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RESEARCH PAPER

General Architecture

Intuitive and logical way of thinking in the education of architectural design courses

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Abstract

Different approaches and methods are used in the architecture design process that logical and intuitional methods are the most common ones. The role of knowledge in each method is different. Investigating aspects of knowledge demonstrated the hierarchy from data to wisdom and the interaction of explicit and tacit types, subjective and objective sources, and analytical and exploratory ways of processing knowledge. Logical methods rely more on explicit and objective knowledge with analysis, while intuitive methods rely more on tacit and subjective knowledge that processed by exploratory ways. To investigate the difference between the two methods, we conducted a survey that involved architecture students in two groups of logical and intuitive methods. Results demonstrated that they have different opinions about the role of each type of knowledge, the importance of knowledge in each step of the design process, and the role of sources of information in their design process. We concluded that an integrative method that considers different aspects and integrated interactions of all aspects of knowledge is needed..

Keywords: *Knowledge, Design process, Intuitive, Logical, Architecture education*

1. INTRODUCTION

The substantial role of knowledge in architecture design is undeniable. The architects mostly ask themselves if they have collected and analyzed the required information correctly. Logical and intuitive methods are the main methods of architectural design. The logical methods mostly are based on knowledge, logic, and scientific facts. The 'form follows function' motto is one aspect of this method [1]. The decisions of architecture with the intuitive method are mostly based on intuition and not analysis [2]. Just like a live plant that is grown from a seed [3]. Some think that with the logical method, more information is collected and better organized. Therefore the use of information and knowledge in intuitive methods has been underestimated.

The paper aims to evaluate the different role of knowledge in the design process between logical and intuitive methods. Therefore at the first step, we identified different aspects and kinds of knowledge by scientific definitions. At the second step, we recognized the logical and intuitive methods, and the theoretical framework was made. The architect educators mostly rely on one approach and deny other approaches. Difference between two methods in the use of knowledge is the main subject of this research. Therefore we asked if one of these approaches, logical or intuitive, excels in collection and the use of knowledge. In order to investigate this issue, at the third step, we conducted a questionnaire study to investigate architecture student's viewpoint about the role of knowledge in the architectural design process and to compare the intuitive and logical method. Two groups of architecture undergraduate students were selected for this study; one group designed their first design course in the logical method and other group designed with the intuitive approach. The type of survey described here ought to provide us with the first stage of important general information about two popular methods of the architectural design process.

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2. LITERATURE REVIEW

2.1. The logical and intuitive design process

There are different approaches to the design theories. At the beginning theories, the design was considered as a kind of problem-solving, and some systematic methods were developed for the design process. The empirical

approach did not provide a framework but descriptions [4]. The Theorists explained that design process diagrams don't help designers [2]. Schon explained that design proceeds as a reflective conversation with the situation that is an interactive process between the designer and the external presentation of design idea [4]. One of the first subjects of design researches was the design methods, especially the methods to create form and space in architecture. Broadbent and Ward categorized architectural design methods into the *pragmatic, iconic, canonic*, and *analogical* design [5]. The *pragmatic* method like vernacular architecture developed based on try and error. The *iconic* is repetition of mental images. *Canonic* builds upon an iconic design by the provision of rules, or components, as design resources. Designers use an analog medium such as a nature to simulate design situation [5]. Lawson introduced *narrative* method that architects narrate a story or combination of events [2]. McGinty explained the *analogies, metaphors, essences, programmatic concepts,* and *ideals* design methods [6]. Jencks proposed new methods include *organitech, fractal, blobmeisters, enigmatic signifier, data scape, landform,* and *cosmogonies* [7]. Those categorizations were based on the outcome form of design but not the process of generating form. Jormakka considered the origins of ideas in *nature, geometry, music, mathematics, accident and unconscious, rational, precedent, response to site* and generative processes like *data scape, diagram, parametric, superposition and scaling*, *morphing, folding* and *animate form* [1].

