CHAPTER 2

Design Pedagogy: Higher Education Possibilities for the Twenty-First Century

Aidan Rowe

INTRODUCTION

Higher education in the twenty-first century faces unique challenges, changing contexts, and opportunities (Birdsall, 1999; Tapscott, 2012). To respond to and address these issues academia has looked to incorporate a variety of new learning and teaching practices. Some common approaches that have been proposed include attempts to: increase interdisciplinary learning opportunities to address education across disciplines (Bear & Skorton, 2019; Klaassen, 2018); create increased collaborative learning situations enabling students to work with a wider range of people (Helfand, 2014) and; ensure students have experiential curricular learning experiences to ground and extend their education in meaningful situational contexts (University of Toronto, 2017).

A common factor in these identified approaches is that these learning practices—and others—have a long history and are commonly used within

A. Rowe (✉)
University of Alberta, Edmonton, AB, Canada
e-mail: aidan.rowe@ualberta.ca

design education. In this chapter, I argue that design pedagogy, particularly framed through what Davis (1998) terms Design-Based Learning (DBL), offers experience with unique teaching and learning practices to other, non-design areas in academia, and can serve as an inspirational educational model for the twenty-first century.

Design-Based Learning commonly employs a range of exciting, interconnected, robust, and needed learning and teaching practices that include:

- Students assuming a critical stance questioning existing practices and then responding;
- Learning through problem-focused scenarios;
- Employing a variety of alternative communication methods in the studio;
- Interdisciplinary and interprofessional learning opportunities where students work with other fields;
- Collaborative learning situations where students work with—not just for—other actors;
- Situating design as a future-oriented activity;
- Curricular and co-curricular experiential learning experiences that position education beyond the classroom;
- A focus on hands-on creation where students learn through doing; and,
- Framing design activity through a human-centred approach.

While common to Design-Based Learning these pedagogical practices are often at the cutting edge of other academic disciplines. This chapter begins by situating the author and the work and then articulating a broad overview of the changing space and needs of twenty-first-century higher education, it then describes how learning takes place within the design studio (the central location for Design-Based Learning). The paper then identifies and contextualizes nine characteristics found in Design-Based Learning. It concludes by recognizing the areas within design education that need further development.

It is hoped that by noting the unique practices and methods utilized in design education we are, first, able to recognize, reaffirm, build upon and further incorporate them into our pedagogical practices. Secondly, it also enables opportunities for a critique of DBL, recognizing strengths and

weaknesses in this model. And finally, it creates prospects to articulate the possibilities of applying them externally to other academic areas.

Importantly this interrogation allows us to ask questions about what and who we teach, but also larger questions of why we teach. If we conceptualize higher education in a broad sense—and after Simon's (1969) thoughts on design—as the "changing of existing situations into preferred ones" we must engage with the edges and the possibilities of our pedagogies (p. 130).

Situating the Author and the Work

Educated in both Canada and the UK, the author has taught design full-time for over 20 years in Canada, England, and Germany. Originally situated in visual communication design he has taught across a wide range of areas including industrial design, fashion design, service design, design for health, and visual communication design (and spaces in between). He has held positions in art and design colleges (UK), a technical university (Germany), and a large, research-intensive public university (Canada).

Increasingly he has worked in, and with, other academic areas integrating DBL practices in non-design academic areas including nursing, medicine, engineering, and public health. Importantly, this work has helped to inform and extend his teaching practice in design.

The possibilities discussed here—identifying practices found within design pedagogy that could benefit other academic areas—are grounded in his own experience. While these possibilities do not present a unified framework that is applicable to all areas, they do represent opportunities for interrogating design education and improving higher education pedagogies.

Changing Needs and Demands in Higher Education

Universities and colleges today face complex challenges, evolving contexts, and dynamic opportunities. To prepare for these challenges and to respond to them, a variety of learning and teaching requirements have been identified (and, in some instances, have been implemented).

The call for new pedagogical practices to address these needs is being driven by a range of factors including student demand, shifting industry wants, growing recognition of wicked problems, pedagogical

advancements, and broader societal and cultural shifts and requirements (Robertson, 2021; University of Toronto, 2017). What is broadly recognized though is that the traditional, siloed university learning model that is representative of much of contemporary higher education is outdated and ineffective at meeting the needs of the twenty-first century (Robertson, 2021; Thomas & Brown, 2009).

