THE POTENTIAL OF REASONING METHODS AS A TEACHING STRATEGY SUPPORTING STUDENTS’ CREATIVE THINKING IN ARCHITECTURAL DESIGN

Han Hee Choi and Mi Jeong Kim
Department of Housing and Interior Design
Kyung Hee University
Republic of Korea

*Corresponding Author’s email address: mijeongkim@khu.ac.kr

Abstract
Much research has emphasized the importance of ‘learning by doing’ in design education. Reasoning methods would be an effective strategy to support students’ reflection-in-action in designing. ‘Knowing how’ is associated with ‘design thinking’, and further, with ‘creativity’, which is essential for design outcomes. This research explores the potential of reasoning methods, specifically analogical reasoning and metaphorical reasoning, in design education for encouraging students to produce creative thinking in a design studio. For one semester, students were educated to adopt analogies and metaphors in designing and how students approached given design problems to produce design ideas was observed. The results showed that adopting reasoning methods as a teaching strategy in a design studio encouraged the development of the students’ design thinking by reorienting their approach to design, which eventually led to enhanced creativity in designing. Based on the results, this research presents critical issues to be considered for encouraging students to utilize analogical and metaphorical reasoning in designing.

Keywords: Analogical reasoning; creativity; design education; design thinking; metaphorical reasoning

INTRODUCTION
Much research has emphasized the importance of ‘learning by doing’ in design education (Demirbas and Demirkan, 2003; Casakin, 2004; Kvan and Jia, 2005; Casakin, 2011). A design studio incorporates critical courses where students can acquire design skills and enhance their levels of expertise through practical learning (Schön, 1983; Kvan and Jia, 2005). In the context of the ‘knowing how’ in designing, it is generally recognized that the development of expertise depends on the pedagogical model used in a design studio (Casakin, 2011). Schön defined the design studio as “a reflective practicum in designing”, where learning can develop through a process of ‘reflection-in-action’ (Schön, 1983; Schon, 1988). The term ‘reflective’ characterizes not only active learning and tacit knowledge in a design studio, but also the concept of reflective education as a ‘conversation’ in which the students and instructors gradually come to understand each other (Wang, 2010).

Reasoning methods would be an effective strategy to support students’ reflection-in-action in designing because students’ design thinking could be influenced by different reasoning methods during the design process. Dorst (2010 and 2011) defined reasoning patterns and emphasized abduction as the fundamental reasoning pattern for design strategy affording creative thinking. Much research on reasoning methods has been done in area of product design. There is little research to adopt the reasoning methods empirically in the architectural design. This research aims to explore the potential of reasoning methods in architectural design education for encouraging students to produce creative thinking in a design studio.

Cross (2007) argued that design competences could be acquired through education as well
as existing innately. Education needs to be concerned with the processes by which students are educated to obtain the relevant knowledge or skills (Peters, 1965; Cross, 2007). The design studio is the core of the curriculum for architectural design education, and all other design courses are related to the design studio (Demirbas, 2001). Accordingly, appropriate teaching methods should be put into practice in the design studio. This research is interested in two representative reasoning methods, analogical and metaphorical, which could play an important role in design problem-solving (Casakin, 2004).

ARCHITECTURAL EDUCATION AND CREATIVITY
Creativity is central to the practice of design; however, its many meanings and the lack of an unambiguous disciplinary definition make it difficult to define (Perry, 1987; Deshpande and Khan, 2010; Williams et al, 2010). Torrance (1976) defined creativity as novel and unique ideas that can be used to interpret design problems from new and different perspectives. Although assessing creativity in design education is a highly contentious issue, but it is also a requirement against which all design projects are assessed. Further, assessing creativity has a number of innate limitations, as it is dependent upon the know-how of expert judges and professional designers (Howard et al, 2008; Ostwald and Williams, 2008; Hausman, 2009).