There are two common methods of architectural design, logical and intuitive, that belong to different thinking approach. The *programming* design method of McGinty [6], the *rational* method of Jormakka [1], and the *data scape* of Jencks [7] are kinds of logical methods. In the logical methods, designers try to find a realistic and logical way to develop design solutions, and they rely on knowledge and logic and not intuition or inspiration. The scientific facts of the design, especially the facts related to the program and site, are the most important elements in this method. The "form follows function" motto leads its process [8]. The rational processes are based on a profitable perception of human beings and the use of decision-making theories to find the best, most profitable, solution [9-10]. Fundamental steps of the logical process include that decision maker considers all the options ahead, evaluate the implications of each option, choose the alternative with maximum satisfaction. These processes are dependent on scientific analysis and forecasting. It is along with developing advanced techniques for collecting and evaluating information, alternative making, and prediction [11]. This rule-based design method is better matched to new design strategies like parametric design [12].

Intuitive method processes take place in the designer's mind and are far from rational and reasoned control. The theorists proposed the creative processes instead of standard systematic design methods. The moment of illumination (Eureka) has special importance in the creative process. The moment that creative ideas begin to appear. Getting to this moment needs pre endeavor [2]. Wallas [13] defined creative process into four stages, after it completed in five stages include first insight, saturation, incubation, illumination, and verification [14]. At the first insight stage, designer detects the design problem and decides to solve it. At the saturation stage, designer consciously tries to find the design solution [2]. Sawyer studied design studio models and pedagogical beliefs in US and found that intuitive method based on creative process, ideas coming from making and doing and not linear instructions, is the highly accepted and the most common design method [15]. The definition of two main methods and classification of design methods is presented in table 1. Kumar defined another design method that is among intuitive and logical, called innovation planning [16]. He defined the innovative moment as magic, genius, Intelligence, or revelation that always stays in the black box. In this research, two logical and intuitive methods have been compared by the use of the survey method.

Table 1 design methods classification and definitions

Design Method	Definition	Example
Logical	Realistic and logical way to develop design solutions [8]	Programmatic [6]
	Considering all options, evaluating the implications of each option, choosing the alternative with maximum satisfaction [11]	Data scape [7]
	Rationally collecting and evaluating information, alternative making, and prediction [11]	Rational [1]
Intuitive	Taking place in the designer's mind with the moment of illumination that creative ideas begin to appear [14]	Unconscious [1]
	Decision making based on intuition and not analysis [2]	Timeless way [3]
	Making and doing and nonlinear process [a]	
Other methods	Pragmatic, iconic, canonic, analogical [5]	
	Narrative [2]	
	Analogies, metaphors, essences, ideals [6]	
	Organitech, fractal, blobmeisters, enigmatic signifier, landform, cosmogonies [7]	
	Nature, geometry, music, mathematics, precedent, response to site, generative processes [1]	

2.2. The role of Data in architectural design

Vast Data and knowledge have been used in architecture design at different levels. The various types of knowledge used in architecture design have been considered by the researchers. One of the main sources of Data in each

architecture project is context. Climate data of the place of the project is one of the first data that designers usually take attention to. Lawson defined the sources of knowing the design problem into employer, users, designers, and legislators, inner constrains include the needed functions and relations and outside include context and environment conditions. He defined basic constrains, practical, shapes, and symbolism [2]. Abel defined architectural design information sources into location, social level, building type, technology, and aesthetics [17]. Rezaei categorized inside sources into cultural concepts, precedents, meaning, history, philosophy, location, city and urban concepts, ethical and political agenda, science, art, and social levels. He defined the outside sources into program and function, dimensions and sizes, standards, hierarchy and circulation paths, site and climate and geography, legal and regulatory constraints, structures, materials, costs and employer [8]. Parshall and Pena [18] categorized information into place, function, economy, and time. Duerk programming plan defined subject into current and future. Current situation analysis includes the context (site analysis, users, regulations, constraints, and climate) in all aspects of cultural, social, political, historical, archaeological backgrounds. Forecasting future situation includes a set of criteria that a successful design must have included mission, goals, functional requirements, and concepts [19].

The mission is more general, goals are in the second layer, the functional requirements are practical and concepts define the way to meeting needs and achieving goals [20]. The amount of factors that affect architecture design is large and diverse. Collecting this large amount of information and analyzing it is one of the main parts of the design process. Different types of sources of information in architectural design are categorized based on inside/outside and current/ future categorization in table 2.

