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MEGARON 2020;15(3):343-349
DOI: 10.14744/MEGARON.2020.32650

Open Design Education: Addressing Accountability in the Age of Computing

Açık Tasarım Eğitimine Doğru: Hesaplama ve Hesap Verebilme

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ABSTRACT

Attitudes complement knowledge and skills but are often overlooked as assessable competencies in higher education. In architectural design curriculum, attitudes are especially relevant in order to ensure the training of responsible designers. As humanistic and environmental approaches are increasingly at the forefront, the studio cultures of the schools seek to cultivate collaborative and participatory skills on individual creativity. The parallel acclaim of computational methods expounds the reasoning processes of design and new opportunities arise for open and liable cultures of design. However, the task of connecting these methods to a broader competency in design is still not fulfilled. This paper provides an interdisciplinary context for accountability as an attitude in design education and a conceptual framework for implementing and assessing it through computational methods. It argues that computation in early-design education, in the form of shape rules and devices of visual computing, is supportive in instilling reflective attitudes by promoting knowledge sharing with accountability among learners.

Keywords: *Collaborative design; computational design; ethics; first-year design education; reflective practice.*

ÖZ

Yükseköğretimde öğrenim çıktıları olarak bilgi ve becerileri tamamlayan tutumlar, doğrudan değerlendirilemeyen yeterlilikler olarak genellikle geri planda kalır. Mimarlık eğitiminde hümanist, sürdürülebilir ve çevreci yaklaşımlar küresel ve yerel gündemlere uygun olarak artarken okulların stüdyo kültürlerinde benimsenen tutumlar, işbirlikçi ve katılımcı süreçlerden çok bireysel yaratıcı süreçler ön plana çıkabilmektedir. Hesaplamalı tasarım yöntemleri ise tasarımın muhakeme adımlarını açık ederek paylaşımcı tutumları beslerken, açık ve sorumluluk bilinci güden tasarım kültürleri oluşturmak için yeni fırsatlar sunmaktadır. Bu makale, hesap verebilir olmayı bir tutum olarak tasarım eğitiminde uygulamak ve değerlendirmek amacıyla kullanılan hesaplamalı tasarım yöntemlerine disiplinler arası bir literatürle bağlam ve kuramsal bir çerçeve sunmaktadır. Tasarım eğitiminin ilk yılında, süreci dışsallaştıran görsel kuralların kullanımı ile görsel hesaplama uygulamaları, süreci açıkça paylaşan, sorgulayan ve bağlamlarıyla ilişkilendiren tutumları beslemeye yarar.

Anahtar sözcükler: *İşbirlikçi tasarım; hesaplamalı tasarım; etik; mimarlık eğitiminin birinci yılı; yansıtıcı uygulama.*

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Article arrival date: **August 10, 2019** - **Accepted for publication:** **August 06, 2020**

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Introduction: Cultivating Attitudes for Designing with Computing

Attitudes, knowledge, and skills are the overarching competency categories sought in learning (Adam, 2006). As tendencies and habits that drive personal behaviors and thinking patterns, attitudes give direction to what one does with their knowledge and skills. In the context of architectural design education, attitudes are related with value-based decision-making (Hulstijn & Burgemeestre, 2015). This embodies, but is not limited to, accountability within a shared value system. Transparency of the values adhered to and accountability of decisions directly shape the social interactions of designers. A computational way to cultivate this attitude in architectural design education is the subject matter of this paper.

As digital media and technologies transform the means, processes, and modes of communication and production in architectural design, architecture programs are continuously incorporating the learning of new skills in attempts to embed "the digital" in the curriculum. As the emphasis is on the technical content, however, the effect of learning these skills on attitudes has not yet been adequately explored.

The digital in architecture is the subject of a research field often referred to as computational design, covering a wide range of topics from CAD and fabrication to simulation and performance optimization. Computation, in this broader area, is a way of materializing the reasoning processes in the design (Stiny, 2006), regardless of whether a computer is used or not. We consider that this externalization of reasoning provides a transparency in the interactions between stakeholders and supports the desired accountability in the training process for a designer. This paper reveals this potential of computation in the implementation and evaluation of accountability as an attitude in early design education with transparent interactions in the studio. Digital design technology has been viewed as a support for social or person-to-person communication, discussion, and reflection in design processes (Mitchell, 1995). This potential is either unintentional or implicit in the early years of architectural design education. A growing number of first-year architectural design studios incorporate computational design skills that primarily focus on the use of fast-evolving digital tools to model, represent, and produce design ideas. Occasionally, computation is introduced as a rule-based visual tool for students to externalize their design processes step-by-step and part-by-part (Stiny, 1980; Özkar, 2005; Knight, 2012). However, there is not much research done on the attitudes supported by such computational approaches in design education. This shortcoming may be partly due to the presumed distance between abstract computational design representations and what they imply for peers and society in general (Ostwald, 2010). Differently, we consider that visual computing encourages openness about design reasoning, sharing and answerability, and thus serves the social processes of design. Framing the value of accountability in design with regards to the transparency of processes and the social practices of designing, this study builds a case for the methodological impact of computation on mediating the socio-ethical conduct in design studio interactions in architectural education in order to pave a way for further exploration of how attitudes may be conveyed and assessed.

