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Information visualizations for knowledge acquisition: The impact of dimensionality and color coding

Tanja Keller [a,*], Peter Gerjets [b], Katharina Scheiter [a], Bärbel Garsoffky [b]

[a] *University of Tuebingen, Konrad-Adenauer-Street 40, 72072 Tuebingen, Germany*
[b] *Knowledge Media Research Center, Tuebingen, Germany*

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Abstract

Information visualizations – interactive graphical representations of large amounts of abstract data which do not have a natural visual representation – have mainly been used to support information retrieval. This article investigates whether information visualizations are also suitable for fostering knowledge acquisition as well as how information visualizations, from a cognitive perspective, have to be designed to be efficient learning tools. An experimental study provided evidence that information visualizations support knowledge acquisition. In addition, with regard to the appropriate design, the empirical results showed that two-dimensional information visualizations are better suited for supporting processes of knowledge acquisition than three-dimensional ones and that color-coded information visualizations slightly increase performance in a knowledge test compared to monochromatic ones.

Keywords: Information visualization; Knowledge acquisition; Dimensionality; Color coding

* Corresponding author. Tel.: +49 7071 979 301; fax: +49 7071 979 100.
E-mail address: t.keller@iwm-kmrc.de (T. Keller).

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1. Introduction

Technological innovation enables the storing of fast-growing quantities of information. Accordingly, it has become increasingly important to develop efficient methods to structure large and complex information sets. Recently, there have been several attempts to tackle this challenge by using computer-based information visualizations, that is, graphical representations of large amounts of abstract data which do not have a natural visual representation (Wiss, Carr, & Jonsson, 1998). According to Card, Mackinlay, and Shneiderman (1999), information visualizations can be characterized as "computer-supported, interactive, visual representations of abstract nonphysically based data to amplify cognition" (p. 6). For instance, information visualizations have been used to display the information units of abstract data sets like document collections or text-based information contents of the World Wide Web. A simplified sketch of the type of spatial information visualization used in the empirical study presented in this article is shown in Fig. 1. In this sketch, four information units (A, B, C, and D) are displayed together with three of their attributes that are represented by means of three spatial dimensions. In other words, the four information units are arranged in a three-dimensional information space according to their values for the three attributes that are represented by three orthogonal axes.

Information units pool those parts of data sets that belong together. The units can be described by their values of numerous different attributes. Typically, only a subset of these attributes can be represented spatially (i.e., three attributes at the most). Thus, other attributes of the information units may be represented textually (e.g., by means of a pop-up window) or by other representational codes (e.g., color coding).

Currently, there is a trend in computer science to develop technically complex information visualizations. This trend – which is motivated by the intention to include the current state-of-the-art technologies – has led to an increased development of information visualizations that use three spatial dimensions to visualize data. Research with regard to these advanced information visualizations has mainly been focusing on solving technical problems in the context of information-retrieval tasks where information visualizations prove very helpful in enhancing a user's ability to

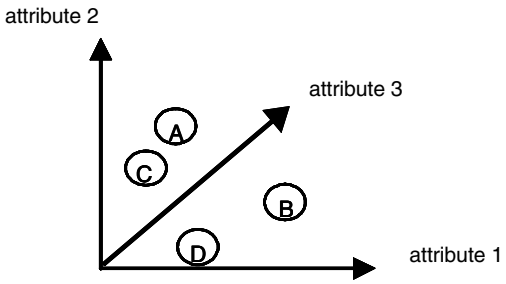

Fig. 1. Simplified sketch of a three-dimensional information visualization.