The kind of information used in design includes rules, criteria, standards, and also precedents. Eilouti [21] proposed seven kinds of information that architectures extract from precedents; scenario, pattern, system, concept, components, rules and principles. The type of information that is extracted from the precedents depends on the type and level of data from precedents that designers access to [22] and the designer's goals for source selection that affect the strategy of searching and reading precedents' data [23]. Empirical studies of expert architects demonstrated that they always collect information at the beginning of design [24]. The raw data collected by designers must be processed to mean and turn to information [25]. The design team must find ways to share project information correctly and completely [26], [27]. Some scholars tried to develop trainings to educate design students to share design information in interactive manner [28]. One of the important issues besides the kind of information is how information is obtained; the process of obtaining information is getting started before the design problem or after that, the needed information is received by education, experience, or research during the design process.

Table 2 sources of information in architecture

	Inside	Outside
Current	Building type [17]	Context [2,17,19]
	Aesthetics [17]	Environment conditions [2]
	Cultural concepts, Meaning [8]	Location [17-18]
	Precedents [8,21]	Standards, rules [8,21]
Future	Function [2,18-19]	Technology [17]
	Mission, Goals [19]	Economy [18]

2.3. Knowledge definition and categorization

To find out the role of knowledge in the architecture design process, at first, the levels of knowledge and kinds of it must be known. There is a known hierarchy of knowledge from data, information, science, and wisdom [29]. Some theorists considered a stage between science and wisdom called intelligence [30], or understanding [31]. Therefore the stages are defined as follows;

- Data is the symbols that are found and saved. Data includes words, Numbers, or shapes that are units to communicate. Also, data includes some sensory symptoms [30]. The raw data simply exists that does not have the meaning by itself [31].
- Information consists of data that has been given meaning by way of relational connection [ibid]. Information is a message that implies decision or action [30].
- The science includes knowing or recognizing (what), a capacity to act (how) and understanding (why) and it placed in the mind. The goal of science is to make life better [30], and science is a set of useful information [31].
- Intelligence includes the ability to sense the environment, to make decisions, and to control action, the ability to recognize events, and to reason about the plan for the future [30]. Intelligence also is the ability to succeed in life based on personal or social values that depends on balance between analytical, creative, and practical abilities [32]. Understanding includes an interpolative process in both cognitive and analytical aspects. The process of understanding makes it possible to take the knowledge and synthesize new knowledge from the previously held knowledge [31].
- Wisdom involves understanding the truth of the world, true judgment, and proper behavior [30]. An extrapolative process is non-deterministic and non-probabilistic. It includes all the previous levels of consciousness. It helps to know we

previously have no understanding. It asks questions to which there is no humanly-known answer. Therefore, by wisdom, we also discern, or judge, between right and wrong, good and bad [31]. Wisdom is an ideal stage that scarcely is accessible.

Knowledge also categorized into explicit and tacit. Tacit knowledge is the knowledge in the mind but is hard to be expressed [33]. The tacit knowledge includes skills, ideas, and experiences that cannot be codified logically or expressed systematically [34]. This kind of knowledge has been captured by experience. Both tacit and explicit knowledge by interaction help the creation of new knowledge and should not be separated from each other [35]. Also, the sources of design knowledge can be categorized into objectivity (external reality) and subjectivity (designer's intentions and wishes). Objectives include the facts that exist independent of the individual's mind; therefore, it is not influenced by perceptions, emotions, and imaginations. Objectivism implies ideas and facts exist independent of the individual's mind, and they are recognizable [36]. Subjectivity knowledge does not directly come from outside facts, but it passes through layers of mind, emotions, memories, perceptions, values, and wishes [37]. The process of seeking and acquiring knowledge has been categorized into discovering and analysis. The analysis comprises comprehensive review, categorization, ranking, and typology that have logical merit. But discovery is a curious exploration and has intuitive merit [38].

The classification of knowledge from data to wisdom is hierarchical. In the other word, wisdom is on the higher level of knowledge and comprises other layers. But explicit/tacit, objective/subjective, and discover/analysis duals are equal, and we need both parts in interaction to find out or understand (Table 3). In this research, we investigated the difference between logical and intuitive design process in the application of different types of knowledge.

