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Nurturing Students Design Skill through Analogy and Metaphor Reasoning

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Abstract

The main aim of architectural educators is to foster students' design skills. Many researchers describe architectural design projects as a wicked problem that requires different tools to be solved. Metaphor and analogy are supposed to be helpful reasoning in solving architectural problems. This research query based on exploring students' skill, and aimed to extend other researchers' observations on applying analogy and metaphor through design process and the final product. An investigation was held using two groups of students in the first year of architectural design studio (Basic Design Course). The First group designed their project depending on metaphor reasoning; the second group depended on analogy reasoning. A comparison was shown assessing design process, students' skills and projects output. The research shows benefits verses the challenges and misconceptions which faced students through design process. Also, it pinpoints how metaphor and analogy can up-bring students' deign skills.

1.Introduction

Architectural education and practice is a continuous process of learning and experience. Ozsoy and Gokmen discussed the importance of gaining humanistic knowledge in architectural education in addition to the solving of technical problems. They pointed out that the main goal of education should involve ways of developing the student ability to synthesize, of evaluating the obtained data, improving the ability to conceive problems and to be trained with the ways of encountering problems with the help of the required tools and design skills (Ozsoyand Gokmen,2003).[i] The development of a design project or idea evidently requires more than just knowledge, definitions of clear limits between rational and irrational aspects, objective and subjective aspects, and logical and creative aspects should be established. The challenge in design, teaching and practicing, lies in balancing between these aspects (Luz and Jiménez, 2000).[ii]

The transmission of architectural knowledge is conditioned by thorough and creative questioning and interpreting. Architectural education should develop students' capacity to question, select, interpret and connect information from various fields when confronted with a specific design problem (Radu,2003).[iii]This cannot be gained through memorization but the ways to learn about it can be taught through practicing (Lokce, 1994).[iv] Architectural design project depends directly on the experience of the individual who develops it and, consequently, relies on his/ her knowledge and understanding of reality, jointly with the conception about possibilities of change, beside their understanding of what and how they are doing tactic (Wiggins,1989).[v]

Many researchers discussed the importance of metaphor reasoning when applied in different engineering fields Casakin (2006),[vi]and analogy reasoning (Do and Gross, 1995),[vii] while hey with others discussed both(hey et al., 2008).[viii] Other researchers compared the work of novices and experts, in different engineering fields, when applying analogy reasoning (Ozkan and Dogan (2013)[ix], Jansson& Smith[x], 1991; Linsey et al., 2010[xi]; Viswanathan & Linsey, 2013), Moss, Kotovsky, and Cagan (2006)[xii] (Cross, 2004)[xiii], (Casakin and Goldschmidt 1999)[xiv], (Chai, etl.,2015)[xv].

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This research extends other researchers' observations by comparing the use of both analogy and metaphor at different phases of the design process and design output. The aim of this research is to analyze students' design skills: Students' abilities of conceiving problems, analyzing, synthesizing, connecting information of various fields, self-reflection and evaluating gained skills through design process.

1.1 Metaphor

Aristotle defined metaphor as "…consists in giving the name that belongs to something else" Onuf (2013).[xvi] The effectiveness of imagination can be increased through metaphorical thinking Indurkhya (1999),[xvii]Metaphorical projection is one of the fundamental means of understanding and explaining situations by which one can project structure, make new connections, and remold our experience. Metaphors increase our perception of reality by shattering our sense of reality, and that reality goes through phases of metamorphosis through metaphors Ricoeur (1991).[xviii] Understanding the reality using a simple metaphor statement, that underpins many frames. These frames are usually expressed by group of statements and keywords that explain the problem situation; the implicit adoption of certain concepts to describe the situation. Making implicit situation explicit will create added value that all designers are striving for (Dorst, 2011).[xix]

Architects tend to use metaphorical statements to solve their wicked problems and to give their designs new meaning, identity, uniqueness and novelty. "Space is a fluid" for example was used to express that "rooms flow freely into each other" in Reyes-Retana House. The fluid is used as a metaphoric source to design free movement between rooms, as a metaphoric target (Caballero, 1963).[xx] "Social container" is the metaphoric concept for the hospital and housing project in Indonesia. Social container reflects cultural revolution, the project aimed to benefit Indonesian local citizens, who don't
have access to essential social services (Prog, 2012).[xxi] When defining a container metaphor, as Lakoffand Johnson explained, the building is considered as a container, the local citizens (users) are the container substance (Lakoff, Johnson, 1980).[xxii]

