The Development of Design Thinking: The Role of Personal and Pedagogical Factors

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Abstract

A wide range of design literature discusses the role of the studio and its related pedagogy in the development of designerly thinking. A number of potential factors that affect this development process are posed by scholars in a variety of design disciplines, but a full understanding of these factors as experienced from the student perspective is lacking. In addition, there are commonalities between design disciplines, but an understanding of pedagogical or studio features or issues relating to specific design disciplines is limited. I will examine the experience of first-year design students as they develop designerly thinking, including a discussion of factors internal and external to the student. Pedagogical factors relating to specific design disciplines will be considered.

Design as a recognized discipline and method of inquiry has increased in scope and breadth, and the focus of design pedagogy has shifted to recognize and adapt to digital methodologies and react to factors encountered in traditional design learning. Design pedagogy—and by indirect extension, the studio design approach—has a long history, spanning from the early methods utilized at the École des Beaux-Arts in the late 19th century (Kuhn, 2001) to the present day. While these traditional studio methods have adapted over time through the differentiation of design disciplines and pragmatic applications of technology (Findeli, 1990), the core blending of functional and structural elements in a problem solving orientation have been consistent across a wide variety of design disciplines (Kuhn, 2001; Brandt, et al., 2008). While a core design pedagogy has been widely implemented, the role of the pedagogy in moving a student toward mastery, linked to a change in the way they think about design (Siegel & Stolterman, 2008; Cross, 2011), is not well understood. In this study, I will evaluate the experiences of first-year design students, in conjunction with the role of faculty in creating a discipline-specific design pedagogy, to understand factors that affect their development of designerly thinking.

Definitions

Design is a notoriously difficult concept or practice to define. Stolterman (2011) defines design as "the activity we humans engage in when we are not satisfied with our reality and we decide to intentionally change it" (para. 6), and this definition will be used to ground this review in the most general conception of design as an activity and discipline. Design disciplines in their normative pedagogical forms are generally seen as bound by the methodology and praxis of the design studio (Cross, 2007; Schön, 1983), which is comprised of an informal learning environment shaped by exploration and peer and instructor critique with little direct instruction. The design studio is also typically structured on the premise of design thinking, whereby individuals—all of whom have the innate potential for design ability (Cross, 2007) —learn to think and act in a context of design judgment and situational appropriateness to develop and defend solutions rather than using a

predefined structure or linear process (Boling & Smith, 2010; Brandt, et al., 2008; Breslin & Buchanan, 2008; Teal, 2010; Shaffer, 2003). Schön (1987) presents this design studio as a location where projects are individually or collaboratively executed, where projects are normally selected based on their applicability and conformance to the actual practice of that design discipline. The design studio and its intrinsically related design pedagogy are treated together in this review, with the design studio acting as the primary outlet of the generally accepted norms of an overarching design pedagogy, a feature that Shulman (2005) terms a "signature pedagogy." Although design pedagogies exist that do not rely on the studio model as a primary driver, these approaches are not seen as normative within design education as a whole (Brandt, et al., 2008).

Review of Literature

A literature review was conducted to establish a baseline of design pedagogy and potential factors that affect the designerly thinking of the design student as they transition from novice to expert designer. The identified literature includes the application of this signature pedagogy in a variety of design disciplines, including: computer science, graphic design, instructional design, architecture, and human-computer interaction. From the resulting identified literature, emergent candidate themes of factors that are informed by design pedagogy were identified. These emergent themes, developed and supported by related literature, form the tentative outline of potential factors that follows.

Environmental Factors

Private and public space. For many new studio programs, the lack of defined studio space is problematic, resulting in the lack of the desired studio culture, which this shared, persistent space denotes (Blevis, Rogers, Siegel, Hazlewood, & Stephano, 2004; Reimer & Douglas, 2003). In particular, the lack of private space results in limited opportunities for students to remake a space as their own, which may translate to a lack of comfort working in that space (Lester, FitzGerald, & Stone, 1997). It is suggested that a mix of public spaces and defined private work areas meets the needs of the design studio most succinctly, providing common areas for critique and peer interaction, while also allowing students to work in a consistent, self-defined space (Wang, 2010; Reimer & Douglas, 2003).

