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A Conceptual Framework

ARUNA VENKATESH AND HENRY MA

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Tacit Knowledge Construction in Studio-based Learning: A Conceptual Framework

Aruna Venkatesh,¹ The Hong Kong Polytechnic University, Hong Kong
Henry Ma, The Hong Kong Polytechnic University, Hong Kong

Abstract: The design studio is the primary site for experimenting, exploring, and generating knowledge in design education. Much of this knowledge, like the nature of design, is tacit. The transmission of tacit knowledge has relied on the heuristics of teaching and the learning-by-doing method, which is a rather one-dimensional pedagogical approach to its complex nature and acquisition in design education. It is an internal construct as well as a social construct shaped through contexts, collaborations and interactions in the symbiotic milieu of the design studio. This article presents a holistic understanding of tacit knowledge supported by literature on constructivist theories and studio pedagogy. In doing so, it proposes a conceptual framework for the efficacy of tacit knowledge construction in the studio.

Keywords: Tacit Knowledge, Knowledge Construction, Studio Pedagogy

Introduction

As the role of design has a far-reaching impact in diverse fields, it is imperative to preserve and strengthen the unique ways in which the discipline is taught and learnt in design schools. Chief among these approaches is studio pedagogy, which continues to be a prominent area of research in design education. Justifiably so, as it is a learning environment where its layered elements of surface structures, pedagogy and epistemology interact to form a “coherent system of activities” (Shaffer 2003, 4). Instruction, critiquing, experimenting, and collaboration that are ubiquitous to its environment are all equal contributors to knowledge, where the focus of pedagogy is the design artefact and not the instructor (Shulman 2005).

Akin to the act of design is its tacit nature, which is the designer’s source of creativity and innovation (Von Krogh, Ichijō, and Nonaka 2000). Tacit knowledge is an area that falls well into the comfort zone of expert designers, but its transmission and acquisition are problematic in design education. Teachers find it difficult to articulate their expertise, or when they do, students might not be able to interpret it as intended by the teacher (Perkins 2006). Students face a predicament when entering the studio, where they have to figure out what and how they need to learn only by going through the experience of designing (Schön 1985). The problem exacerbates in professional practice, which is an interdisciplinary environment with many stakeholders and complex design problems. It places a high demand for abstract knowledge and skills from novice designers.

The acquisition of tacit knowledge is a complex process. That the studio mode in design education assumes the learning-by-doing model as an effective approach to tacit knowledge acquisition (Schön 1985) is a simplistic and one-dimensional pedagogical approach. Tacit knowledge also entails the cognitive dimension of mental models, beliefs, perspectives, perceptions, and sensory systems (Nonaka 2008; Ignatow 2007), which constantly change through socio-cultural conditions (Mareis 2012; Loenhoff 2015). The studio plays a role in facilitating a dynamic social environment where tacit knowledge is constructed and internalized

¹ Corresponding Author: Aruna Venkatesh, 11 Yuk Choi Rd, School of Design, The Hong Kong Polytechnic University, Hung Hom, Hong Kong. email: arvenruch@gmail.com

by the student. An investigation into a holistic understanding of how design students construct their tacit knowledge in studio pedagogy is currently insufficient.

The relationship between tacit knowledge and Constructivism was long established by educators such as Schön (1985) and Perkins (2006). Recently, design education seems to lean toward a more constructivist approach than the traditional master-apprentice model. However, a lack of pedagogical training for educators implies that their teaching approach is a “reflection of how and what they learned as a design student or as a design practitioner” (Oygur and Orthel 2015, 446). Coupled with a lack of consensus on what constitutes a body of knowledge in design disciplines makes it difficult for design students to acquire tacit knowledge.

In light of the above issues in tacit knowledge acquisition, this article attempts to present a conceptual framework of tacit knowledge construction in design education. It provides a multi-dimensional understanding of the transmission and acquisition of tacit knowledge facilitated by the design studio by arguing against the one-dimensional approach mentioned above. A thorough literature review of critically examined concepts and theories backs the argument to provide a theoretical foundation for the framework.

Meanings and Dimensions of Tacit Knowledge

Historically, tacit knowledge has been discussed and debated in philosophical and epistemological studies. It has been positioned against explicit, discursive or propositional forms of knowledge and challenged with rationalist questions on its validity (Adloff, Gerund, and Kaldewey 2015). However, design researchers criticized a rationalist orientation and instead sought a practice-based approach that included creative, intuitive, and tacit design aspects. The practical approaches of design and tacit knowledge share a common attribute of non-verbal activities (Mareis 2012).

