Realistic versus Schematic Interactive Visualizations for Learning Surveying Practices: A Comparative Study

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ABSTRACT

Many benefits have been claimed for visualizations, a general assumption being that learning is facilitated. However, several researchers argue that little is known about the cognitive value of graphical representations, be they schematic visualizations, such as diagrams or more realistic, such as virtual reality. The study reported in the paper investigated whether the type of visualization (schematic versus realistic) has an effect on undergraduate students’ learning of surveying practices (specifically, ‘chaining’). The study compared two interactive virtual learning environments, one containing realistic visualizations of terrains and instruments, and one containing schematic graphical representations. Results of an experiment with 62 students show that there were not significant differences in learning between students who were exposed and interacted with the realistic visualizations versus those who interacted with the schematic ones.

Keywords: Multimedia Learning, Realistic Visualizations, Schematic Visualizations, Surveying Education, Surveying Practices

INTRODUCTION

Surveying is “…the science and art of making all essential measurements to determine the relative position of points and/or physical and cultural details above, on, or beneath the surface of the Earth, and to depict them in a usable form, or to establish the position of points and/or details…” (American Congress on Surveying and Mapping - ACSM).

Teaching construction surveying presents many challenges such as limited students’ access to instruments, limited availability of terrains on which to practice, dependence on
weather conditions, need for one to one training, difficulty in assessing the individual student’s performance with accuracy, and more. Recently, several researchers have recognized the potential of interactive visualizations for enhancing students’ learning of surveying concepts and practices. However, no study reported in the literature has investigated which specific aspects of visualizations are most effective for learning surveying. Although visualizations can have fundamentally different structural features, serve diverse functions and convey different content for different target audiences, in educational research, they are often treated as a single, uniform entity and, as a result, “...reviews on learning with visualizations are equivocal, with studies showing widely varying effects (negative to positive) on learning.” (Scheiter et al., 2009).

In the context of surveying education, all visualizations described in the literature present a high degree of realism. However, it is not known yet whether a realistic visualization that represents objects and processes with high fidelity is more effective at facilitating learning of surveying practices than a schematic visualization that illustrates the same objects and processes with diagrams and line drawings. The study reported in the paper fills this knowledge gap by answering the question of whether the amount of realistic detail of interactive visualizations has an effect on undergraduate students’ procedural learning of chaining. The findings of the study reported in the paper are important as they can help educational researchers and visualization designers decide if they should take on the substantial cost and time-consuming effort to develop a highly realistic visualization (such as a photorealistic virtual learning environment) when simple line drawings or diagrams might be as or more effective for those particular learning objectives and target users.

The paper is organized as follows: in section 2 we review existing visualization taxonomies, discuss prior experiments that compared realistic versus schematic visualizations, and present a review of recently developed visualizations for surveying education. In section 3 we describe the study and in section 4 we discuss the findings and outline future work.

BACKGROUND

Classification of Visualizations

In this paper, we use the definition of Scheiter and colleagues, who characterized visualizations as “external representations that are intended to communicate information by using a visuo-spatial layout of this information and that are processed in the visual sensory system” (Scheiter et al., 2008, p. 3). Visualizations range from simple diagrams and black and white line drawings, to complex animations, multimedia and virtual reality. Various classifications of visualizations have been proposed. Some taxonomies focus on the structural features of the visualizations (e.g. form and physical aspects that can be observed objectively), some are based on their functional features (e.g. use and purpose) and a few take into consideration also content features. Examples of functional classifications include the ones by Macdonald Ross (1973) who suggested how numbers should be shown based on task criteria and purpose of communication, and Tufte (1983). Structural classifications include the one by Rankin (1990) who proposed structural categories of graphs, and the one by Lohse et al. (1994) who classified visualizations based on subjects’ ratings of the visual similarity between graphical representations. Lohse and colleagues identified 6 basic categories of visual representations (e.g. graphs, tables, maps, diagrams, network and icons) and proposed two dimensions that further distinguish these categories. One dimension suggested that a graphical representation can express either continuous or discrete information; while the second dimension suggested that some visualizations are more efficient than others for conveying information. Imhof et al.
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