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Research Paper

# Developing a Design Thinking Model of Architectural Education Based on Wisdom and Creativity Styles Mediated with Self-Directed Learning

**Farhad Karvan**[a*]

[a] Assistant Professor, Department of Architecture, Faculty of Art and Architecture, Hamedan Unit, Islamic Azad University Hamedan, Iran (Corresponding Author).

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## ABSTRACT

Educational planners have long focused on designing novel approaches and thus attached importance to the approach of design thinking and relevant variables by understanding the position of cognition in architectural education. The goal of the present study was to formulate a structural model of design thinking based on wisdom and creativity styles with the mediation of self-directed learning among students. To this end, the main study hypothesis states that the proposed model enjoys good fit with study data. All female architecture students at the Technical and Vocational University of Hamedan (600 people), who were studying from 2022 to 2023, comprised the statistical population of the study. The sampling method was convenience (No. 255). Three-Dimensional scales, namely, Ardelt's Wisdom, Kirton's Creativity Styles, Dosi's Design Thinking and Fisher's Self-Directed Learning Measure, were used to collect data; the data were also analyzed by Structural Equation Modeling. Structural section results indicated that the direct effect of wisdom on self-directed learning and design thinking was positive and significant. The direct effect of innovator style on self-directed learning and design thinking was also positive and significant. The direct effect of the adaptor style on self-directed learning was relatively significant; however, it did not have a significant effect on design thinking. The direct effect of self-directed learning on design thinking was also positive and significant. The study of the mediating role of self-directed learning indicated that it significantly mediated the relationship between wisdom and creativity styles with design thinking. Hence, the study concluded that students' design thinking can be reinforced by developing proportionate and variable-related educational programs.

**Keywords**: Architecture Education, Design Thinking, Creativity Styles, Self-Directed Learning.

* E_mail: f.karvan@iauh.ac.ir

## 1. INTRODUCTION

The investigation, development and identification of educational models have always attracted the attention of educational system designers, especially architectural education experts. Education experts have long investigated the position of cognitive factor, such as the role of thinking on education; for this, it is increasingly becoming important to present proportionate methodology based on design thinking models. Since traditional methods of architectural education do not meet students' needs (Labib et al. 2019), the aim of novel educational approaches is to create key skills in learners. The design thinking approach that requires creative thinking in producing problem solutions plays a major role in educating architecture. This means that learners in educational settings should logically read, think, reason and solve complex problems (Willingham and Rotherham 2009).

A design actually originates from a thinking method, which Edward de Bono calls it design thinking (Feizi and Khakzand 2006). Despite benefits of design thinking, educating and utilizing this method involve ambiguities, which increasingly reveals the necessity of exploring the concept of design thinking.

### 1.1. Research Literature

Design thinking serves as a learning method in education (Shively et al. 2018). Research has shown that design thinking has become an integral part of design education areas because it requires creative thinking in generating solutions (Rotherham and Willingham 2009). Research findings reveal the instructors who make use of design thinking in education could experience an increase in education quality, innovation and creativity (Warr et al. 2020; Jiang et al. 2018). Hence, some research has investigated design thinking variables such as wisdom, creativity styles and self-directed learning. The following summarizes some examples.

**Table1. Research Literature on the Subject under Study**

| Researcher | Findings |
|---|---|
| Jiang et al. 2018 | Design thinking helps to increase innovation, interaction, and cooperation |
| Val et al. 2017 | Design thinking improves entrepreneurship |
| Warr et al. 2020 | Design thinking enhances educational quality |
| Aranda et al. 2020 | Design thinking reinforces cognitive memory, divergent thinking, assessment thinking |
| Hubbard and Datnow 2020 | Motivation, creative thinking and problem solving |
| Lawson 2005 | Manners of thinking in architecture |
| Kangas et al. 2018 | Design thinking improves envisioning and designing |
| Glen et al. 2015 | Design thinking reinforces problem solving and innovation |
| Dorst 2010 | Using the various methods of reasoning and design thinking |
| Schon 1984 | Linking architecture to design thinking as reflective thinking |
| Cross 1982 | Design-based manners of thinking |
| Lynch et al. 2019 | Changing thinking methods with design thinking |
| Roberts et al. 2021 | Explaining wisdom by thinking |
| Avsec et al. 2021 | Relationship between design thinking and self-directed learning |
| Ghorbani and Khormaei 2018 | Structural relationship between creativity and wisdom |

