

DOI: [10.38027/ICCAUA2022EN0172](https://doi.org/10.38027/ICCAUA2022EN0172)

Architectural Design Studio as A Knowledge Intensive System: Sociology of Design Knowledge

Dr. Evren ÜLKERYILDIZ

Akdeniz University, Faculty of Architecture, Department of Architecture, Antalya, Turkey
E-mail: evrenulkeryildiz@akdeniz.edu.tr

Abstract

Architectural design studios are still an inseparable part of the architectural design education. Different pedagogical approaches, architectural design norms, evaluation methods and assumptions prevail on how to carry out architectural design studios. It is widely acknowledged that is a futile attempt to search for a unitarist approach on how to carry out architectural design studios. A new conceptualization of architectural design studio can open up new venues to appreciate the plurality of various ways of organizing and running architectural design studios. It is a challenging task to identify how exactly students acquire new design knowledge from the design-oriented, knowledge-intensive, and fragmented architectural design studio environment. Architectural design studio can be conceptualized knowledge-intensive social system in which participants, individually and collectively, acquire *design knowledge*, assimilate *design knowledge*, transform *design knowledge* and finally exploit *design knowledge* to construct an output. This knowledge intensive social system, is in fact, points out the subtle operation of social learning process. Design knowledge is always embedded in design studio environment. It is subjected to the prior assumptions, design routines, practices, and power relations among social actors of the design studio. The basic idea is to conceptualize the design studio environment as a knowledge ecology composed of socially enacted knowledge process provides an alternative view to articulate a systematic framework to explore the social nature of design knowledge and its taxonomy. Understanding how this social learning environment operates can provide important insights on the taxonomy of design knowledge. The research presented herein studies the design knowledge and its typology by developing a new conceptual framework. The proposed framework builds on a succinct review of different, competing and conflicting conceptualizations of “knowledge” and “design knowledge”.

Keywords: Design knowledge; Knowledge typology; Design studio; Design climate; Sociology of knowledge.

1. Introduction

Behavioral psychology has been dominantly occupied with the investigation of *changes in beliefs* and attitudes due to external stimuli whereas cognitive psychology has been focused on how mental process operates. Behavioral psychology proposes that *changes in behaviors* can be conceptualized as *learning* (Dole & Sinatra, 1998). Furthermore, behavioral psychology recognizes that environment (climate) has a paramount effect on behavior in particular, in responding to a stimulus triggered by the environment. This response to the environment which can lead a change in the patterns of behaviors of social actors is called *learning* (Zonooz, Farzam, Satarifar, & Bakhshi, 2011).

However, a *change* in mental process has been a key research area in the field of study in cognitive psychology. From cognitive psychology view, a change in mental process is synonymous with *learning process* (Dole & Sinatra, 1998). Changing the way of thinking can lead to subsequent changes in the structures of knowledge and in turn the creation of new knowledge structures (Piaget, 1952). Piagetian theory proposes that when the new knowledge structure conform with the existing cognitive structure then it leads a process called ‘assimilation’ where significant changes to existing knowledge structures are not observed. In the spirit of bridging the cognitive and constructivist perspectives of knowledge creation phenomenon, Dole and Sinatra (1998) emphasize the iterative nature of the *change*, in other words *reconstruction knowledge*, and *conceptualize this process as a continuum which ranges from ‘low cognitive engagement’ to ‘high metacognitive engagement’*. The concept of ‘engagement continuum’ can be defined as a change in knowledge structure triggered by confronting with a new information that conflicts with prior knowledge. The anomalous degree of new information and/or the lack of conceptual coherence with previous knowledge structure can lead cognitive engagement which eventually results in with *change* (Dole & Sinatra, 1998), reconstruction or *creation* of ‘knowledge structure’. In the light of foregoing discussion, it is essential task to answer the following question; ‘What knowledge is?’