Contrast to traditional classroom space. Introductory design students on the graduate and undergraduate levels unfamiliar with the environment that the design studio denotes may be uncomfortable due to the lack of apparent structure or adherence to traditional classroom norms (Burdhardt & Hacker, 2004; Demirba & Demirkan, 2003; Ochsner, 2000). This contrast is especially problematic for graduate students entering a design discipline from a field outside the traditional design experience, for instance, students entering a graduate program in Human- Computer Interaction from an undergraduate background in Computer Science (Boling & Smith, 2010; Siegel & Stolterman, 2008). The positioning of the professor in this classroom space may also be unfamiliar, as the design professor is primarily concerned with indirect instruction (Reimer and Douglas, 2003), accomplished through informal desk crits rather than a traditional lecture stance.

Unfamiliar tools and norms. A design student uninitiated to the design studio is frustrated by the difference in tools with which to express themselves (Mawson, 2003; Ochsner, 2000). In place of notes and textbooks, a design studio is most frequently oriented towards sketching (Buxton, 2007; Do & Gross, 1996; Lee & Breitenberg, 2010) and rapid prototyping (Akalin & Sezal, 2009; Dutton, 1987), which may require a wide range of tools and media depending on the target environment or specific design profession. Any combination of these tools, which eventually allow for thoughts to be quickly captured for quick iteration (Lee & Breitenberg, 2010; Mawson, 2003), require mastery in isolation prior to being useful in the ideation process (Norman, 1998). The norms of working with

tools in isolation or in a collaborative context may also be unfamiliar to the introductory design student: collaborative work may be difficult for a student that has previously completed work on a largely directed basis (Cross, 2007; Ledewitz, 1985; Schön, 1987). Schön (1988) also notes that students may discard or ignore material that is not seen to be immediately relevant or helpful. In many design fields, a tension between the ways of knowing and executing critical research also colors the role of design within the larger academic context (Boling & Smith, 2012; Schön, 1988).

Complexity of technological tools. While the physical design studio introduces a large number of physical tools that may create feelings of unfamiliarity or lack of immediate comfort, the online or digital studio experience creates additional layers of required technological competence (Marx, 2000; Oxman, 2008; Gross & Do, 1999). Kvan (2001) and Oxman (2008) relate the coming technological divide due to the rapidly increasing level of baseline technological competence to perform basic design tasks in the digital architecture studio, with Marx (2000) concluding that the technological competencies must be separated from the design- specific competencies to maximize the effectiveness of the studio experience, regarding tool- level competency as secondary. Won (2001) also describes the bias that technology-based tools can exert on the design process, resulting in greater visual fidelity, but self-limiting expression due to the relative strengths and weaknesses of these tools. Oxman (2008) also notes the digital divide that is created by the use of digital tools for visual discovery as compared to sketching as a method of design thinking.

Social Factors

Social issues within the design studio may appear at the introductory level, as a function of discomfort when working with peers or openly receiving feedback, or social issues might reactivate in developing or intermediate design students who have created mental structures or design processes—some of which may be protective in nature (Ochsner, 2000) —that are self- limiting the designerly progression of that student. The core social activity of the studio, however, is the critique process—both in the giving and receiving of critique—which generally takes place in the context of design production (Blevis, 2010). Within the general work processes of the studio, the introduction of the group dynamic also often requires collaborative group work and a willingness to break rules in an organized sense to encourage innovation (Gregory, 2003; Wylant, 2008), which requires additional social interaction in an organized, consensus-oriented way. Also critical in the development of social skills in orientation to the design space is the development and sustainment of a design culture, which reflects the goals and structures of the design process itself (Nelson & Stolterman, 2000; Blevis, Rogers, Siegel, Hazlewood, & Stephano, 2004)

