

Learning Patterns in Architectural Design Studios

An Exploration of Tutor and Student Collaboration in Design Critiques

Julie Milovanovic

https://doi.org/10.21606/drs_lxd2021.07.186

Learning how to design as an architect is the main objective of architectural design studios. Students develop design knowledge as they learn by designing, guided by their tutors. This study highlights characteristics of design critiques organization over time by analyzing design activities (designing vs. explain design) and collaboration between students and tutors. In this exploratory study, four design critiques from a master design studio in architecture are analyzed based on the protocol analysis methodology. Moments when students can acquire design knowledge are identified based on the type of design activity: designing - Description, Reflection, Design Move – or explaining design - Precedent, Design principle or Methodology. The findings reveal that design critiques are mainly focused on designing itself (tacit knowledge) more than explaining how to design (explicit knowledge). This provides empirical support for Donald Schön's description of learning design in the studios through a learning-by-imitation approach. Interestingly, collaboration between students and tutors appeared in each design critique which shows a high engagement of all the participants to the critique.

Keywords: design education; architectural design studio, design critique; design knowledge; protocol analysis

Introduction

The mode of teaching and learning in the design studio derives from the apprenticeship model, as a consequence of the implicitness of the learning objective: design itself (Cross, 1982). Designers' knowledge can be described through Polanyi's concept of tacit knowing: designers can know more than they can tell (Polanyi, 1966). Even though designing depends on the designers' knowledge of design (explicit knowledge or theories, norms), it mainly relies on their knowledge of how to design (tacit knowledge or 'knowledge-in-action') (Schön, 1983). The pedagogic frameworks of learning-by-doing, largely spread among architecture schools, adapt to the tacit dimension of design knowledge. The design studio format provides a relevant setting to tacitly learn how to design.

The design studio stands at the core of the architectural curriculum (Schön, 1985). In design studios, students develop their skills of thinking and acting as architects, developing their architects' ethos (Cuff, 1991). During the design studio, students and tutors interact, discuss and co-design through a set of design representations. Design critiques are a key moment in the design studio pedagogy (Anthony, 1991; Parnell et al., 2007). Previous studies based on ethnographic observations of design studios, surveys or interviews, aimed to either highlight studio features and organization, or to point out flaws and possible improvements (Healy, 2016; Oh et al., 2013; Schön, 1985). Drawbacks of the design studio culture appear related to a lack of clarifications of the pedagogic objectives. Moreover, poor communication between tutors and students as well as deconstructed criticism sometimes jeopardize students' learning experiences (Sara & Parnell, 2013). Cognitive model-based analyses of design conversations in pedagogic settings, either juries or design critique were studied in recent research (Adams & Siddiqui, 2016). Prior work focused on knowledge organization (Adams et al., 2016; Cardoso et al., 2014; Dong et al., 2016; Wolmarans, 2016), designing and co-designing in the studio (Boudhraa et al., 2019; Ferreira et al., 2016; Gero & Jiang, 2016), or social interactions between



This work is licensed under a
[Creative Commons Attribution-NonCommercial-Share Alike 4.0 International License](https://creativecommons.org/licenses/by-nc-sa/4.0/).
<https://creativecommons.org/licenses/by-nc-sa/4.0/>

tutors and students (Goldschmidt et al., 2010; Oak & Lloyd, 2016). Those studies either developed precise models of designers' cognitive or social behavior during the design critiques or defined patterns of teaching and reasoning during the critiques. The research presented here builds on these previous studies to provide new insights to describe learning patterns during design critiques.

The aim of this article is to highlight characteristics of design critiques temporal organization by analyzing design activities (designing vs. explaining design) and the collaboration between students and tutors. The methodology is based on the protocol analysis approach (Ericsson & Simon, 1984; Van Someren et al., 1994), to provide quantitative information about the design critique organization. This exploratory case study of four design critique in an architectural design studio provides first results to improve our understanding of the relationship between design activities, collaboration and design knowledge. The significance of such studies is to develop guidelines to enhance studio critique setting to support design pedagogy.

Characteristics of Design Critiques Learning Environment

The design critiques setting

Design critiques format vary from one-on-one critique, involving a tutor and a student, to group critiques, peer discussion, informal juries, pin-ups, and final juries (Anthony, 1991; Oh et al., 2013). One-on-one desk critiques offer, on a regular basis, a space for students to confront their designs with their tutor, seek hints and answers when they are stuck with specific design issue. Other design critique formats, like juries, enable students to obtain feedback on their design by a wider array of experts and to train for oral presentations in front of an audience. Depending on the format, not only knowledge and skills on design are developed, but also interpersonal competencies. Oh *et al.* (2013) defined a descriptive framework of design critiques, identifying eleven factors which are divided in two categories: critiquing conditions (design phases, individual differences, knowledge/experiences, student response type, design artifacts, learning goals) and critiquing methods (critiquing types, student/tutor relationship, communicational modalities, delivery types, delivery). The communicational modalities, delivery types and student/tutor relationship anchor the design critique process in a social situation. To function as a pedagogic tool, tutors need to build a constructive critique and bring transparency to critiques' goals (Dinham, 1989). Indeed, students sometimes struggle to emancipate from critique's apparent subjectivity. The difference between personal opinions and tutor's analytic criticism should be acknowledged by students to reinforce critiques' learning outcome. Tutors' profiles, their behaviors and relationships strongly impact the design critique process and consequently highly influence design learning.