Architectural designers always endeavour to design a building which has a certain identity in their project. Metaphors seem to be quite beneficial instruments compared to several other methods and approaches applied by architects in order to achieve this purpose (Casakin, 2007)[xxiii].Design problems are too complex to be solved with completely linear, rational, logical methods, metaphors, defined as "imaginative rationality" appear to be quite appropriate tools for solving such problems since they unite rationality and imagination(Ayiran,2012).[xxiv] Casakin had investigated the relationships between factors of creativity and factors of metaphors in architectural design studio, the results shows that metaphor helps in generating innovation and creativity. Casakin's successive researches showed the importance of applying metaphor, in design studio. He proved that students acquired more knowledge and experience besides achieving originality in their designs (Casakin, 2007).[xxv]

1.2 Analogy

Analogy is based on linking between two different things that share similar features. One object or situation is perceived in terms of another. It involves drawing similarities (c,d,e) and differences (f,g,h) between a target (A) and a source (B) to transfer a certain solution or matter from the source to the target with a corresponding statement "A is like B" (LeclercqandHeylighen,2002).[xxvi] Visual analogy frequently assists designers more than other types of analogy, (Goldschmidt &Smolkov, 2006), [xxvii] especially in architectural designs; remarkable examples include the works of master architects such as the early sketches of Robert Venturi, the Duck and the Decorated Shed, "the Restaurant is like a Duck""(Venturi, etl. 2001) [xxviii] and lately Santiago Calatrava's designs inspired by animals' skeletons (Calatrava, 1996).[xxix] Using visual analogy to establish mapping via structural or surface relations can lead to a meaningful outcome and produce remarkable architecture.

Boden concluded that novel ideas can be generated by "recognizing analogies" "unusual juxtaposition of ideas" "produced by reference" solving problems, exploration and evaluation (Boden, 1990).[xxx] Visual analogy is also commonly used in professional design education. Goldschmidt stated that "evidence proves that novices, in particular, benefit from guidance to use analogy, which helps them to better understand abstract concepts and to fully exploit

their capacity to retrieve and implement previously acquired knowledge"(Goldschmidt, 2001).[xxxi] Tutors can help students retrieve possible analogy through at least two 'reminding' mechanisms that appear to be at work. Reminding may be visual, as when a shape sketched in the emerging design recalls a reference form, or it may be linked through a concept about the design (Kolodner 1993).[xxxii] Then retrieval of images may be indexed based upon conceptual design features, on function, (in domains that involve a physical artifact) on visual similarity, or shape. Visual mapping can be done by defining similarities between the target (A) and the source (B)(Goldschmidt, 2001). So when designing by analogy one should understand A and B as objects that consist of many features. Then, relevant features should be included, while non-relevant features should be excluded.

Recognizing similarities as well as differences is really necessary in order to avoid the danger that the notion of analogy becomes synonymous with vague resemblance (Dorst, Royakkers, 2006).[xxxiii]Clear differencing can orient the designer to focus on features of referent B then transform these with features to the target A. According to Tversky, one can assume that the referent (source) has the most salient features, which justify a comparison (Tversky, 1977).[xxxiv] When generating alternative solutions, abstraction and adaptation are required to draw analogies between dissimilar domains and to identify similarities between apparently different structures. It is important to notice, however, that abstraction should not modify content, but make the problem independent of domain or context instead.[xxxv] In order to achieve the final design, designing process (mapping) frequently involves abstracting of images through drawing, copying, tracing, transforming and incorporating reference forms(Guiton 1987).[xxxvi] The levels of abstraction beside the exposure to different forms of sources affect design output (Christensen and Schunn, 2007).[xxxvii]