Despite theoretical literature related to the subject under study, no study has ever examined creativity styles, along with wisdom, mediated with self-directed learning in design thinking. Much research has addressed the positive relationship between creativity styles and design thinking; this study, however, deals with design thinking based on wisdom and creativity styles. Since educating design thinking has been a major goal of architectural education, it is critical to identify the factors that relate to design thinking. This study also identified self-directed learning as a mediating variable between creativity styles and wisdom with design thinking.

## 2. THEORETICAL FOUNDATIONS

### 2.1. Design Thinking (DT)

Educational subjects in architecture constitute major issues of an educational system. Meantime, design comprises the core of the architectural education structure. In other words, design thinking serves as a cognitive style theory in design (Stock et al. 2018). Buchanan (1992) defines design and designed thinking as a problem-solving activity, while considering the design process to include the two stages of problem analysis and problem-solving integration. In other words, design and design thinking

is a method for creative problem-solving (Vande Zande 2011). Design thinking enables constructive thinking and creative problem-solving (Thoring et al. 2020; Borge et al. 2020; Guaman-Quintanilla et al. 2020). In fact, design thinking enables the student to acquire and develop problem-solving and critical thinking skills (Deaner and McCreery-Keller 2018). Cross Nigle (2011) broadly describes design thinking to be a thinking style, thinking mindset and the study of cognitive processes, subsequently noted in the act of designing. Dunne and Martin (2006) also described design thinking to be the cognitive processes used by designers.

A designer's thinking style is a pivotal element in the design thinking approach (Carlgren 2013). Fraser Heather (2011) described thinking styles as comprising being open, empathy, internal motive mindfulness, adaptation and optimism. Avsec & Jagiello (2021) identified the following constructs for measuring design thinking and regarded them as the basis for design thinking: flexibility, risk-embracing, human-centeredness, empathy, mindfulness, a holistic approach, problem reframing, teamworking, open to various viewpoints, learning-oriented, experimentation, experimental intelligence., critical questioning, innovative thinking, envisioning new things, creative self-confidence, desire for influence, optimism for influence. Design thinking has been defined by researchers at the University of Stanford as empathy, knowledge, ideation, prototype and experimentation (Plattner et al. 2016). Besides, design thinking, which falls under the framework of creativity, empathy, and rationality, can increase problem or solution-based task duties and also depend on critical thinking and decision-making abilities as complementary to creativity (Wrigley and Straker 2017).

### 2.2. Creativity (Adaptor-Innovator (A-I)) Styles

Creativity is concerned with a process that can be developed and reconstructed. Creativity is a multi-dimensionally complex process (Barbot and Reiter-Palmon 2019), which represents various methods (Dietrich 2019). It is also the ultimate objective of the educational system in raising creative forces. Creativity is made up of various factors: fluidity, flexibility, expansion and originality (novelty) (Guilford 1987; Falanga et al. 2020). Creative (adaptor-innovator) thinking in highly influential by providing various solutions for generating creative ideas (Ni et al. 2014). Creative generation is also dependent on ideas, idea flexibility and idea originality (Karvan et al. 2020).

Creativity is mainly focused on measuring the quantity rather than the quality of answers, which are evaluated based on fluidity (the number of ideas), flexibility (diversity in classifying ideas), originality (the uniqueness of ideas), and complexity and details (the elaboration and description of ideas) (Jami et al. 2021).