What happens during design critiques?

The design critique sets an environment for students to get feedback on their design. Recurrent steps organize design critiques: students presenting their work; tutors listening and observing; tutors and students noticing issues, reframing design problems; addressing those problems by questioning, analyzing and bringing up possible solutions or guidelines (Oh *et al.*, 2013; Schön, 1985). The latter can be referred to as designing, where talking and sketching intertwine. In *The Design Studio*, Schön (1985) identifies four design critique action types performed by the tutor and the student that functions by pairs: telling (tutor) and listening (student); demonstrating (tutor) and imitating (student). The first set corresponds to explicit formulation of design knowledge, like specific instructions to follow, theoretical solutions, requirements about representations' format or references to precedents; and the second refers to a situation where designing occurs through the tutor's demonstration, that includes reframing, analyzing and proposing changes (Schön, 1985; Goldschmidt, Hochman and Dafni, 2010). Learning activities in the studio were classified by Heylighen, Bouwen, & Neuckermans (1999) in four distinct moments: demonstrations employing both verbal and graphic design language, descriptions of a design principle, reference to precedent, and tutors' designing and sketching. Here again, two main activities are depicted: the first in relation to designing or reflection-in-action and the second that put forward methods, general theories or precedents to inspire students' design. During design critiques, alternating different sequences of reasoning have proven to enhanced students' design quality (Wolmarans, 2016) and improve their learning outcome (Cardoso et al., 2014; Dong, Garbuio and Lovallo, 2016). The quality of design critiques for students' knowledge development mainly relies on the capacity of tutors to clarify their expectations (Dinham, 1989), to exploit appropriate coaching strategies (Adams et al., 2016) and to choreograph design critiques to provide an enriching environment for students to develop their skills (Mewburn, 2012; Oak et al., 2016). Empirical studies of design critiques analyzing cognitive behaviors of tutors and students show markers of co-designing (Dorta, Kinayoglu and Boudhraâ, 2016). Teaching through co-designing provides an appropriate pedagogic strategy for students to engage in design

critiques (Boudhraâ *et al.*, 2019).

Tutors and students' behaviors during design critiques

Tutors teaching in design studios are often experienced designers who serve as role models for their students. Schön (1985) describes the tutor as a coach or facilitator, while Goldschmidt, Hochman and Dafni (2010) further developed definitions of the tutor's profile (source of expertise, coach, 'buddy'). In their study, they analyze design critiques of three tutors, identifying diverse facets of tutor performance and their capacity to adapt their feedback depending on students' reactions. According to Webster (2008) and Mewburn (2012), teaching in the studio should be student-centered, implying that students must participate actively to enhance their learning outcome.

Communication between tutors and students is a key factor in the student's learning process. Their relationship can be mapped onto the patient/analyst one in psychoanalysis, highlighting students' dependency on their tutor due to the vulnerability that they experience while designing (Ochsner, 2000). The asymmetry of design knowledge between novices (students) and experts (tutors) is another factor that falters students' self-confidence on their capacity to design. The knowledge gap between tutors and students can hinder mutual understanding on design issues. Therefore, tutors need to manage their expert position to facilitate students' learning and organize their coaching strategies to establish constructive communication as a pedagogic bond.

Identifying design knowledge

The objective of the studio is for students to acquire design knowledge: declarative knowledge about design, conceptual and procedural knowledge on how to design as an architect, and interpersonal design knowledge on how to become an architect (a role with social, ethical and architectural values). Curry (2014) draws a parallel between knowledge types (declarative, conceptual, procedural and strategic) with designers' level of expertise. Students possess the first three, and tutors' expertise appear in their strategic knowledge. They have experiences as a professional, that act as 'design repertoires' (Schön, 1985) for their designing processes. Goldschmidt's study (2003) pointed out some of the knowledge categories mentioned above. A dichotomy appears between knowledge about architectural practice and knowledge linked to the field of architecture. Several specific features of the design critique as pedagogic setting emerged. Activities during studio critiques revolves around doing design. The action-oriented learning framework derives from the tacit characteristic of design knowledge. Learning by doing, by practicing and by experiencing prevails in design critiques. Tutors' responsibility lies in their capacity to guide students, by demonstrating, co-designing, questioning and pushing students to think in designerly ways. Indeed, students and tutors social interactions forge a pedagogic bond for design knowledge to be handled and built upon. All those features should be accounted to question design pedagogy. Through their analysis, we will better define what happens in design critiques. Based on such findings we can move toward an evaluation of the pedagogic performance of design critiques.