The following section is an overview of what accountability implies and how it is applied among early architectural design education competencies. We delineate three contexts in which accountability is addressed as a quintessential attitude for design practice and education, and how these are supported by computation. The following section sets out a case of current efforts on how design education cultivates such attitudes, considering Schön's model of reflection-in-action. Finally, computational design is argued to be a reflection tool in early design education, contributing to process sharing and thus accountability.

Attitudes of Accountability for Architectural Design Practice and Education

Accountability refers to the character of social actions produced to be "observable and reportable" (Garfinkel, 2016). In design, it is the competency to have an argument for the execution and the reliability of the outcomes. Making the process visible towards its moral ends has ethical implications. As the design process gradually moves from individual to collective agency, the transparency and accountability of persons or organizations operationally expose the design reasoning to all actors of the design process. This perspective calls for design students to be aware of reasoning and to embed it in broader structures of action, rather than simply learning decision-making practices on the job. This is in line with Herbert Simon's (1996) view on design as a systematic discipline involving choices aimed at transforming existing situations into preferred ones, so ethics is usually framed in decision-making processes. Current pedagogies opt for increasing the awareness of responsibility in future professional behavior, but do not specifically address the type of design actions performed in the studio.

Below, we delineate three interrelated forms of accountability from the relevant multidisciplinary literature to consider in today's design practice and education. Accountability, as outlined above, emerges as a matter of concern in the open use of design technologies, the transparent manifestations of processes in forms, and the collaborative relationships with peers and with experts. These forms of accountability extend to practice, but our focus is on learning that precedes such practices. To extend to practice, it would be crucial to include accountability in relationships with the users. Limited by the scope of design education, we deliberately exclude the user perspective.

Accountability in Collective Technological Action

Technological developments and computational approaches to design have tested the nature of human actions (Johnson, 2004) and raised novel issues in the ethical dimension of design. Accountability becomes an issue in at least two conditions that computational approaches bring to design: a new social form of design creativity through the decentralization of agency in dealing with complex data-driven processes, and the dissolution of authorship as often observed in automated digital and parametric design (Carpo, 2014). Accountability in the latter is addressed when the human agents, and not the tools, are held responsible. In the former, digital culture is characterized by a shared agency. Open-source codes, DIY and maker cultures are valued for the democratization of technologies (Tanenbaum et al., 2013) because they enable designers to learn by sharing, comparing, and collectively building up information. The integration of digital media into architecture has opened new frontiers for dynamic forms of collaboration in the design process. The Building Information Modelling (BIM) is a sign of the transition from a single author model to collective and transparent design processes (Bernstein & Deodhar, 2015). The increased collaboration in practice requires an understanding of computational design as an attitude of transparency in actions and interactions of the design process.

Being Accountable through Form

In parametric modeling that is supposed to be more than a mere automated form-finding tool, the model is instrumental at explicitly defining some of the reasoning leading to the outcomes. It is possible, however, to also adhere to visual definitions in computation rather than solely to the numerically and symbolically defined parameters in design. Forms maintain the "ethical traces" (Lachterman, 1989), or the transparency of the process of their construction. If aspects of the design process are visible through form, they are shareable, open to scrutiny, and pedagogically instrumental towards encouraging accountability. The illustrated example in Figure 1 shows some underlying geometric relations between shapes perceived in both the figure and the ground. These visible clues might serve as a tool to convey the knowledge of how these shapes come together to peers. Visual representations of a design computation via shape rules embody these visual parameters and references (Knight, 1994), and help one to trace the transformations of designs.

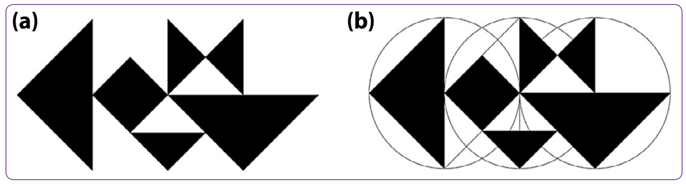

Figure 1. A comparison between **(a)** a first-year architecture student's composition of 2D shapes and **(b)** the same composition with its referential system. The underlying geometrical construction makes the design observable and notifiable to other peers.

