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Role of Analogy in Architecture Design Education

Kaumoodi
Jamia Millia Islamia,
New delhi,

Abstract **- Analogy is a powerful approach for problem solving, learning, or discovery that employs a practical method to achieve the immediate goals. In design, where designers are constantly exposed to stimuli, analogies are considered to be particularly helpful.**
However, few researches have given enough attention to analogy in design contexts. Therefore, this study deals with the use of these tools by investigating the effect that students have on them through analogical learning and thereby proposes a framework to enhance the process of designing among students with the use of analogy.
The aim of this research is to develop a framework of analogy in design studio for the purpose of inducing analogical learning among the students of B.Arch., 2nd year. The framework also incorporates analogical reasoning and thinking through analogical learning.
The research will also evaluate the comparison between the results of the pre- test i.e. before introducing the analogical learning with that of post- test which is after presenting various approaches of designing to examine the effect of analogy used on the design solutions of the students in architecture design studios.

Index Terms–Analogy, Analogical Thinking, Analogical Reasoning, Design Process

I. INTRODUCTION

Analogical thinking involves the use of prior 'source' information that can aid in the solving of a current 'target' problem. Reasoning by analogy is considered to be at the center of cognitive processes, in particular those involving creative problem solving (Keith J. Holoak, 1995). Whereas research on analogical thinking is prolific, little work has been done on analogy in the visual domain. In design problem solving, visual analogies are frequently used in design in part due to the large variety of visual displays that aid students when searching for creative design solutions. Since the design process is viewed as an explorative activity characterized by visual thinking (goldschmidt, 2003), the use of visual displays by means of analogy is considered a potent strategy for creative problem solving.
Few investigations dealt with different aspects of the use of analogy and visual displays in design problem solving. Some examples are (goldschmidt, 2003), and (goldschmidt H. C., 1999), who investigated visual analogy in design, and (casakin, 2006) and (yilmaz, 2017) who studied the effect of visual displays on design performance. All these works acknowledged the critical role played by visual representations in creative problem solving. Despite the crucial function that is argued for visual reasoning in creative problem solving, few existing research seems to have paid considerable attention to visual analogizing in different design problem contexts, or under different levels of expertise.
This research reports the results of design improvement as a result of the use of the framework in visual analogy and visual displays in ill-defined and well-defined problem solving. A major focus is set on the role played by design expertise.

A. Aim

The aim of this research is to propose a framework for the purpose of enhancing design skills among architectural students through the use of analogy in design studios.

B. Objective

- To examine the importance of analogy in architecture design.
- To investigate the framework of analogy established in prior researches in enhancing the designing skills among students.
- To compare the outcomes of different approaches applied in design problems with the use of analogy.
- To propose a framework incorporating the findings and eliminating the shortcomings of various researches to enhance the effectiveness of analogical thinking in design education.

C. Scope of study

The scope of this research is to study the various approaches in designing a framework of design problem to enhance the analogy thinking in design process.

This research also incorporates the findings and shortcomings of various researches in order to propose a new set of approaches to enhance the designing process in architectural studios.

D. Delimitation

- There is no physical or face to face interaction to float the experiment due to an urgent lockdown. Therefore, the experiment is oriented towards an online platform.
- The researcher has not intended to compare Indian Architectural Education System with that of other countries.

E. Hypothesis

Analogy aids in improving the designing skills of students in architectural education.

F. Research question

- What is the role of analogy in architecture education?
- How analogy could be applied in design studios?

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- What are various ways of enhancing effectiveness of analogical learning in architecture design?

