow suggested instructional methods (i.e. following all sections of the tutorial before the test and filling out the survey after the test).

Figure 1. Walkthrough animation of the tutorial.

Implementation

The experiment consisted of three stages. The first stage was about learning using the tutorials, the second stage was about testing the students in the production of an animation and demonstration about the use of procedures they have learned (performance-based evaluation based on the recall and comprehension of digital procedures). The third stage was running an interview among the students regarding their perceived learning and multimedia preferences. Without any distinction of gender or age, the students of this class were evenly and randomly assigned to follow one of two tutorials and then to undergo the test. While there were no place or time restrictions to learn from the tutorials, the practice test took place in the class laboratory during two hours; the students also filled out a "debriefing" survey. The tutorials included the same procedural content related to instructions in the preparation of a walkthrough animation using a free camera and the corresponding rendering of an AVI file. Both tutorials were subdivided into 6 sections addressing the main steps of the process. The tutorial of the static content was created as a conventional set of web pages depicting step by step instructions together with illustrations (screen-captures) of the program to be used for creating the animation (Autodesk VIZ). Each instructional section was presented in a single web page that hyperlinked to the previous/ following section. The tutorial of dynamic content was produced also using web pages but only as launcher for different Flash animations addressing the different sections of the tutorial. The Flash animations were created using the CAMTASIA STUDIO program for producing full motion screen-captures of all movements and activity visible on the computer screen while demonstrating how to create the animation. It also allowed for the simultaneous recording of spoken explanations to coincide with the live action. The tutorial was recorded, edited, and saved in AVI file format and exported as an interactive Macromedia Flash multimedia package. Both tutorials were delivered online and the students were instructed to access them through the campus network to avoid any problem on accessibility (See Figure 2).

During the test, the students were not allowed to consult their peer or use the online tutorials; they were restricted to see only their personal notes. They used their own 3d modeling environments to create a unique walkthrough animation solution and render it with a draft quality. While waiting during the rendering time, the students were asked to fill a questionnaire of two parts: the first part related to their perceived learning (12 true-false questions) and the second part served to collect data on their preferences regarding tutorial modality (5 true-false questions). The questionnaire took approximately 15 min. to be completed by the class.

Data Analysis and Results

As freshman students of the same Honors class, they were all fairly familiarized (intermediate users) with the use of 3D modeling concepts and software. However they did not have prior-knowledge about the techniques included in the tutorials; in specific regarding camera animation procedures. The results of the test were processed based on a ranking that graded those who failed finishing the task, those who

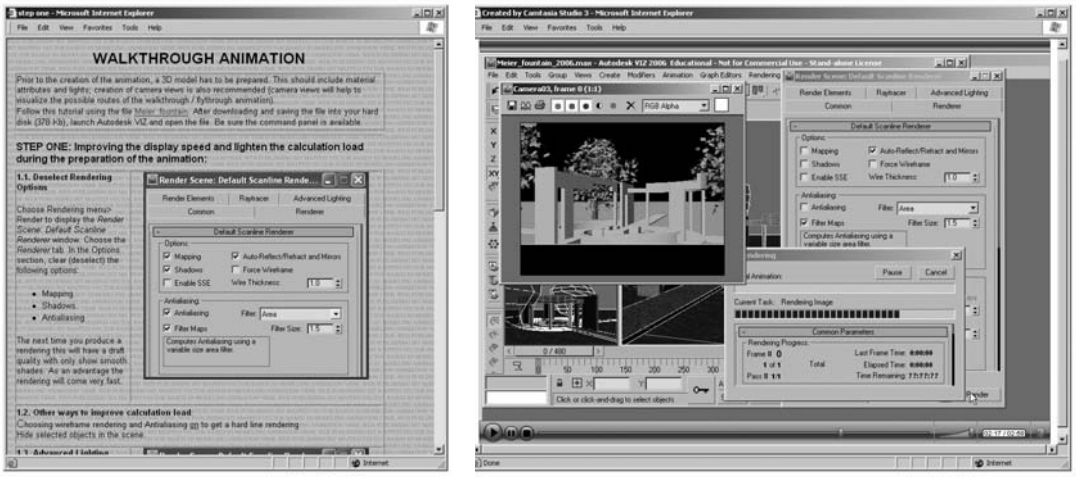

Figure 2. Written/static tutorial (web page) and spoken/animated tutorial (Flash animation).