Method to Analyze Design Critiques

The methodology is based on the analysis of the semantic content of the design conversation between tutors and students during design critiques. The method used for this study is *protocol analysis* (Ericsson & Simon, 1984; Van Someren *et al.*, 1994). Protocol analysis was initially exploited to describe cognitive processes based on the verbal analysis of think-aloud transcripts, called protocols. The assumption is that designers train of thoughts formulated out loud captures the essence of their thinking processes. This method can be adapted to a group conversation (Jiang and Yen, 2009). In this case, the design conversation between designers accounts for thinking processes (Goldschmidt, 1995). Here, we apply that methodology to tutors and students conversation during design critiques.

To use protocol analysis as a research methodology, the first step is to transcribe the design critique conversation. Then, the protocols (transcribed dialogue between tutors and students) are encoded to analyze the design activity over time. The protocols are segmented into cognitive actions based on coding categories. Segments of the transcript data were defined by two criteria: firstly, by speakers (tutor or student), secondly, by cognitive action (ideas or concepts).

Coding scheme

The coding scheme was defined before the observations took place, based on theoretical frameworks stemming from empirical findings. Coding the protocols gives a possibility to measure and understand how design issues and solutions are raised and organized during the critique. In a previous study, Goldschmidt, Hochman and Dafni (2010) analyzed tutors' behavior to examine communication during the design critiques.

They used a coding scheme based on eight types of cognitive action: report / reviews / analysis of the state of design; clarification questions; proposals for change / improvement; reference to design precedents / examples; explication of design issues, theory / principles / norms / conventions; statements regarding design methodology / presentation; praise, expression of satisfaction, encouragement; questioning, pointing out of mistakes / shortcomings and expressions of dissatisfaction.

Design critiques illustrate sequences of designing and learning. For that reason, we considered a combination of a design-based coding and knowledge-based coding. According to Polanyi (1966), tacit knowledge is linked to action, context-based and hardly formalized; whereas explicit knowledge is codified and easily transmittable. Applied to the design critique situation, tacit knowledge is embedded in design itself while explicit knowledge appears in utterances on design methods or theories. Goldschmidt, Hochman and Dafni (2010) coding scheme already included both types, and since not only tutors but students' behaviors were analyzed in this study, a refinement of that coding scheme was done to map onto both types of participants. The final code falls into six categories: a description of the state of design (Description); an analysis of state of design (Reflection); a proposal for a change in design (Design move); a reference to a design precedent (Precedent); an explanation of a theory, a principle or a norm (Design principle); a statement regarding a methodology (Methodology) (Table 1).

Table 1. Coding scheme capturing categories of design actions during design critiques

<i>Type of verbalization</i>	<i>Example from the encoded transcripts</i>
1. Description of state of design	"Because from the beginning, what I wanted is that it continues and dives in, because it gives a view without the railing that ruins the view and to keep this wide opening."
2. Analysis about state of design	"But this public space is big so... well when we have this type of building, it means that we have a circulation from the sea to the sea, so maybe there is a connection to have in the other way."
3. Proposing a change in design	"From that point, it is a path with... this, this could be on the inside if you... we could have, for example, just a structure and then you are just above the water."
4. Reference to a design precedent	"Have you seen the Museum of Modern Art in Sao Paulo, from Lina do Bardi?"
5. Explanation of a theory, a principle or a norm	"There were housings beside a patio, a void, so that's why, that gives more interesting views inside, on the patio. You arrive on a vertical element, or you see the patio from the top."
6. Statement regarding a methodology	"You have to start to draw at scale, we need to see details, plans, elements."

Case study: Four design critiques from a master design studio

Design critiques from this case study occurred a week after a semi-formal jury and three weeks before the final one. Four design critiques were videotaped in situ, in the studio, while other students were working on their design. All observations and recordings were made on the same day in a master's studio at the Graduate School of Architecture of Nantes, France. This studio included fourth- and fifth-year students. The observer sat with students and tutors, but did not participate in the critique. An action camera placed on a desk lamp above the table was used to videotape design critiques. The observation setting aimed at capturing genuine behavior during the design critiques. Students and tutors knew that the observations were for research purposes but were not aware of its aim. Nevertheless, bias due to the observations have to be considered. Students that presented that morning were either picked randomly by their tutors or volunteered to get feedback on their design. By chance, they all were 5th year students that were designing their final project.