Table 3 Knowledge categorization

Subject	Aspects	Relation
Layer	Data /Information /Science /Intelligence /Wisdom	Hierarchical
Type	Explicit /Tacit	Equal and interaction
Source	Objective / Subjective	
Process	Discovery / Analysis	

3. THEORETICAL FRAMEWORK

The difference between logical and intuitive methods has been discussed, and the type, layers, and sources of knowledge have been known. Therefore we can compare two approaches. One the strategy that used in logical approach is programming to control the design information. Programming is one of the steps of the design process that helps designers to systematically utilize information in different layers of design process. Programming helps to design based on practical research. Theorists believed that the results of programming in the design process are saving time, efficiency, reducing mistakes, and the proper use of peoples and environment [19- 20]. Therefore in the logical method, data turns into information, information leads to design solutions, but it does not attain wisdom. Logical methods use design making and problem-solving models from other disciplines, and they are known as the theory of information processing for problem-solving [9]. They use explicit knowledge and not tacit. The logical methods also are objectivists, and they rely on external and real sources of information. The logical methods have predetermined rules and use objective techniques, options, and evaluations [11]. The problem and place are sources of the primary generator of design in logical methods [9].

On the other side, the intuitional methods rely on subjective more than decision making by objectives and external information. The context information also is collected, but objectives have been considered in differently. A creative person carries out with the same data in a new way [39]. Information in the mind of a creative person has a dynamic nature and continuously finds a new structure [2]. It seems that collecting and analyzing information have better control in the logical method, but in the intuitive method also the information has been processed but in a different way. Cross [24] defined two groups of intuitive and logical architects by observing and surveying professional architects. He found that intuitive architects take some decisions unconsciously, and they don't have any clear and expressive reason for their design acts. Buchanan [40] discussed that design thinking must be based on knowledge from various areas and disciplines. Knowledge can be a source for inspiration, practical limitation, or criteria for evaluation, but it must become ideas in the designer's mind. The designer with integrate mind use both logical and intuitional reasoning to understand design knowledge [41]. The dynamic nature of information must be considered in the design process, like as solving a puzzle consists of a lot of data that be appeared and changed at the same time. The design knowledge is tacit that appeared when knower and knowing become the same [40- 41]. The designer explores, discovers, changes, and transforms data in the intuitive design process. The raw data slowly becomes wisdom by understanding, changing, transforming, integrating, and reorganizing [41]. Table 4 demonstrates the hypothesis of the research that extracted from discussing literature and expresses the intuitive method is based on tacit, subjective, and discovery that closed to wisdom, but the logical method is based on explicit, objective, and analysis. But no one considers interaction of dual aspects to integrate the knowledge.

Table 4 Difference between intuitive and logical approaches regarding to the role of knowledge

	Layer					Type			Source			Process		
	Data	Information	Science	Intelligence	Wisdom	Tacit	Explicit	Interaction	Objectives	Subjective	Interaction	Discovery	Analysis	Interaction
Intuitive				*	*	*				*		*		
Logical	*	*	*	*			*		*				*	

4. METHODOLOGY

This research has been done in three steps based on McKenney and Reeves [42] proposed model of design education research. At the first step, *exploration*, we reviewed the known concepts of knowledge in different aspects and in relation to design. At the second step, *construction*, the theoretical framework was made and students have been educated based on logical or intuitive methods. At the third step, *reflection*, we developed a questionnaire to find out the students' viewpoint about the role of knowledge in their design process. The survey we conducted involved 53 participants, second-year students of architecture atthe University of Tehran in two groups (30 participants educated in logical method and 23 participants educated in Intuitive method).

For more than seventeen years, the undergraduate students of architecture at the University of Tehran have been divided into two groups. The first group of students has spent architecture design one by the logical approach. They have studied the site and problem, analyzed them, drawn diagrams, produced alternatives, and selected the best alternative logically. The second group has been educated in Intuitive approach in architecture design one and followed an Intuitive program in an architectural design task. At the semester that the research was done, 65 students have been educated based on this strategy. 53 students from all 65 persons volunteered to answer the questionnaire (sample size ratio is 53/65=0.81).

