Chapter 15
Using Graphics to Improve Understanding of Conceptual Models

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ABSTRACT
Making Entity-Relationship diagrams easier to understand for novices has been a topic of previous research. This study provides experimental evidence that suggests using small representative graphics (iconic graphics) to replace standard entity boxes in an ER diagram can have a positive effect on domain understanding for novice users. Cognitive Load Theory and the Cognitive Theory of Multimedia Learning are used to hypothesize that iconic graphics reduce extraneous cognitive load of model viewers leading to more complete mental models and consequently improved understanding. Domain understanding was measured using comprehension and transfer (problem solving) tasks. Results confirm the main hypothesis. In addition, iconic graphics were found to be less effective in improving domain understanding with English as second language (ESL) participants. ESL results are shown to be consistent with predictions based on the Cognitive Load Theory. The importance of this work for systems analysts and designers comes from two considerations. First, the use of iconic graphics seems to reduce the extraneous cognitive load associated with these complex systems. Secondly, the reduction in extraneous load enables users to apply more germane load which relates directly with levels of domain understanding. Thus iconic graphics may provide a simple tool that facilitates better understanding of ER diagrams and the data structure for proposed information systems.

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INTRODUCTION

The entity relationship (ER) diagram (Chen, 1976), remains an important element in information systems documentation and development (Batra, 2005). As information systems become more sophisticated, information systems professionals recognize that an understanding of the conceptual structure of a system becomes increasingly important in implementation decisions (Moody, 1996). The conceptual data model often holds the key to understanding what a system is able to accomplish and, perhaps more importantly, unable to accomplish. For this reason, developing useful ER diagrams able to communicate these capabilities is of growing importance. While much research attention has been focused on how to develop consistent and complete ER diagrams, less research has been directed on how to make ER diagrams more understandable, particularly to users who have little or no experience with the diagramming methods (Topi & Ramesh, 2002). One of the main roles of ER diagramming is to support communication between developers and users (who are often novices modelers) (Kung & Solvberg, 1986). Therefore, we believe it is important to research techniques for improving understanding of ER diagrams for novice users.

This chapter addresses research opportunities identified by Wand & Weber’s (2002) framework. Specifically, we rely on cognitive theory to investigate the effects of using small pictorial representations, what we call iconic images, embedded in ER diagrams on model viewer’s understanding. Although our findings are specific to ER diagrams, these findings suggest the potential for further research into the use of multimedia elements in other conceptual modeling techniques leading to new applications of existing systems development methodologies.

The following section of this chapter provides a brief overview of conceptual modeling and comparative research in the field. Next, descriptions of the Cognitive Load Theory (Sweller, 1988; Sweller & Chandler, 1994) and the Cognitive Theory of Multimedia Learning (Mayer, 2001) are presented. This is followed by an overview of the experimental procedures including hypotheses generation, method, and results. The chapter closes with a discussion of the results along with research implications and conclusions.

COMPARATIVE RESEARCH IN CONCEPTUAL MODELING

Conceptual modeling provides the means to organize requirements for a system to form a meaningful whole (Andrade, et al., 2004). ER diagramming is an example of conceptual modeling that focuses on data structure. Approaches to IS development often include conceptual modeling tools to communicate and validate requirements. Curtis, Krasner and Iscoe (1988) found that problems of fluctuating and conflicting requirements in software design projects can be associated with communication breakdown. They identified a need for increased communication in requirements development. The breakdown in communications can happen across many levels.

Figure 1 offers a generic model of interactions between parties involved during systems development projects. The three parties are: 1) Stakeholders of the to-be system (e.g. end-users, managers), 2) Systems Analysts (intermediaries), and 3) Developer/Designers of the to-be system. Stakeholders often have the best understanding of the business process and the needs of the new system. Systems analysts are typically responsible for determining what should be built (requirements) via direct communication with stakeholders, while developers/designers are responsible for how the system will be put together to meet business objectives. Communication between systems analysts and stakeholders involves a two stage iterative process: requirements gathering and requirements validation. Stage 1, requirements gathering, is a process that analysts use to understand the busi-
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