In architectural education, creativity is frequently set down as a learning objective; students must be creative to solve ill-defined design problems. Students are generally educated to develop their logical and convergent thinking to find correct answers and thus often engage in linear thinking when attempting to solve ill-defined design problems. Thus, students should be provided with a more complete understanding of design thinking for creativity in their education. Oxman (1995) categorized seven types of research on design thinking: (i) design methodology; (ii) design as problem-solving; (iii) design cognition; (iv) the psychological aspects and mental activities related to design; (v) artificial intelligence (AI) in design; (vi) the computational model, method, systems and technologies; and (vii) collaborations. Chakradeo (2010) noted that an education in architecture has three basic components: (i) knowledge (the theoretical part of any education programme that is taught using education technologies); (ii) skills (taught by practice and demonstration); and (iii) design (the teaching of which is still being discussed and debated, as creativity is the essential component of design).

Scott et al (2004) emphasized the effectiveness of well-designed education programs in developing creativity. Based on Scott et al’s (2004) findings, Cropley and Cropley (2010) outlined five principles for successfully educating students to be creative in designing: (i) targeted practice in the solving of problems; (ii) highly organized and systematic training based on realistic examples; (iii) creativity training for extended periods of structured practice; (iv) training on broad knowledge and skills; and (v) targeted practice aimed at acquiring specific knowledge and skills. Nabin (2010) contended that any design education program should link theories to applied design work in a studio setting and that students should be granted greater autonomy by synthesizing the principles of Constructivist Learning and Problem-Based Learning (PBL) to actively involve them in their education. Demirkan (2016) emphasized the role of the instructor in architectural education, noting that it is not only the role of an instructor to teach new information, but also to guide students’ education experiences by encouraging them to learn, explore, and apply new information in novel ways.

DESIGN THINKING AND REASONING METHODS
Design problems are open-ended tasks, so ‘designerly’ practices should be critical in design disciplines for the challenge of dealing with open, complex problems. Designers create and manipulate ‘frames’ in their field of practice to elaborate professional practices to do this as shown in Figure 1 (Dorst, 2011). To produce the maximum values of design outcomes, some researchers have argued that the design process should be drawn up by adopting reasoning
methods based on the understanding of key aspects of the design problem (Blackwell, 2006; Casakin, 2011; Cheong et al, 2012).

\[
\text{WHAT} + \text{HOW} \rightarrow \text{RESULT}.
\]

Figure 1. Frames for Designerly Practices (Dorst, 2011).

Analogies refer to similarities between relationships, classified by the conceptual distance between the source and target domains (Dahl and Moreau, 2002). They are often used in generating ideas to transfer knowledge through analogical mapping from a source domain to a target domain containing the problem to be solved (Mak and Shu, 2004). Similarity links analogically related items by establishing structural commonalities in addition to surface between the source and target domains (Gentner, 1989; Goldschmidt, 2001). The analogies abstracted from similarity relationships can be further divided into two types. Within-domain analogies are used between conceptually close source and target domains. Between-domain analogies are used between different source and target domains, e.g., from biological phenomena to electromechanical products (Mak and Shu, 2004). Analogical reasoning makes people aware of a problem from a different perspective so that the problem can be interpreted from a new angle (Holyoak, 1995). Abstracting and transferring knowledge from one concept to another allows designers to develop novel design concepts (Cheong et al, 2012).

Metaphors can help the designer comprehend unfamiliar problems and enlarge the range of potential design solutions, particularly in the early stages of the design process (Casakin, 2004). In common usage, a metaphor is regarded simply as a literary term. For example, writers help the reader to understand a thing by describing it as though it were another: "my daughter is a peach", where the target domain of description (my daughter) is the topic of the metaphor, and the source domain (a peach) is its vehicle (Blackwell, 2006). Metaphors enable us to understand an unknown situation in reference to a familiar one (Ortony, 1991). When solving non-routine design problems, metaphors can assist reflection about the essence of a situation, otherwise it could be difficult to predict what a solution will look like (Schön, 1983). In general, research on metaphors highlights the principal features of the thought process that are most significant in creativity (Mail, 1987). Casakin (2004) demonstrates that metaphors play an important role in design creativity by investigating relationships between creativity and metaphors.