According to Kirton (2000), there must be a distinction between a creative level of ability and a creative practice style. A creative style appears to be related with some high-level creativity criteria (Ee Seng et al. 2007). Kirton developed the cognitive style as a natural orientation or a preferential instrument for problem-solving in two innovator and adaptor styles. A creative individual (with an innovator cognitive style) searches and looks for diverse data, as well as abnormal and creative ideas. To Kirton, people with innovator styles will have access to larger cognitive areas than adaptor-styled people, when facing with problems. An adaptive individual (with an adaptor style) tends to use public data, embraces problems as they are and provides ideas he has been asked for. In this style, the result of thinking is clear in advance; in the innovator thinking, however, no definite or already-known result is available as there are many possible answers (solutions), which may be logically true (Guilford 1987; Falanga et al. 2020). In other words, people with different creativity styles may differ from each other in adopting changes, creativity, decision-making and problem-solution (Sandler-Smith and Badger 1998).

### 2.3. Wisdom

One of the concepts by which wisdom is explained is thinking (Roberts et al. 2021) Research suggests a structural relationship between creativity and wisdom (Ghorbani and Khormaei 2018). Wisdom is a combination of creativity and intelligence, as intellectual people require balancing between intelligence and creativity (Sternberg 2020). Because wisdom is associated with knowledge, awareness and cognition, and also, creativity is characterized by abstract thinking, the ability to think about various aspects of a situation, wisdom can be thus explained through creativity and thinking.

### 2.4. Self-Directed Learning (SDL)

Self-directed learning has become one of the main objectives over the past several decades (Cheng et al. 2010). Self-direction is the basis of all types of learning (Williamson 2007). Self-directed learning involves a large spectrum of self-educated learning, independent learning, non-traditional learning, open learning, collaborative learning, self-learning, self-regulating and self-planned learning (Asfar and Zainuddin 2015). Guglielmino (1997) defines self-directed students to be those who express creativity, independence and perseverance in learning, while enjoying learning and are goal-oriented people (Zhoc and Chen 2016). To Knowles (1975), self-directed learning is a process where the learner, both with or without the help of others, determines the needs, regulates the goals, develops the objectives, identifies the material and human sources for learning, chooses and implements appropriate learning strategies and

evaluates the results and outcomes of his learning, while being innovative and creative (Zhoc and Chen 2016). Avsec et al. (2021) also investigated the relationship between design thinking and self-directed learning in architecture students, Results showed a strong relationship between the application of design thinking for enhancing self-directed learners. In a study "Tendency to Critical Thinking and Self-Directed Learning in Students", Ganbari et al. (2012) concluded that there was a positive and significant relationship between self-directed learning and tendency to critical thinking and creativity.

Several subscales of design thinking such as meta-cognitive knowledge, individual skills, risk-taking and gaining experience are associated with self-directed learning. This means that enhancing self-directed learning in students can increase the learning environment and personal factors such as cognition, emotional states and self-efficacy. Self-directed learning is well predicted by design thinking factors, especially the ability to utilize user experiences in design, problem reframing, team working, the orientation of mastery goal, and innovative thinking. In the design task process, architecture students employ meta-cognitive strategies for changing learning based on processing or their own interest in learning (Kavousi et al. 2020).

Self-directed learning is a type of learning by which the learner conceptualizes, designs, performs and evaluates an educational project. As defined, once students are involved in designing a real world, they are more conscious and focused than their own thinking process, prefer the goal orientation over their performance and use required learning strategies for improving the process of designing and improving the results (Kavousi et al. 2020). Furthermore, the instructor should develop educational activities where meta-cognitive components such as high-order thinking skills can be used and developed (Shareef and Farivarsadri 2020). On the other hand, design education requires a meta-cognitive approach for developing creative processes, which can be concrete for designers, reflecting previous knowledge and experience and consequently enabling the designer to solve any design challenge (Koh et al. 2015 and Halpern 2014). The design thinking used in the design process can be seen as a cyclical process with cycles being dynamic and complementary and helping to change focus and content for mastery over tasks (Plattner et al. 2016; Dorst 2011). The study's conceptual model is illustrated in Figure 1.