A problematic term to define tacit knowledge may be summarized using the following words: implicit, non-verbal, inarticulate, uncodified, intuitive, embodied, unexplained, and knowledge that is difficult to transfer (Wong and Radcliffe 2000). Mareis (2012) adds the terms expertise, connoisseurship, and intuition. Schindler (2015) summarizes attributes of tacit knowledge such as pre-reflective, experiential, embodied, sensuous, material, and practical.

Michael Polanyi, who has been credited for the oft-cited definition of tacit knowledge as “we know more than we can tell” (Polanyi 1966, 4), suggests the difficulty in communicating certain types of knowledge that are termed as tacit. Such knowledge can be demonstrated, but it relies on the learner’s ability to catch the meaning of the demonstration (Polanyi 1966).

Cognitive and Social Dimensions

Central to the notion that tacit knowledge is individualistic and internalized is the role of the body, from which we come to experience a situation (Polanyi 1966). When a situation is experienced, the sensory systems produce mental or amodal representations (Ignatow 2007). New learning occurs when environmental effects change mental representations (Koskinen, Pihlanto, and Vanharanta 2003).

On the other hand, knowledge is not abstract but embodied (Koskinen, Pihlanto, and Vanharanta 2003; Ignatow 2007). Tacit knowledge shares an intrinsic relationship with the phenomena of presence, that is, “situations of spatial and temporal conspicuousness which are perceived non-reflexively” (Adloff, Gerund, and Kaldewey 2015, 14). The explication of tacit knowledge in situations of presence implies it is socially acquired and culturally specific. Mareis (2012) calls for paying attention to the socio-cultural dimension of tacit knowledge to avoid its positivistic reduction as a natural phenomenon. Loenhoff (2015, 24) states that “tacit knowledge is collective knowledge. It is socially shared because it is the result of agents’ successfully coordinated and co-produced action.” The body is a pre-reflexive agent of tacit

knowledge made possible through social experiences or relationships with other agents and the world (Loenhoff 2015).

The Explication of Tacit Knowledge

Explicit knowledge is regarded as the knowledge that is effable, articulable, communicable, transmittable, static, and a manifestation of tacit knowledge (Wong and Radcliffe 2000; Koskinen, Pihlanto, and Vanharanta 2003; Schindler 2015). It can be “transmitted from one person to another through informal, systematic languages or codes” (Wong and Radcliffe 2000, 495).

Design language, being predominately visual, contains codes to explicate the tacit. Drawings and models are examples of such visual representations (Ferreira 2018). From the perspective of Bofylatos and Spyrou (2017), artefacts that exhibit traces of tacit knowledge are also mediators in abductive, inductive, and deductive design processes and a transmitter of cultural values. Schindler (2015) reasons that apart from using visual examples, a certain degree of experience and expertise can explicate tacit knowledge. However, she concludes that sensuous knowledge is difficult to convey due to the subjectivity in experiences (Schindler 2015).

It is the implicit nature of design that makes its explication problematic. The learning-by-doing pedagogical system or the “designerly ways of thinking” that students are expected to learn makes it confusing for them and for teachers who need to explicate their knowledge (Van Dooren et al. 2014). Citing Schön’s concept of “knowing-in-action” and Kolb’s Experiential cycle, Van Dooren et al. (2014, 55) suggest that learning, like designing, is a “continuous process of doing and making explicit.”

Wong and Radcliffe (2000) argue that design knowledge has elements of the tacit and the explicit that are intertwined or lie in varying degrees of a spectrum. In translating the tacit into explicit, the tacit gets transformed; therefore, there is an assumption that “there cannot be any explicit knowledge without tacit knowledge” (Adloff, Gerund, and Kaldewey 2015, 13). In the opinion of Niedderer and Imani (2009), tacit and explicit knowledge co-exist, but the tacit cannot be converted into the explicit.

Tacit Teaching and Learning

“Tacit teaching refers to the many forms of informal instruction—some intentional, some unintentional, and some difficult to categorise simply as one or the other—by which skills, capacities, and dispositions are passed along within a domain of practice” (Burbules 2008, 668). Burbules (2008) challenges standardized forms of teaching intended for explicit learning outcomes. Tacit teaching may be an effective approach because it can result in significant inferences and connections, provide scaffolding, and guide the formulation of individualized understanding (Burbules 2008).

Shifting the focus from design as merely an activity taught through instruction, Andjomshoaa, Islami, and Mokhtabad-Amrei (2011) draw attention toward knowledge-based design processes taught through constructivist approaches. Since the knowing-how skills in architecture and the complexity of solving problems have their domain in tacit knowledge, they state that the “acquisition of tacit knowledge in architectural design education can be defined as pedagogical efficacy” (Andjomshoaa, Islami, and Mokhtabad-Amrei 2011, 216). They conclude that the construction of more meaningful learning and deeper understanding leads to retaining knowledge for a longer time resulting in the generation of tacit knowledge. Suwa, Gero, and Purcell (2000) add that conceptual ideas dynamically constructed through the mediation of tacit knowledge get converted into a generalization of concepts that can be applied in the future, thereby expanding the articulable knowledge (Suwa, Gero, and Purcell 2000).

