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RETHINKING ASSESSMENT FOR GENERATIVE DESIGN EDUCATION

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ABSTRACT
Design is a generative activity able to stimulate complex generative change. Such activity and change are intensified within the hype of generative artificial intelligence in the notion of generativity. Within design education, students are engaged through generative actions, reasoning, behaviours, values, etc. that need to be better understood to account for their development and assessment. Recent research has called for a more in-depth engagement with such actions with respect to assessment theory in educational settings. Elaborating on the construct of generativity, I introduce and consider the notion of 'generative learning' as a new paradigm for design education consistent with how designers think in and on action. Contextualising these notions for design education allows to rethink and reposition design and design instructions as complex generative processes wherein assessment aims to value and to challenge those processes. This raises important questions such as how such generative design education is addressed. I discuss a few principles to support this new paradigm for contemporary design education.

Keywords: Generative change, generativity, assessment, theory, generative design education

1 INTRODUCTION
Design is a generative activity. Designers generate ideas, products, methods, tools, processes, modes of reasoning, behaviours, etc. Design projects are identified through exploratory, generative, and evaluative sequences of research and design [1]. This paper focuses on examining design instructions through the lens of generative design (GD) processes. Over the decade, generative design (GD), in which interactive software is used to generate designs, has become an integral part of designers' activities. Although GD is not new in the literature, with the development of artificial intelligence (AI), generative designing appears to be a key skill in contemporary design education (DE). Introduced in the context of AI research, GD is attracting growing attention in design research and education because of the potential to address simple to complex technical and societal problems. For instance, Singh [2] viewed the need to introduce an integrative GD framework to improve design exploration; whereas Li et al. [3] suggested an evolving thinking to account for GD thinking and processes. Given the interest, GD has earned its place in DE, hence, shaping instructions (e.g., adopting generative tools and interfaces for interactive feedback with chatbots through prompting) and sparking new undergraduate programs (e.g., Design and AI) to tackle the new challenges faced by contemporary society. With this perspective, however, the idea of generativity, mostly used in the context of the design outcomes, needs to be further extended and explored as a new DE paradigm. Additionally, the introduction in current instructions poses a certain number of uncertainties on how 'generative learning' (GL) and related outcomes could be assessed. Given the changing context of assessment due to technology, current design research is exploring what more is needed, beyond the polarity 'assessment of/for learning', to make learning and assessment more authentic, hence, moving the focus from measurement paradigm to meaningful experience. This paper discusses this problem, thereby investigating key principles needed for a 'generativity theory' perspective of DE. It focuses on teaching and learning through the lenses of assessment as key to understand the teaching-learning duality. The paper is organized as follows: I first investigate challenges and limitations in current assessment in DE in Section 2 below. This is followed by Section 3 which examines 'generativity theory' in design research and education. Section 4 introduces the GL paradigm, while Section 5 discusses few principles adopted from design research to account for assessment in the context of GL. I conclude with a summary of key points, and possible avenues worth investigating.

2 LIMITATIONS OF CURRENT ASSESSMENTS IN DESIGN EDUCATION

Current design higher education (HE) is calling for a new generation of designers: e.g., 'polymath interpolators', 'trailblazers', etc. To support these visions, Rodgers [4] identified three key changes required to occur: (1) changes in the design profession itself (discipline misinterpretation), (2) changes in the economic factors in the global market (employment and economic changes), and (3) rapid technological development within information and computer technology. However, instructional practices to support these changes and uncertainties are questioned, in particular, in the DE areas. Additionally, several DE experts, program directors, researchers acknowledge for instance that 'the best engineers are no longer good enough' [5] and that there is no second chance for transforming engineering education and training complex skills. With respect to these challenges, DE has several areas that require more in-depth consideration for the improvement of assessment.