G. Tools used

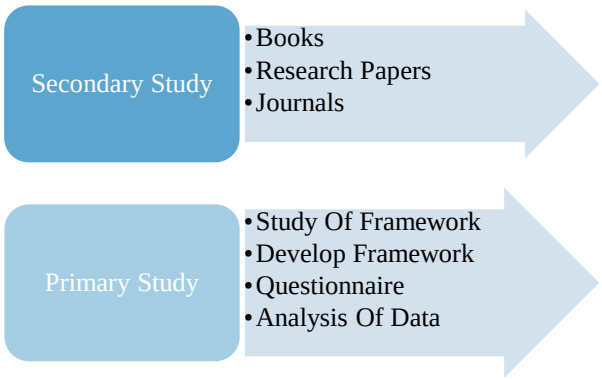
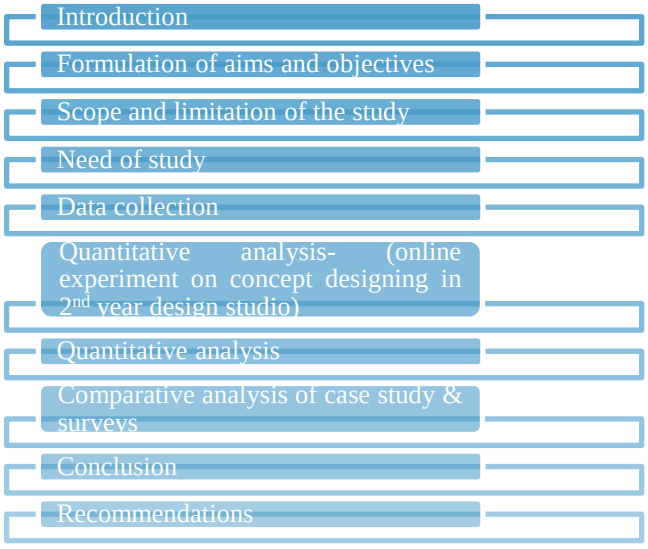


Figure 1 Data Collection Tools (Source- Author)

H. Research methodology

A method is a tool that can help solve problems and reach new knowledge. The different methods that would be used in this research are shown in figure below: -

TABLE 1 RESEARCH METHODOLOGY (SOURCE-AUTHOR)



II. BACKGROUND OF ANALOGICAL REASONING

Analogical reasoning is considered to be central to creative thought. For instance, (Boden, 2004) claims that the creation of novel ideas often involves the transformation of existing knowledge into something new.

In design, analogical reasoning allows individuals to find similarity between an existing knowledge base and a target design space, and transform that existing knowledge into new design solutions.

(gentner, january, 2001) Identify two levels at which similarities can be found in analogical reasoning: superficial and relational. The superficial level refers to object attributes. The relational level can be further decomposed into two levels: relation between objects and relation between relations, i.e., "higher-order relation".

The use of analogy enables to understand an unknown situation in terms of a familiar situation. Analogical reasoning is concerned with the identification, retrieval, mapping and transfer of relational knowledge from a familiar situation (known as the *source*), to a situation that has yet to be explained (known as the *target*), in which at least one of the related elements is missing (Keith J. Holoak, 1995); (Vosniadou, 1989). This entails applying high-order abstractions.

A. Role Of Analogy In Design

The use of analogy and sometimes visual analogy plays a vital role in enhancing design skills in many different scientific and artistic domains.

Since the design process is defined as an explorative and creative activity (hernan casakin, 2007) characterized by visual thinking (goldschmidt G. , april 1994), the use of visual displays by means of analogy is seen as a powerful strategy for creative problem solving. Researchers like (goldschmidt G. , april 1994), who investigated visual analogy in design, and (smolkov, september 2006)who studied the effect of analogy on design performance acknowledged the importance of visual representations on creative problem solving. (goldschmidt G. , april 1994) Explained that establishing correspondences between sources and a design target can assist in a successful organization of the design into a coherent structural system. Creative cognition processes embracing the use of analogy are critical in the generation of new ideas. In this process, designers redefine the design problem from innovative viewpoints (Schon, 1983)and establish analogical associations with the design problem. Generalizing and transferring analogical principles from one domain to another.