Correspondingly, learning has an element of tacitness and maybe even uncertain to the learner who has internalized the teaching (Burbules 2008). Then again, this kind of approach favored in

design education leads to creating design education myths. The acquisition of expertise, for instance, is a significant pedagogical barrier for students (Smith 2013). It is a form of “threshold concept” or troublesome knowledge that is inherently tacit (Meyer and Land 2006). The use of minimal guidance, especially for novice designers, causes learning misconceptions (Van Dooren et al. 2014). Discussions in the studio tend to be focused on the design product, but to become designers, “students have to learn the process of designing” (Van Dooren et al. 2014, 69).

Knowledge Construction

Constructivism is concerned with the construction of knowledge and meanings based on prior experiences, which constantly change with new experiences, situations, and social interactions (Mertens 2010; Lincoln, Lynham, and Guba 2011). Contrary to the belief that Constructivism is solely cognitive in nature, there are, in fact, two notions of Constructivism—cognitive and socio-cultural or psychological and interactionism (Cobb 2005). In the view of cognitive theorists such as Piaget, the construction of knowledge is an internal activity in the learner’s mind. Perceptual and conceptual models are unique to an individual (Von Glaserfeld 2005). Creating meaning from experiences is an important point of departure for Constructivism from cognitivist theories (Ertmer and Newby 2013).

Constructionism, developed by Papert (1980), stresses that the contextuality and dynamics of change in knowledge construction lead to meaningful outcomes. Often used interchangeably, Crotty (1998) clarifies that Constructivism has a cognitive focus on meaning-making, whereas constructionism focuses on the “collective generation (and transmission) of knowledge” (Crotty 1998, 68–69). Psychologists such as Vygotsky and Bruner, who leaned toward social interactionism, were interested in communication or dialogue in effective learning and the joint construction of meaning between the participants (Fosnot and Perry 2005).

Constructivist Teaching and Learning

As Constructivism implies a deeper form of learning, constructivist approaches are more effective in “advanced knowledge acquisition,” where learners develop the “conceptual power needed to deal with complex and ill-structured problems” (Ertmer and Newby 2013, 57). However, Perkins (1991) argues that constructivist learning imposes a cognitive load on learners who face the daunting task of developing complex mental models independently. To overcome such pitfalls, he recommends that adequate scaffolding can help learners relate prior naïve intuitive models to newly constructed models, thereby employing a “conflict-deferred” strategy (Perkins 1991, 19).

Constructivists focus on the learner’s active involvement in the learning process. Therefore, teaching has to facilitate the effective construction of meaning by providing relevant and authentic contexts for experiences. Collaborative learning and social discussions expand and take the learning to a higher level. As students use prior knowledge to analyze and interpret new situations, the role of the teacher is to monitor and provide guidance in the construction processes. An indication of progress from a lower to higher knowledge continuum is when students think like professionals. That is, they move from a “knowing-that” to a “knowing-how” level by utilizing reflection-in-action in unfamiliar situations (Ertmer and Newby 2013, 60).

Impact of Technology and Online Platforms

Ertmer and Newby (2013) acknowledge that the explosion of the internet as an easy access tool to information has transformative implications on the learning process. It has enabled a “knowledge-building” and a “knowledge-sharing” system where knowledge no longer resides in the individual but others (Ertmer and Newby 2013, 66). Teaching methods that embrace

technology can provide multiple platforms to cater to 21st-century skills of problem-solving, critical thinking, creativity, and collaborative working. By overcoming geographical and time restrictions, technologies can broaden communities of learners to incorporate multi-disciplinary approaches to complex problem-solving. However, Constructivism remains a relevant and dominant learning theory. The use of online and software systems can empower a constructivist learning environment (Driscoll 2005).

Associated Theories

Symbolic interactionism, transformative learning, and experiential learning as associated theories share philosophical roots with Constructivism in pragmatism and have non-positivistic moorings. They are related to practical applications, subjective to experiences and meaning-making. In particular, they highlight the active engagement of the learner as crucial to knowledge construction. What also stands out from the theories is the aspect of dialogue that is essential to knowledge construction. Lastly, critical reflection appears as a vital component of the process.

Design as an activity incorporates thinking, doing and acting at various levels of interaction (individual, professional and societal), through verbal and non-verbal cognitive modes (between people and artefacts) and in different environments (physical and virtual). Thus constructivist learning is easily adapted in design education.