This call for change is not new though, the formative educational theorist John Dewey (1963) placed great importance on the learner's experience and active participation in the learning process (Schubert, 1996). More recently, in the 1960s, Canadian media theorist Marshall McLuhan (with Fiore, 2001) questioned the traditional, top–down specialist pedagogy model declaring "[e]ducation must shift from instruction … to discovery—to probing and exploration" (p. 100). In 1972, the polymath Erich Jantsch noted the growing complexity of the world, stating that there is a need for "a type of education which fosters judgement in complex and dynamically changing situations" (pp. 101–102). More recent pedagogic research supports this broader shift.

For example, recent work has (re)enforced the (re)declaration of creativity, innovation, and critical thinking as crucial skills for twenty-first-century students, abilities needed to prepare for a future that will be characterized by continually shifting demands, relationships, ecologies, and workplaces (Rampersad & Patel, 2014). Egan et al. (2017) describe these skills as "key to effective learning in higher education and beyond" (p. 21). McLaughlan and Lodge (2019) reinforce this claim, noting that graduates entering "professions in the twenty-first century will require an enhanced capacity for innovation and adaption to change" (p. 1). Thomas and Brown (2009) declare that the one defining feature of this century is that it will be "characterized by constant change" and that these skills are foundational for future students (p. 1).

The need for experiential learning has also been recognized as a crucial pedagogical opportunity for students. Experiential learning—falling under numerous names including co-ops, practicums, work experience, community-service-learning, work-integrated learning, amongst others— creates genuine learning opportunities for students—often outside the classroom—that locates and broadens their studies in meaningful environments (Schubert, 1996). Students can apply their learning in new, external situations while also building skills to work meaningfully with partners and collaborators. Eyler (2009) states that this "helps students both to bridge classroom study and life in the world and to transform

inert knowledge into knowledge-in-use". And while forms of experiential learning are more common in vocational or professionally oriented programmes they are not as pervasive in more traditional areas of the university system (Eyler, 2009).

Growing opportunities for students to learn between and across disciplinary and functional boundaries have also been identified as a crucial area that needs further development (Jamieson et al., 2022). These opportunities enable students to "understand and make connections across a diverse array of knowledge and skills, they embark on a path to more rewarding lives and employment opportunities" (Bear & Skorton, 2019, p. 60). Relatedly, students need the further possibility of learning and collaborating with a range of partners and collaborators (in and out of university settings) that cross professions, histories, and futures. These collaborative pedagogical opportunities help to put learning "into a situated context that deals with systems and identity as well as the transmission of knowledge" (Thomas & Brown, 2009, p. 1).

In addition to working across boundaries and collaborating with a range of partners, students need meaningful opportunities to consider issues surrounding globalization and culture (Rowe, 2013). In a continually connected world that crosses borders and continents, educators need to structure learning that addresses broader conceptualizations of culture and globalization including asking questions of longstanding inequities and continued imbalances. As Robertson (2021) asks, how "we might insert the idea of the global and the development of global competences, into teaching and learning" (p. 2).

Learning focused on expanded and extended forms of communication is also needed today. Traditional academic settings often rely upon specific and established forms of communication models—often replicating the instructor's own learning experiences (Canniffe, 2018). Frequently these are formal, traditional, and summative, and while these forms are still important there is also a need to expand the opportunity for students to gain a broader range of communication skills that embrace different technologies, audiences, futures, and needs, so that students are, as Parker (2009) notes "encouraged to think more laterally about the sites and spaces in which those skills could be used" (p. 15).

There has also been an increasing focus on recognizing the growing scale and complexity of social system problems faced in the twenty-first century. These problems span disciplines, are ill-formulated and pernicious, and there are no simple solutions. Often these are termed "wicked

problems" (Rittel & Webber, 1973) and they can serve as a big idea curricular framework in higher education. The growing use of the United Nations Sustainable Development Goals (2015) in education settings offers similar opportunities, where students address issues that do not sit within established disciplinary boundaries (e.g. climate action, gender inequality, etc.) and that require collaboration and innovative forms of thinking and doing.

These identified the twenty-first-century educational needs, while not an exhaustive list, help to articulate the changing spaces of higher education. Additionally, they document the need to develop and implement innovative learning practices to help address these challenges and embrace the opportunities presented. As Thomas and Brown (2009) note, for educational institutions to take advantage of these opportunities the pedagogical response needs "to be as rich and complex as the challenges and opportunities we face" (p. 15).

The Design Studio: A Brief Overview

Design education, particularly that which is practiced in a studio setting, offers a range of unique pedagogical practices. Shulman (2005) defines the shared pedagogical practices found in the design studio as a form of "signature pedagogy" in that they are "pervasive and routine, cutting across topics and courses, programs and institutions" (p. 56).

