Using Iconic Graphics in Entity-Relationship Diagrams: The Impact on Understanding

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ABSTRACT

This study reports on an experiment examining the impact of iconic graphics on participants’ understanding of domains represented by entity relationship diagrams. Cognitive load theory and the cognitive theory of multimedia learning are used to hypothesize that iconic graphics reduce the cognitive load of model viewers, leading to more complete mental models and consequently improved understanding. Results, as measured by transfer (problem solving) tasks, confirm the main hypothesis. Additionally, iconic images were found to be less effective in improving domain understanding with English-as-a-second-language (ESL) participants. ESL results are shown to be consistent with predictions based on the cognitive load theory.

Keywords: CLT; cognition; conceptual modeling, CTML; ER diagrams; understanding

INTRODUCTION

Conceptual models, such as the entity relationship (ER) model (Chen, 1976), remain important tools during the analysis phase of information systems development projects (Batra, 2005). Conceptual modeling supports the communication between developers and users, helps analysts understand the domain, provides input for the design phase, and documents system requirements (Kung & Solvberg, 1986). The importance of conceptual modeling has prompted calls for increased research in this area (Topi & Ramesh, 2002; Wand & Weber, 2002).

This study is directed toward research opportunities identified by Wand and Weber’s (2002) framework. Specifically, we rely on cognitive theory to investigate the effects of using iconic images embedded in ER diagrams on model viewers’ 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.

The following section provides a brief overview of conceptual modeling and comparative research in the field. Next, descriptions of
the cognitive load theory (CLT; Sweller, 1988; Sweller & Chandler, 1994) and the cognitive theory of multimedia learning (CTML; Mayer, 2001) are presented. This is followed by an overview of the experimental procedures including hypotheses generation, method, and results. Finally, a discussion of the results along with research implications and conclusions are provided.

**Comparative Research in Conceptual Modeling**

Conceptual modeling provides the means to organize requirements for a system to form a meaningful whole (Andrade, Ares, Garcia, Pazos, Rodriguez, & Silva, 2004). 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 (a) stakeholders of the to-be system (e.g., end users, managers), (b) systems analysts (intermediaries), and (c) developers and 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 and 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 business and technical requirements of the system, whereas Stage 2 requirements validation is the process stakeholders use to approve requirements as conceptualized and documented by the analysts. Understanding documentation presented to stakeholders, which often includes conceptual models, is important for the overall success of a development project.

Research in requirements gathering and validation has focused on the importance of conceptual modeling (Topi & Ramesh, 2002; Wand & Weber, 2002), which occurs early in the analysis phase of information systems projects. The large number of techniques available to analysts suggests that a comparison of conceptual modeling techniques is of particular importance. Comparative research can be

**Figure 1. Interaction among the various players during the SDLC**

![Diagram](https://via.placeholder.com/150)
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