2.1 Different assessment paradigms, assumptions, and methods

Assessment in HE has been through different traditions and assumptions. For instance, Serafini [6] identified 3 paradigms of assessment over the years: (1) the 'measurement paradigm', a longstanding tradition concerned with high-stakes, norm-referenced standardized testing; (2) the 'assessment as procedure' focusing on qualitative data collection to justify the measurement; and (3) the 'assessment as inquiry' that is a student-centred inquiry process for which assessment is part of the learning process. These paradigms are echoing three primary assessment concepts: 'assessment of learning' (AoL) associated with traditional assessment modes (e.g. summative testing), compared to 'assessment for learning' (AfL) and 'assessment as learning' (AaL) which support a more progressive, transformative, formative process [7]. Given the association with innovative approaches like collaborative learning and self- and peer-assessment, recent research has called for a shift to AfL and AaL [8].

Since adopting a single assessment method is not enough to determine competence acquisition, current design instructions mix assessments methods to map student learning, however, not without limitations such as the increase of assessment complexity [9]. Such mapping approaches are often sustained by two famous myths in educational assessments: the 'big data' measurement myth which is the belief that the increase of measurement aspects would improve the measurement point; and the opposite view, 'the silver bullet', acknowledges that there is no pertinence in combining multiple measurements, hence, relying on a single, generally high-quality outcome, to perform the assessment. Limitations remain, such as, for instance, the failure to capture holistic learning. As Ashwin mentioned, any silver bullet will bounce back against Goodhart's Law suggesting that once a measure is converted to a performance indicator it stops to be a 'good' measure [10].

2.2 Assessment in design project/problem-based learning

Learning in design can be of different types: formal, informal, and nonformal learning; making design assessment a truly complex instructional process. Among active instructional approaches, project/problem-based learning (PBL) is considered as a key pedagogy for design. PBL Assessment in design presents several challenges. Design is viewed as a complex, subjective, open-ended and ill-structured activity requiring the development of complex coordinated knowledge, skills, and attitudes (KSA), in a variety of aspects, that are crucial to a successful completion of a design task performance. Design students are expected to integrate and acquire multiple competencies such as decision making, problem-solving, management, and collaboration which appear to be hardly captured through traditional assessments. Given current advances in computing and non-invasive technologies, it is argued that design learning can be captured only if the learning is understood and there is constructive alignment between instructions, learning objective and assessment. As the result of a competency-based approach, PBL assessment is still highly summative-oriented relying on various design learning outcomes (LOs) while integrating the learners (self/peer-assessment). Sometimes, industry mentors are included to assess certain competencies that a faculty member cannot assess very well, such as the market value. Design supports the generation of multiple types of outcomes, processes, etc. Therefore, understanding generativity in the context of design and education assessment is essential.

3 GENERATIVITY IN DESIGN RESEARCH AND EDUCATION

'Generativity' is a paradigm which can take various forms. When discussed within the literature, the concept of generativity appears to mean different things to researchers from different areas. The concept of 'generativity' was introduced by Erikson [11] in the context of a theory of personality development

with the primary concern of guiding the next generation of individuals. It is addressed as a psychological construct that is situated in the psychology of individual lives considering key social challenges. What does it mean to be generative? From Erickson's psychosocial theory, one should strive to contribute to positive changes that benefit self and others, to avoid stagnation. This human-centricity is crucial for design as a collaborative and creative activity. Erickson originally centred his vision of 'generativity' on the achievement and development of children, but he also explained that the notion could include productivity and creativity in people.

The idea of generativity is also central to design science research which usually studies generativity in terms of the generative power of design theories, methods, and their 'generativeness', their robustness. From this line, Hatchuel et al. [12] view design science as 'the science of generativity'. There are now several design theories that support the paradigm of design as a generative process, i.e. its ability to produce novel solutions [13]. With the development of generative AI, in particular large language models (LLMs), design has taken a new shift in many ways. Broadly situated, the LLMs potential in design lies in enabling five key tasks: converting text prompts to design specifications, converting designs to manufacturing instructions, creating design spaces and variations, calculating performance, and exploring performance-based design solutions [14]. Additionally, in the early design phases, a student designer in need of better representations and appreciations of an imagined product can choose to visualise concepts in high fidelity without the need for prototyping or expertise in visualisation techniques, such as rendering, and to vary the aesthetics of those concept designs through chatbot-type interfaces. Although this is quite extensively used in design focused HE, not all educational systems have adopted this view. However, it is important for institutions to know how to better frame the use of GD to maximise the benefits and minimise the negative consequences.