The studio setting usually involves a smaller cohort learning environment, typically between 12 and 20 students, that meet for longer periods (e.g. six hours per week, sometimes broken up into smaller bi-weekly blocks) than traditional university courses. The studio blends problem and inquiry-based learning using a "cognitive apprenticeship model" with a focus on design-based responses to identified challenges, briefs, and problems (McLaughlan & Lodge, 2019, p. 4). Importantly, briefs are broad and often loosely defined, ensuring students have an opportunity for further research and refinement.

Students may work formally in groups on briefs, or individually, and the studio is a highly collaborative environment with near-continual discussion, observation, feedback, and contribution. Feedback may be delivered individually (instructor to student) and during class, or, through a public (within the class) presentation called a critique (crit). Often, within a crit an instructor may take the lead in providing feedback, students may be called to introduce their work, and additionally, they may

be required to critique the work of fellow students. There is a focus on constructive feedback, where comments are actionable and address areas to improve. Importantly, feedback given at these stages is often formative, enabling opportunity for reflection, refinement, and improvement through iterative development. This situating of constructive failure as a central component of the studio is fairly unique in comparison to the majority of higher education environments, where "failure is viewed negatively and curricula are specifically designed to mitigate the risk of student failure" (McLaughlan & Lodge, 2019, p. 5).

Characteristics of Design-Based Learning

Design-Based Learning offers a range of unique and specific practices that collectively present design pedagogy as a distinctive educational experience within the university. Davis (1998, p. 7) articulates the benefits of DBL particularly in regard to current challenges, noting that in DBL we "find dynamic examples of learning and problem-solving perfectly suited to an environment of ever-expanding information, diverse citizen needs, and great uncertainty created by the failure of traditional problem-solving models". Building on the notion of signature pedagogies, Shulman (2005, p. 54) notes the collective nature of these prevalent and unifying practices (across programmes, schools, and even countries) and that they "implicitly define what counts as knowledge in a field and how things become known". While many of these individual characteristics may be found in the learning practices of other academic disciplines—for example, nursing, computer science, or engineering—the collective nature presents a unique and important educational exemplar. Importantly, many of the teaching and learning practices located within Design-Based Learning address identified needs of students, the modern university, and society.

The characteristics listed above are neither exhaustive nor compulsory nor are they as individual as noted, they often weave together, supporting and extending one another. Different programmes, schools, or sub-disciplines within design might focus on some more than others, just as others may be more tangential. In some form or other, they appear in Design-Based Learning.

Central to design education is the requirement for students to assume a critical stance, where they question existing practices and then respond to them. This criticality is applied to both existing situations and artefacts

(Why was this done? Could we do this?) in addition to their work and the work of fellow students (Does this work? How could this be better?). Postman and Weingartner (1969) refer to this as developing the anthropological perspective in students, so they can both exist in a culture and separate themselves from it to critique it. McLaughlan and Lodge (2019) describe the process of students applying criticality to their work (and that of classmates) as a form of Socratic dialogue, helping them to identify and externalize opportunities and weaknesses of their work. This iterative process of making, assessing, reflecting, and making again is central to design pedagogy.

Learning through problem-focused scenarios facilitates opportunities for students to play an active role in creating alternate futures in response to identified situations. Historically—and, too often currently—design is framed as a problem-solving discipline, where a specific problem is presented to a designer (or design students) and they respond, presenting their solution. The shift from problem-solving to problem-focused (also called problem-based, problem-finding, or problem-seeking) moves the process from a passive (receiving the brief) to an active (creating the brief) learning environment, where students have the opportunity to better understand "the very constraints and conflicting requirements that make problems difficult" (McLaughlan & Lodge, 2019, p. 7). Importantly, Marenko and Brassett (2015) note that this shift enables the design process to focus on invention rather than attempting to reveal solutions that may already exist.

Design-Based Learning also employs a variety of communication and presentation methods. While learning in the studio employs many traditional academic modes of teaching—e.g. lectures, presentations, etc.—it also employs a range of unique practices that blur the line between instructor and student. These include crits, where instructors and students constructively critique the designed artefact (whether product, system, or service), this is often a formative exercise where there is a later opportunity for students to refine their work. As students work together in the studio on the same project there are official and unofficial forms of co-learning taking place at all times, from the casual observation of a fellow student's work, direct discussion of the brief, and asking for feedback and guidance. As Shulman (2005, p. 54) notes "[s]tudents are experimenting and collaborating, building things and commenting on each other's work without the mediation of an instructor". The instructor is also circulating around the studio checking in individually with students and providing

personalized guidance and feedback. While the instructor is clearly in charge of the class, learning and teaching are taking place at many levels and from many sources. Shraiky and Lamb (2013, p. 467) describe this rich environment as offering a mix of "problem-based, action-based and practice-based learning".

