



Cognitive load in hypermedia reading comprehension: Influence of text type and linearity

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Abstract

In this paper the assumption of cognitive overhead in hypermedia learning is specified by cognitive load theory. This analysis is based on different types of cognitive load, the dimension of linearity/non-linearity as well as text characteristics. We propose a model stating that extraneous cognitive load in hypermedia learning is basically determined by the interaction of text presentation format (linear/non-linear) with text type (text with and without narrative structures). This assumption was tested by means of a 2×2 experimental design. Sixty participants completed a computer-based learning program that contained a narrative text or an encyclopaedia text in either linear or non-linear presentation format. Results confirm the suggested interaction hypothesis postulating that non-linear information presentation of narrative text structure increases cognitive load and decreases knowledge acquisition. However, for encyclopaedia text participants' knowledge acquisition was not affected by linear or non-linear presentation format. Furthermore, results suggest a cross-validation of cognitive load measures and propositional analysis.

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1. Introduction

Much of past research in information retrieval from hypertext or hypermedia has addressed the “lost-in-hyperspace”-phenomenon or cognitive overhead (cf. Conklin, 1987). Especially interventions for overcoming lost-in-hyperspace has emerged many different approaches (e.g., Chiu & Wang, 2000; Dias & Sousa, 1997; McDonald & Stevenson, 1998; van Nimwegen, Pouw, & van Oostendorp, 1999). Nevertheless, approaches to investigate the cognitive overhead phenomenon are rare. In this paper we specify this phenomenon by basic cognitive mechanisms of text comprehension and cognitive load theory.

2. Cognitive overhead and cognitive load theory

Cognitive overhead addresses the limitation of the human working memory and cognitive processes in hypertext/hypermedia learning (Conklin, 1987): Learners have to process information represented in hypertext nodes and plan their (further) navigation simultaneously which demands higher resources of working memory (cf. Bannert, 2004; Gerdes, 1996). Niederhauser, Reynolds, Salmen, and Skolmoski (2000) compared reading and navigation strategies in hypermedia learning on their impact of learning outcomes. Results suggest that learners using a sequential and almost linear information retrieval show higher learning success than participants using a non-linear browsing strategy.

Despite this basic evidence for occurrence of the cognitive overhead phenomenon, it is a general assumption rather than a specific theoretically grounded concept that would allow predicting learning success or failure. A more specific and appropriate approach for examining learning processes with linear and non-linear knowledge media is provided by cognitive load theory (CLT; Paas, Renkl, & Sweller, 2004; Sweller, 1994). CLT differentiates between *intrinsic cognitive load* (ICL), *extraneous cognitive load* (ECL) and *germane cognitive load* (GCL; Sweller, van Merriënboer, & Paas, 1998). All three proposed types of cognitive load are assumed to be additive. In case of exceeding working memory resources information processing will be decreased which inhibits knowledge acquisition (Paas, Tuovinen, Tabbers, & Van Gerven, 2003).

Especially the ECL seems to be what is meant by “cognitive overhead”. If the assumption of cognitive overhead would be adequate, learners should always profit more from linear text than from non-linear text because learning with non-linear (hyper-)text requires always additional mental effort in navigation planning and monitoring. However, cognitive load theory postulates that additional mental effort does not always inhibit learning, for example, if this additional effort leads to deeper elaboration processes.

Our main argument in this paper is that inappropriate instructional format causing a high ECL could also affect a higher GCL. In hypertext learning, students are enforced to reflect upon their prior knowledge in order to make decisions about navigation. This additional cognitive effort could lead to deeper elaboration and, thus, contribute to learning success (limited resources due to ECL help to activate GCL). Learners have here to activate prior knowledge and possible schemata in order to overcome obstacles of the ECL.

Studies examining differences in knowledge acquisition from text and hypertext are often difficult to interpret because dimensions of linearity/non-linearity are vague and influence of text type is neglected.

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