1.3 Metaphor and analogy in the design process

"…the search for a solution through a vast maze of possibilities. Successful problem solving involves searching the maze selectively and reducing it to manageable solutions (Simon, 1969).[xxxviii] Metaphor and analogy can narrow the vast maze of possibilities. Both analogy and metaphor express and explain a situation in one domain by situation in another; posit that whereas the fundamental property of analogies is the relational and structural similarity, metaphors span the spectrum of relational similarity at one end, and appearance similarity at the other. These definitions do describe analogy and metaphor as used within the design context, but the key difference is in the elements that are mapped between domains and how they are used in the design process. Metaphors frame and assist designers in defining the design problem. Metaphors are commonly used to map users' understanding, activities and reactions to a product. They help make sense of customer needs or physical attributes from the source of inspiration. Metaphors' exceptional communication ability provides meaning to a design situation as well as to users; a house seen as a paradise for its users becomes a different place entirely. Analogy, in contrast, primarily maps the causal structure between the source and the target. The causal structure includes architectural functional solutions, geometry or component configuration (Gentner and Markman, 1997).[xxxix]

Reasoning process is similar for both analogy and metaphor when applied in solving engineering problems. The process was divided into two main phases. It begins with a difficult step; cognitive phase. The core of this phase is to encode (memorize) the source. The designer starts with many resources after which he should retrieve the most appropriate source (Hey et al., 2008).[xl] The second phase was described as a relatively straightforward step. It begins with mapping between the source and the target problem, then alternatives for solutions are found and inferences based on the mapping (Hey et al., 2008). Understanding how reasoning works, through design process, requires paying close attention not only to the ways in which it is verbally and rhetorically expressed, but also how those expressions link up with specific aspects of architecture some concrete and visible while others abstract and invisible(Murphy et al.,2012).[xli] The conceptual distance serves as a measurement of surface similarity (superficial) and structural similarity (deep) between source and target. A study, done by Ozkan and Dogan, showed that students may reach structural similarities partially; their designs rarely avoid surface similarities (Ozkan and Dogan2013).[xlii]

2 The Investigation

The research query revolved around whether first year students in the field of Architecture have appropriate and sufficient knowledge to deal with metaphor and analogy. How metaphor and analogy can nurture students' design skill to give better project outputs and learning outcomes. How tutors can help students' to improve their design skill. How tutors can make the design process more explicit. Exploring these queries can be more explicit by comparing between metaphor and analogy.

This research depends on observation and reflective teaching notes besides students' grades to draw out

results. Analyzing evidence collected during action research to test the improvement of students' knowledge as well as their design skills. Tutors base pedagogy on assumptions that are combined with knowledge of content, learners and pedagogy inform their decision making on a daily basis.

2.1 Definition

The authors took part in tutoring two classes of first year undergraduate students at the Department of Architecture, at University. Metaphor reasoning was implemented for the first group, while Analogy reasoning was implemented for the second group. Both classes undertook the same project of 8 weeks duration. And both groups consist of 50 students. It is important for the tutors to understand their student's level of experience and design ability in order to provide effective feedback (Atman et al. 1999).[xliii] The two groups of students, who were engaged in this investigation, had very little knowledge of architecture at the beginning of the course and most of them had barely any idea concerning design, architectural drawing skills, or architectural sketching techniques. Their design knowledge and drawing techniques were based on only three previous courses.[xliv]

2.2 Pedagogy framework

Learning and teaching can be achieved successfully when a teacher understands the nature of their own pedagogical reasoning; the core of deign thinking (CorcoranandSim,2009).[xlv] In problem solving, generally, when the designer knows what and how, the result could be achieved in a straight forward manner. In wicked design problem solving, the designer may have an idea about the value he/she wishes to create, and face an unclear definition for the 'how', a 'working principle' that will help achieve the value aimed for, or, perhaps, an unclear understanding of 'what' (an object, a system). Students and other novice designers randomly generate proposals for both the 'how' and the 'what', and then seek to find a matching pair that leads to the aspired value. A valuable result could be achieved by using a backwards- forward process to build up a new what and how with a useful definition and understanding; by starting with the value that's aimed to be created, the designer can develop up a frame that describes and interprets the situation he needs to solve (Dorst, 2011).

Dorst developed the following equation for designers:

What (thing) + How (working principles) = Result (value).