Accountability in Learning with and from Experts and Peers

In higher education today, learning is regarded less as a stand-alone act and more as a collaboration with peers that brings together experiences, insights, and instruments (Crosby & Morgan, 2016). 21st century learners are expected to be prepared to create and share knowledge together in collective, multi-disciplinary, participatory, and accountable practices (Dede, 2010). Learning environments are based on interpersonal and group dynamics, with collaboration and knowledge sharing between students. Along with flexibility, adaptability, and self-direction, accountability is deemed one of the non-cognitive skills that drive interpersonal relationships between students.

The knowledge sharing in learning is both the dissemination and exchange of explicit or implicit knowledge, ideas, experiences, and skills from one individual to another individual student or group of students (Wei et al., 2012). In architectural education, the studio set-up brings together individuals who produce and reflect in parallel. The multiplicity of ideas, methods, and perspectives are shared and learnt directly or indirectly from peers. The resulting comparisons initiate reflections on processes of one's own as well as other students. Moreover, the interchange between a design studio professor and a student can also be thought of as knowledge sharing. Often considered as a form of knowledge transfer and evaluation, studio critique serves as a form of accountability (Vetting Wolf et al., 2006). However, in this mostly one-directional transfer between the expert and the novice, it is where students are practicing accountability for their design decisions in an asymmetrical power relationship. Alternatively, peer review sessions have been shown to empower students (Dutton, 1991) more than desk critiques provided by the instructors. Peer interaction supports collaboration, sharing, interference, and reflection in learning.

These forms of accountability help us draw a framework for a pedagogical setting to cultivate attitudes such as transparency and answerability in design education, especially from the early years. Externalization of reasoning processes and design ideas is necessary for building a culture of seeking meaningful feedback from peers and experts. Technological approaches, in the form of computation that externalizes and articulates the design process, can be useful for augmenting the reflections and interactions in a pluralistic and collaborative environment.

Reflection as Methodology to Foster Attitudes in Design Learning

In architectural design education, it is not easy to open up accountability as an attitude to keep the design process. Attitudes are usually acquired in tacit learning. Following this assumption, we look for the means to support the conditions which the three forms of accountability delineated above rely on in the first-year architecture education: tools to externalize the reflection on action and a collaborative setting.

Reflection has been one of the central concepts of Donald Schön's (1983) influential work in design education and design studies. Schön's "reflection-in-action" and "reflection-on-action" models imply thinking about the process and its consequences during and after, respectively. The latter, reflection on a done deed or a process, facilitates the learner's awareness of oneself and, if done openly, of other peers' knowing and learning. For this reflection to occur, the process or product needs to have been materialized. When a process is externalized and shared with the members of a community, feedback stimulates rethinking of what has been done and recreating it with a new idea.

Reflection in design studios is highly influenced by the curriculum, the immediate physical and social context as well as the overall studio culture in architectural education. Generally, reflections are articulated in different formats in the design studio, depending on the competency to be acquired. In addition to pin-up reviews, forms of reflection can be student portfolios, journals, weblogs, and showcases. These forms serve as tools to monitor and self-reflect on one's learning and development. They are also regarded as tools to encourage individual student accountability (Shupe, 2008). Usually, the assessment of these forms of reflection is left to the student alone and may not always result effectively as the student might lack the motivation to self-reflect. Involving experts and peers in the reflective process ensures that learners are aware of what they have learned and triggers the intrinsic motivation and attitude to carry out further self-reflective activities.

If reflection reveals the form of accountability in learning from peers and experts, the tools of reflection encourage accountability in collective technological action, particularly one that focuses on visual computing with shapes. A recent tool of reflection in design education is the visual formalism of shape rules (Stiny, 2006). Shape rules document the actions that make up the designs. The rule set, i.e. the grammar that defines the process up to a design, is an interpretative product and can be different each time it is created. A shape rule has a left side and a right side with an arrow in between. Each rule translates an action in the design where one shape (shown on the left) is changed into another (shown on the right). Thus, rules are the operators in a computational representation of the visual and spatial transformations in design.

Shape rules and grammars have been previously introduced into architectural design education (Pupo et al., 2007) to bolster the "shift away from individual design to languages of design" (Stiny, 1980). They have also been introduced in first-year architectural design studios (Gürsoy & Özkar, 2015), where they became visual representations of design moves and served as means of reflection on action. In our studies, we introduced the formalism of shape rules to a group of first-year architecture students in Epoka University to explore through protocol study whether students could utilize them not only as means of reflection but also of conversation and collaboration in a tacit process of acquiring attitudes of accountability towards peers.

