

The impact of designers' goals on design-by-analogy

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Selection of source is an important step in design-by-analogy. The aim of this study is to explore the impact of designers' goals for source selection on analogical design outcome. Participants consist of 130 architecture students involved in a design-by-analogy practice. The results indicate that there are significant relations between designers' goals and the type of selected source, similarity between source and target, and novelty of the design ideas. Moreover, the findings indicate that goals of function, climate response, and symbolism improve the similarity between source and target and novelty of ideas; while goals of familiarity, aesthetics, and economy of time hinder them. We conclude that design expertise can enhance students' ability in analogical design with an impact on their goals.

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Design students and expert designers frequently use the design-by-analogy method. Analogy involves transfer of knowledge from one known domain (source) to another domain (target) (Blanchette & Dunbar, 2000). Analogical reasoning entails utilization of 'source' information as a means to facilitate attempts to solve the 'target' problem (Ball, Ormerod, & Morley, 2004). Previous studies confirmed the importance of analogical thinking in design in general (Ball et al., 2004; Ozkan & Dogan, 2013) and in architectural design in particular (Casakin & Goldschmidt, 1999; Casakin, 2004). Selection of source is regarded as an important step in design-by-analogy, which affects the success of analogy (Casakin & Goldschmidt, 1999; Goldschmidt, 2001).

The goals formulated for source selection can be considered as the fundamental factors in analogical reasoning (Holyoak & Thagard, 1997; Ward, 1998). Designers' goals for source selection influence the selection of sources and may affect the outcome of analogical design. Previously conducted studies confirmed that designers' level of expertise affected designers' selection of

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source as well as their goals (Chai, Cen, Ruan, Yang, & Li, 2015; Ozkan & Dogan, 2013). Ozkan and Dogan (2013) demonstrated that designers' goals are directly affected by their design expertise. Some researchers considered the distance between source and target (analogical distance) as an important factor affecting the outcome of analogical design (Christensen & Schunn, 2007; Goldschmidt, 2011; Chan et al., 2011; Fu et al., 2013). Moreover, selecting a source from among near or far sources is affected by designers' purposes. Designers seeking extraordinary forms of creativity select far sources, and those looking for minor novelty select near sources (Ozkan & Dogan, 2013; Ward, 1998).

Previous studies in design-by-analogy indicate the importance of designers' goals; therefore this study aims at specifying those set of designers' goals that have remarkable effects on design-by-analogy and presents the results of an experimental study investigating the effect of designers' goals on source selection, similarity between source and design ideas, and novelty of design ideas. This study focuses on designers' goals, investigates their impact on design-by-analogy, and specifies effective goals. It is predicted that there are relations between designers' goals and type of selected sources, similarity between source and solution, novelty of design ideas, and the level of designers' expertise.

1 Background

1.1 Analogical design

Analogy is an important method for ideation in design (Moreno et al., 2014). Both expert and novice designers use design-by-analogy method (Ball et al., 2004), which is a fundamental strategy in problem solving and originates from thinking based on similarities (Vosniadou & Ortony, 1989). Casakin and Goldschmidt (1999) found that using visual analogy can help students in architectural design. Moreover, it can help experts to solve ill-defined problems (Casakin, 2005, 2010). Analogical design process consists of either identification, retrieval, mapping, and transference steps (Casakin, 2004), or two steps of mapping from source to abstraction and from abstraction to the new design (Goldschmidt, 2001).

Gentner (1983) discussed structural mapping as mapping the relation between objects and not the attributes of objects. She differentiated the types of similarity between source and target as *literal similarity*, in which a large number of attributes are mapped from source to target, consisting of object and relation attributes; *analogy*, in which only relation attributes and not object ones are mapped; *abstraction*, in which the source is an abstract relational structure, all attributes are mapped to the target, and no attribute remains unmapped; *anomaly*, in which no similarity is established between source and target

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