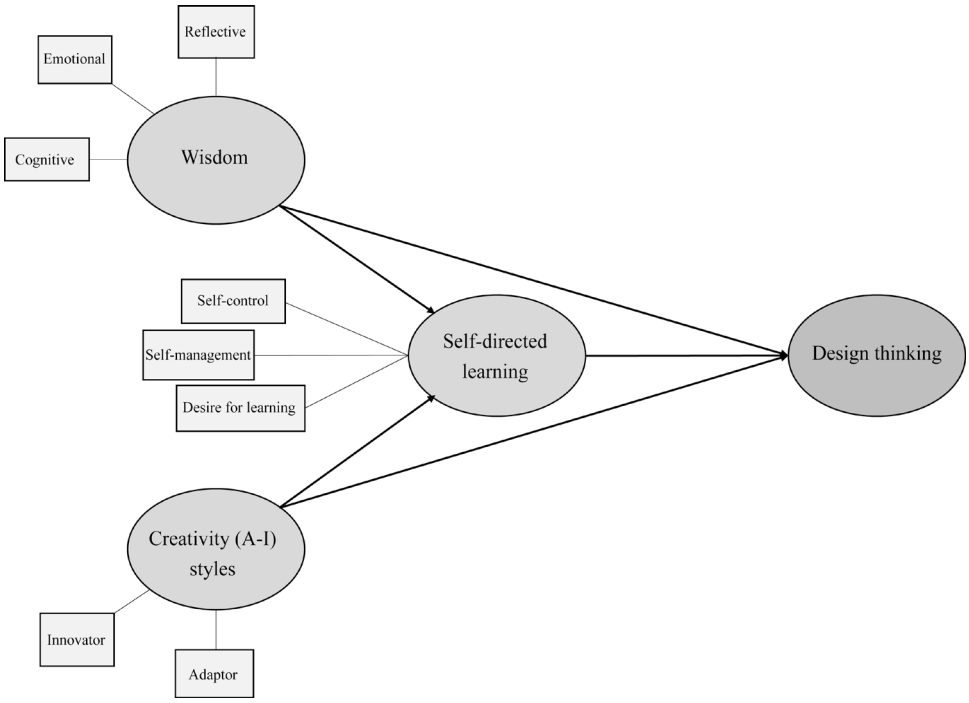


**Fig. 1. The Conceptual Model of the Study**

## 3. METHODOLOGY

This study used a correlation methodology in the form of structural equation modeling. All female architecture students at the Technical and Vocational University of Hamedan (600 people), who were studying from 2022 to 2023, comprised the statistical population of the study. The sampling method was convenience sampling (No. 255). Also, three tests were used for data collection.

### 3.1. Three-Dimensional Wisdom Scale

Ardelt's questionnaire was developed based on the concept of wisdom using cognitive, emotional and reflective components. The questionnaire includes 39 items (in two A and B forms) on a 5-degree Likert scale, each with a 1-5 range. Fourteen items pertained to the cognitive dimension (people's ability and tendency to perceive the real meaning of life), 12 items to the reflective dimension (peoples' tendency to consider occurrences and events from different perspectives) and 13 items to the emotional dimension (the expression of emotions and affection to others). The overall wisdom score is obtained from scores of each dimension on the scale. Ardelt reported the validity of the cognitive, reflective and emotional dimensions at 71, 75 and 66%, respectively, and obtained the overall score at 72, while calculating the reliability coefficient at 85% (Azizisaeid et al. 2019).