4 GENERATIVE LEARNING: A NEW PARADIGM FOR DESIGN EDUCATION?

Learning can be viewed as a process of generation, integration, and coordination of knowledge, and their constituent skills and attitudes (KSA). Piaget [15] viewed this process as assimilation and accommodation. Assimilation refers to the *generation* of new ideas and concepts, i.e. knowledge structures (KSs), and their mapping into existing schemas; whereas accommodation implies learners modify existing schemata to the new *generated* KSs in memory. According to Epstein [16] generative behaviours result from an orderly, dynamic competition among previously established behaviours. From this perspective, generativity is not limited to creation but also extends to a dynamic integration of with existing KSs. Schön [17] called this theoretical shift a 'generative metaphor'. Furthermore, two key learning processes in complex learning are schema construction and automation [18], which can be seen as characteristics of complex GL processes. Learning happens when there is a change in long-term memory [19], therefore GL can be used to support this complex change. Generative people are found to be productive in different ways, including teaching and mentoring in real life [20].

What does this mean for design instruction? From a cognitive perspective, a meaningful learning experience is associated with the generation of relevant connections between KSs without which any assessment for learning seems irrelevant. From an educator perspective, and following Ball's [21] 'model of generative change', generative teachers "refers to the teachers' ability to continually add to their understanding by connecting their personal and professional knowledge with the knowledge that they gain from their students to produce or originate knowledge that is useful to them in pedagogical problem solving and in meeting the educational needs of their students" (p. 47). With this, Ball used the term 'generative change' to describe "a process of self-perpetuating change wherein a teacher's pedagogical practices are inspired and influenced by the instructional approaches and theory that he or she is exposed to in a professional development program" (Ibid.). Following this line, effective generative change occurs if both instructors and students engage in a mutual development. In this article, I use 'generative learning' to imply that change wherein instructors generate meaningful learning experiences for their learners who will be able to develop pertinent GL processes necessary to their educational and professional development. This being said, the question now is whether the generativeness of a well-structured knowledge system is established or not, and how to measure such generativeness.

As discussed earlier, the literature on assessment abounds with paradigms and contestations. Generally, four worldviews are referenced to how theories are used in assessment research: post-positivist (addressing the objective measurement aspect with criterion and psychometric research), interpretivist (addressing subjectivity in social interactions), critical-transformative (addressing how knowledge is

reshaped, reconstructed with respect to social issues), and practical perspective (concerned with making a difference in the assessment) [22]. A main concern is that critical theories are lacking (Ibid.). Given the lack of agreement in addressing assessment contestations and challenges, more research is needed that would help consolidate assessment practices. For instance, Forde-Leaves et al. [7] re-examined the assessment inquiry discourse with three key aspects: *autonomy*, *logic* and *basis of success*. They developed a framework, which, they argued, reconciles polarised positions on assessment practices that hampered the development of an integrated theory of assessment by showing complexities underlying them. However, this framework has not yet been tested to account for key contextual and social assessment aspects, especially in design education.

5 FEW PRINCIPLES FOR GENERATIVE LEARNING AND ASSESSMENT

In this section, I discuss a few assumptions for GL. Teachers are key to foster student learning. From this angle, Ball [21] investigated the development of educators' generative knowledge, and how they used this knowledge in their thinking about students and teaching. His model positions teachers as 'generative thinkers' able to address the challenges faced by their students through continuous change and development. Inspired by this model of 'generative change', key research principles for assessment of/for GL need to be explored.

5.1 Creative learning and assessment

A real flaw of the majority of current assessments in HE is that most are based on predetermined results, which makes it impossible to assess key skills such as creativity and critical thinking [23]. For instance, within design, creativity assessment (CA) methods such as criterion-referenced and/or norm-referenced assessment are often developed to compare the design LOs with standards and criteria, and with fellow learners, respectively, to set learner performance. However, even though holistic CA methods are lacking, subjectivity remains with rating inconsistencies and change/variety of the assessment interpretations. The measurement aspect needs to be improved, for instance, combining raters from diverse background and often specific expertise to measure creativity while mitigating inconsistencies through well designed criterion [24]. Future CAs need to address psychometric methods with suitable qualitative methods (e.g., user validity) assisted with think aloud verbal protocols for instance.

