The Effects of Construct Redundancy on Readers’ Understanding of Conceptual Models

Palash Bera, Operations and IT Management, John Cook School of Business, Saint Louis University, St. Louis, MO, USA
Geert Poels, Faculty of Economics and Business Administration, Ghent University, Gent, Belgium

ABSTRACT

This paper investigates the effect of construct redundancy on readers’ understanding of conceptual models. Conceptual models play a crucial role in understanding the domain related to information system development. The clarity of such models can be compromised if they are constructed using a conceptual modelling grammar exhibiting construct redundancy where one real-world phenomenon maps to two or more grammar constructs. With two empirical studies on solving domain-related problems using Unified Modeling Language (UML) class diagrams as conceptual domain models, it was found that when construct redundancy is present at different strengths, then the effect of the redundancy on the understanding of a model depends on the modeling knowledge of the reader. Novice readers with minimal modeling knowledge find models difficult to interpret when a strong level of redundancy caused by distinct construct redundancy exists. However, when the models have a weak level of redundancy then these readers find them easier to understand compared to models without redundancy. In contrast, trained readers are indifferent to a weak level of redundancy in a model.

KEYWORDS

Conceptual Models, Information System Development, Redundancy, Unified Modeling Language (UML)

1. INTRODUCTION

Information systems (IS) are representations of other real-world systems. Wand and Weber (2017) suggest that to determine what constitutes a good representation, we need to refer to ontological theories. They introduced a theory of ontological expressiveness (1993) that predicts that if a conceptual modeling grammar does not have a one-one mapping between its constructs and the constructs of an ontological theory then the scripts generated by the grammar will not be clean and complete. One way to compromise ontological expressiveness is if an ontological construct that conceptualizes some real-world phenomenon maps to two or more grammatical constructs, a situation known as construct redundancy. Such a compromise might reduce the clarity of a model and thus affect its interpretation.

The literature has identified construct redundancy in conceptual modeling grammars such as in UML (Opdahl & Henderson-Sellers, 2002) and in process modeling languages (Recker, Indulska, Rosemann, & Green, 2010). However, the empirical research in this area is limited. Fickinger and Recker (2013) find that the studies on redundancies in process modeling obtain mixed results. Green and Rosemann (2001) find that construct redundancy in the views of the ARIS framework provides users a mechanism to manage complexity in modeling. Recker et al. (2010) find that practitioners have

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little problems with construct redundancy in the BPMN modelling grammar. Modelers with medium to extensive experience seemed to be more aware of ontological deficiencies in BPMN (including instances of construct redundancy), but could mitigate these deficiencies by developing workarounds. Recker and Rosemann (2010) find that experienced modelers perceive ontological deficiencies in BPMN (including construct redundancy related to the representation in BPMN diagrams of events and transformations) more strongly than inexperienced modelers. Recker et al. (2010) find that construct redundancy in the BPMN representation of real-world objects and events negatively impacts the perceived ease of use of BPMN but that this effect only holds for users that were previously confronted with modeling situations where ambiguities related to construct redundancy showed up. Thus, the effect of construct redundancy on model understanding might depend on the readers’ knowledge of the models. In the same vein, Fickinger and Recker (2013) not only suggest that more empirical research should be carried out on construct redundancy but such research should focus on individual differences. Accordingly, in this paper, we focus on the question of how conceptual models with construct redundancy affect the understanding of readers with varied modeling knowledge.

In section 2, we discuss ontological expressiveness and operationalize two kinds of construct redundancy with different strengths which we illustrate using UML class diagrams. Using cognitive and learning theories, we predict that these construct redundant models have different effects on the readers’ understanding based on their modeling knowledge. We test the prediction in section 3 by conducting two empirical studies. We discuss our results in section 4 and present a conclusion in section 5.

2. THEORETICAL BACKGROUND AND PREDICTION

Ontological theory explains the structure and behavior of the world. If one agrees to the worldview expressed by the ontological theory, then a mental model of some real-world situation can be created in terms of the ontological constructs and this model can be externalized by articulating it with grammatical constructs (Guizzardi, 2005). The theory of ontological expressiveness (Wand & Weber, 1993) identifies four types of ontological deficiency of a conceptual modeling grammar that might affect the ability to represent some real-world phenomena completely and clearly. These deficiencies are: (a) construct deficit – when the grammar contains no construct that maps to a particular ontological construct, (b) construct excess- when the grammar contains a construct that does not map to any ontological construct, (c) construct overload- when the grammar contains a construct that maps to two or more ontological constructs, and (d) construct redundancy- when the grammar contains two or more constructs that map to a single ontological construct. Wand and Weber (2017) mention that construct deficit undermines the ontological completeness of a grammar and ontological excess, overload, and redundancy undermine its ontological clarity.

As the theory of ontological expressiveness can by itself not explain why a lack of ontological clarity impacts the ability to understand a conceptual modeling script, researchers have resorted to various theories of perception, cognition, memory, and language to propose empirically verifiable hypotheses. Using such theories, several conceptual modeling grammars or some of their constructs have been evaluated. This includes the use of entities to represent both things and events (construct overload) (Allen & March, 2006), the use of optional attributes and relationships to represent optional properties (construct excess) (Bodart, Patel, Sim, & Weber, 2004; Bowen, O’Farrell, & Rohde, 2009; Dunn, Gerard, & Grabski, 2011; Gemino & Wand, 2005), the use of relationships or associations to represent composites (construct overload) (Graeme Shanks, Tansley, Nuredini, Tobin, & Weber, 2008), and the use of constructs to represent intrinsic properties (construct overload) (Weber & Zhang, 1996). Recently, Tilakaratna & Rajapakse (2017) evaluated the ontological completeness and clarity of UML and suggest a subset of UML constructs that is better suitable for conceptual modeling.

The types of deficiencies regarding ontological clarity investigated in these studies are mostly construct overload and construct excess. The lack of studies investigating construct redundancy is
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