Conditions for Knowledge Construction

Collis and Moonen (2005, 283) define knowledge construction as a “process by which knowledge new to the individual or group is created, based on a generative process.” Drawing from the above theories, conditions for knowledge construction are as follows:

- Active engagement of learners
- Connecting to previous experiences
- Engagement in generative activities
- Going through the experiential learning cycle
- Engagement in participatory and critical discourses
- Meta reflection
- Outcomes result in the creation of new knowledge

Studio Learning through a Constructivist Approach

Aptly referred to as the “signature pedagogy” of the design profession (Shulman 2005), the design studio’s infrastructure supports a flexible learning mode that “accepts uncertainty, serendipity and happenstance as part of the nature of education, wherein the solutions are intentionally incomplete” (Crowther 2013, 19). The studio is conducive to a constructivist learning approach because it provides diversified perspectives, multi-sensory experiences, opportunities for experimentation, and active engagement in experiential learning (Kurt 2009; Ucar and Kandemir 2011). Ferreira (2018) argues that though the studio model may be constructivist in nature, it stands as a distinctive pedagogical model most appropriate to design.

As part of the experiential learning cycle, learning by doing is emphasised as a core pedagogical approach of the studio. The materiality of the designed artefact, whether physical or digital, acts as a manifestation of learning and is central to discussions (Shreeve 2015). Crowther (2013, 20) adds that “learning about design, learning to design and learning to become an architect” are the types of learning accommodated in studio education. Disciplinary representational skills are essential for studio learning, according to Goldschmidt (2019). The

acquisition of disciplinary knowledge is built on the learner's previous experience and developed through the assistance of a coach or teacher (Goldschmidt 2019).

The studio-learning model that comes with the expectation of students to be independent learners can be daunting for some students not acquainted with the complexities of learning in design subjects (Winters 2011). Schön (1985) explains that learning to design is both a paradox and a predicament for students. Students need to find out by themselves what and how they need to know, for the instructor will not be able to put it in words. As they enter the studio by abandoning previous knowledge and values and unlearning new skills, the experience may lead to anxiety and distrust (Schön 1985).

Teaching Roles and Practices in the Studio

Though conducive to a constructivist environment, hegemony and role conflicts in the studio can affect student engagement and identity transformation (Belluigi 2016; Dutton 1987). Efficacy of knowledge construction depends on studio tutors' pedagogical responsibility to take on supportive roles, adopting appropriate design models to understand the tacit design process and fostering an environment of reciprocal relationships.

The responsibility of studio education to integrate the learning of skills, language and problem-solving approaches at the same time causes problems in formulating explicit teaching objectives (Ledewitz 1985). Studio masters find it difficult to make explicit their knowledge and competencies of artistry (Schön 1985). Teaching might also become heuristic and intuitive in nature (Ferreira 2018). Dutton (1987) refers to Argyris' study on studio teaching to highlight the following: discrepancies of espoused theories and theories-in use, working in isolation and not utilising other's resources, dependency on tutors and a mystery-mastery syndrome where tacit assumptions are rarely questioned (Dutton 1987).

Social Interactions in the Studio

Interactions in the studio are centered on the tutor and student exchanges, more commonly known as design reviews or the crit. Tacit understandings of design practice such as design thinking can be made visible or audible through exchanges, dialogues or conversations in the studio (Adams 2015; Shreeve 2015). The crit is considered as a "pedagogical talk" that "can reveal nuances of teaching approaches that may not be easily accessible or shareable" (Adams 2015, 8). It is an effective communicative activity that transmits declarative and procedural aspects of design knowledge from the studio master to the student (Uluoğlu 2000).

Informal interactive settings such as peer interactions are equally crucial in tacit knowledge construction. As an implicit learning process in the studio, they provide opportunities for students to evaluate their work against others and act as skills and resource-base for the community (McClellan and Hourigan 2013). Collective knowledge built through conversations creates artefacts of understanding (Blumenfeld et al. 1996). McClellan and Hourigan regard peer dialogues as active and comparable to reflection-in-action, while tutor discussions are more passive and comparable to reflection-on-action (McClellan and Hourigan 2013).

The studio as a place for collaboration and exchange of ideas is a social construction of knowledge in itself. Dutton (1987) states that the design studio has wider connections that influence political, economic, and societal dimensions. Design activities in the studio are performed according to the unwritten and implicit rules of each discipline. Rules guide how meaning is made in learning communities in the studio (Brandt et al. 2013). Communities of practice are unique to the studio. They act as bridges between academic and professional communities (Brandt et al. 2013; Shreeve 2015).

Online and learning communities supported by multimedia broaden sharing experiences, knowledge, and values and beliefs (Oztok 2013). Conversations in virtual environments have

socio and cultural implications on design education (Salama 2015). These platforms offer opportunities to address the complexity of design problems through a multi-disciplinary approach where multiple solutions are negotiated through diversified perspectives, meanings and values (Salama 2015; Liedtka 2014).