Willingness to give critique. The design studio is founded upon a culture of open critique (Wang, 2010), both between peers and professors, encouraging reflection and learning (Pringle, 2009). Designers can construct their own design knowledge through the act of critique and self-reflection about the design processes of their colleagues (Lewis, 2005; Soufi & Edmonds, 1996). As a corollary to the process of accepting critique, questions asked during a formal or informal critique may add dimension to the creative process, spurring innovative thinking in all studio participants (Logan, 2008).

Willingness to receive critique. Designers must be willing to accept regular critique in the design studio environment, as an outgrowth of the experiential journey to becoming a practitioner (Pringle, 2009; Danvers, 2003). The designer can interact with the instructor to justify their actions—through a synthesis of verbal and visual components—of telling and showing (Demirba & Demirkan, 2003; Schön, 1983), or the critical process of evaluation can result in misconceptions about design principles (Oxman, 1999). In particular, Siegel and Stolterman (2008) note that an unwillingness to accept critique in a constructive way can result in a difficult transition between their stages of pre-

emergent thinking and designerly thinking. The process that exists between these two states is by nature indeterminate, but the designer can be seen as creating patterns of thinking as they relate to specific design concepts (Danvers, 2003; Oxman, 1999). Expanding or breaking down these patterns through the process of critique is important to creating validated, flexible patterns that can be applied to new problems in the future (Danvers, 2003).

Formative Factors

Formative factors are, perhaps, the most elusive, as much debate still exists on how designerly thinking is measured and what stages exist between entry-level and practitioner-level design competencies. A large body of literature exists on the definition and formation of creativity, often within the design process (Crilly, 2010; Lewis, 2005), but this thread of analysis is outside the scope of this literature review. More generically, however, factors are seen by many to exist in how an entry-level designer tends to think about the design discipline, or, in a meta- cognitive sense, how the student would describe or explain their relationship to or knowledge of design.

Personal design knowledge. The goal of the design studio is to produce students who "think" like someone in that design field (Cross, 2011). In the architectural studio, the goal is to produce a student that thinks like a practitioner in the specified design discipline (Ledewitz, 1985; Oxman, 1999). Mapping the progress of an individual student to this general norm, however, is less clearly defined, even to a successful design student or practitioner (Yilmaz, Seifert, & Gozalez, 2010). Ledewitz (1985) notes that, "despite the fact we do not define [design] precisely, we can easily distinguish those students who have learned to 'think architecturally' from those who have not" (p. 3). Siegel (2008) defines this transformation as a "metamorphosis" whereby students pass through a number of factors in terms of how they think about and practice design. Overcoming or penetrating these factors indicates the general transformation of a designer from a pre-emergent state to that of a designerly thinker and practitioner. Sachs (1999) also identifies the importance of recognizing "stuckness" in the studio, encouraging students to identify the source of their design factors in a causative sense, discovering potential factors in design practice, thinking, or interpersonal conflicts; upon overcoming or recognizing these incidents, design knowledge can be strengthened or created (Ledewitz, 1985). Meanwhile, Heylighen, Cavallin, and Bianchin (2009) reiterate the value of recognizing on a personal level the fundamental aspect of change related to the design education process, noting that "designers are concerned not only with what is, but with what should be" (p. 98). Change also represents openness to new ideas and flexibility within existing design knowledge to incorporate new experiences and information (Danvers, 2003).