The questionnaire was divided into three sections with the following topics;

- The type of knowledge: How much is the rate of usage of each type of knowledge in architecture design? (Knowledge learned in architecture education, experience before education, site and context study, function and design problem study, design method knowledge, unknown information that must be learned in future)
- The step of the design process: How much is the rate of usage of knowledge and information in each step of the design process in architecture design? (collecting information at the beginning of design, analyzing the design problem step, concept or idea generation step, architectural maps generation step, presentation of the final design, talking about idea and defense of design)
- The source of information: to what extent each type of source of information is useful to access the required knowledge in architecture design? (books, precedents, Internet, knowledge learned in architecture education, design educators, senior students counsel)

To answer the questions, students filled the 5-point Likert scales (e.g., 1 =very low; 2= low; 3 =medium; 4 =high; 5 =very high). The students were asked to answer an open-ended question to write their additional sources of information.

The data collected were analyzed by SPSS software, and the one-way analysis of variance (ANOVA) was used to determine whether there are any statistically significant differences between the viewpoint of two groups of participants about the role of knowledge in the design process.

5. RESULTS

In the following subsections, the results of the main topics of the questionnaire are presented.

5.1. The role of each type of knowledge

The results of one-way analysis of variance (ANOVA) between subjects demonstrated that the role of each type of knowledge is different between two groups in some cases. There were significant differences in the case of university education, site and context studying, and problem studying scores between two groups (Table 5). Descriptive statistics results (Fig. 1) demonstrated that;

- The logical design group believed that the maximum use of knowledge belongs to unknown knowledge that must be learned in future, but Intuitive group believed that the most usable knowledge type is what they learned at the university during four semesters. The unknown knowledge is the knowledge that students consider it as the knowledge from future education in architecture that they don't know it yet.
- The low usage type of knowledge is related to the knowledge that they learned before university and experience in their life.
- The university education knowledge was more

important for the Intuitive group than the logical group.

- The context and problem studying get higher scores by Intuitive group than the logical group. This result is unpredictable because the logical group analyzes context and problem systematically but the intuitive group gave higher score to context and problem studying.

Table 5 The role of each type of knowledge, Results of between groups test of one way ANOVA

	Sum of Squares	df	Mean Square	F	Sig.	
University Education	1.734	1	1.734	4.499	.046	P<0.05
Before University	.803	1	.803	.674	.421	
Site and Context study	8.244	1	8.244	9.798	.005	P<0.05
Problem Study	2.304	1	2.304	3.989	.049	P<0.05
Design Method	2.531	1	2.531	2.768	.111	
Unknown Future knowledge	.803	1	.803	.991	.331	

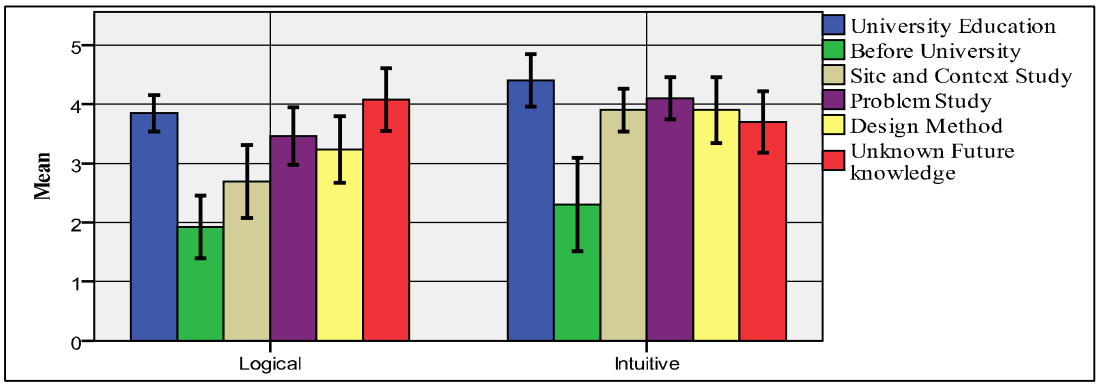

Fig. 1 Mean the usage of each type of knowledge scores for logical and Intuitive participants, Error bars represent standard errors, Error Bars: +/- 2SE

5.2. The importance of knowledge in each step of the design process

The results of ANOVA demonstrated that there was no significant difference between two groups in the case of steps of design process rate of usage of knowledge and information in each step of the design process in architecture design (Table 6). Descriptive statistics results (Fig. 2) demonstrated that;

- Both groups believed that the usage of knowledge in concept generation, map generation, presentation, and defense are more important than the usage of knowledge in data collecting.
- The Intuitive group emphasized the importance of knowledge in map generation step, but the logical group emphasized the importance of knowledge in concept or idea generation step.