### 3.2. Kirton Adaptor-Innovator (KAI) Questionnaire

The Kirton questionnaire (2000) was designed to measure the cognitive (innovator/adaptor) style. The scale is made of 32 items of 5 choices (e.g., very easy, easy, neither difficult nor easy, difficult and very difficult). The minimum score is 32 and the maximum 160, averaging 96. The questionnaire places the subjects into two groups. The scores ranging from 97-160 demonstrates the innovator cognitive style and the score ranging from 32-96 demonstrates the adaptor cognitive style. Also, the minimum score of the scale is 32 and the maximum 160. Kirton reported higher validity and reliability. Cronbach's alpha coefficient of this questionnaire was reported to be 0.88 by Wittich, Daneial Von & Antonakis, Johan (2011). The reliability coefficient of this scale was 0.82 using Cronbach's alpha, while the reliability coefficients of the innovator and adaptor subscales were 0.74 and 0.70. The content validity (CVR) of this questionnaire was 0.68 and the content validity coefficient (CVI) was 0.80 (Moosivand 2020).

### 3.3. Design Thinking Questionnaire

This scale was designed by Dosi Clio, Rosati Francesca, & Vignoli Matteo (2018) and contains 19 constructs or components. It has also 19 items based on a 4-degree Likert scale (1=irrelevant; 2=partly relevant; 3=relevant; 4=highly relevant). The components of this questionnaire were: flexibility, risk-embracing, human-centeredness, empathy, mindfulness, holistic approaches, problem-reframing, team working, openness to viewpoints, learning oriented, experimentation, empirical intelligence, critical questioning, innovative thinking, desire to new things, creative self-confidence, tendency to make a difference, optimism for influence.

### 3.4. Self-Directed Learning (SDL) Scale

This questionnaire was developed by Fisher Murray, King Jennifer, and Tague Grace (2001), which includes 52 items. The final version had its items reduced to 41, after being standardized. This scale has a 5-degree Likert scale of totally disagree (1) to totally agree (5). The minimum and maximum scores are 41 and 205. This scale has three subscales of self-control, self-management, and desire for learning. This scale was first standardized by Nadi and Sajjadian (2006) in Iran. Its overall validity was 0.82. The validity of the three mentioned subscales was 0.60, 0.78 and 0.71, respectively. Cronbach's alpha of the entire test was 0.89.

## 4. FINDINGS

The number of 255 students took part in the study. The mean and standard deviation of the age of the subjects were 22.41±1.87 years. According to the studied problem, the main and secondary questions were analyzed. The main question of the study is: "Can a model of design thinking in architectural education be provided using creativity, wisdom and the mediating role of self-directed learning, while at the same time enjoying good fit?" This study also sought to answer two questions:

1. How are wisdom and creativity styles (directly) associated with design thinking?
2. How does self-directed learning (indirectly) mediates between wisdom and creativity styles with design thinking?

**Table 2. Standard Deviation and Correlation between Study Variables**

| Variables | Means | SD | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| 1. Wisdom | 103.73 | 11.72 | - | | | | |
| 2. Creativity-Innovator | 113.60 | 6.39 | 0.15* | - | | | |
| 3. Creativity -Adaptor | 59.94 | 4.65 | -0.25** | 0.11 | - | | |
| 4. Self-Directed Learning | 158.54 | 22.38 | 0.51** | 0.43** | -0.39** | - | |
| 5. Design Learning | 266.26 | 42.31 | 0.45** | 0.36** | -0.37** | 0.71** | - |

*P<0.05, **P<0.01

Table 2 shows that there is a positive and significant relationship between wisdom and self-directed learning (P<0.01; r=0.51) and design thinking (P<0.01 and r=0.45). There is also a positive and significant relationship between innovator style and self-directed learning (P<0.01; r=0.43) and design thinking (P<0.01; r=0.43).