2. The Concept of Knowledge

Epistemological view has been occupied with defining the term “knowledge” since antiquity - from the classical Greek era to modern era. Engaging in a debate to question, reconstructing the concept of knowledge and proposing

a universal truth is simply beyond the scope of this research. However, it is necessary to review different perspectives that prevail on the concept of knowledge. Understanding how 'knowledge structures changes' in particular setting such as architectural design studio, requires reviewing the main assumptions proposed for studying the concept of knowledge and its reconstruction or creation.

A common assumption of the concept of knowledge is about its hierarchical nature where knowledge is hierarchy organized as data, information, and knowledge (Alavi & Leidner, 2001; Zack, 1999). Data can be defined as raw numbers and can be in any form, it does not have meaning unless it has been processed and converted to information. The information is converted data by relational connections where its meaning may be given or may not be given. Information is possessed by individuals in a deterministic way and when it has personalized in mind then knowledge can become existed. Therefore, knowledge can be considered as affirmed information which is commonly stored. A piece of knowledge is 'information memorized' in mind. In such case, it has been defined as justified true belief since Plato (360 B.C.E). It is very common to come across in literature that the hierarchal nature of knowledge, hierarchy between data to information, is questioned on the ground that there are some evidences that support the inverse relationship assumption about the direction in which the cognitive process operates. Unless knowledge has already been created verbalized and structured, the information does not exist and data do not exist if it has not measured for information (Tuomi, 1999). A reconciliation about these competing assumptions can be achieved by accepting its reversible nature of knowledge and the dynamic flow from one state to another state predominantly influenced by the flow of any impetus.

3. Aspects of Knowledge

Different perspectives which prevail on the concept of knowledge offer distinctive views when it comes to identify 'what describes the knowledge' and how 'knowledge can be perceived'. A brief review of literature on "concept of knowledge" reveals the presence of alternative dimensions of knowledge such as; (1) a capacity, (2) a process, (3) an object, (4) a situation of having access to information, (5) a state of mind (Alavi & Leidner, 2001) and (6) a barrier (Carlile, 2002). The concept of knowledge has been defined as "a capacity" to use information (Watson, 2008) for decision making. According to this view, knowledge is that of an ability to interpret information by learning and experience. The core theme in this view is mostly focus on 'building intellectual capital'. The concept of knowledge as "a process" refers to the process of knowing and acting simultaneously and the flow of information from one state/social actor to another state/social actor. The concept of knowledge as "an object" refers a process in which it is manipulated and stored (Zack, 1999). The concept knowledge as "accessibility" refers stocks in which it is accessed stocks (Alavi & Leidner, 2001). Furthermore, knowledge can be viewed as a "state of mind" focuses on knowing and understanding based on a cognitive cognition of what is learned, discovered, and perceived. Finally, knowledge can be conceptualized as a routine which is locally embedded and invested in daily practices which can act as a barrier to reconstruct or create new knowledge (Carlile, 2002).

Table 1 Alternative Conceptualization of Knowledge and Their Focality (Adapted: Alavi and Leidner, 2001)

Aspects	Focus
Capacity	An ability to interpret information by learning and experience
Process	Information flow
Object	Can be manipulated and stored
Accessibility	Knowledge stocks
State of mind	What is learned, discovered, and perceived
Barrier	Boundary Spanning

4. Taxonomies of Knowledge

A brief literature on the concept of knowledge reveals that various classification schemes have been proposed in the literature to study the characteristics of knowledge. Polanyi (1966) propose that knowledge can take two forms: (1) tacit knowledge and (3) explicit knowledge. The tacit and explicit forms of knowledge build on the assumption that '*we can know more than we can tell*'. Therefore, expressible knowledge can reflect the only tip of an iceberg on contrary whole-body knowledge which cannot be easily expressed (Nonaka, 1994). Tacit knowledge (implicit) is a personal, context-specific knowledge form and which cannot be stored effectively therefore that has been hard to explicitly formalize and communicated. Explicit knowledge is 'codified', convertible, formal, systematic information or instruction and can be transferred or stored in a codified language (Nonaka & Takeuchi, 1995). The tacit and explicit knowledge classification was reintroduced to the literature early 1990s by Nonaka (1994) to emphasize cognitive and technical qualities of implicit knowledge. Nonaka (1994) points out the cognitive qualities includes a

mental model which refers to beliefs, viewpoints, paradigms, and mental maps, technical qualities refer to concrete know-how, skills, crafts.

