An Alternative Fit through Problem Representation in Cognitive Fit Theory

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ABSTRACT

This paper uses cognitive fit theory to analyze the problem solving process in spreadsheet analyses. Cognitive fit theory proposes the formation of mental representation as a part of the problem solving process. However, there is little research examining mental representation, which is a key concept in cognitive fit theory. This study examines the formation of mental representation and proposes an alternative mechanism of cognitive fit between different problem representations and their corresponding mental representations when the task is invariant, but the problem representation changes. Mental representation is then empirically assessed based on the application of Hick’s law, which states that the response time of users making a choice varies with the logarithm of the number of possible choices. Therefore, this study contributes to research on cognitive fit theory by proposing an alternative fit and by demonstrating a feasible approach for identifying mental representations. It contributes to spreadsheet research by showing how problem representations affect task performance in the case of spreadsheet error correction.

Keywords: Cognitive Fit Theory, Hick’s Law, Mental Representation, Problem Solving Process, Spreadsheet

INTRODUCTION

Cognitive fit theory (Vessey, 1991) is widely used to analyze problem-solving performance in decision-making problems, such as for comparing different data presentation formats (e.g., tables and graphs), for different multi-attribute data presentations, and for various problem domains such as accounting, software maintenance, requirements modeling in systems development and spreadsheet error correction (Dennis & Carte, 1998; Dunn & Grabski, 2001; Smelcer & Carmel, 1997; Agarwal, Sinha, & Tanniru, 1996; Shaft & Vessey, 2006; Umanath & Vessey, 1994; Vessey, 1994; Vessey & Galletta, 1991). Problem solving performance in cognitive fit theory is an outcome of the fit between problem representation and task, both of which are characterized by the information they emphasize.

Task in cognitive fit theory refers to the problem-solving task that the user has to per-
form, while problem representation refers to the way in which the information pertaining to the task is presented to the user. For instance, in the context of spreadsheet analysis, the task could be identifying precedent or dependent cells referred to in formulas or calculating cell values given a formula; while the problem representation could be the format in which the spreadsheet data is presented to the user. When the cognitive processes used to act on the problem representation match those used to complete the task, cognitive fit is said to exist, resulting in superior problem solving performance (Agarwal, De, & Sinha, 1999; Vessey, 1991). In order to capture the problem solving process, cognitive fit theory conceptualizes “mental representation”, which is determined by the information requirements of the task and the information emphasized by the problem representation. Mental representation is an important step in the problem solving process underlined by cognitive fit theory; however there is significantly less understanding on mental representation. Current research on cognitive fit theory assumes that mental representations exist, without further validations. Therefore, the need to examine mental representation instead of simply measuring performance outcome (e.g., Shaft & Vessey, 2006) has been highlighted.

Both cognitive fit theory and its extension (which examines the fit between two different mental representations resulting from two different tasks) proposed by Shaft and Vessey (2006) focus primarily on the task and its implications on the formation of mental representation and subsequent cognitive fit. Therefore, an investigation towards assessing mental representation and ways of examining it has so far been unaddressed in the cognitive fit literature. We address this gap by proposing the alternative fit, which is a fit between different components of a problem representation. The essential difference from the original cognitive fit theory is that the alternative fit focuses on the problem representation rather than on the role of task. This is an important distinction given that representational features of the problem have important implications on analysis and performance for the same given task (Hahn & Kim, 1999).

In the alternative fit proposed here, we demonstrate that certain information components of the problem representation are used to create the mental representation, and other components are then used to achieve a fit between the mental representation and the problem representation. This is applicable in a situation where the original cognitive fit does not occur. This study further demonstrates a way of validating the mental representation as manifested in the problem solving process in the context of spreadsheet cell referencing.

Spreadsheet error correction is one among the various problem-solving contexts in which cognitive fit theory has been applied (Goswami, Chan, & Kim, 2008). Spreadsheet errors pose significant business risks to organizations (EUSPRIG, http://www.eusprig.org/), and an alarmingly high number of organizational spreadsheets contain errors (Panko, 2011). Spreadsheets are often ineffectively and inefficiently designed due to a multitude of reasons such as, social, cultural and cognitive reasons (Bhavnani, Peck, & Reif, 2008). Accordingly, significant research effort has been expended in studying spreadsheet error correction (Bishop & McDaid, 2011; Burnett, Sheretov, Ren, & Rothermel, 2002; Chadwick, Knight, & Rajalingham, 2001; Chan, Ying, & Peh, 2000; Clermont, 2003; Davis, 1996; Hendry & Green, 1993; Igarashi, Mackinlay, Chang, & Zellweger, 1998; Lentini, Nardi, & Simonetta, 2000; Rajalingham, Chadwick, Knight, & Edwards, 2000; Sajaniemi, 2000).

The process of spreadsheet error correction still remains tedious and difficult (Goswami et al., 2008; Panko, 1999; Panko & Sprague, 1998; Teo & Lee-Partridge, 1999) because of the cognitive difficulties in comprehending spreadsheets. Since spreadsheet formulas define the interconnections between rows and columns in a spreadsheet, understanding formulas is an essential part in understanding the structure of a spreadsheet. In order to understand formulas, one has to trace cell references in formulas to identify the different cells that make up the
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