B. *Kinds Of Analogy: Similarity And Domain Knowledge*

The design process goes through the flow of information along with ideas but at different levels and design is a set of ideas and events and the architectural mind searches in memory to find elements and components that match the needs of the problem , And compensate for the lack of information through the various references, the designer can achieve a wide range of goals through the design idea, and different projects vary these objectives or change the value resulting from the achievement and hence show the levels of application of the architectural idea as follows:

- Function Level
- The space level
- Movement level
- Level of formation
- The level of relationship with the environment

(SARA R. MAJEEDA, June 2019) The classification of ideas may be difficult as the way of thinking and expressing it is clearly different from one person to another, but there is a link between each group of ideas that makes it a doctrine and direction analogy to it in its general framework and

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characteristics are driven to say that this idea follows him or not and here The relationship of analogy to thinking of three levels [formal, functional and structural] is evident at the level of architectural design. The types of architectural ideas may be classified as follows:

The planning idea: This idea is reflected in the overall planning of the project as a whole to appear in the buildings and coordination of the relationship and bonding of the blocks, usually in multi-building projects or projects that require open areas with specific spaces and this idea is a general idea mostly include type or more of the following ideas mentioned.

Technical idea: This idea deals with the core of the design problem directly through its solution in a purely technical manner, and using the means of technology and innovations. It should be noted here that it cannot be said that this idea is a design idea unless it affects the design directly, The goal is to design a product that solves a problem, not a problem for any design, but it is ultimately dry and expansive so it is also best to combine it with another kind of ideas to give it a soul. (SARA R. MAJEEDA, June 2019)

The Philosophical Concept: The philosophical approach is one of the most powerful intellectual schools and has the ability to convey general concepts. At the same time, it may lead to disdain of the idea, especially when the philosophy becomes a novel with several chapters. The strength of this type of ideas is reinforced by the multiplicity of ideas and their links with the project and its components. It is also necessary to mention here the need to move away from the surface in the translation of the idea and the search for the dimensional dimensions of its contents (Broadbent., 1973).

Inspirational idea: Each line of the lines gives a different impression in the brain and when combined together in a stereoscopic shape, a general suggestion is formed that translates into the brain in a certain way (happiness, hope, sadness, balance, disturbance, etc.). It can be said here that this type of ideas is often used with another type, because it does not ensure the delivery of the side of inspiration in a uniform manner for all (SARA R. MAJEEDA, June 2019).

The symbolic idea: It is very analogy to the idea of inspiration, but does not depend on the meaning inspired by the line and the interpreter of the brain receptor, but depends on the link of the shape of the project through some of the usual symbols such as the food dish link to the restaurant, or bank paper bank and so on. In primary forms or lines should not reflect the basic form of the element but symbolize it.

Impressionist idea: It is a very superficial idea and a lot of criticism, and it can be said that it does not require a high amount of knowledge and does not need to develop where a project-related element is captured and falls on the project's current form as it is, It is not clear here that this type of thinking has failed.

Abstract idea: Here the designer to quote a specific element and be of a symbolic or inspirational nature, but not only contrary to the design, but enters the process of abstraction to finally get a new form serves the distribution of blocks required according to the studies of the project, and the strength of this idea if the introduction The philosophical aspect of the process of abstraction itself (SARA R. MAJEEDA, June 2019).

Structural idea: The construction idea is often derived from the abstraction of a structure in nature, used to solve the problem of construction but in a unique way, it can be argued that this idea is a branch of the abstract idea (Broadbent, October 1970).

II. ANALOGY AS VISUAL STIMULI AND IDEA GENERATION IN DESIGN

A. Supporting Analogy for Idea Generation In Design Education

The previous studies demonstrated that students are not always aware of the importance and utility of analogical reasoning in design. Therefore its appropriation and implementation requires training. In this last part of the chapter, an intervention program would be approached which ultimate goal is to help students progressively develop the abilities required to use analogy spontaneously.

The way that an analogous examples are represented and perceived (i.e., handmade sketches, schemas, drawings, photographs) affect how knowledge is retrieved and applied to the problem at hand (K Lauche, 2008); (J Hey, 2008).

