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RESEARCH ARTICLE

Does the smartest designer design better? Effect of intelligence quotient on students' design skills in architectural design studio

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Abstract
Understanding the cognitive processes of the human mind is necessary to further learn about design thinking processes. Cognitive studies are also significant in the research about design studio. The aim of this study is to examine the effect of designers intelligence quotient (IQ) on their designs.
The statistical population in this study consisted of all Deylaman Institute of Higher Education architecture graduate students enrolled in 2011. Sixty of these students were selected via simple random sampling based on the finite population sample size calculation formula. The students' IQ was measured using Raven's Progressive Matrices. The students' scores in Architecture Design Studio (ADS) courses from first grade (ADS-1) to fifth grade (ADS-5) and the mean scores of the design courses were used in determining the students' design ability. Inferential statistics, as well as correlation analysis and mean comparison test for independent samples with SPSS, were also employed to analyze the research data.
Results indicated that the students' IQ, ADS-1 to ADS-4 scores, and the mean scores of the students' design courses were not significantly correlated. By contrast, the students' IQ and ADS-5 scores were significantly correlated. As the complexity of the design problem and designers' experience increased, the effect of IQ on design seemingly intensified.

1. Introduction

Design studio is considered the core of the design curriculum (Demirbaş and Demirkan, 2003). Researchers have described design studio as the center of architecture education (Schön, 1985; Ochsner, 2000; Vyas et al., 2013). Starting from an ill-defined problem (Schön, 1983), the development of ideas

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and solutions is evaluated through different types of critique (Oh et al., 2013). These procedures are common in all design studios. Social interaction and interpersonal interactions among design studio participants, including student-student and student-tutor, are significant. The importance of collaboration (Vyas et al., 2013), teamwork, and decision making in design studio has been studied as well (Yang, 2010). Architecture students should also develop a set of design thinking (Dorst 2011) and creative skills (Demirkan and Afacan, 2012), which are increasingly prioritized in workplaces and in society as a whole. A set of problem solving skills is among the abilities that design studio students required to manage a growing spectrum of new complex ranges of problems and situations caused by societal changes in students' future careers. Learning theories in design studio have also been discussed (Demirbaş and Demirkan, 2007).

Considering the importance of design thinking in the design process (Dorst, 2011) and in design studio (Oxman, 2004), researchers have emphasized the necessity to understand the cognitive processes of the human mind to enhance the understanding of design thinking (Oxman, 1996, Nguyen and Zeng, 2012) and to view design as a high-level cognitive ability. Design cognition studies are conducted via experimental and empirical methods (Alexiou et al., 2009).

According to Gregory and Zangwill (1987), "Design generally implies the action of intentional intelligence". Meanwhile, Cross (1999) introduced the natural intelligence concept in design with the assumption that design itself is a special type of intelligence. Papamichael and Protzen (1993)discussed the limits of intelligence in design. Other studies emphasized the significance of spatial ability as a type of intelligence in graphic-based courses (Potter and van der Merwe, 2001; Sorby, 2005; Sutton and Williams, 2010a). Furthermore, Allison (2008) concluded that spatial ability is crucial in learning and problem solving.

However, effective and measurable predictive mental factors, and tools that can influence the design process in design studio are insufficiently studied.

Raven's Matrices tests are originally developed to measure the "eduction" (from the Latin word *educere*, which means "to draw out") of relations(Mackintosh and Bennett, 2005); moreover, these tests are some of the best indicators of the g factor (Snow and Kyllonen, 1984, Kunda et al.. 2013). The g factor assesses the positive correlations among various cognitive abilities and implies that individual performances on a certain type of cognitive task could be compared with those on other types of cognitive tasks (Kamphaus et al., 1997).

Raven tests directly measure two major elements of the general cognitive ability (g), namely, (1) "eductive ability", which is the capacity to "make meaning out of confusion", easing the manner of dealing with complexity; and (2) "reproductive ability", which is the capacity to process, remember, and recreate explicit information, and those who communicate interpersonally(Raven, 2000).

Raven tests have been extensively applied in research and in practice, and a vast "pool of data" has been accumulated thus so far (Raven, 2000).Given the independence of language skills in Raven tests, the three versions of these tests (Advanced, Colored, and Standard Progressive Matrices) have been among the most widely applied intelligence tests(Brouwers et al., 2009).

The current study reflects a hypothesis of the correlation between students' intelligence quotient (IQ) and design abilities in architectural design studio. The IQ indicator is based on Raven's Progressive Matrices applied to the sample of Deylaman Institute of Higher Education architecture students enrolled in 2011. The architecture design skill indicator is obtained according to scores during the first year of Architecture Design Studio (ADS-1) to the final year (ADS-5). This study initially considers a theoretical framework that includes six components, namely, (1) a design studio in architecture education; (2) design thinking in design studio; (3) a cognitive approach in design; (4) spatial ability and design studio; (5) design, problem solving and IQ; and (6) creativity, design, and IQ. Subsequently, hypotheses are formed. Descriptive and inferential statistics are employed to test the hypotheses using the SPSS software.

2. Theoretical framework

2.1. Design studio in architecture education

According to the "learning by doing" philosophy(Schön, 1983), design studio is widely recognized as an indispensable component of the design curriculum(Shih et al., 2006) and as the heart of architectural education(Oh et al., 2013).

Demirbaş and Demirkan (2007) regarded design studio as the core of the design curriculum, and noted that all other courses in the curriculum should be related to design studio. Demirbaş and Demirkan (2003) contended that design studio is related to design problems sociologically and to design education relations with other disciplines epistemologically.

By bridging mental and social abilities, Rüedi (1996) viewed design as a "mediator" between invention (mental activity) and realization (social activity). Design is an open-ended problem-solving process, and the functions of design theories support designers' cognitive abilities (Verma, 1997). Hence, design studio helps in the free exchange of ideas (Tate, 1987)through an information process that may be assumed as a social and organizational method for both tutors and students (Iivari and Hirschheim, 1996).

Regarding the significance of designers' experiences compared with regulations and facts (Demirkan, 1998), a design studio in architectural education is the first environment where the initial experiences for future professions can be obtained (Demirbaş and Demirkan, 2003).

Schön (1985) concluded that the design studio learning process starts with ill-defined problems and is developed through the "reflection-in-action" approach. In design studio, the knowledge learnt in different courses should be applied in the design process to determine an optimal solution for the design of an ill-defined problem. In design education, teaching and learning methods are intended to balance critical awareness and the creative process (Demirbaş and Demirkan, 2007). Schön (1983) also emphasized that the studio-based learning and teaching method can be extended to other professional educations in other disciplines. In design studio, students communicate with one another, and receive comments from other students and a tutor (Kvan and Jia, 2005), which is a process called critique. Oh et al. (2013) reviewed different types of critiques in design studio.