**METHODOLOGY**

To investigate the potential of analogical and metaphorical reasoning as design strategies for creative designs, a studio scenario dealing with residential design was carefully planned and applied to a regular studio course targeting second-year undergraduate students majoring in interior architecture. We wondered how a teaching method that encourages students to adopt analogical and metaphorical reasoning in a studio course for a longer period (16 weeks) would affect students’ design thinking and interpretation of the design problems. The use of analogies and metaphors in designing would stimulate students’ design thinking, which would bring changes in the design process and eventually lead to creative design ideas. Two hypotheses were established and the evaluation criteria for the observation were developed based on related research.

Hypothesis 1: The appreciation of innovative forms of design work would encourage students to adopt analogical reasoning in designing as a stimulus for design forms.

Hypothesis 2: The use of formless stimuli would prevent students from existing forms of design work and encourage them to adopt metaphorical reasoning in designing.
Hypothesis 1 intended to investigate if unconventional forms could stimulate students to adopt analogical reasoning, leading to changes of perspective, and further, to the production of innovative ideas in designing. In most cases, students are given with conventional forms for getting insights into the theme of the design tasks. For example, if the design task is to design a house, students often refer to conventional house designs for getting some initial ideas on their designs. Hypothesis 2 intended to investigate if using formless stimuli in designing could encourage students to adopt metaphorical reasoning, leading eventually to the embodiment or transfer of their feelings or imagination into a design form. It was expected that formless stimuli could encourage students to develop abstract meanings for the theme of the task rather than specific forms for designing the given task straightforwardly.

Evaluation Criteria and Observation Notes

Evaluation criteria for creativity were developed based on related research. Creativity is generally characterized by several keywords, including novelty, newness, originality, appropriateness, functional feasibility, conceptual validity, unobvious, adaptive, leap, change, unexpected, communicated, transformation, comparisons, and resourceful (Mayer, 1999; Atkinson, 2000; Howard-Jones, 2002; Howard et al, 2008). Table 1 sets out a customized creativity criteria comprising three categories (each of which has three sub-categories). The nine sub-categories were used as indicators for assessing creativity in the experiment. The criteria were used as metrics to identify whether the use of reasoning methods in ideation were applied as design strategies in creative designs. The creativity criteria focused on new and diverse ideations, and practical aspects of ideas in relation to architectural design.

Table 1. Creativity Criteria (Source: Authors).

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Categories</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novelty</td>
<td>Unexpected</td>
<td>design ideas in terms of uncommonness</td>
</tr>
<tr>
<td></td>
<td>Originality</td>
<td>design ideas that did not exist before</td>
</tr>
<tr>
<td></td>
<td>Transformation</td>
<td>the degree of the changes in design ideas at each step</td>
</tr>
<tr>
<td>Appropriateness</td>
<td>Construction</td>
<td>design ideas that can be constructed or applicable in reality</td>
</tr>
<tr>
<td></td>
<td>Function</td>
<td>design ideas that meet the function of the residential space</td>
</tr>
<tr>
<td></td>
<td>Aesthetics</td>
<td>the degree of beauty</td>
</tr>
<tr>
<td>Third element</td>
<td>Unobvious</td>
<td>design ideas that are abstract or ambiguous</td>
</tr>
<tr>
<td></td>
<td>Communicated</td>
<td>the degree of the proper delivery of design ideas</td>
</tr>
<tr>
<td></td>
<td>Resourceful</td>
<td>design ideas in terms of fluency</td>
</tr>
</tbody>
</table>

The novelty and appropriateness categories are representative features of creativity; they were divided into sub-categories in order to investigate them in a more detailed and systematic way. The final category, the third element associated with creativity, is included in the criteria based on the assumption that a large number of abstract, untypical, and varied ideas could be produced by the adoption of reasoning methods in designing, thereby extending designers’ thinking.