During the first part of this design studio, students lead an urban analysis of the site, by groups of three students, to develop a program including housing and services. The second part of the curriculum focused on design itself, and was done individually, based on the overall analysis and guidelines. Design critiques were videotaped after the design requirements were settled. Students were developing their concept into an architectural project. Although every student worked on the same site, they each developed different programs, especially for the services which could be libraries, museums, coffees and restaurants, or shared co-working spaces. Three tutors were running the studio, and for each critique, two of them participated as shown in figure 1. Both tutors have professional and academic experience. During the first part of each design critique, students started by describing their design and the latest features they had been working on. The

design critiques lasted between 27 minutes and 50 minutes. Every design critique protocol was encoded twice by the author. The second coding was done 5 months after the first one to ensure better reliability of the results. The coding agreement within codes was higher than 70% for each case, which also ensures coding reliability.

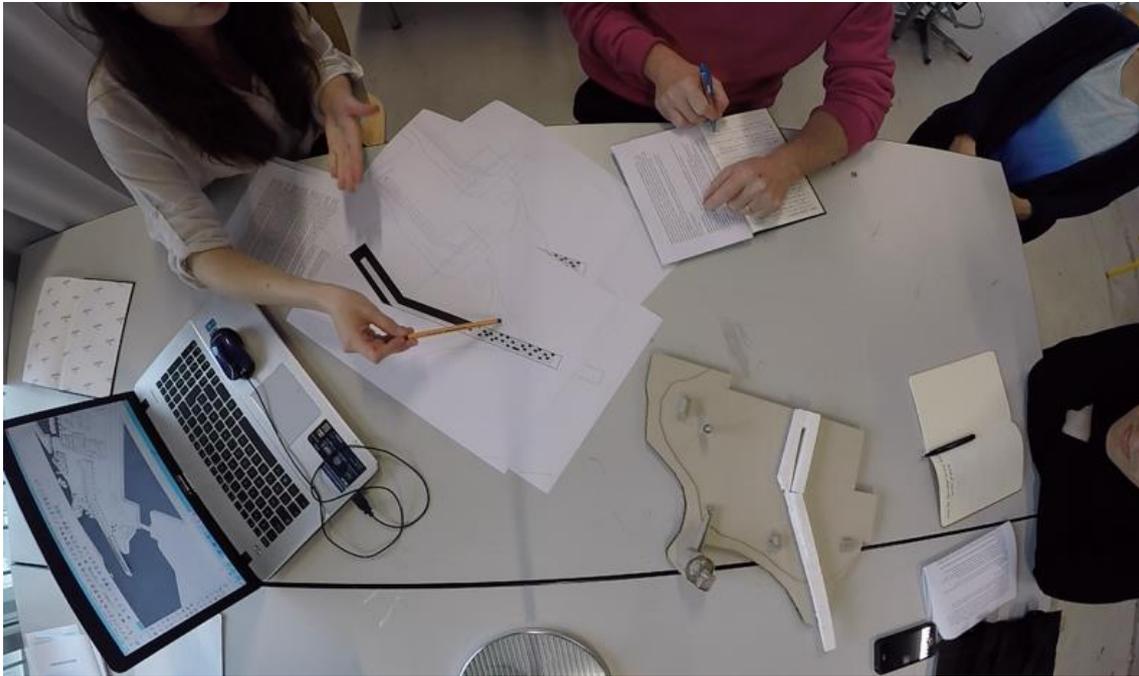


Figure 1. Photograph of student #2 design critique with the student on the left, the two tutors and the observer on the right

Results

Dominance of tacit design knowledge during design critiques

For all the design critiques, reflection-in-action (Description, Reflection and Move, represented in blue in Figure 2) is dominant over moments related to explicit design knowledge (Precedent, Design principle and Methodology). In general, Description segments prevail for students. Both tutors engage more equally in Description, Reflection and Design move verbalizations.

Student #1 and Student #3 display a similar behavior in terms of participation to the design activity.

Description represents between 60 and 70% of their interventions. Around 16% of their verbalizations are Reflections, and around 7% are Design moves. Student #2 and Student#3 mainly focus on a Description of their design as more than 90% of their verbalizations are Descriptions.

Students and tutors' verbalizations of explicit design knowledge represent less than 20% of the total of verbalizations (Figure 2). When doing so, most of the time, they referred to a design Precedent or described a design Methodology. These findings highlight the dominance of learning by doing design as most of the design critique is focused on designing itself. Moreover, students were all about to graduate, therefore, there might have been a lesser need for explicit design knowledge during the critique.