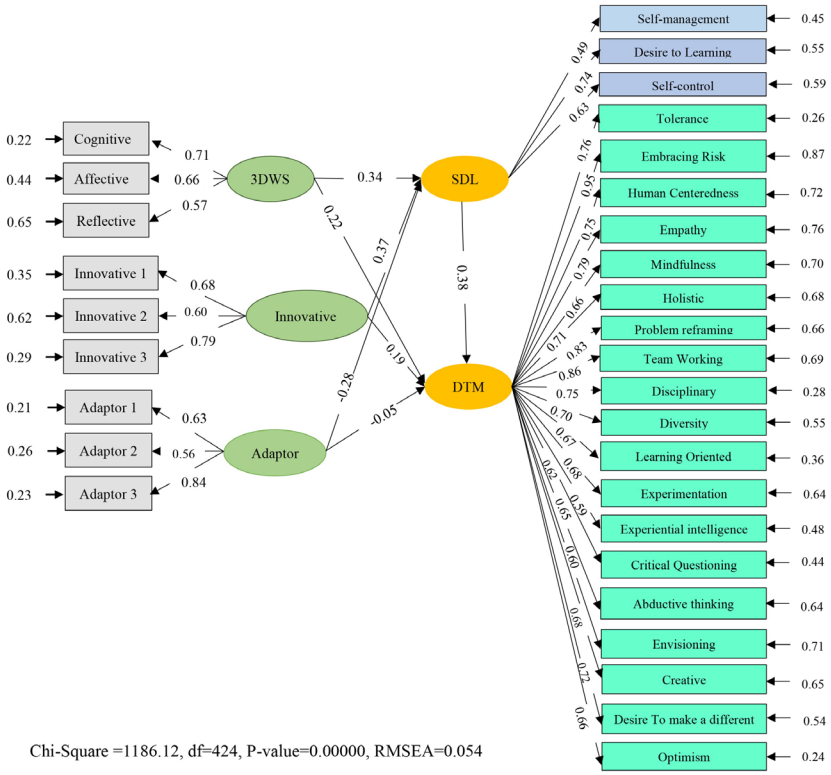


**Fig. 2. Relationship between Wisdom and Creativity Styles with Design Thinking Mediated with Self-Directed Learning under a Standard State**

Wisdom (3DW); Innovator Creativity Style (Innovative); Adaptor Creativity Style (Adaptor); Self-directed learning (SDL) and Design thinking (DTM)

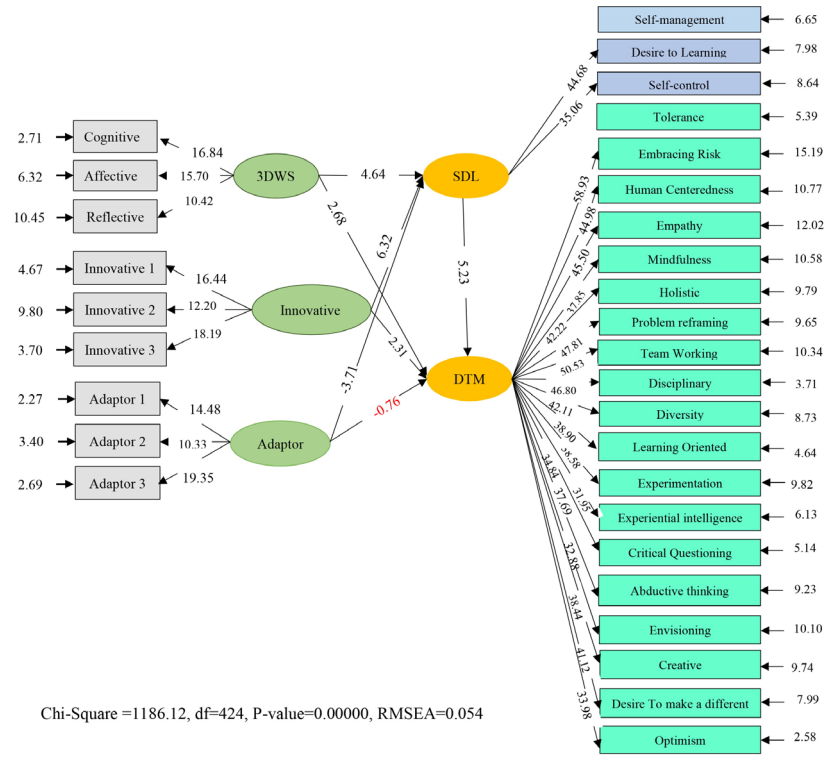


**Fig. 3. The Relationship between Wisdom and Creativity Styles with Design Thinking Mediated with Self-Directed Learning under a Significant State**