Knowledge can also be explored in terms of (1) knowledge content, (2) tacit-ness, and its (3) complexity (Lane, Koka, & Pathak, 2006). The first one, knowledge content, refers to 'know-what' and is usually expressed as *declarative* knowledge. The second one, tacit-ness, refers to 'know-how' which is commonly expressed as *procedural* knowledge. Finally, complexity refers to the number of interdependent routines, individuals, and resources. Alavi and Leidner (2001) state that knowledge can be grouped into four categories namely (1) causal, (2) conditional, (3) relational, and (4) pragmatic. The first category of knowledge can be used to describe or explain situations or reasons where it corresponds to 'know-why' type of knowledge form. The second category, conditional knowledge, describes when certain activities may occur or we call it 'know-when' type of knowledge form. The third category, relational knowledge, refers to relational conditions between events or activities and it corresponds to the 'know-with' type of knowledge form. The last category is pragmatic knowledge form which offers the need and usefulness of knowledge.

Jane Zhao and Anand (2009) present two types of districts but parallel knowledge types: (1) individual and (2) collective. The taxonomy proposed by Jane Zhao and Anand (2009) has close similarity with the one that has been previously proposed by Nonaka, Toyama, and Konno (2000). Jane Zhao and Anad (2009) offer a taxonmy which is well-differentiated in terms of its implicitness and socially embedded nature (i.e., the norms and routines of the organization). In this sense, collective knowledge constitutes individual knowledge and is more complicated to transfer mainly due to its social embedded nature (Jane Zhao & Anand, 2009).

Lim (2009) proposes a conceptual model with three different forms of knowledge; (1) disciplinary, (2) domain-specific and (3) encoded. The ontological dimension used in this model offers a view perspective on how to study the concept of knowledge. The first form, disciplinary knowledge, refers to the process of acquiring raw scientific knowledge while actively interacting with scientific communities. The second form, domain-specific knowledge, refers to the process of acquiring knowledge directly related to the production of new knowledge or innovation. These two forms knowledge are parallel with explicit knowledge forms. The third form, encoded knowledge, refers to the process of absorbing which is already embedded knowledge in tools, procedures, process or artifacts. The last form of knowledge can be also called the tacit form of knowledge. Carlile (2002) introduces a new way of classifying knowledge by borrowing the concept of 'barrier' from linguistics. This model differentiates knowledge based on the presence of three knowledge boundaries. The first boundary, syntactic, refers to a process of expression with a certain kind of structure/form. The second boundary, semantic, refers to a process of expression with a certain kind of content/meaning. Finally, pragmatic boundary refers to a process of expression with a certain kind of use. These three boundaries metaphorically refer to (1) analogies, (2) gestures and (3) patterns (Huang and Huang 2013).

Depending on the degree of objective and subjective interpretation, in other words knowledge epistemology, knowledge can be also classified into two distinct dimensions: objective and subjective knowledge (Popper, 1972). Furthermore, it is clear that the subjective-objective *dichotomous states* of knowledge are related with the tacit-explicit forms of knowledge proposed by Nonaka and Takeuchi (1995).

Table 2 Knowledge Taxonomies According to Alternative Dimensions

Epistemological dimension	Socio-cognitive Dimension	Contextual dimension	Ontological dimension	Linguistic dimension
<ul style="list-style-type: none"> • Tacit (objective) • Explicit (subjective) 	<ul style="list-style-type: none"> • Individual • Collective 	<ul style="list-style-type: none"> • Declarative • Procedural • Causal • Conditional • Relational 	<ul style="list-style-type: none"> • Disciplinary • Domain-specific • Encoded 	<ul style="list-style-type: none"> • Syntactic • Semantic • Pragmatic • Metaphorical

4.1 Design Knowledge

Lawson's (2004) seminal book titled 'Why might design knowledge be special' proposes that design knowledge can be learned by doing rather than reading a textbook and it is a predictive but uncertain process which is laden with values. Lawson (2004) argues that design knowledge can be only acquired in a special kind of way since the design is a creative process by its nature. Design knowledge can be conceptualized as as *a state of creative or imaginative consciousness*. This state does not involve a solid process. On contrary it is a fluent process and can be characterized as iterative and reflective search process.