Other Pedagogies

Project-based learning has two main features: a question or problem is to be solved, and it ends in a product or artefact. Learning and doing are inextricable in creating artefacts that are explicit representations of students' constructed knowledge in different stages of problem-solving (Blumenfeld et al. 1996). Based on constructivist principles, students actively construct their knowledge through sharing and social interactions in context-specific settings. It is student-centric learning that leads to a deeper understanding of a topic (Kokotsaki, Menzies, and Wiggins 2016; Bell 2010).

On similar notes, situated learning adopts a decentered strategy of the master-apprentice model shifting the focus to learning in a community. Situated learning accommodates the metacognitive and social aspects of learning. The learner constructs the learning through implicit teaching approaches, grounded in authentic situations and supported by the learning community (Lave and Wenger 1991; Choi and Hannafin 1995).

To conclude, several pedagogical models and theories mentioned in the literature review suggest strategies to teach for tacit knowledge acquisition. However, studies are inadequate in offering a holistic pedagogical approach for the effective teaching and learning of tacit knowledge. Traditionally, tutors have relied on its acquisition through a learning-by-doing pedagogical model, a simplistic and one-dimensional approach. This leads to a heuristic teaching approach which suggests a lack of a theoretical understanding of tacit knowledge. It can put students at a disadvantage in learning. The proposed conceptual framework intends to provide a structure for the facilitation of tacit knowledge construction, taking into account three pedagogical considerations of teaching, learning, and social interactions in the studio.

Development of the Conceptual Framework

Components of Tacit Knowledge Construction

Expanding on the definition and conditions of knowledge construction previously mentioned, a working definition of tacit knowledge construction is a generative process where an individual is actively engaged to create new and tacit outcomes.

Figure 1 diagrammatically represents the components of tacit knowledge construction through the main categories of processes and new knowledge outcomes. The generative process requires the active engagement of learners in the experiential cycle supported by the cognitive development at the individual level and shaped through the socialization process in the studio. Literature also suggests that tacit and explicit knowledge follow a cyclic conversion process. Design knowledge is explicated through the visual environment in the studio, mainly consisting of artefacts and representations specific to the discipline. At the same time, the verbal makes the critical thinking and strategies of design visible and shareable.