TEST SCORES (# students)	written/static	spoken/animated
Failed to finish (0 points)	0 points (2 students)	0 (0)
Task completed (50 points)	100 (2)	150 (3)
Task completed-satisfactorily result (100 points)	100 (1)	200 (2)
TOTAL	200 (5)	350 (5)
Mean factor	0.4	0.70

Table 1. Performance of the two groups according to the test scores.

completed the task, and those who completed the task and did it satisfactorily. The table 1 reports on the students' performance in accordance with the group they were assigned to: (See table 1)

This experiment provides evidence that suggests that students who learned and practiced using an "audio-visually rich" online tutorial performed better based on memory and comprehension of the procedures and were able to successfully accomplish the task by creating and rendering an animation. This online tutorial is "audio-visually rich" because it makes use of a standard linear video segment with spoken text, animated images, and standard playback interactivity. This option seems to be more effective than the online tutorial that only makes use of static written text and images.

Regarding students' perceived learning, we can also state that the audio-visually rich on-line tutorial received the highest level of acceptance among the students, who expressed that their overall knowledge improved by using the tutorial. In general terms, the majority of students declared they have enjoyed and found it easy to follow the online tutorial; the majority also declared they used the program to practice in preparing the animations while studying; they revisited some of the instructions after finishing. In all these cases, the majority of negative answers belonged to the group assigned with the written text/static images tutorial. All the students agreed that it was beneficial to subdivide the issues on independent sections of the on-line tutorials. The students' choice for an online tutorial or the explanation of the same content in class was exactly evenly divided. The majority of students who preferred the explanation in class belonged to the group assigned with the spoken text/animated images tutorial. In this regard, we can assert that students are also aware of the role of the instructor as the main source of knowledge and guidance, and have expressed their preference of having the online tutorials in addition, not in replacement, to the regular classes.

Regarding the students' preferences on issues of modality in their respective tutorials, we can conclude that the majority agreed with the chosen format, structure, and content of both tutorials with two interesting exemptions: one that may suggest the use of opportunistic triggers for additional explanations in dynamic presentations (e.g. on-line text), and the other one that disregards the advantages of printing functions in static presentations.

Production Effort

The costs in the production of any of the two tutorials include the human resources (instructor and assistant) and the material resources (hardware and software, and others) involved in the production of the e-learning tutorials. For the creation of the written/static tutorial the instructor spent eighteen hours in the preparation of the text for the web pages and supervision of the final version; and one graduate non-teaching assistant (GANT) spent twenty hours creating the illustrations (screen captures), edition of the web pages, and creation of the website online. The creation of the spoken/animated tutorial was done in a previous semester while the instructor was giving the same instructions in class, therefore without adding cost to the production of this tutorial. The way it was done included the live recording of the entire class using the CAMTASIA STUDIO program and post-edition of the tutorial's sections. The instructor spent four hours preparing the lecture and in the coordination and revision of the final edition. The GANT spent twenty hours in the edition of the recording, created the different FLASH animations for the sections of the tutorial, prepared the web pages used as launchers of the animations and uploaded everything online. Software and hardware costs were negligible in both cases since all necessary items are freely available in campus. The final production costs were higher for the written/static tutorial = 900 $, than for the spoken/animated tutorial = 370 $.

4.Conclusions

In this study, we have demonstrated that the design and production of e-learning tutorials for design students is not a trivial task. The design considerations may include among others the educational strategies applied to the learning task, the students' learning style, and cognitive theories of multimedia learning. The experiment we undertook was beneficial in so far we identified that an audio-visually rich tutorial tends to promote better learning outcomes than static multimedia tutorials. Coincidentally the production effort analysis also points out to an inexpensive way of producing these audio-visually rich tutorials that at the same time is friendly and hassle-free for the instructors. We are very optimistic about producing this type of e-learning resources and look forward to test them at larger scale.

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