The suggested educational approach includes a number of training phases that goes from basic cognitive operations such as analysis of design principles from examples, finding commonalities between different problems, and more complex problem-oriented tasks like experiencing problem situations that are similar to the problem at hand (e.g., (Bransford, 1989); (BEGG, Problem-oriented training promotes spontaneous analogical transfer: Memory-oriented training, 1991). The program includes the following stages:

- **Identification of knowledge from within-domain sources:**
  This first stage of the training process consists in the analysis of basic design principles from visual displays belonging to the architectural field, like for example building schools, libraries, etc. In particular, students are exposed to a collection of architectural precedents, considered as authoritative examples by well known architects from whom it is possible to learn a lesson. The aim of this stage is to identify and retrieve design ideas from within-domain sources, and represent them graphically by means of sketches and diagrams (SARA R. MAJEEDA, June 2019).
- **Mapping of knowledge from within-domain sources:**
  The second stage of the process deals with the identification and mapping of commonalities from visual stimuli belonging to a same knowledge category (e.g., different types of high-rise buildings). Students should identify and map common shared principles from available sources, and represent them graphically using schemas. It is expected that higher-order relations (structural similarities) will be established between some of the visual displays. In a following step, a similar task will be conducted where students need to identify and establish mappings between visual sources belonging to different typological groups (e.g., schools and libraries). The aim is to help students make high level abstractions and establish structural mappings from close sources (Dejong, 1989).

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- **Use of within-domain and between-domain analogy in design problem solving:**
  The third stage consists in a problem-oriented task concerned with the use of within domain analogy in design problem solving. According to Ward (1998), the construction and application of highly representative, and therefore easily accessible analogs is a most frequent activity in problem solving activities (SARA R. MAJEEDA, June 2019).
  Therefore, in this phase of the process students will be exposed to a number of problems that are similar to the problem at hand, and will be instructed to use analogy to solve the problem. Previous studies (casakin, 2010); (goldschmidt H. C., 1999); (kennedy, 1990)) showed that instructions to use analogy have a strong effect on analogical reasoning. One of the reasons is because instructions imply the existence of implicit or explicit goals that affect the whole analogical process (Keith J. Holoak, 1995). In a second step, students will be provided with a different problem and a panel containing within-domain and between domain visual displays. It is expected that students will be able to apply the cognitive mechanisms with which they were trained previously, and will identify, map, and transfer ideas from the available visual analogs to the target problem. The use of various source domains is believed to aid in the production of successful analogies, and in the quality of the design ideas (moreau, 2002).

III. QUALITATIVE ANALYSIS- RESEARCH FRAMEWORK

The experiment is conducted in the 2nd year design studio among 10 students of Jamia Millia Islamia University. It is based on analogical learning in design problems.
Aim: - The aim of experiment was to incorporate the use of analogical learning in design studios
Objective:

- To explore the student's cognitive domain in the process of concept designing.
- To facilitate analogical learning through analogous cases based on similar problems of concept design.

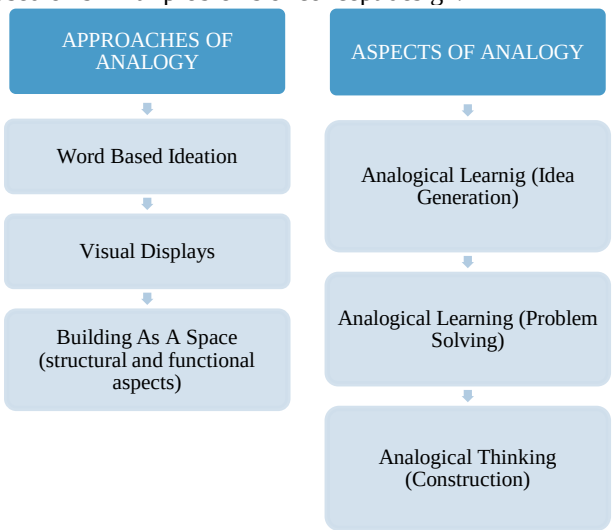

Figure 2 Approaches of Analogy (Source - (Wu, 2014)

A. *Implementation of Framework: -*

Table 2 Implementation of Framework

Stage 1: Alnalogical Learnig (observation and discovery)
• Identification of knowlege from within domain sources and introduction of design concept.
Stage 2: Alnalogical reasoning
• Maping of knowledge through different approaches of concept design.
Stage 3: Alnalogical thinking
• application of different approaches and new ideas to design concept.
Stage 4: construction
• development of concept design
Stage 5: Analysis
• comparison of prior and post test results
Stage 6: Result
• progress in design solutions