Similar to the previous studies cited above, the pedagogy of the first-year architectural design studio in Epoka University relies on abstraction as an intellectual and practical method of inquiry into design. In many foundation studios, abstract forms are tools to facilitate the judgment process by keeping the focus not on form itself but on exploring the relations between forms with minimal numbers of features. The tasks assigned to students are abstract thematic compositions with two-dimensional or three-dimensional design elements.

In the studio, we observed that the participating student group did not always follow technical precision when defining the shape rules. Nonetheless, they were able to represent the actions that transform one shape into another in their designs. Figure 2 shows what three students out of the group represented when they were asked to show the spatial relations they designate while designing with given design elements as shape rules. Students systematically visualized the spatial groupings of the planar and linear design elements they used. By thinking on isolated relationships expressed with visual rules, students had the opportunity to reflect on the constructive basis of their designs. These drawings

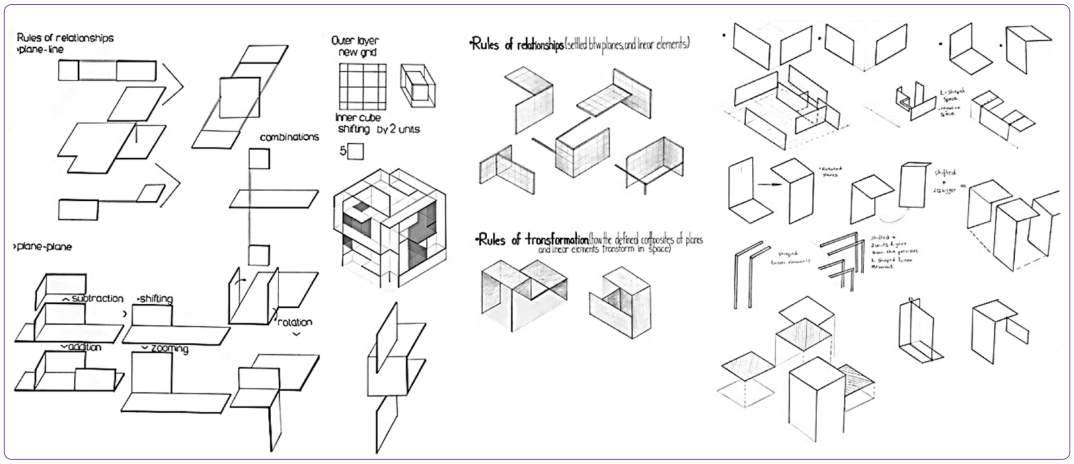

Figure 2. Design languages showing the possible spatial relations of elements as proposed by different novice students.

became instrumental in externalizing their decisions, design languages and further actions.

In the setup of our main study with the students, students were instructed with a three-staged protocol, a variant of the design game developed by Habraken and Gross (1988) After an individual design mode, a pair-and-share mode would follow and switched back to the individual mode again. During Stage I, i.e. reflection-in-action, students were expected to perform an individual 2D design based on a given design brief. Next, n Stage II, students paired up for reflection-on-action. They exchanged their designs within the pair, and each was encouraged to reflect on what they assumed to be the design decisions of their partner from the previous stage. In Stage III, students were expected to follow and apply in a new design, the rules they identified in their partner's work, hence reflection on reflection-on-action.

Encouraging students to give accounts of their designs through computational formalisms fostered an open sharing, praising, or scrutinizing one's own position as well as others. As a group of peers all participating students were exposed to different understandings of the same design problem.

When asked to reflect on the work of their matched peers to identify and represent relationships of abstract shapes through shape rules, the majority of the students focused on recurring parts and shape alignments. A sampling, illustrated in Figure 3, shows the work of Student B for Stage I, the partially rule-based interpretation of that work by Student A for Stage II, the work proposed by Student A for Stage III and based on that interpretation. Student A reads the figure-ground relations of the trapezoidal shapes in Student B's work as a consistent set of elements and employs this rule in her new composition while varying the tones of the figures and the ground.