One of the intuitively appealing approaches to study the concept of *design* in both engineering and architectural disciplines is conceptualizing it as a *creative knowledge-based activity* (Al-Sayed, Dalton, & Hölscher, 2010). In the sense of creativity, this knowledge base activity, design, relates to a delicate balance between being both 'useful'

and 'original' similar to 'form' and 'function' and also it is concerned with a cumulative search for optimal design solutions (Askland, Ostwald, & Williams, 2010). The view of the design as a solving problem process requires not only *divergent thinking* to the development of new ideas according to design's novelty but also *convergent thinking* relates to the usefulness and appropriateness of the design in which creation takes place (Lawson, 2006). Therefore, design is 'not one way of thinking' but it is a simultaneous mixture of the miscellaneous thinking way which involves primarily deduction, induction, and problem solving (Dorst, 2011), and reasoning (Uluoğlu, 2000) without a sharp distinction between each other.

In the light of contemporary literature on design, it can be argued that there is a close relationship between design and creativity (Askland et al., 2010). Yet this relationship is not solely related with the critical engagement of addressing the 'the nature of creativity', but also understanding the different aspects of creativity. The constructions of 'creativity' have been predominantly discussed under four dimensions since Rhodes' (1961) seminal article which proposes four dimension study creativity: (1) processes, (2) products, (3) person/people, and (4) environmental press. Each dimension sheds light on a different aspect of creativity. A creative *process* which refers to behavioral aspects and generally emphasizes the solution-focused nature of design thinking. It is argued to involve with the activities of exploration, idea generation, creative leap, use of technology (Askland et al., 2010). A creative *product* which refers to created new structure according to its novelty utility and value (Gero & Maher, 2013). A creative *person/people* which refers to the designers who have the ability of divergent and convergent thinking simultaneously (Lawson, 2006), also able to question prior-knowledge and knowledge structures. Finally, environmental press which refers to the relations of the designer with 'design climate' in particular with the general influences generated by environmental settings (Askland et al., 2010).

4.1.1 The epistemological dimension of design knowledge

The design studio is a critic-centered learning environment in which students engage with the construction of their own design knowledge. In this learning environment, design critiques play a paramount role in design climate. It is widely acknowledged that design knowledge has some unique characteristics such as tacitness, subjectivity, or objectivity. The 'design climate' in this learning environment is primary constructed by (1) absorbing new knowledge, (2) assimilating it with existing values and design routines and (3) finally transferring it from desk critiques to their existing knowledge structure (Goldschmidt, 2003). Design climate is a sub-process of design culture in which diffused knowledge is not always explicit but tacit and constructed by identification, synthesis and integration of any kind of knowledge into design practice. Design knowledge is more heavily dependent on experiential or episodic memory than the knowledge used in many other professions and such knowledge is often tacit which is accumulated through practice rather than through instruction (Lawson, 2004).

4.1.2 The socio-cognitive dimension of design knowledge

The design studio is learning environment which can be viewed as a reflection or image of architectural design practice (Cuff, 1992; Sachs, 1999) or a social environment in which architectural design practice is embedded (Morkel, 2011). Kahvecioglu (2007) assumes that an architectural design studio is more than an environment of knowledge acquisition and transfer for the students of design. It is a creative climate for knowledge creation and a social environment that opens up free access to any information for creating new design knowledge and ideas collectively. Architectural design studios are primarily based on collaborative stimulus and conditions that target (1) to jointly work (co-work) on the design problem together, in other words co-creative process, in a more social and flexible space, (2) to make collective decisions, and (3) to develop and construct design solutions actively as situated in real design settings. It mimics the professionalism, mutual respect, and sharing responsibilities on collective design decisions which prevail in real design practices. The design studio, also promotes social interaction, dialogue, and collaboration between individuals to develop the ability to deal with complex design problems through criticism and discussions which enables student to develop critical thinking, spatial and cognitive sensibility. The design does not solely involve knowledge transfer, "it has a new vision of knowledge, as a building process of collaborative sense-making" (Mozota, 2003, pp.160). The objective is to present opportunities to those involved not only to learn while doing (cognitive learning) but also present a context for conversations which feed dialogic relationships and the social construction of knowledge (Mozota, 2003).