Personal process. While design is difficult to define in isolation, it may be due to the multiplicity of mental processes and frameworks that designers use to structure their personal design process (Notess & Blevis, 2004; Boling & Smith, 2010). In particular, the studio process can be seen as reinforcing the development of personal design knowledge (Yilmaz, Seifert, & Gonzalez, 2010), which ultimately forms a personal problem solving strategy, or design process (Akalin & Sezal, 2009; Fincher, 1999) that they internalize and adjust over time (Pringle, 2009). Devoid of this process, the design student is left to externalized representations of design process (Blevis & Siegel, 2005), many of which overly linearize or simplify the design process (Lewis, 2005; Mawson, 2003; Smith and Boling, 2009; Teal, 2010). The role of experience, both external and internal, is also important in developing a personal process; Strickfaden and Heylighen (2010) note the role of the professor and student in discussing experience to build design knowledge, both through precedent and theory.

Problem solving behaviors. Traditional problem solving strategies are targeted at well-defined problems, which are generally acknowledged to not exist in real world design problems (Breslin & Buchanan, 2008; Cross, 2007). Moving beyond the structure and strategies appropriate for

a well-defined problem, a "wicked" problem has no direct solutions or standard methodologies that can be applied in a formulaic sense (Cross, 2001, 2007), although strategies can be used to push the designer in new, previously unconsidered directions (Lewis, 2005; Ludden, Schifferstein, & Hekkert, 2008). The willingness to accept the constraints indicated by these wicked problems (Dutton, 2006), along with the removal of the idea of a best solution or "right" solution as a possible outcome is key in the development of designerly thinking as it relates to problem solving (Siegel & Stolterman, 2008). Exploration is seen as a natural way of reconciling these difficult problems, utilizing design heuristics to guide the exploration of the problem space (Yilmaz, Seifert, & Gozalez, 2010) and emergent characteristics of design artifacts to guide problem solving behaviors (Soufi & Edmonds, 1996). Since problems are discussed in relation to other experiences or design issues through practice, some learnings regarding the problem solving process may not transfer directly to problems in the future, resulting in a slower, inductive approach to the understanding of theory (Breslin & Buchanan, 2008).

Evaluative Factors

Evaluation can be seen as a confluence of the previous three categories, as environmental factors, social factors, and formative cognitive functions mesh together in the basic evaluation activities of the design studio (Schön, 1988).

Public critique and feedback. Public feedback is the core of the design studio experience, creating opportunities to present design concepts, respond to peer and professor critique, and iterate the design appropriately to meet defined constraints and desired outcomes (Dutton, 1987; Schön, 1988). The public critique process is crucial to the development of design thinking (Blevis, 2010), and Walliss and Greig (2009) along with Danvers (2003) conclude that the indeterminacy and the lack of clear, unbiased feedback that often results from this approach encourages designers to think introspectively and further their intellectual development by questioning and being questioned. Additionally, the metaphor of the design may be ambiguous or not communicated equally among all members of the studio, resulting in additional feedback with which to continue the design process (Coyne, Snodgrass, & Martin, 1994; Logan, 2008).

Self-reflection. Wang and Ilhan (2009) note the importance of understanding how creative processes and their outputs relate to one another, even though each of these elements— whether it be design artifact, concept, or feedback—in isolation is not predictive of the next step in the creative process. This interaction between elements generates what Cross (2007) terms "the creative leap," forming the next iteration in the design process, often without a clear link from previous design iterations (p. 65). While innovation is one of the defined causes of this "creative leap," it is also a natural outcome of the self-reflection process and the linking of feedback, experience, and design knowledge (Crilly, 2010; Dorst, 2006; Wylant, 2008). Meta- cognition is also an important feature of the self reflection process, as it serves to synthesize existing knowledge and patterns gathered through internal and external experience (Dorst, 2006; Ledewitz, 1985; Strickfaden & Heylighen, 2010) formed in the design studio, consolidating these themes in a way that furthers the design process and encourages future exploration of the problem space (Spanbroek, 2010).