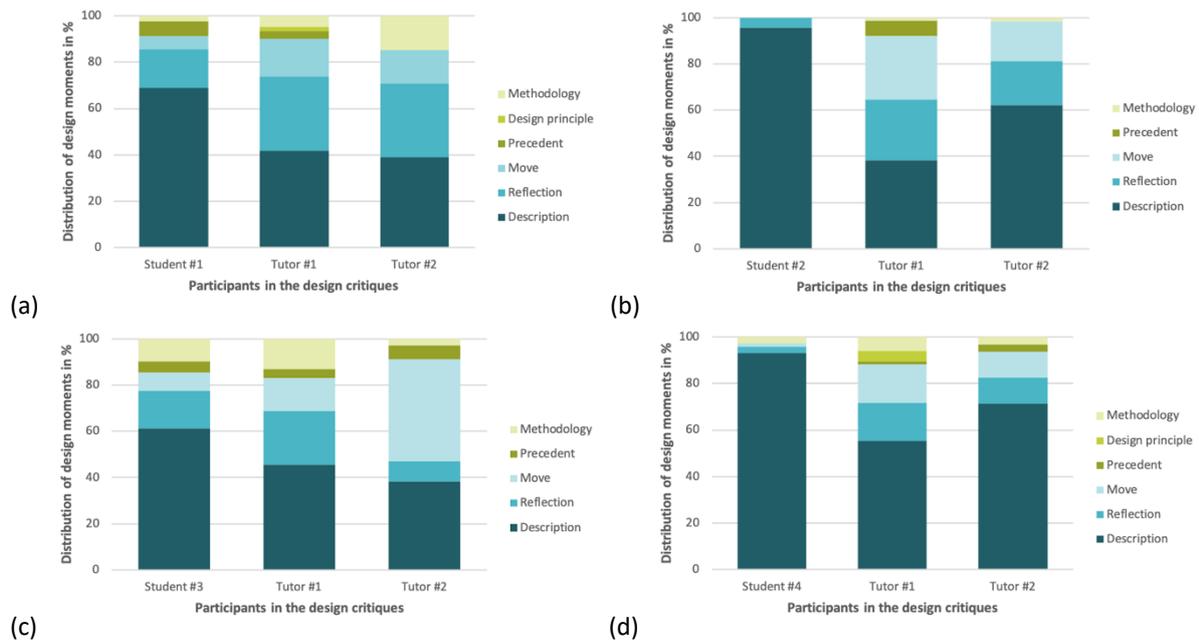


Figure 2. Distribution of design activities for each design critique: Student #1 (a), Student #2 (b), Student #3 (c) and Student #4 (d). The color blue represents design moments related to tacit design knowledge (Description, Reflection and Design move) and the color green represent explicit design knowledge (Precedent, Design principle and Methodology).

Tutor and students behaviors over time during design critiques

To extend the analysis of design critiques setting, we explored the temporal aspect of each design critique. A timeline of each design critique was generated to highlight how the design critiques unfold (green dots on Figure 3 to Figure 6). Tutors and students' interactions are represented on the same timeline to better grasp how they interacted. To simplify the analysis, both tutors were grouped. All four design critiques started similarly, with a description of the current state of the design. Apart from Student #2 design critique, the descriptive part of the design critique is collaborative (see the blue oscillation in Figure 3, Figure 5 and Figure 6). Interestingly, all four design critiques are highly collaborative as we see a fast pace interaction between students and tutors (blue line in Figure 3 to Figure 6).

When looking at reflection-in-action moments (Description, Reflection and Design move), the timeline points out fast iterations between each element, showing cycles of designing over the time of the design critique. Although those moments are led by tutors, students participate in it. In three sessions, for Student #1 (Figure 3), Student #3 (Figure 5) and Students #4 (Figure 6), long moments in the design critique illustrate an association of tacit design knowledge (Description, Reflection and Design move) and explicit design knowledge (Methodology, Precedent and Design principle), represented in orange dotted ellipses on the timelines. Those moments occurred either halfway through the design critique or at the end. Such dynamic seems specific to design critique settings, where a design proposition might not be clear and need to be explained through design principles or methodology. Using Precedents is also a way to open the design space by providing examples, and using design analogy to move on in the design process.

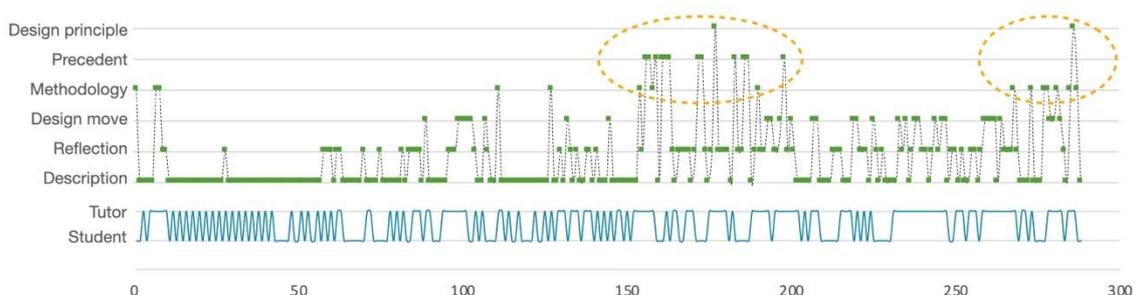


Figure 3. Timeline of the occurrence of design moments and tutor / student interactions for Student #1 design critique. Green squares show the occurrence of design moments. The blue line shows the interactions between tutors and students.