Firstly, the three sub-categories of novelty—unexpected, originality and transformation—can be connected to strategies associated with creative design such as mutation and emergence, with a focus on accomplishment of non-pre-existing meanings or forms. Secondly, the three sub-categories of construction, function, and aesthetics emphasize the practical aspects of the proposed design idea realizing the residential purpose in reality. Thirdly, the three sub-categories of the third element—unobvious, resourceful, and communicated—can be ambiguous, making it necessary for a variety of trials to be delivered effectively in order for essential ideas to be selected.

In addition to using the customized creativity criteria to evaluate the design outcomes, an
observational method was also used to assess students’ design behaviors in the design processes. Under the observational method, students’ design processes and sketches were recorded and observation notes made by a lecturer (see Table 2). The lecturer was a designer with over 25 years practical experience and 10 years teaching experience in design studios. In the observation notes, the lecturer noted the behaviors students exhibited in the design processes and spent 10 to 15 minutes with each student in turn during four hours of each studio time. The observation notes were then analyzed and interpreted by two researchers (a lecturer and an expert researcher in design studies) in relation to the design strategies adopted by students and what changes occurred in students’ design processes.

Table 2. Observation Note (Source: Authors).

<table>
<thead>
<tr>
<th>Design Process and Sketches</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011. Sep. 17</td>
</tr>
<tr>
<td>- S1 and S2 discuss the feeling aroused by the basic three colors: red, blue, and yellow</td>
</tr>
<tr>
<td>- However, S1 was not able to extract any image from the discussion, so kept sketching by himself</td>
</tr>
<tr>
<td>- S1 thought the feeling caused by red and blue should be strong, so chose the yellow color and returned to the discussion with S2 for mutual evaluation.</td>
</tr>
<tr>
<td>- By associating with the yellow color, they started to talk about kindergarten: S1 considered the yellow color to be childish and S2 talked about the soft feeling of cotton candy experienced when she was a child.</td>
</tr>
</tbody>
</table>

| Ellipsis |

Observation Results

Through this mutual discussion, students shared the contents and progress of their designs. They seemed to be comfortable with the discussion, but they still did not show the expression of their opinions actively. They tried to modify their designs based on criticism from others. By analyzing the problems with the existing design ideas and identifying the residents’ characteristics, they tried to apply those things to their design. Although they kept trying to utilize the motifs in their design, they seemed to have difficulties in utilizing them effectively.

More lectures on metaphors should be given to students.

EXPERIMENT DESIGN

One studio course, which ran for the second semester (16 weeks) in the department of interior architecture in a university, was selected for this study. Twenty-four students were separated into two groups; twelve students for an analogy class (Class A) and twelve students for a metaphor class (Class M). Students’ marks in previous studio courses were used to ensure that capable students were distributed equally between the two classes. The participants in this study were second-year interior architecture students; thus, they had similar general education backgrounds and experiences. One researcher joined the studio as a lecturer and another researcher attended the studio as an observer. Many empirical studies on designers’ cognition include a relatively small number of participants when seeking an understanding of specific cognitive processes. Although the number of participants was relatively small, our research ran for one semester to observe students’ design behaviors during the design process, thus providing sufficient data for an empirical study. The large number of data elements of the participants was analyzed in qualitative ways.

Studio Composition and Procedure

As a teaching method for enhancing students’ creative thinking, the use of morphological materials was applied in a studio course in Class A, and the use of abstract materials in a studio course in Class M. The studio procedure is shown in Table 3.
Table 3. Studio Composition and Procedure (Source: Authors).