4.1.3 The contextual dimension of design knowledge

Goldschmidt (2003) suggests that design climate, in other words the characteristics of design studio, can encourage participants to acquire, assimilate and transform knowledge. Yet it is quite difficult to decide whether the expertise-driven or creativity-driven tendencies are better in a design studio environment to acquire design knowledge. Therefore, designers need to know relevant contextual knowledge, whether it is in the form of *declarative* (know-what) and *procedural* (know-how) and make sure that all forms knowledge related with the current design problem

should be transmitted and diffused to the participants of design studio setting (Goldschmidt, 2003). On contrast, declarative and procedural knowledge which come with interpretive nature and structure that cannot be easily separable. Yet designers can still construct new knowledge, learn through *explicit* and *tacit* knowledge that they have encountered or exposed during desk critiques in design studios settings (Goldschmidt, 2003).

Uluoğlu (2000) argues that knowledge types in design studio can be studied from four categorical perspectives namely (1) categories, (2) structure, (3) representation, and (4) content. The proposed classification scheme aims to develop a systematical approach to explore the knowledge construction process in design settings. *Knowledge categories* refers to the presence of concepts which can be filled by knowledge content as a function of its depth and scope relationship within a frame structure. *Structuring knowledge* refers to the organization of relational bonds between and/or among interrelated concepts within frame structures which creates a network consisting of hierarchical links between and/or among units under consideration. *Knowledge representation* refers mainly to the specific knowledge flow patterns channeled by the objectives/intents of the design critiques. Finally, *knowledge content* refers to more subjective and individual-specific features in which the quality of knowledge as a function of its qualitative nature (scope) and quantitative nature (depth) which define the conceptual frame for the knowledge involved.

4.1.4 Ontological dimension of design knowledge

The design studio is a critic-centered learning environment which supports students to experiment the construction of design knowledge. Design knowledge and its creation in the studio setting commonly takes place under the guidance of design studio instructors. Design studio instructors can be considered as a source of various types of design knowledge. Design knowledge in such a learning setting is accessible through different forms of design critiques (Goldschmidt, Hochman, & Dafni, 2010).

Schön (1987) points out that searching and acquiring available and applicable knowledge are essential processes to develop and construct a structure for the design problem that is under consideration and in turn solve it. However design problem structuring and solving phases have idiosyncratic nature. Yet the demarcation between these processes is not clear cut as it may appear and also intensively influence knowledge search patterns followed by design students (Restrepo & Christiaans, 2004).

During the design problem structuring process, the creation of design knowledge for a solution depends not only on prior knowledge and experience or acquired knowledge but also interacting with design requirements from external knowledge sources and addressing information access challenges for the relevant knowledge (Restrepo & Christiaans, 2004). Information access in a design setting can be defined as an ability to structure design problems while acquiring relevant and proper information about the specific context of design problem that is under consideration (Restrepo & Christiaans, 2004).

The common search patterns used by social actors such as design students can be used classify into three knowledge types: (1) searching for raw scientific knowledge while actively interacting with scientific design knowledge - disciplinary design knowledge, (2) searching for knowledge directly related production of new design - domain-specific design knowledge and, (3) searching gathering which is already embedded knowledge in tools like CAD, process or artifacts - encoded design knowledge.

4.1.5 The linguistic dimension of design knowledge

In a design studio setting, the interaction between design students and their instructors is like a different kind of non-scripted drama (Kahvecioglu, 2007). It is not a linear form of knowledge flow that follows a sequential fixed pattern or trajectory. On the contrary, it follows multiple trajectories which include multi-dimensional structural routines which is influence from the current design environment. In this sense, the ability to construct new design knowledge that involves fundamental changes in the syntax of design to perform how to design.