5.2 Traceability

Design is a complex, ill-structured activity, for which designers use their *knowledge-in-action* [25]. Therefore, an essential component of assessing designers' learning is understanding their action through traceability. Prior research suggested that learning and assessment should be visible components [26]. Sometimes instructors lack an understanding of the learning paths and outcomes when students come up with the designs. Additionally, as our models of human cognition are debated, and with respect to GL, traceability appears to be a highly valuable skill in GL practices. Traditionally, the assessment load falls on the instructors/mentors who may not always be aware of the individual and collective contributions of students as the result of PBL structuring. Even though self/peer-assessment is introduced to address this issue, the problem remains. Therefore, to reduce the assessment complexity, the assessee needs to highlight as much as possible for him/herself and the assessors, the design thinking, and the individual and collaborative generative actions/processes for the learning and performance to be appreciable. This is crucial especially for effective feedback. For instance, in interacting with generative tools, the Chatbot history is a mine of richness that can be exploited by both students and instructors with respect to the assessment. Therefore, a critical assessment theory advocates the traceability assumption for all reasoning from progressive to radical generative processes and outcomes.

5.3 Interactive feedback

Feedback is viewed as one of the most effective instructional approaches in classroom. As a basis of assessment, it has a powerful influence on learning [27] and is central to assessment. Drawing on sustainable assessment theory, Boud and Molloy [28] suggested we rethink our model of feedback for learning, shifting from a teacher-driven to a student-driven feedback approach. Some design instructors support the minimally feedback approach to students, while plenty of research have proven the importance of explicit instructions and feedback in learning. There is no effective generative change in learning without appropriate feedback. Additionally, the way through which, and the time when the feedback is provided matter and can affect the learning and assessment.

5.4 Critically transformative

An assessment should reflect its context to become a transformative force. In competency-based assessment, authenticity plays an important role for this transformation. Gulikers et al. [29] identified 5 dimensions of authentic assessment which are: the task (addressing whole learning experience as experts do), the physical context (reflecting the way expertise is used in professional practice), the social context (resembling the social processes in a real-life, professional situation), the result or form (related to the type and amount of output), and the criteria (addressing how you evaluate and requiring appropriate criterion-referenced judgments). Over the past decade, critical theories such as the 'transformative learning theory' were introduced to support adults' shift in frames of references, perspectives, and habits of mind [30]. This theory, for instance, posits learning as the process that transforms problematic reference frames, thereby increasing their inclusion, openness, reflection and emotional ability to change. With regards to design, students need to develop a deeper engagement in their reflective and reflexive actions within their GL. They often need to ask what is the value of the generated design outcome.

6 CONCLUSIONS

In this paper, I discuss the extension of a limited notion of 'generative design' to a more holistic concept of 'generativity' and 'generative learning' for DE practices and discuss their relevance. Inspired by Ball's 'model of generative change', I argue that design instructions can be viewed as a process of co-generation of KSA, behaviours, processes, etc. From this perspective, learning, when applied to DE, is this generative process in which students develop those actions. I review the notion of generativity and generative designing to see how they can be adapted to an instructional perspective, yet still considering key aspects of how teaching, assessment, and learning happen. Applying these notions in DE allows us to rethink of design as a GL process wherein assessment is the extent to which learners have generated meaningful learning experiences. The question of how such complex design learning is assessed is being asked. Few important assessment principles from literature are presented. The discussion sought to investigate whether framing a GL philosophy into a theory is appropriate or not for DE. In light of this, the paper opens an avenue for the investigation of GL processes involved in design, and the foundation for a new way of viewing design as a GL process of actions and behaviours. To account for a relevant theory, there is long way to go. Additional research is needed on the discussed assumptions. For instance, it is pertinent to challenge the notions described here through experimental research and to understand the positioning of this approach with respect to a suitable assessment framework as described in [22] for a critical theory of educational assessment consistent with generative design education. With the advance of assistive technology, mixed measurements methods can help explore the assessment perspective with respect to the GL processes.

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