<table>
<thead>
<tr>
<th>week</th>
<th>Lecture/Design Task/Given Materials</th>
<th>Teaching &amp; Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to the studio course</td>
<td>Notice the schedule and requirements for this course</td>
</tr>
<tr>
<td>2</td>
<td>Lecture on Design Studies</td>
<td>Theoretical background of creativity, design thinking, reasoning methods, etc.</td>
</tr>
<tr>
<td>3–5</td>
<td>Task 1. Renovating my house to a style in which I would want to live</td>
<td>Identify each student’s design capability and characteristics</td>
</tr>
<tr>
<td>6–11</td>
<td>Task 2. Designing a unique house for me: Given Materials: Class A: a collection of radical architecture works Class M: three basic colors</td>
<td>Encourage students to adopt the targeted reasoning methods Class A: adopting analogies Class M: adopting metaphors</td>
</tr>
<tr>
<td>12–15</td>
<td>Task 3. Designing a house as a place that has a story or memory: Class A: no given material/selecting own materials Class M: no given material/selecting own materials</td>
<td>Encourage students to adopt the targeted reasoning methods Class A: adopting analogies Class M: adopting metaphors</td>
</tr>
</tbody>
</table>

From week 3, participants were asked to work on three successive design tasks for the duration of the course. Design task 1 was used as an introductory activity to prepare students for the design activity and to identify each student’s design characteristics and behaviors. The three tasks were developed as individual design tasks so that the researchers could observe detailed changes in each student’s design cognitions and behaviors. Design tasks 2 and 3 were intended as stimulants to draw analogical and metaphorical reasoning processes from the students. A lecturer observed students at work as an investigator during the course and another researcher collaborated on the interpretation of the observation and adjustment of the teaching methods over all courses for one semester. In the task 2 session, the lecturer taught each student using one-to-one tutoring and gave additional lectures on analogical and metaphorical reasoning when needed. For the task 3 session, discussion time with other members of the class was included in order to assist students to conceptualize the abstract design theme effectively. In tasks 2 and 3, additional teaching methods (e.g., one-to-one tutoring lectures on targeted reasoning methods and discussion time with other students in the class) were used to encourage students to intentionally adopt the targeted reasoning method.

Design task 2 (week 6–11)
For Class A, a collection of radical, anti-form architectural building works designed by Greg Lynn, Andreas Angelidakis, etc. was given to students to induce the use of analogical reasoning in producing innovative design ideas. It was anticipated that appreciation of innovative designs would stimulate the students to use analogical reasoning more, as opposed to appreciation of general housing designs and being confined by existing visual forms of the houses. On the other hand, in Class M, to encourage students to interpret shapeless, formless materials abstractly, without paying attention to the appearance of the material, three basic colors—red, blue, and yellow—were given to the students as a stimulus that they were supposed to refer to in producing house designs. We expected that students would depend on the emotions generated by the given colors, rather than being fixed to the visual forms, so they might adopt more metaphorical reasoning in embodying the images of the given colours into the house designs.

Design task 3 (week 12–15)
There was no given material in design task 2 and students were encouraged to select their own...
materials. Further, the theme of the design task was designated as ‘designing a house as a place which has a story or memory’ in order to exclude any visual form or preconception of the materials. As a starting point, students in Class A were given some time to talk about their experiences, dreams, memories, etc. with their classmates in order to inspire their self-motivation for the given task. They were asked to choose one concept associated with visual forms and to develop their house design by referring to it. Students in Class M were also asked to talk about their experiences, dreams, memories, etc. with their classmates and were then requested to develop one story into an intangible, abstract concept for the house design. This was anticipated to lead students to adopt metaphorical reasoning for the theme of design task 3, by excluding the preconceptions.

RESULTS
An evaluation team of five professional interior designers assessed each student’s design outcomes for tasks 2 and 3 based on the proposed creativity criteria. Each member of the evaluation team had over 20 years practical experience in interior design. Prior to the analyses for tasks 2 and 3, two researchers reviewed students’ task 1 designs to determine each student’s design features and aptitude. The followings were their interpretations of the design processes from the observation notes and the creativity assessments of the evaluation team. Both evaluations were done based on the customized creativity criteria.

Analyses of the Design Process in Design Task 2
Design Task 2 – designing a unique house for me
Students in the two classes produced similar results in terms of the creativity except the 3rd element.