The design process which performed verbally and implicitly by design students mainly involves imitating the design processes or approaches followed by their instructors (Van Aken, 2005). This imitation process is one of the key new knowledge gathering mechanisms observed in the design studio settings. Scholars have been involved to study the linguistic nature of knowledge types to gain deeper insights on subtle role of boundary objects Boundary objects refers to (1) objects that can be described as artifacts, (2) entities that can be physical or virtual concrete or abstract which carry information in the form of explicit or tacit knowledge for a specific social circle or an organization (Fong, Valerdi, & Srinivasan, 2007). Carlile's (2002) pioneering work which to lay the foundation of linguistic nature of knowledge classifies boundary objects into three groups: (1) syntactic which refers to syntax or databases measures, design principles, basic elements, (2) semantic which refers methods, definitions, codified knowledge, and the last group (3) pragmatic which is related to models, projects, sketches, and diagrams. Furthermore, Huang and Huang (2013) have proposed an additional item for that category which is a metaphoric dimension. Metaphorical knowledge refers to whether can be in tacit or explicit knowledge form that consists of analogies gestures, patterns.

These are generally tacit information that has an effective way to shape common cognition to reach a common belief that includes figurative language and genres, nonverbal expressions, visionary objects.

5. Conclusion

Design knowledge always has to continue its evolution within its categories because it reveals a previously untested reality in a setting that is structured to simulate real design practice. The main aim of the design studio is to present a so called a theatre or an artificial setting to act as a 'designer' or an 'architect' and let them to perform in the specified design practice while supporting design students to construct their own design knowledge. In this sense, design knowledge is often hidden and tacit which can be transferred by imitation and experience (Mozota, 2003). Design knowledge is more subjective and experiential since it is embedded in studio settings. In design studio, retrieved experience has recorded intellectually and saved in 'design memory' (Eilouti, 2009). Design knowledge that is gained from prior design experience is one of the basic knowledge sources. Praxis of the design studio is primarily oriented toward utilization of prior design knowledge, transforming, extending, stretching, deforming knowledge into new design problem. Cross (1982) labels this process as a 'designerly way of knowing'. Design knowledge can be defined as *a state of creative or imaginative consciousness*. This state is not a solid phase. On contrary, it is a fluent process which involves iteration and reflection. Design studio settings host a unique structured and socialized space approach to problem-based learning (Rodrigo & Nguyen, 2013). The emergence of social integration and accessibility of information in a design studio environment increases the diffusion of design knowledge and destruction of rigid boundaries which inhibits knowledge acquisition and easy exchange of knowledge. However, the structure of design studio does not allow consuming dispensed knowledge like data osmosis but it creates a network that can absorb new design knowledge through various forms of critiques and feedbacks which mainly driven by the rapid iterations of design solutions. Therefore, design knowledge is a state of creative consciousness which has to be *socially constructed*. The creation of design knowledge does not exist in isolation. Praxis of the design studio is structured on the premise of iteration – continuous social interaction between and/or among participants of the design studio such as students, design instructors and their critiques. Design studio imitates real design practice and predominantly demonstrates a social network, whereby design projects are individually designed and collaboratively executed. Investigation on knowledge types provides several indicators to reflect knowledge characteristics that influence the design process; design knowledge is always; (1) *embedded in design studio* setting and is subject to the prior assumptions; (2) *experience-oriented* hence it is more heavily dependent on experiential memory than the knowledge used in many other professions; (3) *tacit* which is accumulated through practice rather than through instruction. Furthermore, design knowledge is highly related to (4) *imagination* and (5) *iterative* process operating within social collectivity which has to be (6) *socially constructed*. The basic idea is to view design studio as a knowledge ecology composed of socially enacted knowledge process provides an objective to articulate a systematic framework for exploring and in turn uncovering the social nature of design knowledge and its taxonomy.

Acknowledgements

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interests

The authors declare no conflict of interest.

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