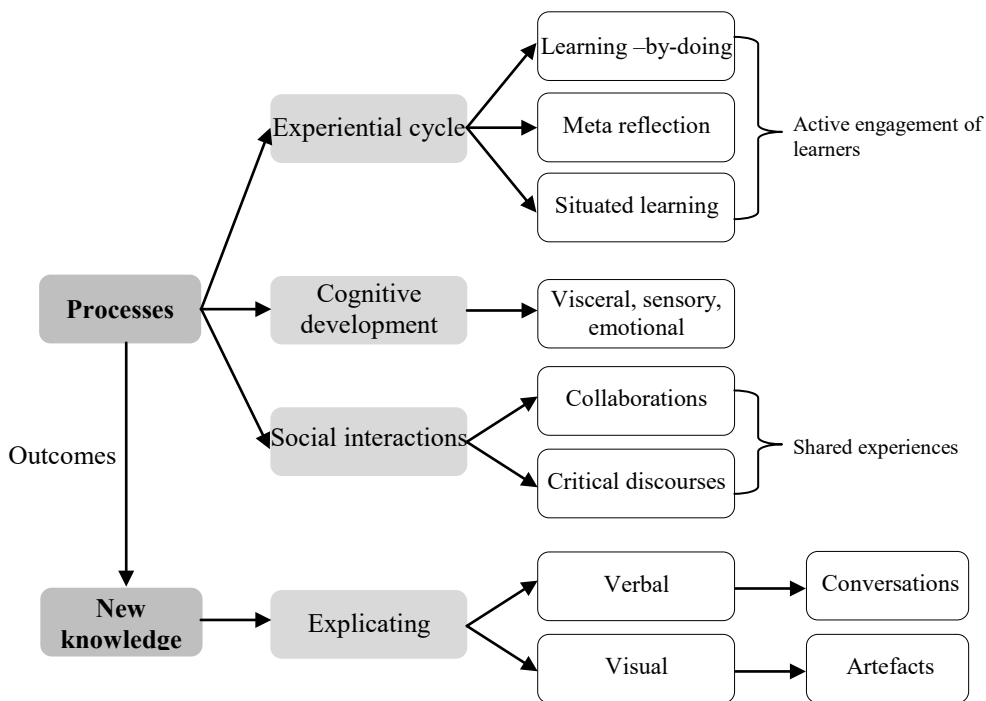


Figure 1: Components of Tacit Knowledge Construction
 Source: Venkatesh

Consolidating the Literature into a Conceptual Framework

To justify the multi-dimensional approach and address the knowledge gap, three main categories for tacit knowledge construction were abstracted and consolidated from relevant theories and models. They incorporate the components of tacit knowledge construction as mentioned above. The three categories that center on teaching, learning, and social interactions were conceptualized into three concepts. The definition of pedagogical efficacy by Andjomshoaa, Islami, and Mokhtabad-Amrei (2011) and studio pedagogy were synthesized into the concept of studio pedagogical efficacy for the teaching aspect of tacit knowledge. Active engagement in learning places the student at the center of the knowledge construction processes. The social interactive environment of the studio influences the above two concepts. Each concept was deconstructed into sub-concepts to study the defining features of the concept, which are explained below.

Studio Pedagogical Efficacy

As a distinct approach in design education, studio pedagogy provides “an interaction space, a forum, an ‘espace transitoir’, which allows the expression and development of concept knowledge” (Heylighen, Bouwen, and Neuckermans 1999, 234). Its efficacy in tacit knowledge construction depends on teaching methodologies that encourage independent learning, expand cognitive capabilities in design thinking, provide authentic contexts, and facilitate participatory learning environments.

In line with the constructivist theories, teaching efficacy depends on the kind of roles, methodology, strategies, and methods that tutors employ to facilitate tacit knowledge construction in the studio. Depending upon the manner of knowledge transmission in the studio, Uluoğlu (2000) categorizes the roles as fourteen molds. Additionally, tutors might aid students in their role

constructions through critical reflection of their pedagogical practices (Belluigi 2016) and deconstruct their tacit knowledge through analysis and self-awareness (Ferreira 2018).

Methodological examples include Schön's Reflective Practice and Dorst's dual-mode model, which refer to the approach or models tutors use to facilitate problem-solving processes. Ledewitz (1985) is in favor of a concept-test design model as a means for students to understand the design process cyclically and holistically. Salama (2015) proposes a process-based model for studio teaching, where students control design actions and decisions. Goldschmidt (2019) suggests that the teacher should scaffold the learner in the design progress through a double-loop learning process where assumptions, decisions, and mental models are re-examined in the design problem-solution space. Authentic contexts and a collaborative learning environment afforded by teaching strategies such as situated learning stimulate the metacognitive and social aspects of learning. Providing for such learning experiences are examples of pedagogical requirements for tacit knowledge construction.

In the view of Suwa, Gero, and Purcell (2000), sharing of knowledge through crit sessions leads to unexpected discoveries and shared mental constructs. Models and theories such as Ferreira's Design Studio Model (2018), the Design Grammar Model developed by Ferreira, Christiaans, and Almendra (2015) and the Pedagogical Content Knowledge (Adams et al. 2015) make tutors' tacit knowledge visible to students, using strategies such as cognitive apprenticeship and meta-language during the crit. Similarly, Van Dooren et al. (2014) propose a framework to make the design process explicit and develop a vocabulary for design discussions.

Active Engagement in Learning

Project-based learning and experiential learning are theories that subscribe to learning-by-doing design, wherein students acquire tacit knowledge through a hands-on learning experience. Active engagement in the experiential learning cycle is a process of exploration, experimenting and making connections to previous experiences. By exploring real-world problems, students identify and understand disciplinary principles and tacit concepts of the profession.

Correspondingly, knowledge is constructed when learners connect learning to previous experiences. The cognitive notion of Constructivism assumes that the interpretation of new experiences either fit prior experiences or create a new schema (Fosnot 2005). New meanings are created when students confront threshold experiences (Meyer and Land 2006) that have transformative effects on their learning and self-identity. An awareness of self-change is possible through meta-cognition (Flavell 1979).

Meanings and identities are shaped through the participatory learning environment of the studio made possible through peer learning and critical discourses that results in new frames of reference supported by Constructivism and transformative learning theories. Peer learning gains importance over the years of education, where the intervention of tutors decreases (Uluoğlu 2000), making students accountable for their own learning. In doing so, students construct knowledge that is meaningful to them.

Social Interactive Environment

Shared experiences and conversational exchanges range through different levels of interactions and take place in multiple spaces in the studio. Social learning environments form the backdrop of critical discourses in the studio. When creative acts are critically analyzed and evaluated through multiple perspectives, they generate new propositions and expand the boundaries of the design problem, and, in turn, expand the cognitive dimensions of tacit knowledge construction. Sharing experiences, probing, debating, and evaluating multiple interpretations and perceptions can lead to new approaches to framing design problems, nurturing design reasoning abilities in design education (McDonnell 2015; Dorst 2015).