■ Novelty
Students experienced difficulties in developing novel ideas through reasoning methods because the adoption of reasoning methods as a strategy for stimulating ideas was new to them. In terms of ‘unexpected’, they seemed to be unable to detach themselves from the conventional ideas derived from the given motif, and thus did not produce uncommon ideas. Although the given item provided various morphological motifs, students in Class A did not create their own designs by re-interpreting the motifs, but imitated the motifs in designs (Figure 2).

![Figure 2. One example from Class A that did not utilise the given item effectively (Source: Authors).](image-url)

Students in Class M also experienced difficulties in abandoning conventional designs. The intention of the three colors as the given material was to induce the use of metaphorical reasoning; however, contrary to our expectations, the dominant strategy utilized was analogical...
reasoning. For example, students’ thinking started from the color red, went to Christmas, thence to Santa Claus, and eventually reached the shape of a gift pack, which illustrated the morphological symbol associated with the colour red (Figure 3).

<table>
<thead>
<tr>
<th>Given motif: Basic three colours</th>
<th>Design development: associating the red colour with Christmas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Representing a form of the Santa Claus gift pack</td>
<td>Final 3D</td>
</tr>
</tbody>
</table>

Figure 3. One example from Class M that did not utilise the given item effectively (Source: Authors).

Students attempted to check if their ideas were correct or incorrect with the lecturer, even though the lecturer repeatedly explained that there was no one correct design process. To enable students to understand the difference between reproduction and transformation and to use reasoning methods effectively, lectures on design theory and reasoning methods were provided.

In terms of originality, some students started to utilise the given item proficiently after the lectures and produced more innovative developments in designs (Figure 5) compared to their previous designs. In terms of transformation, most students seemed to attempt to change their design ideas at every step in order to continuously develop alternative ideas.

■ Appropriateness
For Class A and Class M, the degree of function is high. This result implies that specific strategies such as analogic and metaphoric reasoning methods might stimulate students to revise their design ideas or concepts more often with a focus on the functions of the residential space. In terms of construction, although the second-year students had not yet learned about the structure of buildings, they seemed to develop their designs based on the constructability. There were variations on the aesthetic aspect of the proposed designs among students.

<table>
<thead>
<tr>
<th>Given motif: Cloud House, Andreas Angelidakis</th>
<th>Design development: applying the shape of the elevation of a building to the floor plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final plan</td>
<td>Final 3D</td>
</tr>
</tbody>
</table>

Figure 4. One example that utilised the given item effectively after the supplementary lectures (Source: Authors).
Third element
Students experienced difficulties in developing divergent thinking with reasoning methods, despite being given continuous lectures on design theories and reasoning methods. They were encouraged to develop many ideas, which could be vague or unobvious; however, the students seemed to confine themselves to the initial ideas, not extending their design thinking effectively (Figure 3 and 4). Initially, the degree of proper delivery of design ideas differed according to the students’ sketching skills. After students were encouraged to write down their ideas if they felt necessary, some students who had previously exhibited a passive attitude toward communicating became more active by combining sketches with notes to deliver their ideas (Figure 5). In terms of resourceful in the third element, students in Class M had difficulties in developing design ideas based on the abstract colors.

Analyses of the Design Process in Design Task 3
Design Task 3 – designing a house as a place that has a story or memory
The observation of the task 3 session shows that students appeared to become accustomed to the use of reasoning methods for their design thinking and to develop more advanced design ideas for design task 3.

Novelty
Students in Class A and Class M produced relatively novel design ideas in originality and trialled various transformations of the design ideas. Compared to design task 2, students in Class A seemed to develop more divergent thinking and enjoy their design activities by adopting their own motifs (Figure 6). They produced various design sketches to include their stories or memories in the house design by adopting analogical reasoning of their own motif. It seemed that self-selected motifs facilitated the incorporation of students’ immersion into their own designs because the motif was so familiar to them. The result of the design process suggests the significance of self-motivation in design thinking when reasoning methods are adopted.
Compared to the design task 2 session, students in Class M also produced more ideas with variations in the design task 3 session. Most students attempted to develop untypical design ideas by utilizing the metaphorical reasoning method, going beyond their conventional design activities. They strived to recall their memories to stimulate novel ideas in solving task 3, which brought about transformations of ideas and development of unexpected designs.