Understanding What, How and Result through design process is essential to monitor and evaluate students' design progress and design skills. The investigation went through three main evaluations, one stop-point in each phase. The metaphor and analogy reasoning comparison was performed all through design process, as the investigation Framework figure (1) shows. The validity of the qualitative results of this investigation derives fromthe proposed Pedagogical strategy, which is based on the following principles:

(1) Reflective teaching, Reflection-on-action: reflection means recognizing, examining and ruminating over the way tutors teach Schon (1983).[xlvi]After every design studio notes were addressed, besides the evaluation of all reflection notes after the project ended Navaneedhan (2011).[xlvii]Many researchers believe that teaching educators how to become self-reflection is an important component of teacher training. Being self-reflective requires that they examine what works and what needs to be improved, push students to think about doing, through design process (Sickler- Voit,2007).[xlviii] Tutors provide weekly sheets for students which highlight main misconception points, and stipulate the next tasks, besides defining learning outcomes; to be clear for both students and tutors team members.

(2) Communicating the design development; by interpretation of their sketches, within studio feedback and critiques. The use of sketches as an extension of mental imagery; therefore has the freedom of imagery to retrieve previously stored images and to manipulate them rapidly (Goldschmidt,2003).[xlix]

(3) Portfolio Assessment: A portfolio is a structured collection comprising evidence and critical reflection on that evidence. Summative assessment is based upon the cumulative output of the preceding weeks of formative assessment and feedback (Holgate,2008).[l]Tutors' comments has power to control the student's work, so that it is easy for students to follow tutor's direction without considering how they want to develop, or without fully understanding what the tutor's feedback means (Oh, etl., 2013),[li] besides, students found it easier to satisfy their tutors and get the

highest grades. So to make sure that students fully understood tutors' feedback, they were asked to bring all their sketches with them to every studio session, as a project portfolio. This helped students and their tutors track the design process, define errors, and any misconceptions.

(4) Formal Feedback Provision: The iterative process of the studio tutorial allows the tutor to monitor students' progress effectively; any misunderstandings in communications or expectations can be attended to at the following session. Feedback provides the practice of critiquing (Holgate,2008).

(5) Informal progress feedback, through meetings outsides studio session besides social media communications raise tutors ability to communicate assessment criteria explicitly (Holgate,2008). Formal studio feedback and critique sessions were mostly structured as a series of interlocking reasoning processes. Initial presentations usually involved persuasive and rhetorical components in which students attempted to convince their tutors that their design proposal is an ideal solution by reasoning through the choices they have made and highlighting the project's strongest points. On the other hand, tutors as critics identify particular features of the design for further discussion and elaboration, often drawing out what they see as problems requiring solutions, or areas needing improvement. Walking through why a feature is problematic, or successful, from the critic's point of view requires a reasoned explanation that in general makes sense to both the critic and the student. The students were then free to accept or counter the criticism with his/her reasoning (Murphy et al.,2012).[lii]

2.3 The investigation phases

The project assigned to students was to design a Career Studio. A Studio that caters to a user's career needs, his/her expectations and provides him/her with living spaces reflecting the specific (career) personality. Students were free to propose their own program and the different spaces, but there were rules they had to adhere to in their design:

- The designed space to be within a maximum area of 100 m^2
- The design should provide spaces for everyday activities, such as sitting, relaxing, sleeping, eating, and working.
- Students should have an understanding of human scale and standards of different spaces.

The first group designed their project using metaphor reasoning, while the second group used analogy reasoning. Both groups went through three major design phases as the investigation Framework figure (1) shows.