Critical discussions in the studio are agents of meaning-making and adjusting of value frames. Meaning is shaped through social interactions as much as it is an internal construct. Likewise, value frameworks and value judgments are tacit outcomes co-constructed through conversational exchanges in the studio. Ferreira (2018) defines design conversations as a dynamic interaction between various elements that influence each other. Knowledge in these discussions is communicated through verbal and visual design languages where reflective conversations with the situations get explicated and converted to tacit-knowing-in-action (Schön 1984).

The conversation is centered on the design project, having “explicit and implicit levels of language” (Ferreira 2018, 87). Mediated through design artefacts, the conversations may result in new insights, new understandings of the design situation and redesigning the project. Thus the “explorative conversation” (Ferreira 2018, 88) leads to knowledge construction. The designed artefact is a tool to communicate or externalize the designer’s ideas as well as a cognitive tool to think. It is a means to share coded knowledge that translates a designer’s cognitive activity (Cross 2006).

Georgiev and Taura (2014) investigate the notion of polysemy in design review conversations. Polysemy, defined as the quality of having multiple meanings and the ability to think flexibly, is related to design thinking and contributes to the successful generation of design ideas and concepts (Georgiev and Taura 2014).

Fleming (1998) represents the design talk in a crit on a continuum of object-laden to language-laden talk. Conversations between the student and teacher not only oscillate between different languages; they are also multi-layered and multi-levelled. Heylighen, Bouwen, and Neuckermans (1999) describe these levels as reciprocal reflective conversations, the language of doing or demonstrating, language about designing or meta-language, use of precedents and the act of sketching. More experienced tutors use meta-language to make explicit strategies and insights (Heylighen, Bouwen, and Neuckermans 1999).

Several studies have been conducted, and models developed on studio conversations in design education. Ferreira’s Design Studio Model (Ferreira 2018), which solely focuses on teacher-student interactions, is divided into levels of the design studio, design conversations and design language. Ferreira, Christiaans, and Almendra (2015) attempt to make the content of design reviews visible through a Design Grammar Model, focusing on the artefact’s attributes. Kehoe (2001) uses the pedagogical technique of critical design dialogue to study different learning environments in design studios. Goldschmidt, Hochman, and Dafni (2010) use linkography to study teachers’ performance in a crit. By analyzing teachers’ roles and profiles, they conclude that the teacher must match students’ needs and tendencies more than share knowledge. They must allow students to participate in dialogues, share ownership in raising issues, and put forth ideas (Goldschmidt, Hochman, and Dafni 2010). Sonalkar, Mabogunje, and Leifer (2015) utilized the concept of professional vision to study interpersonal interactions of design reviews. Their investigations revealed that students and reviewers participate in articulating professional vision expressions and co-create the conversational content.

Starting from Schön’s contention that the “studio master and student construct a dialogue in the media of words and performance” (Schön 1984, 6), all of the above studies were conducted in design reviews facilitated by tutors. However, design practice is the interplay of verbal, material and social phenomena (Fleming 1998). If design practices are recognised as “conversational processes of making sense together” (Fleming 1998, 43), it is also an interplay of formal and informal conversations. Uluoğlu (2000) observes that discussions in the earlier years are more in the form of structured knowledge discourses that moves to supportive knowledge discourses in the later years to make the student more independent.

Technologies such as online platforms and social media broaden, empower, and extend learning beyond physical space and time boundaries. Tacit knowledge is thus constructed in the intersections of interactive spaces inside and outside the studio. Table 1 is a summary and representation of the conceptual framework.

Table 1: Conceptual Framework for Tacit Knowledge Construction

<i>Concepts</i>	<i>Sub-concepts</i>	<i>Theories/Models/Frameworks</i>	<i>Purpose</i>
<i>Studio pedagogical efficacy</i>	Teaching methodology	Experiential learning Transformative theory Schön’s Reflective Practice Dorst’s dual-mode model Concept-test model Process-based model Moulds & knowledge types Double-loop learning	Use teaching methods and strategies for students to scaffold the design process, guidance in problem-framing and shift between design thinking modes, nurture critical thinking and reflection, examine teaching roles and behaviour that facilitate autonomous learning and provide motivation for learning
	Pedagogical requirements	Project-based learning Situated learning Experiential learning	Exposing students to various situations of varying content and context. Providing authentic and tasks, embodied experiences, promoting reflection
	Sharing of tacit knowledge	Schön’s Reflective Practice Design Grammar model Design studio model Dooren’s five elements Pedagogical content knowledge Unexpected discoveries (Suwa)	Constructing shared mental models through critical and reflective conversations mediated through artefacts, explication of expertise through cognitive apprenticeship and discussion, encourage cognitive development by identifying unintended design features
<i>Active engagement in learning</i>	Learning-by-doing	Project-based learning Experiential learning	Engagement in meaningful projects, experimenting and exploring the problem, reflecting
	Connecting learning	Experiential learning	Making connections to previous learning experiences
	Interpretation of teaching	Symbolic Interactionism Threshold Concepts	Co-constructing meaning with peers, educators and artefacts. Understanding disciplinary concepts in design praxis and practice
	Learning awareness	Meta-cognition	Self-reflection, awareness of thinking and learning processes
	Developing self-identity	Transformative theory	Shaping of value frames through critical assessment
	Participatory learning	Peer learning Transformative theory	Initiating informal & democratic settings for reflective discourses, collaborations and generating collective knowledge resources
<i>Social/interactive environment</i>	Shared experiences	Transformative learning Symbolic Interactionism	Interactive relationships with self and social environment mediated through artefacts. Co-constructing meaning and values
	Conversational exchanges	Schön’s Reflective Practice Project-based learning Design Studio Model Critical Design Dialogue Professional Vision	Critical analysis through multiple perspectives for problem reframing and generating new propositions. Visual and verbal articulations through coded language and meta language. Formal and informal discussions. Use of online platforms to expand interactive spaces