### Appropriateness

Rather than focusing on the appropriateness of the design output, the students in Class A and Class M seemed to concentrate more on the development of conceptual ideas based on the self-selected materials. There was not much advancement in terms of construction and function compared to the task 2 session. Their focus was on the novelty of the proposed ideas, emphasizing uncommonness and unexpectedness, not constructability in reality. They did not consider the residential functions of the houses such as circulation and connectedness very carefully. However, the aesthetic aspects such as proportions and formativeness were improved compared to those in the task 2 session.

### Third element

Compared to the design task 2 session, students in Class M also produced more ideas with variations and delivered such ideas comprehensibly in the design task 3 session. These results imply that metaphoric reasoning with such self-selected materials might encourage students to emphasize the fluency of their design ideas. Of primary importance, students were given some discussion time to talk about their experiences, dreams, memories, etc. with their classmates; as a result of this, their self-motivation for the given task seemed to be stimulated and abstract concepts for the house design were developed based on one selected story through the discussions. For example, one student employed the story ‘The Chronicles of Narnia’ as a concept motif for her design and selected four keywords representing four characters in the story. In the process of embodying the analyzed characters into the design, she actively utilized metaphorical reasoning, as shown in Figure 7.

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**Figure 6.** One example that shows the process of developing motifs for my grandfather and me in Class A. 
(Source: Authors).

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<table>
<thead>
<tr>
<th>Sketch at the initial stage: drawing appearance of my grandfather and me (transformation)</th>
<th>Sketch at the middle stage: modelling appearance of my grandfather and me</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sketch at the initial stage: drawing appearance of my grandfather and me (transformation)</td>
<td>Sketch at the middle stage: modelling appearance of my grandfather and me</td>
</tr>
<tr>
<td>Final plan</td>
<td>Final 3D</td>
</tr>
</tbody>
</table>
Whenever they became stuck at some point, the students attempted to adopt reasoning methods to break through the barriers, leading to resourceful ideas. They did not care whether the lecturer said the proposed ideas were correct or not anymore. Although they still had difficulties in expressing their ideas fully through the sketches, they persevered by representing their ideas using computer tools, without hesitating to develop the design further.

To sum up, students generally seemed to lack an understanding of the analogical and metaphorical reasoning and design theories before theoretical lectures were given. Students in the task 2 session often had trouble utilizing the given materials effectively and have entrenched conventional ideas. In the task 3 session, students were encouraged to select their own materials for self-motivation and the theme of the design task was associated with no visual form of the materials. Above all, compared to Class A, the opportunity to have discussions on the conceptualization of designs based on the abstract theme in Class M seemed to have more effect on design development. Students in Class M first seemed to lack confidence in developing their designs by themselves because their designs were required to be embodied based on shapeless or formless motifs. However, they seemed to be able to develop their design ideas, specifically in detail, through the discussion process with other class members, which increased students’ confidence in the designs.
DISCUSSION AND CONCLUSION

In cognitive stimulation, the knowledge embodied in the examples stimulates ideas that designers would not otherwise have accessed (Perttula, 2006; Wilson, 2010). Thus, when the education program was developed, to expose students to those examples, design tasks that would intensify multiple ideas were selected. Based on the assumption that morphological stimulation and formless imaginable stimulation would have a positive effect on idea generation, forms or formless materials were provided to students to support analogical and metaphorical reasoning.

Hypothesis 1 was validated by the observation of Class A emphasizing the adoption of analogical reasoning in design thinking. Students seemed to become accustomed to the use of reasoning methods for their design thinking as they carried out design task 2 and to develop more advanced design ideas for design task 3. They started to utilize the given item more proficiently after the lectures and produced more innovative developments in designs. The lectures were intended to encourage students to adopt analogical reasoning actively in the design process. Although students in Class A initially experienced difficulties in re-interpreting the motifs, they gradually developed more divergent thinking and produced various design sketches to include their stories or memories by adopting analogical reasoning of their own motif. Self-selected motifs facilitated the incorporation of students’ empathy into their own designs.