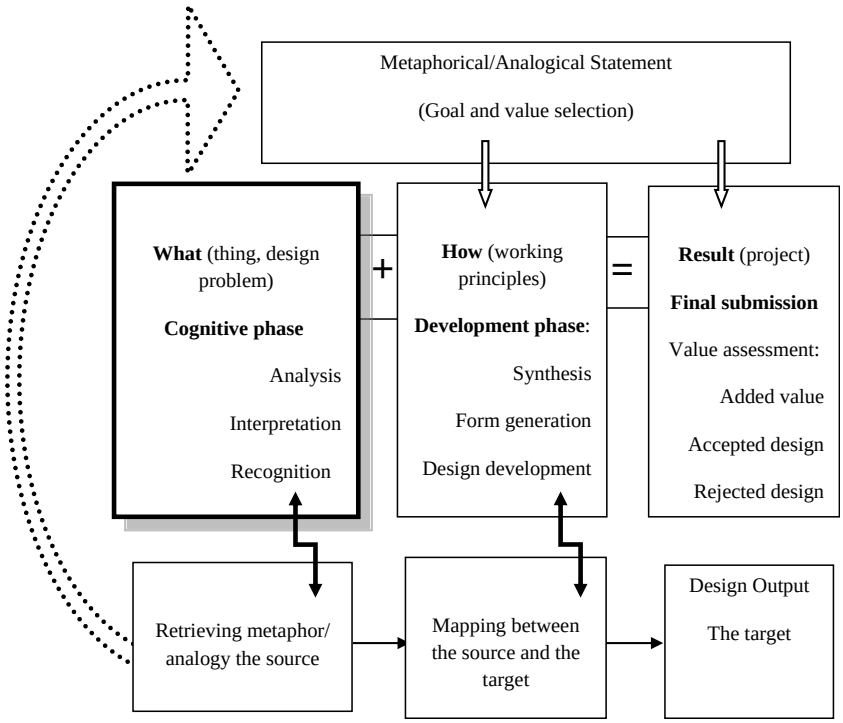


Figure 1: The investigation Framework diagram done by authors, depending on Dorst equation.

2.3.1 Cognitively Conceptual Framework: Writing manuscripts

The project started by defining "What". Both groups of students were asked to read about the career they chose and what would constitute as a corresponding lifestyle. A number of students managed to have interviews with their clients, some personal, others online. After analyzing the career particulars, students were almost ready to begin retrieving metaphor and analogy sources. The metaphor reasoning group was asked to write the curriculum vitae for their character. The curriculum vitae started with a main statement (metaphoric statement) describing the character's hopes, goals and objectives in life, and ended with four- five keywords that best described the client. These keywords provided the base for students to retrieve possible metaphoric sources. Internet search tools were the generator that helped them find the best source for their metaphor. Students were then asked to find four to five architectural and abstract images that expressed their metaphor, with the keywords that best defined the desired experience.

The Analogy reasoning group wrote descriptions about the characters' careers and the effect on one's lifestyle, aims, goals and hopes. Students were then asked to trace the characteristics shared by the same career. These major characteristics or lifestyle keywords were the starting point for the search for analogy sources. Internet search tools were also the generator that helped students in searching and deciding the best sources for analogy; whether sources that had similar visual properties in nature, or sources that could help in defining geometry, order and function. Students were asked to submit three alternatives for their possible analogy sources. Tutors helped students to choose the most suitable options. Then students tried to draw a tree diagram that shows mapping between the target of their design problem and the source of their analogy. The tree diagram identifies the relationship between the source and the target: A is to B as C is to D'. Retrieving metaphor and analogy sources made students read more about users, and their careers which led to redefining

"What" and the goal/ value selection, learning outcomes for this phase were:

- Expansion of students' knowledge by reading, searching and retrieving sources from different domains
- Practice in subject research and in forming career descriptions and pinpointing common characteristics.
- Practice in writing out descriptive manuscripts and extracting keywords.
- Understanding architectural design problems through interpreting, connecting information and understanding of analogy and metaphor sources.
- Practice in linking between keywords and architectural and abstract images in the metaphor process, in comparison with finding the best natural source that may fit their client; the target for the group of analogy methodology.

2.3.2 Design development phase represents the mapping between the metaphor/ analogy source and the target; synthesizing the design.

In this phase, metaphor group began to develop their design by attempting to map between the metaphor source and the desired target; their understanding of their client's way of life, using the images that they had collected and had become part of their mental and imaginary library. In this phase students were asked to submit three alternatives, and choose the best that fit their scenario. Alternatives were shown and compared through both sketch models and drawings: plans, sections and elevations. Tutors' feedback helped to guide students' decisions. The analogy group started to do mapping between their natural source of analogy and their target; by understanding the visual properties, structure, geometry and order of the natural source and reflecting these properties in their design. The main tools were abstracting, sketching and adaptation to fit users' needs and scale. This phase required a lot of effort in order to create dialogue with sketches, by interpreting meanings and through linking between the source and the design product.

