Work in Progress - Computer-based Instruction & Web-based Tutorials: Effectiveness and Applications

Patrick Connolly and Kellen Maicher
Purdue University
peconnolly@tech.purdue.edu, maicher@tech.purdue.edu

Abstract – Computer-based tutorials are playing an ever increasing role in education and in the field of e-learning. Advantages of web-based learning modules include the ability to reach a much wider and diverse population, learner control of pacing and approach, flexibility in instructional methodology, and assessment. However, the effectiveness of e-learning hinges on its adherence to proper educational theory and should be validated with rigorous experimental testing. This paper describes the authors’ ongoing work with the development, testing, and implementation of an interactive web-based tutorial for the instruction of orthographic multiview drawing principles, including an unique interactive drawing program and feedback mechanism. Preliminary analysis of tutorial testing are reported, along with a description of future related web-based module development and testing plans. The authors anticipate that continued efforts in this area will provide a novel and effective educational aid and foundation for application in other topic areas.

Index Terms – Computer-based instruction, web-based tutorials, e-learning.

TUTORIALS AND E-LEARNING

The application of tutorials as an educational tool is not a new concept. Presenting information with the purpose of individually guiding learners through the process of gaining information and skills is a function that has been implemented for many years using manual, semi-automated, and fully automated methodologies. The use of tutorial tools has proven beneficial in many areas of education, especially remediation and retention. The nearly ubiquitous acceptance and application of the computer as an educational tool has provided an excellent opportunity for further development and implementation of the tutorial as an effective means of instruction. With the relatively recent developments and focus on distance education and non-traditional, self-paced learning, computer-based and web-based instruction has become a significant topic of discussion [1]-[3].

The internet has become a medium capable of many modes of informational exchange. As web technologies mature and their capabilities increase, their abilities to provide educational information also increases. Many advances in internet technology have led to the expansion of e-learning, which has already become common for a wide range of educational and training materials. Commonly defined as teaching and learning enhanced by information and communication, e-learning has the unique ability to be delivered anywhere an internet connection exists. The current state of e-learning is moving towards more dynamic, interactive applications [4].

The studies discussed in this paper analyze the learning effectiveness of an interactive learning application to determine if a tool can be developed that proves more learning effective than traditional instructional methods. The unique advantage of this application lies not only in its ability to teach content, but also in assessing and providing immediate feedback on student performance.

PRELIMINARY STUDY

The study was developed to examine the learning effectiveness of an online tutorial coupled with an interactive application when compared with the online tutorial coupled with a paper-based assignment. The subject of the learning material is orthographic projection. Both assignments use the task of multiview drawing to communicate orthographic projection concepts. Learning style preference was also examined as a factor in how subjects respond to the different methods of instruction.

I. Method

- Participants: Thirty-four freshman undergraduate students participated in the study as a component of an introductory level class in manufacturing graphics. The control and treatment groups each consisted of seventeen participants.
- Testing Procedure: A survey was given to each participant to determine learning style preference according to the Kolb Learning Style Inventory (KLSI). Participants were given a pretest consisting of fifteen multiple choice problems to assess their familiarity with orthographic projection concepts. The control group performed an online tutorial followed by a paper assignment involving multiview drawing. The treatment group performed the same online tutorial followed by the interactive multiview drawing computer assignment. The control group received an answer key after completing the assignment and the treatment group received instant and dynamic feedback from the computer application regarding their errors. Following the tutorial and assignment, both groups were administered a fifteen question posttest to again assess their understanding of...
orthographic projection concepts. After the posttest, each participant completed a survey to determine prior exposure to multiview drawing and orthographic projection. The survey also gathered qualitative feedback concerning the participants’ impressions of the online tutorial and their impressions of the application tool.

II. Results

A t-test of the difference between pretest and posttest scores revealed only a marginally significant increase in test scores (t = 1.97, p = .0576). A general linear model (GLM) of least squares means revealed no significant difference between the control and treatment group in test score change (t = .73, p > .05). Prior exposure to multiview drawing could be attributed to the generally high test performance, with an average pretest score of ~95% and an average posttest score of ~96%. Despite a seemingly negligible difference of means, the range was only between 80% and 100%, which may explain why results were marginally significant. Analysis of the pretest and posttest revealed a largely uneven distribution of problem types. This variance was determined to be another delimitation of the study that affected student test performance. KLSI scores were not applicable because some subjects’ learning style preferences were indeterminable. Overall, however, the sample was most representative of the accommodator: preferring active experimentation over reflective observation and concrete experience over abstract conceptualization.

REVISED STUDY

A revised study was completed to examine participants with no prior exposure to multiview drawing. Spatial ability assessment was added to the design to determine participants’ spatial acuity and to examine possible correlation between comprehension of orthographic projection concepts and spatial aptitude. Pretest and posttest problems were redistributed according to a taxonomy developed on the basis of number and type of features in the multiview object entities.

I. Method

- Participants: Thirty-six undergraduate students enrolled in a technology in education course participated in the revised study. Two of the participants had previous experience with orthogonal projection concepts.

- Testing Procedure: Participants took a survey to determine learning style preference. Spatial ability was assessed with the Purdue Visualization Test of Rotations (PVT: R). Participants were administered the revised fifteen question pretest. The control group completed the tutorial and the paper assignment, while the treatment group completed the tutorial and the interactive assignment. The participants completed the fifteen revised problems on the posttest then answered on a survey whether or not they had prior exposure to multiview drawing and orthographic projection.

II. Results

The t-test of the difference between pretest and posttest scores for the revised study showed a significant increase in the mean test score (t = 5.41, p < .0001). The GLM showed again that no significant difference existed between the control group and the treatment group (t = .53, p > .05). An analysis of variance (ANOVA) found spatial ability, as measured by the PVT: R, to have a significant correlation to pretest scores (f = 11.67, p = .0022) and posttest scores (f = 17.24, p = .0003). KLSI scores were also excluded from statistical analysis for the revised study, but the sample was again largely representative of the accommodator learning style.

CONCLUSIONS

Results suggest both treatments significantly increase learning effectiveness. An inability to find a significant difference in effectiveness between the interactive assignment and the paper assignment suggests the interactive assignment will have the same effect on learning as the paper assignment. Spatial ability of students was found to have a significant positive correlation to test performance. The results of the KLSI show the accommodator to be the prevalent learner of these studies; however, further testing is needed to determine if this is only the case for technologically savvy individuals or all individuals in general.

Further testing will be undertaken to continue examining the effectiveness of web-based instructional tutorials as an alternative to more traditional teaching methods. Variables such as duration of study, topical content, previous experience of learners, learning styles, and demographic differences will be considered for future experiments.

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REFERENCES