Peer and mentor support. In addition to the roles of self-reflection and public critique, peer feedback and mentoring also facilitate the overall goals of evaluation in the design studio (Schön, 1988; Oxman, 1999). Wang (2010) underscores the importance of peers and mentors being able to enter the design conversation and understand the design process and knowledge behind physical design prototypes, understanding and guiding each other through the iterative design process. This externalized communication about design process and outcomes also reinforces the goals of Schön's (1987) "reflection-in-action," propagating an active and ongoing reflection among all participants of the design studio (Wang, 2010; Schön, 1988). However, too much structure or support at varying

levels of design education may result in delayed development of design thinking or the use of varying supports to supplement or replace true design thinking (Ochsner, 2000).

Synthesis of Factors

While each of these emergent categories of factors and associated elements are helpful in establishing an effective design studio, the core of the design studio is the evolving design student. As Siegel and Stolterman (2008) note, this transformational process to designer from non-designer is characterized by the penetration through a variety of barriers. It is through the overcoming of these barriers that individual design knowledge and process is developed, thereby giving the individual student the intellectual tools and practical experience to think in a designerly way. Shaffer (2007) describes an effective design learning environment as a "coherent system of activity," (p. 100) not a collection of strategies or procedures that are only tangentially related. It is through this systems-view of design pedagogy that the importance of common elements such as social interaction, evaluation, and the creation of individual design knowledge becomes evident.

Purpose of Study

Graduate students with little or no design background who matriculate into programs of study within a traditional design discipline offer a unique viewpoint into the development of design thinking. These students often bring additional lived or educational experience from outside of traditional design education, which has the potential to add an additional dimension as compared to undergraduate students enrolled in design education. The development process, tracking the evolution from beginning design student to mature design professional, is affected by a number of factors, including those imposed by the design curriculum and faculty, as well as surface features of the design studio in which most design education is situated. The literature suggests a wide range of factors that may influence this development process from both of these sources, but is inconclusive as to how internal and external factors shape the individual designer as they complete the transition from novice to expert designer embodying designerly thinking. The role of the discipline-specific design pedagogy is also of undetermined importance in this development process, due to the broad application of much of the literature across all fields of design, with significant pedagogical differences generally centered on the construction of discipline-appropriate problems in which to ground student work.

Research Questions

1. What factors appear to restrict the ability of first year design students in their development of designerly thinking?
2. What factors do students report having a positive influence on the positive development of designerly thinking?
3. Are surface features or epistemological factors present in the application of design pedagogy to a specific design discipline?

Method

The methodology for this study follows the structure of post-positivist critical theory. The experiences of individual participants as reported from their vantage point is necessary to elicit responses for which the participants have tacit awareness (Carspecken, 1996). The longitudinally constructed interview format allows the participants to share and reflect on their experiences over a semester of coursework, creating a sufficient source of data to triangulate their experiences, changes in design thinking, and to establish factors that are not addressed by the current literature.

Setting

The study will be conducted at a large midwestern university, focusing on students and faculty in a graduate design programs in the School of Informatics. The human-computer interaction design (HCI-d) master's program trains future practitioners for careers in interaction design and user experience design. The program is generally completed within two years and is only available to residential students, who matriculate in a cohort of approximately 35 students. A majority of students come from a non-design educational background, including baccalaureate degrees in computer science and the liberal arts. HCI-d students take a variety of coursework, including intensive design projects, methods, and theory, concluding with a design capstone project at the end of the second year. A shared studio space is available to all master's students, but the space is not currently used for explicit studio-based instruction and lacks dedicated individual space for each student.

The Researcher

The researcher conducting this study is familiar with a variety of norms and behaviors in design education, having completed undergraduate and graduate coursework in graphic design, HCI-d, and instructional design in four distinct college environments. The researcher is familiar with the faculty and educational setting of the HCI-d department referenced in this study proposal, and has previously taken graduate coursework in this department. In addition to past experience in the HCI-d department, the researcher is engaged as a student mentor for first-year students in a foundational design course during the period of data collection. This mentoring includes regular contact with students and student work as well as access to collaborative design meetings in which the students complete required projects.