Phase two learning outcomes were:

- To exploit the use of images with relative meanings.
- To learn transforming rhetoric ideas to solid design/ mapping between the source image and the targeted deign; by clarify what is good design practice and what is not, through reflective learning and critical thinking during the design process.
- To work with multiple perspectives and make judgments, using complex materials (image meaning,

keywords), human activities and lifestyle that are at the heart of higher education activity.

- To support theory-building activity, learners receive guidance material to help them in their own subsequent work in the form of the framework.
- Understanding of human scale and needs.

2.3.3 Final Submission

Production phase: students were free in the final presentation model materials, presentation method, and arrangement of their drawings.
Phase three Learning outcomes focused on the final product. Project assessment depended on the level of achievement exhibited by the final product, through concentrating on the following:

- Understanding of the user's experience.
- A clear geometrical definition and order
- Appropriate functional relationship
- Human scale
- Presentation of the idea

3 Discussion

In this investigation, students were asked to write down a description for their project, this description comes out with keywords then the keywords were linked to inspiration pictures. The metaphor group depends on architectural pictures while analogy group of students depended on pictures from nature. These inspiration pictures became stimuli through design process. The question of fixation, novelty and the quality of the stimuli arise here. Jansson and Smith described design fixation as the blind adherence to a limited set of ideas in the design process[liii]. Educator roll is to reveal any misconception; to avoid, mitigate or overcome the blind methodologies. Weekly sheets that describes phase, defines learning outcomes, and highlight assessment criteria raised students' expectations and direct their process. Reflective tutors' notes that highlight main misconception points were announced at the end of each studio. These sheet and note developed students' abilities to direct their own learning and evaluate their own progress.

Understanding a user's desires by reading about his/her career, writing out manuscripts, and extracting keywords helped students develop a metaphoric statement/ retrieving analogy recourses that fitted with the aims of their proposed client. Formal feedback allowed tutors discussed the keywords and images with the students, and helped them to learn how to select with suitable interpretation for their selection. See figure 2 and figure 3show sample works for a student in metaphor group, and student in analogy group respectively.

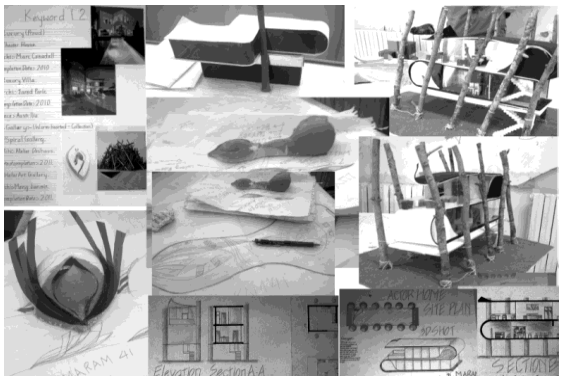
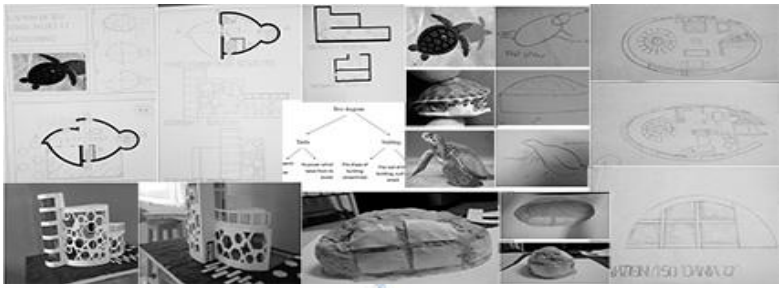


Figure 2 An actor's studio- Three different metaphors and design alternatives



Turtle	Captain of sea
have strong shield, solid beak and strong jaw.	navy property low stipulates that must have physically strength
It always move in sea and its speed in sea greater than its speed in land (Streamlined shape and flat shield help it to be more fast in sea)	always move from one place to another by sea. and spend most time in sea
lay eggs in sand then go back to sea	Lives in the sea, while his family on land
Have ability to see clearly while travelling in sea.	Depends on different shipping tools

Figure 3 A Sea Captain's studio - The turtle is the Source for analogy.