B. *Framework: -*

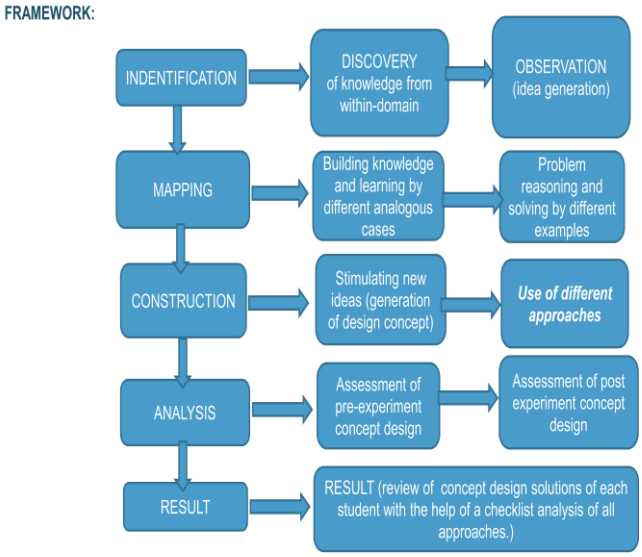

Figure 3 framework of experiment (Source - Author)

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C. *Findings and inferences of experiment:-*

A study was conducted for the students who have participated in the experiment to analyse and compare students' performance in the pre test and post test.

D. Inferences of Pre- Test Concept Sheet

- The results of the pre test conducted clearly shows that initially participants approach to concept design is majorly centered on formal aspects of a building.
- While very few participants incorporated other aspects like: functional and material in their concept design.
- Aspects like contextual and philosophical are not well thought-out by most of the students.
- Therefore, in order to improve the designing skills of the participants, a framework is introduced to use analogy with discussions, visual displays and instructions to generate successful ideas to improve design problem solving.

E. Inferences of Post - Test Concept Sheet

- After the brief discussion on the concept design of a building the significance of concept designing was discussed with the participants with further explanation on various approaches of designing same design problem and visual displays and analogous cases were given to participants.
- The experiments were carried out in online sessions with individual participants. The design outputs obtained from the different design sessions were scored independently.
- The results of the pre test conducted clearly shows that initially participants approach to concept design is majorly centered on formal aspects of a building.
- Whereas with the use of analogy the post test result shows that participants are able to incorporate various approaches of design in their final concept sheet.
- The instructions and use analogous cases with visual displays contributes to generate successful ideas to improve design problem solving, was confirmed in all of the participants.
- The result also shows the effectiveness of the use of analogy with appropriate analogous examples and visual displays in problem solving is increased when guidance is provided. Participants were able to approach concept design holistically incorporating most of the aspects of designing concept.
- The contextual and philosophical approaches which were not clear to the participants in the pre test were implemented successfully by many in concept design in the post test.
- The study also concludes that analogical reasoning in the visual mode is a successful strategy to improve design problem solving. Instructions to use analogous cases of building demonstrate that the participants significantly improved their performance in the approaches of concept designing.

H. Comparative Analysis (Pre-Test and Post- Test)

NUMBER OF APPROACHES USED BY EACH STUDENT

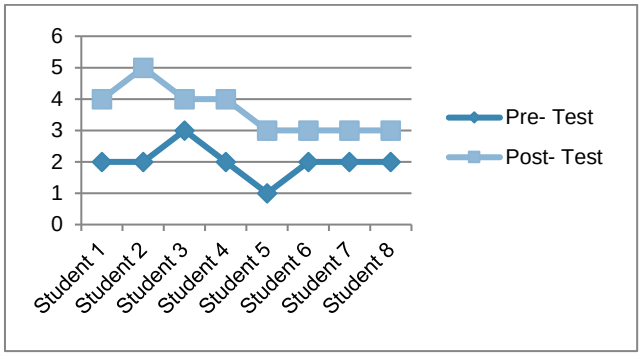

Figure 4 (Source - Author)