**Table 3. Fit Indices of the Developed Model**

| Model Fit Indices | $X^2$ | df | $X^2$/ df | GFI | IFI | TLI | CFI | RMSEA |
|---|---|---|---|---|---|---|---|---|
| Obtained Values | 1186.12 | 424 | 2.80 | 0.94 | 0.93 | 0.94 | 0.96 | 0.054 |

**Table 4. Coefficients of the Model of Explaining Design Thinking based on Wisdom, Creativity Styles Mediated with Self-Directed Learning**

| Direct Path | Standard Coefficient | t |
|---|---|---|
| Effect of Wisdom on Self-Directed Learning | 0.34** | 4.64 |
| Effect of Wisdom on Design Thinking | 0.22** | 2.68 |
| Effect of Innovator style on Self-Directed Learning | 0.37** | 6.32 |
| Effect of Innovator Style on Design Thinking | 0.19** | 2.31 |
| Effect of Adaptor Style on Self-Directed Learning | -0.28** | -3.71 |
| Effect of Adaptor Style on Design Thinking | -0.05 | -0.76 |
| Effect of Self-Directed Learning on Design Thinking | 0.38** | 5.23 |

*P<0.05, **P<0.01

Wisdom has a positive and significant effect on self-directed learning (β=0.34; P<0.01) and design thinking (β=0.22; P<0.01). The innovator style has a positive and significant effect on self-directed learning (β=0.37; P<0.01) and design thinking (β=0.19; P<0.01). The adaptor style has a negative and significant effect on self-directed learning (β=-0.28; P<0.01) but an insignificant effect on design thinking (β=-0.005; P<0.05). Also, findings indicated that self-directed learning has a positive and significant effect on design thinking (β=0.38; P<0.01). The following investigates the mediating role of self-directed learning between wisdom and creativity styles with design thinking.

**Table 5. Mediating Role of Self-Directed Learning between Wisdom and Creativity Styles with Design Thinking through Sobel's Test**

| Predictive Variable | Criterion Variable | Mediating Variable | Sobel's test (z) | P |
|---|---|---|---|---|
| Wisdom | Design Thinking | Self-Directed Learning | 8.47 | 0.001 |
| Innovator Style | Design Thinking | Self-Directed Learning | 7.15 | 0.001 |
| Adaptor Style | Design Thinking | Self-Directed Learning | -6.40 | 0.001 |

Table 5 shows that the variable of self-directed learning plays a significant mediating role between wisdom and design thinking (Z=8.47; P<0.01). Also, the variable of the self-directed learning plays a significant mediating role between the innovator style and design thinking (Z=8.47; P<0.01). The variable of self-directed learning plays a significant mediating role between the adaptor style and design thinking (Z=-6.40; P<0.01). According to the results, the self-directed learning variable had a significant mediating role between wisdom and creativity styles.

## 3. CONCLUSION

The goal of this study was to develop a design thinking model based on creativity styles, wisdom and self-directed learning. Th schematic of the results is illustrated by Figure 4.