Hypothesis 2 was validated by the observation of Class M emphasizing the adoption of metaphorical reasoning in design thinking. Students in Class M produced relatively novel design ideas with originality and various transformations of the ideas. They utilized metaphorical reasoning to generate uncommon ideas, recalling their memories. Rather than focusing on the appropriateness of the design, they concentrated on the conceptual ideas based on the formless materials, which emphasized the fluency of their design ideas and produced more novel shapes or forms of the houses. In particular, with self-selected materials, they adopted more metaphorical reasoning in design thinking. Their self-motivation seemed to be stimulated and abstract concepts for the house designs were developed through the discussions.

In conclusion, the results of this research suggest that reasoning methods such as analogical and metaphorical reasoning play an important role in design problem solving, as they enable design problems to be restructured in non-routine ways. This study explored the potential effects of analogical and metaphorical reasoning methods as a teaching strategy for students’ creativity in design and identified a number of issues that should be considered in design studio education programs.

Firstly, given materials should be selected carefully to support the adoption of analogical and metaphorical reasoning. For example, although basic colors are formless stimulation, they did not act as expected because the students had strong preconceptions associated with a specific morphological concept. It seemed that the students were not capable of overcoming these conventional concepts easily. Thus, to train students to adopt metaphorical reasoning, we need to select given materials that are free from fixed concepts and apply them in the education program.

Secondly, self-motivation came about by the utilization of the materials by students. When students had the opportunity to select their own materials for developing their design, they seemed to enjoy the design process more and adopt reasoning techniques effectively. However, architectural design is a client-focused profession and analogical and metaphorical reasoning would need to be applied while working within client constraints. A space is not designed purely to satisfy the designer’s self-motivation, but to solve other people’s problems by planning places based on client needs and artistic values. Thus, designers should also include other design motifs relevant to their design to develop a more satisfying solution to the design problem.

Thirdly, mutual discussions with other students should be strongly encouraged to support students’ design thinking. In general, one-to-one tutoring is often adopted in design studio courses in order to provide more customized feedback to each student’s work. However, to
further the adoption of reasoning methods in designing, it is necessary to encourage students to take part in discussions and communicate with each other when developing design ideas. During the discussions, students would evaluate their classmates' designs and provide feedback, which enabled the co-evolution process of problem and solution spaces. Thus, students' design thinking was extended and enhanced, which led to improved self-confidence about their own designs.

Fourthly, to provide stimulation that can support students' design thinking, we need to strengthen design theory education and teach more reasoning techniques in studio courses because this teaching strategy has the potential to stimulate students' creative thinking in design education. The studios should emphasize theoretical lectures as well as practical training. Students could learn design theories and strategies through the lectures and practice reasoning methods by applying theories to designs while working on design tasks.

By addressing these issues in practical studio classes, students can be taught different ways to experience and approach ill-defined design problems. Further, in place of conventional teaching strategies, more relevant and effective strategies should be implemented and adopted in architectural design education programs to stimulate students' creative thinking. This study had several limitations, including that it used customized criteria, instruments, and an evaluation team to assess students' creativity and interpret their design processes. However, this research could provide a basis for future empirical studies to examine creativity in design education programs. Further, the proposed creativity criteria and observation notes should be adopted in future research studies.

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REFERENCES


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**AUTHORS**

**Han Hee Choi**  
*Researcher*  
*Department of Housing and Interior Design*  
Kyung Hee University,  
Kyunghheedae-ro 26, Seoul 02447, Republic of Korea  
Email: hanhchoi@gmail.com

**Mi Jeong Kim**  
*Associate Professor*  
*Department of Housing and Interior Design*  
Kyung Hee University,  
Kyunghheedae-ro 26, Seoul 02447, Republic of Korea  
Email: mijeongkim@khu.ac.kr