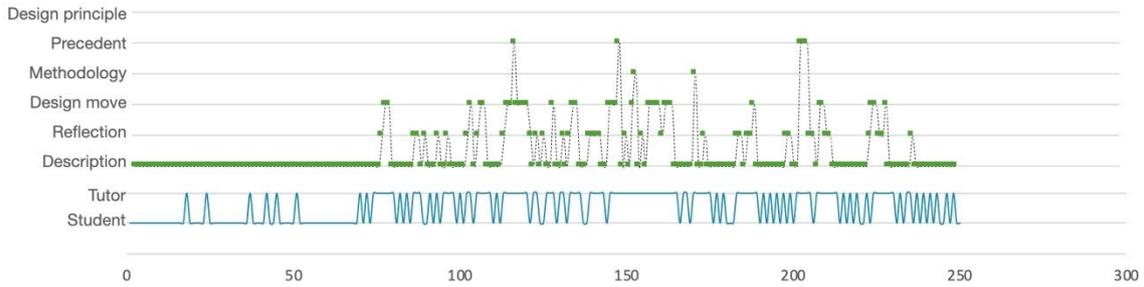


Figure 4. Timeline of the occurrence of design moments and tutor / student interactions for Student #2 design critique. Green squares show the occurrence of design moments. The blue line shows the interactions between tutors and students.

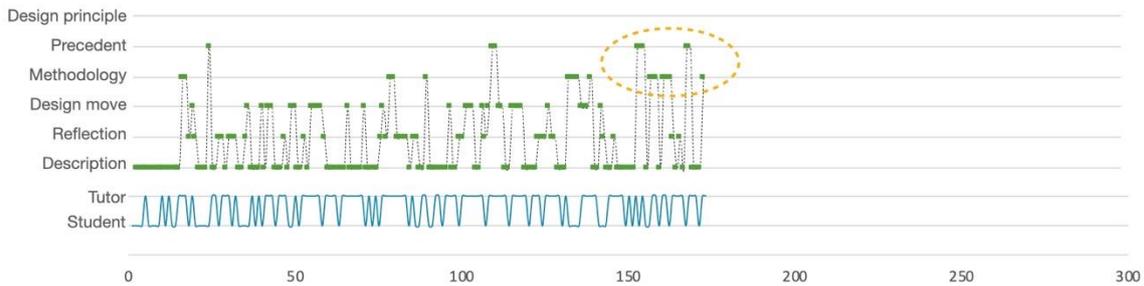


Figure 5. Timeline of the occurrence of design moments and tutor / student interactions for Student #3 design critique. Green squares show the occurrence of design moments. The blue line shows the interactions between tutors and students.

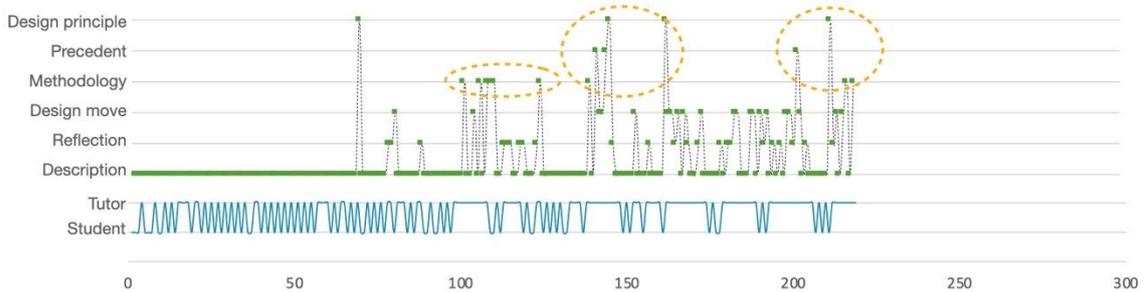


Figure 6. Timeline of the occurrence of design moments and tutor / student interactions for Student #4 design critique. Green squares show the occurrence of design moments. The blue line shows the interactions between tutors and students.

Discussion

The sample of our study is limited to formulate general findings concerning design critiques pedagogy, but provides hints that we can build on for further investigations. It raises questions about how learning can occur during design critiques.

Reflection and Design move occur in all the design critiques observed, but their distribution is unequal depending on the design critique. The master-student type of relationship described by Schön (1983), fostering a learning-by-imitation mode, occurred in this sample of design critiques. It provides an empirical validation of Schön's description of how students learn to design during design critiques. Moments during design critiques that focused on tacit design knowledge also occurred during all design critiques. Students were mainly engaged in both learning-by-doing design and in sharing explicit design knowledge which supports Webster's (2008) and Mewburn's (2012) views on design learning, anchored in a constructivist approach.