TYPES OF APPROCHES USED BY EACH STUDENT

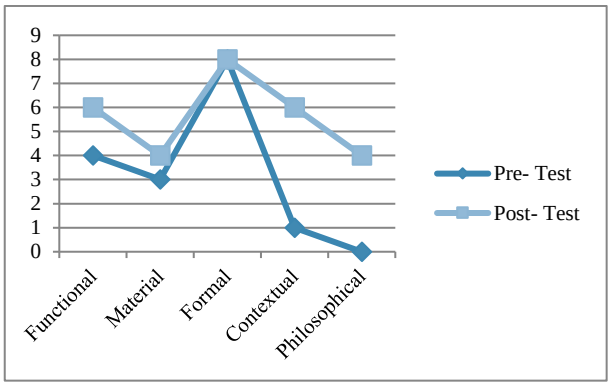

Figure 5 (Source - Author)

IV. QUANTITATIVE ANALYSIS

A questionnaire was used for determining learning preferences of participants and their perception of analogy in design.

Aim: -

To know the effectiveness of analogical learning in architecture design education.

Objective:-

- To find out the perceptions of students regarding design problems in architecture education.
- To study the role of analogy in design development of students in architecture education.

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A. Findings and Inferences:-

Questionnaire included following questions

Q1. What approaches do you use for designing a concept of a building?

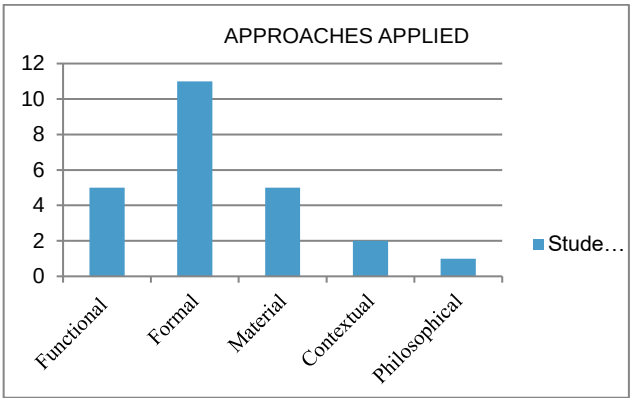

Figure 6 (Source - Author)

- Students were asked about their approaches of designing a concept of a building. 90% of all students responded that they usually use formal approach to design a concept.

Q2. In general, what impact does a design problem have on you?

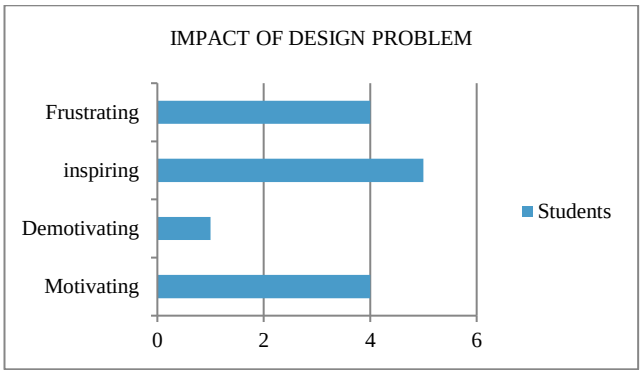

Figure 7 (Source - Author)

- Students were asked about the impact of design problems have on them.
- 50% of all students responded that the design problem inspires them whereas 40% of the students responded that design problems leave them feeling frustrated.

Q3. How much do you usually learn from your design problems?

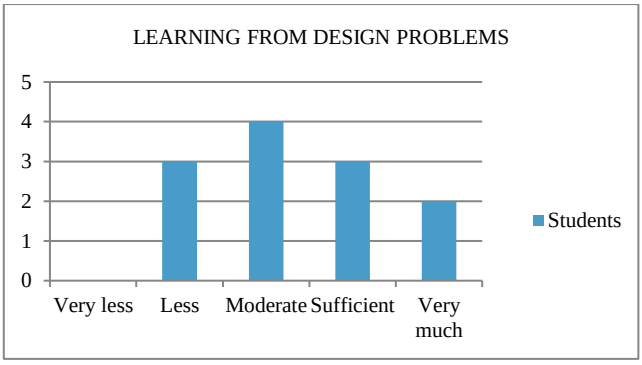

Figure 8 (Source - Author)

- Students were asked their perception of learning from solving design problems.
- 40% of all students responded that the design problem help their learning moderately.