Table 6 The importance of knowledge in each step of the design process, Results of between groups test of one way ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Collecting data beginning of design	.321	1	.321	.506	.485
Analyzing design problem	.000	1	.000	.001	.978
Concept or Idea generation	.618	1	.618	1.410	.248
Maps generation	.281	1	.281	.536	.472
Presentation of final design	.618	1	.618	.854	.366
Defense of design	.097	1	.097	.154	.699

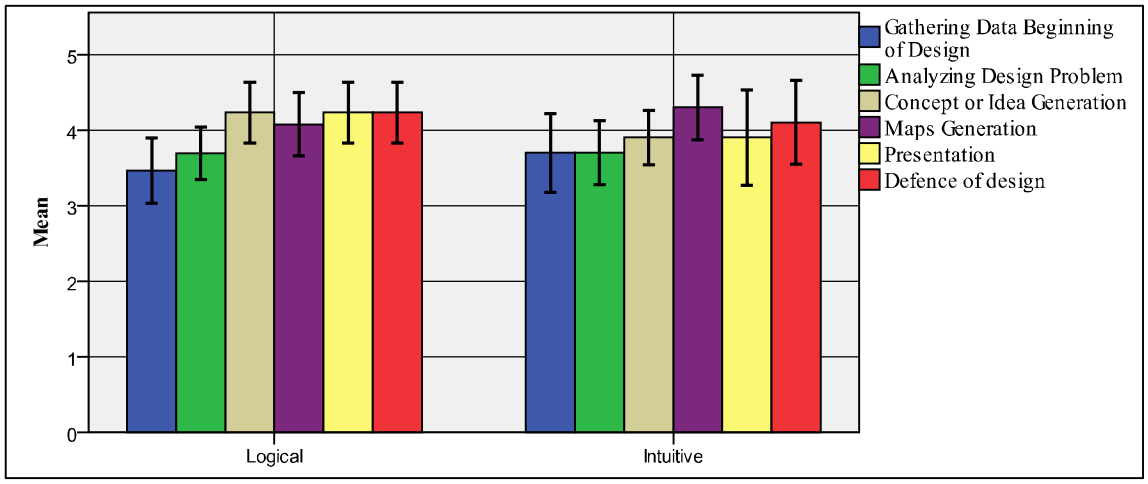

Fig. 2 Mean the use of knowledge in each step of design process scores for logical and Intuitive participants, Error bars represent standard errors, Error Bars: +/- 2SE

5.3. The role of sources of information

The results of one way ANOVA between subjects demonstrated that the role of each source of information is different between the two groups in some cases. There were significant differences in the case of education experience and design educators' scores between two groups (Table 7). Descriptive statistics results (Fig. 3) demonstrated that;

- The fewer importance sources of information for both groups were senior students counsel and books.
- The logical group emphasized on the internet, but the Intuitive group emphasized design educators as the most usage source of information in their design process.
- The role of knowledge that they learned during architecture education was more important for Intuitive group than the logical group.

There was an open-ended question that asked the students' additional sources of information. They mentioned field study and discussion information with classmates.

Table 7 The role of sources of information to acquire the required knowledge, Results of between groups test of one way ANOVA

	Sum of Squares	df	Mean Square	F	Sig.	
Books	.057	1	.057	.057	.814	
Precedents	1.592	1	1.592	2.695	.116	
Internet	.016	1	.016	.027	.870	
Education	2.304	1	2.304	4.776	.040	P<0.05
Design Educators	4.195	1	4.195	6.463	.019	P<0.05
Senior Students	2.893	1	2.893	1.900	.183	