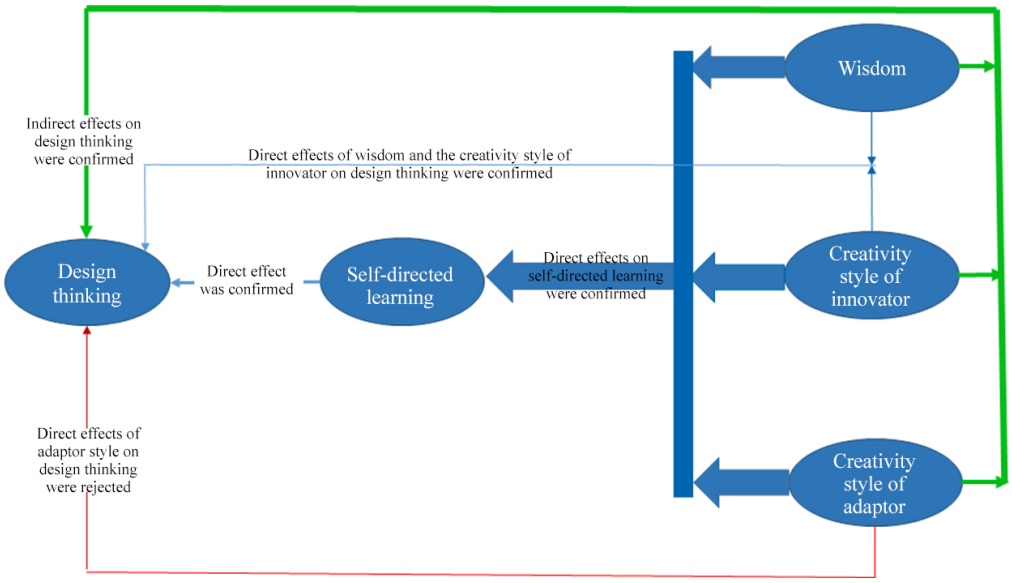


**Fig. 4. Schematic of the Study Results**

Findings revealed that design thinking could be predicted by the variables of wisdom, innovator styles and self-directed learning. Structural relation analysis indicated that wisdom and the innovator style could directly and significantly affect students' design thinking. This finding was in line with those of Thoring et al. 2020; Borge et al. 2020; Guaman-Quintanilla et al. 2020; Deaner et al. 2018; Barbot et al. 2019; Ghorbani et al. 2018; Avsec et al. 2021; Ghanbari et al. 2013.

That design thinking cam be predicted by the creativity styles (innovator and adaptor) and wisdom is explained by the fact that it emphasizes cognitive knowledge, deep insight and understanding, and critical thinking in cognitive and reflective dimensions. Hence, wisdom can affect the design thinking process. It thus appears that wisdom can be explained by creativity and thinking. However, the effects of the adaptor style on design thinking are not significant. The reason why this correlation is not significant is that the creativity style is associated with a higher cognitive level. This suggests that students with the innovator style will have access to larger cognitive areas than adaptor-styles people, when facing with problems. An adaptive individual (with an adaptor style) tends to use public data, embraces problems as they are and provides ideas he has been asked for. Hence, the innovator creativity style is significantly correlated with design thinking, which requires a higher cognitive level. Hence, design thinking in students can be reinforced by developing appropriate educational programs.

The survey of the mediating role of self-directed learning indicated that this variable can significantly mediate between wisdom and creativity styles with design thinking. Also, data showed that their positive and significant effects were in line with the findings of Kavousi et al. (2020) and Sharif et al. (2020).

According to the findings, design thinking is one of the applicably novel methods used to enhance students' skills. This process is also related to innovation, creativity and self-directed learning. Therefore, there is a need for novel design thinking methods in education for raising creative and innovative students. The following can also be proposed based on study findings:

- Architectural education practitioners are recommended to focus more attention to understanding and properly administering design thinking in the form of educational curricula.
- Educational practitioners are also recommended to become familiar with various models of design thinking and deep understanding of their meanings for the better utilization of design thinking in education
- Creativity styles and wisdom should be attended to when design is educated to architecture students
- Students are recommended to receive education about cognitive styles of creativity (e.g., analyzing student sketches in design workshops and criticizing and evaluating creative ideas in the design process to increase design skills)
- Research in interactions between design thinking and other individual variables are recommended.

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## CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

## MORAL APPROVAL

The authors commit to observe all the ethical principles of the publication of the scientific work based on the ethical principles of COPE. In case of any violation of the ethical principles, even after the publication of the article, they give the journal the right to delete the article and follow up on the matter.

## PARTICIPATION PERCENTAGE

The author states that he has directly participated in the stages of conducting research and writing the article.

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