Interim reviews involved the entire class at key milestones during a studio project. Instructors hold interim reviews when they think all students can benefit from sharing their progress and knowledge with others in the class (Oh, etl., 2013). Two benefits can be gained from interim reviews. The first is that students learn from each other. The second is that tutors get to discuss the projects, write down notes, evaluate students' understanding and redirect any misconceptions when necessary. Evaluation of the design results in both reasoning methods were compared and analyzed. Firstly in how they affected students' skills during the design process, and secondly how they guided their way of thinking and the resulting product. The table below summarizes notes that were observed throughout the design process and drawn by reflection-in-action notes for both tutors and students.

Table 1 Comparison between metaphor and analogy reasoning through design process

Learning outcomes	Metaphor reasoning	Analogy reasoning	notes
Conceptual Thinking: conceiving design problem, and analyzing the case	Metaphor reasoning helped students in understanding user's lifestyle.	Retrieving the natural source and finding a convincing link between the target and the source took a lot of effort.	Finding analogy was more challenging due to the need of understanding systems for both source and target
Develop students' capacity to select.	Retrieving metaphor with keywords expands students' capacity to paraphrase the problem situation.	Retrieving analogy with keywords expands students' capacity to select potential sources,	Internet search tools very useful for finding architectural and abstract images/ finding alternatives for natural analogy sources.
Develop students' capacity to interpret	Linking keywords with images was a good exercise for students as it expanded their image library and related meanings.	Analyzing images of the same natural source was a good exercise for students as it expanded their image analysis abilities and understanding.	
Develop students' capacity to connect information from various fields	Metaphoric reasoning expands students rhetoric expressions	Finding analogy from natural sources expands students' knowledge of nature and it can be linked to architecture	
Findand use relevant forms	Tutors' feedback was the main tool that helped students in defining and linking meanings with best relevant form; by stressing the question of what (meaning) and how can it be applied	Tutors' feedback was the main tool that helped students in defining and linking systems; by stressing the question of what (visual structure, system) and how can it be applied	Interaction inside and outside studio sessions allowed tutors to guide and monitor students' progress effectively.
Sketching	Students imitate images from the vast Architectural Image collection. Students' ability to create dialogue with their sketches was improved The Imitated Image require intense sketching to match functional requirements and user lifestyle which improves students' ability in that area	Transforming a natural source into a livable space improved students' sketching abilities	Students' ability to create dialogue with their sketches was improved
Synthesizing: Logical development	Students notice details in people's lifestyles. And how these details can generate design.	students gain logical and visual mapping between source and target	It was a first step for students to gain experience and applying metaphor/ analogy reasoning
Synthesizing: Spatial Development	Students started with understanding the needed experience as enclosure and interior spatial sense lifestyle, and completed their design with copying the exterior images.	Students started with a monumental and out of scale image they completed their design by adapting their design to fit human measurements; scale understanding	
Synthesizing: Geometry	Students understand and imitate Geometrical Order from architectural images	Students search for geometry and order in natural sources.	Extracting geometry from a natural source was very challenging
Synthesizing: Function	Followed user's lifestyle and relevant metaphoric statement	Followed the system of the natural source	Solving functional relations for a studio design was a relatively suitable task for first year students
Time and effort	8 weeks was a reasonable amount of time for a first year student to complete the project	time was not sufficient for intense thinking, logical associations and visual mapping	Working with analogy needs more time and effort than with metaphor.
Novelty of the final design output	Most students stuck with their chosen architectural images	Most students produced new designs extracted from the natural sources they had selected	

3.1 In the Cognitive Conceptual phase

In this phase, students using the metaphor reasoning showed slightly better results.

Average of students' grades in metaphor reasoning was 7.45 while the average was 6.65 using analogy reasoning. The number of students who got 9 out of 10, was 9 students out of 50 (18%) using metaphor, while 3 students (out of 50) using analogy reasoning received a 9.[liv] Tutors noted that in this phase students' levels of ability were similar for both groups, when searching for a career description. Using the internet for searching, using keywords, also made this phase relatively easy. Students were, also, able to write a manuscript describing the client and the relevant lifestyle. The minor difference in grades was due to, as tutors noted, that retrieving decent analogy alternatives was more challenging than finding a metaphor for most students. Tutors also noticed that even when students were able to retrieve analogy sources, they had difficulty in defining links, similarities and differences between the sources and the target; analogy requires visual analysis and understanding of structure for both. Metaphors was more fruitful at this stage because it gave students a more thorough understanding of their proposed career, lifestyle. This result is similar to Casakin's observation; he stated that students of architecture found it easier to employ metaphors as a design tool in the early stages of design when framing and defining the situation (Casakin, 2006).

