International Journal of Accounting Information Systems 26 (2017) 46–67

Contents lists available at ScienceDirect

International Journal of Accounting Information Systems

journal homepage: www.elsevier.com/locate/accinf

The combined effects of user schemas and degree of cognitive fit on data retrieval performance

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A B S T R A C T

Given the massive and accelerating amount of data modern organizations are collecting, it is imperative that employees possess the skills to navigate various data structures and develop sound data manipulation and retrieval strategies. This research investigates whether and how user schemas and the degree of cognitive fit combine to affect data retrieval task performance. We measured two types of user schemas associated with debit-credit-accounting (DCA) and resource-event-agent (REA) accounting systems. All participants completed tasks that were either facilitated by DCA or REA. Degree of cognitive fit was manipulated as high (when the task was facilitated by the system) or low (when the task was not facilitated by the system). Results show that the positive association between users' schemas and data retrieval performance is enhanced when the degree of cognitive fit is high, but is attenuated when the degree of cognitive fit is low. The findings that participants with equivalent amounts of training on the accounting models had varying schema strengths for those models provide prima facie evidence that one should not assume schemas' existence based on experience. Of particular importance is the finding that cognitive fit is even more important than schemas, as this provides guidance for companies interested in facilitating data retrieval to focus their decision support efforts first on providing interfaces that match the tasks to be performed and second on training their decision makers to develop schemas consistent with the interfaces. While the combination of strong user schemas and high cognitive fit will yield the best results, if a company must choose due to limited resources, the provision of high cognitive fit with the interface-task match is more important than developing strong user schemas.

1. Introduction

Davern et al. (2012) discuss several enduring questions in cognitive information systems research. Two areas they identify as fruitful opportunities for further research are specialized knowledge, including schemas by which knowledge is organized, and cognitive fit.[1] Schema theory (traced back to the seminal works of Bartlett, 1932; Bartlett, 1958; Schank and Abelson, 1977; and Rumelhart, 1980) suggests that users have a series of generic knowledge structures in long-term memory that guide their attention,

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[1] Note that database literature often uses the term schema to refer to the definition of a database structure. We use the term "user schema" throughout this paper to stress our usage of schema as a cognitive structure.

http://dx.doi.org/10.1016/j.accinf.2017.06.001
Received 30 November 2016; Received in revised form 25 January 2017; Accepted 15 June 2017
Available online 17 August 2017

expectations, and interpretations; these structures are called schemas. Schemas allow users to overcome the seven plus or minus two capacity limitations of working memory (Miller, 1956) by setting up a mental template to be instantiated during the problem solving process. Schemas facilitate memory and are most useful in complex knowledge domains (Fiske and Linville, 1980). Stronger (more developed) user schemas are associated with better performance; this association has been demonstrated in many domains (Chase and Simon, 1973; Weber, 1996; Gerard, 2005).

Cognitive fit, originally proposed by Vessey (1991) as a model of the problem solving process focused on the match between a problem representation and the task to be performed, has also been demonstrated to facilitate problem-solving performance in many domains (Dennis and Carte, 1998; Dunn and Grabski, 2001; Vessey, 2006). Some cognitive fit studies acknowledge that users do not approach problem-solving with blank slates onto which the new mental representations are written, and propose that user schemas may affect cognitive fit. However, none has directly measured and tested the effect of user schemas in their models; instead they have used proxies such as experience and domain familiarity (Agarwal et al., 1996a, 1996b; Khatri et al., 2006b; and Shaft and Vessey, 2006). Experience is an insufficient proxy for schemas and knowledge; Libby and Luft (1993) showed that experience and knowledge are separate theoretical constructs with distinct operationalizations. Knowledge is defined as information stored in memory, including schemas as a means of organizing that knowledge. This means that researchers interested in knowledge (including schemas) should not operationalize it as experience, rather researchers should measure knowledge using methods from the psychology literature, for example, free recall. Because the prior cognitive fit studies only used the weak proxies of experience or domain familiarity to represent user schemas, the question of how schemas and cognitive fit interact to affect task performance remains unanswered.

An unaddressed question is how people with various degrees of schema development perform information retrieval tasks using differently organized accounting information systems. Given the increasing attention to data analytics coupled with the fact that many organizations maintain multiple software systems (for example, using SAP for domestic operations and NetSuite for foreign subsidiaries), researchers should strive to increase our understanding of associated judgment and decision-making processes associated with data retrieval.

David et al. (2003) classify enterprise systems as originating either from Pacioli's (1494) double-entry accounting or from Porter's (1985) enterprise value chain. Dunn and Grabski (2001) operationalized the double-entry accounting system as DCA (debit-credit-account) and the value chain system as REA (resources-events-agents) in their investigation of data retrieval in the context of cognitive fit. We use the same operationalization of DCA and REA systems in this research, but extend the context to consider how user schemas that match the system structures work in concert with cognitive fit to facilitate data retrieval performance.

The objectives of this research are to examine the influence of schema strength and degree of cognitive fit on data retrieval performance and to determine whether and how schema strength and degree of fit interact with performance on data retrieval tasks. This research informs those interested in cognitive processes related to data retrieval as well as those interested in cognitive fit theory and user schemas. This study uses the REA and DCA accounting models solely as a basis to create conditions of cognitive fit by employing tasks that are facilitated by one model or the other (we call these tasks REA-facilitated and DCA-facilitated tasks). Consistent with the psychology literature, we use free recall tasks to measure the participants' REA and DCA schemas associated with these different systems representations.

The remainder of this paper is organized as follows. In the next section we present our theory development and hypotheses. Then in Section 3 we detail the research method and present the results in Section 4. We conclude by discussing the implications of our findings and suggest avenues for future research.

2. Theory development and hypotheses

2.1. Schema theory and related literature

While the amount of knowledge a person has will play a determining role in task performance, the organization of knowledge (i.e., the schema) plays an essential role in many tasks as well (e.g., Johnson-Laird, 1983). In addition to providing structure for knowledge in long-term memory, schemas can influence whether or not new information is attended to or encoded (e.g., Messick, 1984). Schemas facilitate memory structure and retrieval of information; therefore, they are useful in complex knowledge domains (Fiske and Linville, 1980). Schemas are not directly observable; they must be inferred through cognitive psychology methods such as free recall, which requires people to recall items from memory after exposure to the items.

The classic work of de Groot (1965, 1966) illustrates the role of schemas in problem solving. In seeking to understand the performance of chess masters compared to less-skilled players, de Groot investigated a number of dimensions such as the number of moves considered, the use of heuristics to guide search, and the depth of the search process. Out of every dimension considered, the chess masters only differed significantly on one dimension - the ability to recall board positions from memory. Chase and Simon (1973) replicated de Groot's findings and extended the research by additionally using random chessboard configurations. Chess masters had much better free recall performance compared to novices for board positions taken from actual games, but this performance difference disappeared when random board configurations were recalled, thus ruling out the possibility that the chess masters simply had a higher ability to memorize in general. These findings illustrate a relationship between stronger schemas and better task performance.

The significance of the schema/performance relationship has been discussed in depth in applied domains such as accounting and auditing (Libby and Luft, 1993). In Libby and Luft's (1993) antecedents and consequences of knowledge model, schemas are a form of knowledge (antecedents to knowledge/schemas are experience and ability; the consequence of knowledge is task performance). Libby and Luft's model is significant because it accounted for a puzzling result in the accounting and auditing literature. Prior to this