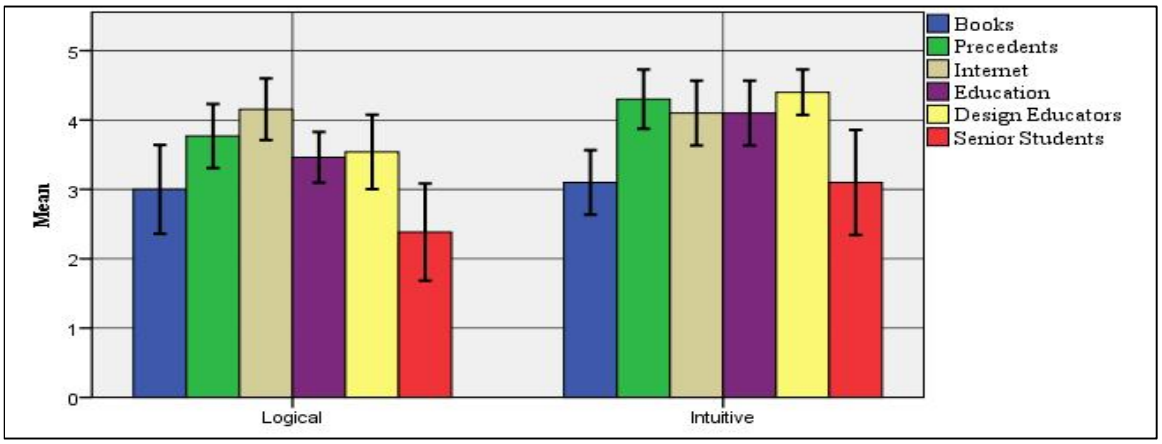

Fig. 3 Mean usage of each type of source of information scores for logical and Intuitive participants, Error bars represent standard errors, Error Bars: +/- 2SE

6. DISCUSSION AND CONCLUSION

In this research, we asked what the difference is between the logical and intuitive method of the design process regarding to the role of knowledge. The intuitive and logical methods have been defined, and we found that an architect with logical method relies more on programs and facts, collects information by systematic research, and tries to find optimum, efficient and more benefit solution. But an architect with intuitive method relies more on values, inspiration, personal intuition, imagination, creativity, discover thinking, and personal genius. The survey study revealed that there are differences between two groups of logical and intuitive students regarding to the role of different kinds of knowledge in the design process. They have different opinion about the importance of kind of knowledge that they used in their design process. The university education (what they learned at the university during four semesters) was more important for the Intuitive group than logical group. The Intuitive group believed that in map generation step, the use of knowledge is more important, but the logical group emphasized on concept or idea generation step. Also, regarding to the most important source of information, the logical group emphasized on the internet, but the intuitive group emphasized on design educators' advice.

The analysis of the role of knowledge in both approach revealed that explicit and objective knowledge with analysis manner had been used more in logical approach, but in intuitive approach, architects rely more on tacit and subjective knowledge that processed by exploratory ways. Because of the importance of knowledge sharing between team, some scholars preferred logical methods [26], but some researchers find strategies to share knowledge in intuitive method [28]. The interaction of both aspects of knowledge (tacit/explicit, subjective/objective sources, and analytic/exploratory manners) that is important to find an integrative vision is neglected in both aspects. Therefore an integrative approach that considers different aspects and integrated interactions has priority over just one approach of intuitive or logical. The results are applicable to architecture education. Other researchers confirmed that there is no valid textbook or special instruction for architecture design education and professors always create their own pedagogical models [15]. Theorists emphasized that knowledge must be used in an integrative manner in architectural design process [43], [44], therefore the educators, instead of insisting on just one approach, it is better to take more attention to other aspects of architecture knowledge as well, and train the students to use the interaction of all ways of thinking. Some scholars developed instructions and method to interact design knowledge [28].

The survey method is not a comprehensive method to understand the difference between logical and intuitive method and there is need for future studies especially empirical experiment by focus on learning and interviews with educators by focus on teaching, e.g. the research that has been done, to understand the difference better by sawyer, to understand the difference better [15]. . Also the lack of similar researches to compare and discuss the results is one of the main constrains of this research. There are some unpredictable findings e.g. the context and problem studying get higher scores by intuitive group than the logical group and internet is more usable source of information for logical group. The discussion of thid results need more similar researches therefore these information are not intelligible with our current knowledge and need more future studies to make them Controversial.

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