Source: Venkatesh

Significance of the Framework

The three concepts and sub-concepts of the framework consider epistemological positions and integrate existing learning theories, perspectives, and concepts to understand tacit knowledge construction in the studio comprehensively. Constructivism is the driving epistemology of knowledge construction that grounds all the concepts. The concepts incorporate the cognitive and social dimensions and cohere to form a holistic tool. The sub-concepts deconstruct the concepts into criteria for tacit knowledge construction.

Each concept considers two opposite yet complementary aspects of the transmission and acquisition of tacit knowledge from educators' and learners' perspectives. The relationship is affected by the visual and social environment of the studio. Therefore, both tutors and students stand to gain from the conceptual framework by using it as a structured reference for developing effective teaching and learning strategies for tacit knowledge construction. Though tutors might already incorporate constructivist teaching methods, they may not be applying for the purposeful facilitation of tacit knowledge construction.

Along with the extensive literature review covered in this article, the conceptual framework can be directly utilized to collect and analyze data for empirical research. A specific area where researchers can apply the framework is in studio pedagogy. The role of the studio is to provide a multi-layered space as a testing lab to deal with uncertainties and a transition space to acquire the required tacit knowledge in academia and practice. It is also a performance space for explicating tacit knowledge, a space for critical engagement and collective knowledge. The framework tests the efficacy of the studio in facilitating tacit knowledge in the above areas.

The framework is generic and applies to all design disciplines as it focuses on the knowing-how rather than the knowing-what of tacit knowledge. All the same, the framework can be expanded to include tacit aspects that are specific to a discipline. It can serve as a guide to formulate transferable and non-transferable skills for intended learning outcomes at the curriculum level of design programs.

However, the framework is not a prescriptive model for tacit knowledge construction. Complexities of tacit knowledge and other dimensions of its construction necessitate further research in areas of studio pedagogy. Teaching and learning styles differ, and knowledge construction is unique to each individual. Tutors may or may not subscribe to a constructivist way of teaching. Tacit learning is affected by several factors, such as cultural influences, behavior, or student typology.

In that regard, this article can provide pointers for researchers to seek newer research directions to accommodate the impact of the above factors and re-conceptualize the framework. Moreover, the shift to online platforms expedited by the global pandemic suggests new pedagogical practices in studio learning. The application of the framework or its adapted version in the above-mentioned areas of future research can develop new propositions or theories in tacit knowledge construction.

Concluding Thoughts

Tacit knowledge holds the key to understanding the artistry of designers. It has the potential to tap and nurture creativity in design students. Rather than a mysterious skill as often considered, it needs to be featured prominently in discussions about design education. Though it is a well-researched area, more often than not, its association with hands-on learning in design overlooks its other aspects that have scope for further research. The aim of developing the conceptual framework is to set a springboard for discussions about its facilitation in design education through the distinct approach of studio learning. It is a further intention to substantiate the arguments made in the article through empirical research.

Newer horizons in studio pedagogy such as online studios and technologies in digital interfaces, 3D modelling, virtual and augmented realities can advance the understanding of tacit knowledge. However, the construction of tacit knowledge is incubated at the fundamental level of the studio, whose inhabitants and their interactions determine its efficacy.

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ABOUT THE AUTHORS

Dr. Aruna Venkatesh: Visiting Lecturer (part-time), School of Design, The Hong Kong Polytechnic University, Hong Kong

Dr. Henry Ma: Associate Dean, School of Design, and Leader of the Creativity and Design Education Lab, The Hong Kong Polytechnic University, Hong Kong; Visiting Professor, College of Art and Design, Zhejiang University of Technology, Zhejiang, China

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