Novices may retrieve incomplete or unfit matches but still provide enough information to reveal implicit decomposition. With the help of tutors, students can manage to do the exercise in an acceptable way. The knowledge students gained, searching for analogy source, raise their ability in linking between domains, analyzing and interpreting skills. Casakin and Goldschmidt, noted that "novice designers do not need to be taught how to use analogy: they already have this cognitive capacity"(Casakin, Goldschmidt, 1999). Here in this case, most students are only introduced to analogical reasoning in architecture for the first time, their cognitive capacity started by this exercise.

3.2 Students' results in the Design development phase

To evaluate this phase and to pinpoint the challenges that faced students, the assessment of grades was done in the middle of the phase. For group 1, students' grade average was 6.88 (out of 10), while it was 6.4 for the second group. This phase was challenging for both groups as it involved a lot of deep thinking, a lot of sketching, skillful linking of architectural images to meanings, keywords and working with multiple perspectives. Tutors' input, through feedback, was to show and explain to students what constituted as good design practice, what works and what doesn't and the making of judgments. Tutors pointed out that this phase consumes a lot of time and effort in order to balance all different aspects of design and linking between desired meanings, images and functional aspects. Hey with others discussed both methodologies when applied by engineers. They stated that this phase has relatively straightforward steps (Heyetal.,2008), but for first year students of architecture, this phase is particularly challenging. The process of translating an idea from rhetoric to solid design requires a lot of effort, transforming analogy source to an architectural design was challenging for metaphor group and analogy group respectively. But it was an exercise that nurture students' thinking and design skills.

3.3 Students' results in Final Submission

For the metaphor group, students' grade average was 7.2 (out of 10), while it was 8.2 for the analogy group. Visual mapping gives novel results with minor fixation; due to transforming their idea from a visual image, a natural domain, to another visual image, the architectural domain. Mapping between source and target was challenging and consumed a lot of time and effort due to the need to understand systems, structure and visual properties for both the source and target.

Creating dialogue between students' and their sketches needs time. Dialogue was created through seeing-moving-seeing process. This process helped students to accumulate their vision and to achieve their goals. It was clear when projects were submitted for final evaluation, that most of them had clear geometrical definition, proper functional relationships, consideration for human scale. The metaphor group had to transfer their idea with an architectural inspiration image without coping. Students of metaphor group could reach to deep and high quality ideas, but most of students tend to copy external architectural images this can explain the drop of students grade in the final output, but at least students have stood on the first step of generating ideas; as they manage to imitate with understanding what they are doing in functional relationship with the relevant metaphor.

4. Conclusions

Students' solutions may not always provide fully developed output, but their solutions can serve as clues that may help them accumulating their knowledge. Gathering data, interpreting and analyzing skills was expanded by both metaphor and analogy. It was found that metaphor is easier and more fruitful in early phases of design. Metaphor can help students understand a user's everyday life; thinking about living experience.

While copying images from architecture rather than creating their own, was an easiest way to achieve their keywords; depending on and sticking with same domain clues due to lack of experience. Combining ideas linking between different domains, besides synthesizing architectural composition consumes times and needs more training; to access deep and non-superficial analogy. On the other hand analogy helps students in extracting new images; when they were exposed to picture of nature, analogy from different domain. This research may provide a rough answer for a question raised by Vasconcelos and Crilly; how many stimuli (inspiration images) to present to designers when trying to limit fixation effects.[lv]In this case, it was the quality of chosen picture not the quantity that makes the difference; Student of analogy group depends on 2-3 picture of natural source they have chosen. And most students of metaphor group depended on 1-3 images out of 20 images. As for further investigations we suggest to take benefits of metaphor and analogy merging both reasoning; with a more specific small test that gives a quantities results that may support or defeat reflective notes.

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