A balance between designing, reflecting, collaborating and observing could describe a relevant scheme to set a suitable environment for students to learn how to design. The design critique can be seen as a sequence of designing activities, where students' cognitive behaviors alternate from a phase to another. This finding aligns with Kolb's experiential learning theory, based on a cycle of phases of experiencing, observing, reflecting and acting (Kolb, 1984).

Our case study confirms the findings of Goldschmidt (2003) and Goldschmidt, Hochman and Dafni (2010) concerning architectural knowledge transfer during critique. Different types of architectural knowledge are

present and potentially transferred between students and tutors. They combined in different ways and diverse knowledge environment. Constructing knowledge-in-action or tacit knowing is at stake in the design studio. Nonetheless, knowledge of how to design, including methods and theories, or analogic reasoning based on precedents are also worthwhile. The combination of both illustrates designers' processes, based on procedural and strategic knowledge (Curry, 2014) or on recalling references from their 'design repertoires' (Schön, 1985). This exploratory study shows the combination of two teaching strategies in during design critiques: teaching by doing design with students and teaching by explaining design principals, theories or norms. This study did not analyze the efficiency of such strategies. A priori, both are needed for students to learn how to design. The studio pedagogy has not evolved much over the past decades. In France, where the observations took place, the design studio setting is still embedded in the apprenticeship model of the Beaux-Arts studio. Although students engage in the design critiques, the studio pedagogy remains tutor centered. More effort is needed to provide a better environment to ease tutor and student communication and mutual understanding. Using digital settings could help foster a more collaborative approach to learning design and benefit students learning experiences (Boudhraâ *et al.*, 2019; Milovanovic, 2019).

Conclusion

Several salient features defining design critiques in terms of pedagogic setting for design skills construction are of interest while questioning design critique organization. Diverse analysis methods to study critiques were designed to explore students and tutors' behavior, communication and interaction. In this study, using the protocol analysis approach gave us insights on students' behaviors during design critiques. The focus of this study was on the activity participants engage in during the design critique. The analysis looked at different types of knowledge (tacit – Description, Reflection, Design move- and explicit – Precedent, Design principle, Methodology-) and tutor / student interactions. This case study helps clarify the relationship between tutors and students' behaviors during design critiques and the organization of different types pedagogic strategies over time (doing design vs. explaining design). As stated in the literature, studio critique format stands as a tradition and its setting as a pedagogic framework has rarely been evaluated by a quantitative approach focusing on participant cognitive behavior. A research gap is to be filled in order to propose directions to enhance design studio pedagogy based on empirical evaluation of design studio performance. The research presented here is a first step toward that objective. Tutors should be aware of the potential of articulating design knowledge from both the explicit and tacit domain, while critiquing. Students' awareness and engagement during those moments might highly benefit their learning outcome. In this study, the effect of students and tutors' interactions, and their participation in different design moments on students' performance was not analyzed. Future work will consist of assessing if there is a correlation between what happens in the critique and students experience and performance in the design studio. The aim will be to offer guidelines to enhance design critique pedagogic framework.

References

- Adams, R. S., Forin, T., Chua, M., & Radcliffe, D. (2016). Characterizing the work of coaching during design reviews. *Design Studies*, 45, 30–67. <https://doi.org/10.1016/j.destud.2015.12.007>
- Adams, R. S., & Siddiqui, J. A. (Eds.). (2016). *Analyzing design review conversations* (Purdue University Press).
- Anthony, K. H. (1991). *Design juries on trial: The renaissance of the design studio* (Van Nostrand Reinhold).
- Boudhraa, S., Dorta, T., Milovanovic, J., & Pierini, D. (2019). Co-ideation critique unfolded: An exploratory study of a co-design studio 'crit' based on the students' experience. *CoDesign*, 15(1). <https://doi.org/10.1080/15710882.2019.1572765>
- Cardoso, C., Eriş, Ö., Badke-Schaub, P., & Aurisicchio, M. (2014). Question asking in design reviews: How does inquiry facilitate the learning interaction? *Design Thinking Research Symposium 10*, Purdue University. <http://docs.lib.purdue.edu/dtrs/2014/Impact/1/>
- Cross, N. (1982). Designerly ways of knowing. *Design Studies*, 3(4), 221–227. [https://doi.org/10.1016/0142-694X\(82\)90040-0](https://doi.org/10.1016/0142-694X(82)90040-0)
- Cuff, D. (1991). *Architecture: The story of practice*. MIT Press.
- Curry, T. (2014). A theoretical basis for recommending the use of design methodologies as teaching strategies in the design studio. *Design Studies*, 35(6), 632–646. <https://doi.org/10.1016/j.destud.2014.04.003>
- Dinham, S. M. (1989). Teaching as design: Theory, research and implications for design teaching. *Design Studies*, 10(2), 80–88.
- Dong, A., Garbuio, M., & Lovallo, D. (2016). Generative sensing in design evaluation. *Design Studies*, 45, 68–91. <https://doi.org/10.1016/j.destud.2016.01.003>