Q4. How do you find the design problem after the analogy learning?

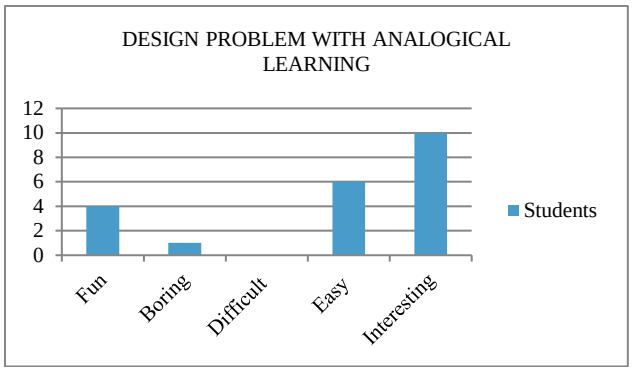

Figure 9 (Source - Author)

Q5. Analogy helped in developing the following skills?

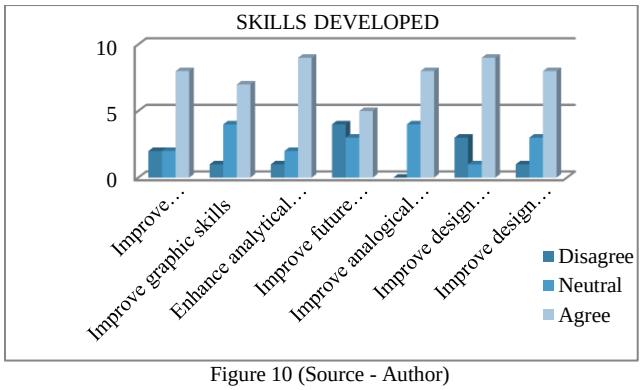

Figure 10 (Source - Author)

- 12 Students surveyed based on what skills they developed from the analogical exercise.
- Likert scale was employed to note the above data. They were asked to rate the above skills according to their experience on a scale of 1- 3 where 1 = disagree and 3= agree. It was observed, the students feel that analogy improve their design knowledge (90%), enhance analytical skills (90%), enhance presentation skills (80%), improve design vocabulary (80%), improve

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graphical skills (67%) and improve future design decisions (50%).

Q6. What effect does the analogy have on your performance?

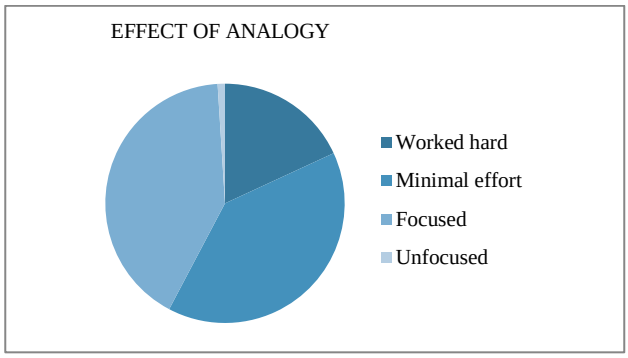

Figure 11 (Source - Author)

- Students were asked about the impact of analogy in their performance.
- 40% of all students responded that by using analogical learning they had put minimal efforts in design.

Q7. How much did you learn with the use of analogical cases in design problem?

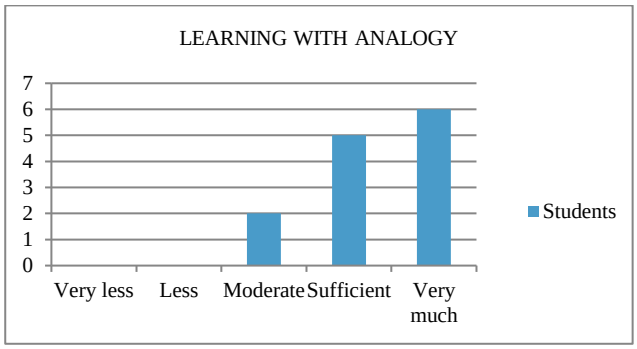

Figure 1 (Source - Author)

- Students were asked their perception of learning from solving design problems with the help of analogy.
- 60% of all students responded that analogy helped very much in their design learning.