Following the three-staged design exercise, we sought for evidence as to whether the students felt accountable towards their peers by analyzing how students assess the processes in their verbal reflections. Even if it was inconclusive due to short duration and cannot be generalized with regard to a limited number of participants, this was an attempt to test a way to assess attitudes in the studio. Previous studies (Dong, 2006; 2008), which discussed how designers assessed the process of their design practice, have employed linguistic analysis technique to analyze design protocols. Similarly, we searched for attitudes in evaluative stances in language through affect (emotions), judgement (ethics) and appreciation (aesthetics). In the verbal clause analysis (Halliday & Matthiessen, 2004) we conducted for the whole written material produced by Student A, the student sometimes generously referred to Student B's propositions as possible positions to the problem at hand. This may be due to the fact that she was aware of being

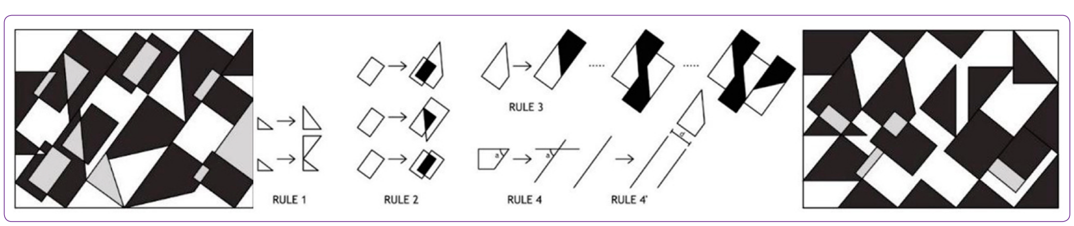

Figure 3. Left: the two-dimensional abstract composition produced by Student B during Stage I. Middle: visual rules identified by Student A on that work in Stage II. Right: composition produced by Student A based on Student B's design during Stage III.

the same position as her work was simultaneously being analyzed by Student B. In other cases, she positioned herself in contradiction with what her partner has done, as evidenced by the frequent use of the conjunction “but”. Sentences that acknowledge a shape relationship were usually descriptive clauses without attitudinal stances. However, these sentences evoked attitudes that were displayed directly in the text, mostly through words of judgement and appreciation such as “successfully”. Student A, at times, understood and validated what the other student did, whereas at other times her divergence is a critical reflection that demands accountability from the partner. This verbal reflection supports Student A’s take on the work of Student B, illustrated in Figure 3, where she traces the rule established by Student B with respect but varies certain aspects of it introducing her own language of design.

Conclusion

To foster ethical practices, there is an increasing need to cultivate and assess attitudes in architectural design education, similar to knowledge and skills. In this paper, we focused on the accountability for design reasoning as an attitude for the design studio considered from the light of higher education, social psychology, and design studies. Accountability is a tacit competency that is not easy to address and assess. Layered as affective, cognitive, and behavioral, attitudes are complex ways in which individuals respond promptly to changing contexts. Studying the means of reflection on individual and collective reasoning in design offers a perspective on how to structure future empirical work on attitudes in the studio.

As design is more and more practiced as a social act of creation in the 21st century, we desired to reveal the methodological impact of computational design thinking on accountability. Adopting design as computation and computation as design, the externalization of the design reasoning process is at the service of the social acts of designing. A collaborative learning environment provides greater opportunities for self and collective reflection and ultimately accountability. First, the externalization of one’s design reasoning brings some transparency to the process. Second, this transparency allows oneself and others to trace reasonings and actions. Finally, sharing one’s knowledge and reasoning initiates reflections for further actions. Externalizing, sharing, and reflection motivate accountable actions in the design environment.

In attempts to validate this point, we referred to the use of analogue computational tools, i.e. shape rules, in a first-year architectural design studio and inquired about reflective thinking to understand whether making visible the divergence and convergence of students’ reflections provide a ground for partaking, and justifying their actions. Our reference framework for accountability derived from three forms of it -- one, in collective action enabled by technology, two, through form itself as the manifestation of design, and, three, in learning with peers. We showed through protocol analysis how visual computation can be a tool for embodying these forms of accountability in design education. More long-term evidence is needed to assess the impact of computational devices on accountable design attitudes in learning environments through externalizing thought processes as well as how this matches with the creativity that is a key feature of design studios. The formalism of visual computation serve the mental constructs of the learners and represent their visual reasoning in design. As such, computation becomes a tool of sharing, comparing, reflecting, and changing that transcends and strengthens the learning experience in design studio settings, especially in the first years.

The openness of visual computing serves to document thinking processes, but it also helps beginner designers develop an understanding of what design thinking entails for communication and collaboration. Thus, computational methods may allow for open design education in support of democratic studio environments, where “openness” is read at different layers: an open design process, open to peer review, open to collaboration, open to sharing, and open to embracing the views of others. Such attitudes are instrumental in design processes for liable conduct towards colleagues, users, and the environment.

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