Participants

Student interviewees. The participants in this study will include up to eight students from the HCI-d program. Potential participants will be solicited through email, using a departmental list-serv. The protocol for inclusion in the study includes accepting every other participant, judged by the order of their email response to the study solicitation. Additionally, the final participants will be adjusted, if necessary, to assure a minimum of 20% international students.

Faculty interviewees. The faculty interviewees in this study will include up to three faculty members from the HCI-d department. Potential participants will be selected based on access to first-year masters students, knowledge of the pedagogical goals of the curriculum, and previous publishing history on issues of design pedagogy or the design studio.

Data Collection

Student interviews. A series of four interviews will be requested from student participants. These interviews will be scheduled to allow for longitudinal data collection over the course of their first semester, placed at the beginning, midpoints, and end of the semester. Each interview will follow a semi-structured format (see Appendix A), with a duration of approximately one hour, and will be recorded to allow for transcription and further analysis. Each student will participate in at least three interviews, with a maximum of four. Stimulated recall from previous interviews will be used to allow for member checking of interview data and provide additional opportunities for reflection on past experiences by the participant.

Faculty interviews. Individual semi-structured interviews will be requested from faculty participants in the master's program department in the last month of the first semester. The interviews will follow a semi-structured format (see Appendix B), with a duration of approximately one hour. Each interview will be recorded, and upon completion, will be transcribed for further analysis. The resulting transcription will be provided to the faculty member for member checking.

Analysis

Data collected from student and faculty interviews will be analyzed using the constant comparative method. A first round of analysis will be conducted on the student interview data in isolation, dividing each set of interview transcripts from a specific interview in the longitudinal sequence into utterances representing a complete thought or idea. The utterances will then be assigned to one or more categories that emerge from the data (Glaser & Strauss, 1999). A second round of analysis will be conducted on the faculty interview data in conjunction with the established categories obtained in the first round of student interview analysis. I anticipate that my themes will be informed by but not limited to the emergent themes addressed in the literature review.

Results

Discussion

Limitations of Study

Conclusion

References

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Appendix A

Student Semi-Structured Interview - First Interview

1. What previous experiences have you had as a designer (either professionally or personally)? What is your academic background? Work history?
2. How would you define the term "design" in a general sense? In your specific discipline?
3. What external or internal factors affect the design process for you?
4. Tell me about a design project you have worked on in the past. What frustrations and/or successes can you recall? [Why do you think the project/class/program was designed that way?]
5. If you have worked on a design project as a team in the past, how did you interact with other people? What role did they play in the design process?
6. Up to this point, what factors (personal, professional, educational, etc.) have shaped you the most as a designer?

Interviewer will ask probing questions to follow up on participant responses.

Student Semi-Structured Interview - Second, Third, and Fourth Interviews

1. How would you define the term "design"? How has your perception of design changed since our last interview?
2. What external or internal factors affect the design process for you?
3. Tell me about a design project you have worked on so far this semester. What frustrations and/or successes can you recall?
4. What role has teamwork played in your design education this semester, if any? How did the team affect the design process?
5. Have you had the opportunity to participate in critique, or have you had your design work critiqued? Tell me about that process.
6. What factors have influenced you the most in your design process or as a designer so far this semester?

Interviewer will ask probing questions to follow up on participant responses.

Appendix B

Faculty Semi-Structured Interview

1. How would you define the term "design" in a general sense? In your specific discipline?
2. What elements of your Master's program contribute the most to educating effective design practitioners? Why?
3. What specific things do you do in educating design students in your discipline, compared to the broader view of design education, if any?
4. Is there an intended course sequence for first-year students? And if so, what role it that sequence intended to play in acculturating and/or developing first-year Master's students?
5. From your perspective, what internal and external factors influence your students as they develop as a design practitioner in the context of your Master's program?
6. Tell me about a project that you have used for first-year Master's students in the past, and the planned role it plays in developing student design thinking. [Prompt from known student-referenced projects, if possible.]

Interviewer will ask probing questions to follow up on participant responses.