Q8. What approaches are you able to use after the exercise on analogy in concept designing?

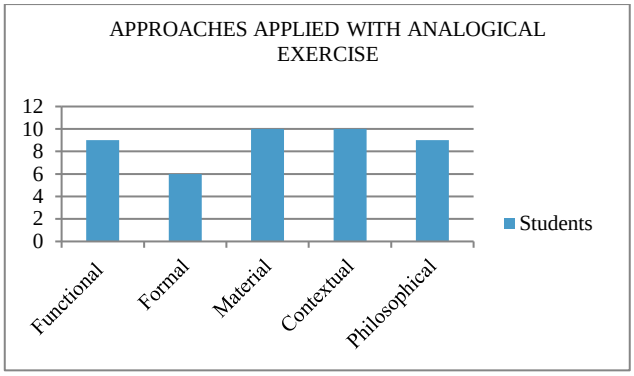

Figure 2 (Source - Author)

- Students were asked about the approaches they are able to use with the help of analogical cases for designing concept.
- 90% of all students responded that they usually use formal approach to design a concept.

Q8. Are you able to apply analogical learning in your design solutions?

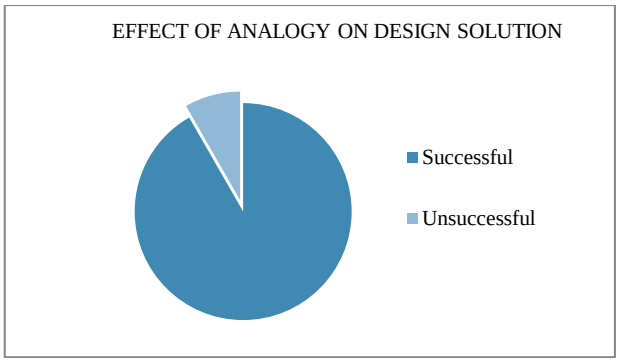

Figure 3 (Source - Author)

- Students were asked to analyze their progress in applying analogy in design solutions.
- 88% of all students responded that they successfully applied analogical learning in their design solutions
- Whereas 12% of the students felt that they are unsuccessful in applying the analogical learning in their design.

V. CONCLUSION

In the experiment of this study, the students learned about concept designing through a framework based on analogical learning to gradually develop their own concepts incorporating various approaches in their design.

Their new knowledge helped the students to develop better design knowledge and vocabulary.

This study confirms the feasibility of using analogical thinking in the teaching of architecture design to enhance analytical skills, improve presentation skills and graphic skills.

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Another aspect that deserves further attention is the role that analogy plays in design education. Analogical learning enables students to acquire skills and knowledge, while they develop their own design solutions and ideas.

Alternatively to the traditional approach, analogy is proposed as an educational tool for the design studio. The use of visual analogy is recommended for intervention programs that aim to help students develop design knowledge, problem reasoning and problem solving and their own design languages.

VI. RECCOMENDATIONS

A. **Breaking the studio class into smaller groups** - Having smaller groups would give more time and attention to individual projects; allow more discussion; and help keep the students attention.

B. **Better time management of the process** - Better time management for the exercise would include limiting the time in which each student has to present their ideas and allowing the same amount of time for feedback to be spent of each individual project. This will keep students more focused and interested in the discussions.

C. **Students should be allowed to choose their own analogical examples** - students should be given freedom to choose their own analogous cases in order to avoid fixation to a specific solution

D. **More encouragement of students in the discussion**- Encouraging students to engage in the discussions while other students are presenting would help them learn and analyze from other students design.

E. **Submission after the activity** -The submissions should occur after the analogical learning to ensure that students get enough time to incorporate the suggestions in the design.

F. **A wider variety of jurors** - A wider number of teachers to be involved in the discussions to offer students different viewpoints on the feedback they receive.

G. Establish a written statement that describes the purpose of design problem to guide students and faculties to enhance their understanding of the problem.

VII. Acknowledgment

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AUTHOR INFORMATION

Kaumoodi, Student, M. Arch, Department of Architecture, Faculty of Architecture and Ekistics, Jamia Millia Islamia, New Delhi, India.