- Ericsson, K. A., & Simon, A. H. (1984). *Protocol Analysis: Verbal reports as data*. MIT Press.
- Ferreira, J., Christiaans, H., & Almendra, R. (2016). A visual tool for analysing teacher and student interactions in a design studio setting. *CoDesign*, 12(1–2), 112–131. <https://doi.org/10.1080/15710882.2015.1135246>
- Gero, J. S., & Jiang, H. (2016). Exploring the Design Cognition of Concept Design Reviews Using the FBS-based Protocol Analysis. In R. S. Adams & J. A. Siddiqui (Eds.), *Analyzing Design Review Conversations* (p. 177). Purdue University Press.
- Goldschmidt, G. (1995). The designer as a team of one. *Design Studies* 16, no. 2, 189–209. [https://doi.org/10.1016/0142-694X\(94\)00009-3](https://doi.org/10.1016/0142-694X(94)00009-3).
- Goldschmidt, G. (2003). Expert knowledge or creative spark? Predicaments in design education. *Expertise in Design, Design Thinking Research Symposium*, 6, 17–19. <http://home.fa.utl.pt/~franc/de1/ext01/ggcriativo.pdf>
- Goldschmidt, G., Hochman, H., & Dafni, I. (2010). The design studio “crit”: Teacher–student communication. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, 24(03), 285–302. <https://doi.org/10.1017/S089006041000020X>
- Healy, J. (2016). The Components of the " Crit" in Art and Design Education. *Irish Journal of Academic Practice*, 5(1), 7.
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs.
- Jiang, H., and Yen, C.-C. (2009). Protocol Analysis in Design Research: A Review. In *Design, Rigor & Relevance IASDR*, 147–56. Seoul, Korea.
- Mewburn, I. (2012). Lost in translation: Reconsidering reflective practice and design studio pedagogy. *Arts and Humanities in Higher Education*, 11(4), 363–379. <https://doi.org/10.1177/1474022210393912>
- Milovanovic, J. (2019). *Exploration of architectural design studio pedagogy: The effect of representational ecosystems on design critiques*. PhD Thesis, Ecole Centrale Nantes, France.
- Oak, A., & Lloyd, P. (2016). “Wait, wait: Dan, your turn”: Performing assessment in the group-based design review. In R. S. Adams & J. A. Siddiqui (Eds.), *Analyzing design review conversations*. Purdue University Press.
- Ochsner, J. K. (2000). Behind the mask: A psychoanalytic perspective on interaction in the design studio. *Journal of Architectural Education*, 53(4), 194–206.
- Oh, Y., Ishizaki, S., Gross, M. D., & Do, Y.-L. E. (2013). A theoretical framework of design critiquing in architecture studios. *Design Studies*, 34, 302–325.
- Parnell, R., Sara, R., Doidge, C., & Parsons, M. L. (2007). *The crit: An architecture student’s handbook* (2nd ed). Elsevier: Architectural Press.
- Polanyi, M. (1966). *The tacit dimension*. Peter Smith.
- Sara, R., & Parnell, R. (2013). Fear and Learning in the Architectural Crit. *Free Journal for Architecture*, 101–125.
- Schön, D. (1983). *The reflective practitioner: How professionals think in action*. Temple Smith.
- Schön, D. (1992). Designing as reflective conversation with the materials of a design situation. *Research in Engineering Design*, 3(3), 131–147. <https://doi.org/10.1007/BF01580516>
- Schön, D. A. (1985). *The Design Studio*. RIBA.
- Van Someren, M. W., Barnard, Y. F., & Sandberg, J. A. C. (1994). *The think aloud method: A practical guide to modelling cognitive processes*. Academic Press.
- Webster, H. (2008). Architectural Education after Schön: Cracks, Blurs, Boundaries and Beyond. *Journal for Education in the Built Environment*, 3(2), 63–74. <https://doi.org/10.11120/jebe.2008.03020063>
- Wolmarans, N. (2016). Inferential reasoning in design: Relations between material product and specialised disciplinary knowledge. *Design Studies*, 45, 92–115. <https://doi.org/10.1016/j.destud.2015.12.003>

Milovanovic Julie

AAU-CRENAU, Graduate School of Architecture Nantes, France

Sustainable Design + Decision Making lab, Virginia Tech, USA

julie.milovanovic@crenau.archi.fr

Julie Milovanovic is a post-doc researcher at the Civil and Environmental Engineering Department and an associate researcher at AAU-CRENAU lab. Her research focuses on design thinking, design education, design neurocognition and the use of digital tools for design education.