Design is a multidisciplinary profession and design education fosters this through interdisciplinary and interprofessional learning opportunities where students work with other disciplines and fields in a variety of roles (Cheatham, 2017). There is a growing recognition of the need for genuine interdisciplinary experience, particularly driven by the growing complexity of societal issues that design has the opportunity of addressing (Friedman, 2012). These interdisciplinary opportunities take a variety of forms within design education including pathways or streams allowing design students to work with students in other areas (e.g. engineering, computer science), to courses designed around thematic challenges (i.e. big ideas), or external briefs where students might work with a collaborating partner. Design education also enables opportunities for interprofessional learning where students from different disciplines model collaboration and learning within an educational setting helping to establish good working practices for later professional life (Buring et al., 2009).

Collaborative learning situations are a key feature of Design-Based Learning, where students work with—not just for—other actors (fellow students, users, collaborators, etc.) throughout the design brief. These collaborative learning scenarios ensure that students are interactive, and importantly, as Shulman (2005) notes, create extended forms of co-accountability, where students are responsible to their peers and not just their instructors. Davis (1998, p. 9) notes that design is a social, and not an individual, activity, and that responsibility for its outcome is shared "with the audiences who make meaning of it through its use". The range of collaborators is also important as students gain an opportunity for negotiation, relationship building, and the modelling of future roles helping to prepare them for life after graduation. At full realization, this collaboration occurs throughout the whole of the learning process from problem identification, to joint work on the iterations, to students partaking in forms of assessment, both formative and summative, Shraiky and Lamb (2013, p. 462) note that as most evaluative processes are public in DBL, "students become participants in the evolution and improvement of each other's work".

Design—and by extension design education—is a future-oriented activity, one that imagines and brings to life that which does not yet exist, and as Ward (2015, p. 229) notes this allows us to "push the boundaries of knowledge", design has a crucial role—and opportunity—to play in bringing social, political, and environmental change to life, and it is not only concerned with the "creation and materialisation of possible worlds, but also a way of thinking and critically responding to current issues and concerns" (Marenko & Brassett, 2015, p. 4). Designers occupy a space between what is today and what will be tomorrow. In a time of nearly constant change, where the world seems to be continually speeding up, the ability to both imagine new futures and bring them to life is a critical and needed skill.

Curricular and co-curricular experiential learning experiences that situate education beyond the traditional classroom (e.g. client-based briefs, community-engaged learning, etc.) have long been a feature of Design-Based Learning. While these learning opportunities fall under a variety of names—from co-ops to work-integrated learning to practicums—design education incorporates these learning experiences within the overall curriculum enabling learners to interact with the world and, importantly, to integrate "new learning into old constructs" (Eyler, 2009, p. 24). Importantly, there has been growing recognition within higher education of the power and possibility of these learning opportunities, for example, a University of Toronto (2017, p. 2) white paper noted that growing its experiential learning opportunities would "collectively enhance both the student learning experience and the University's ability to support broader community and societal needs".

Central to Design-Based Learning is a focus on learning through hands-on creation and making. The process of making is a thread running through an entire project, with various stages of creation taking place, and this iterative process—where a designer makes anew and improves upon previous versions—is central to studio activity. It needs to be emphasized that making is a form of learning, a way to understand and construct knowledge, and not just a final expression of that learning (Davis, 1998). We see the value of the experience of making also articulated in educational theories around constructionism where it is argued that knowledge is constructed through real-life experiments that enable learning and "pairing abstract concepts with concrete experiences to make

sense of knowledge" (Loh, 2018, p. 139). Ward (2015, p. 229) power-fully describes this when he notes the unique role that design has in the academy, that we "make things, to make sense of the world".

We have also seen recognition of the power and intrigue of making and hands-on creating taking place through the popularization of makerspaces—sometimes called hackerspaces, fab labs, or garages. These spaces are often embedded within educational settings—sometimes in a library, otherwise freestanding—giving access to a variety of tools and systems (Pendergast, 2020). Benefits and possibilities include increased engagement in learning, addressing issues of belonging and equity, iden-tity development, and opportunities for students to learn how to learn (Nadelson, 2021).

Finally, design—as a discipline and pedagogy—is most successful when framed through a human-centred approach where there are genuine opportunities for designing with those we design for. Historically, design that looks to involve end-users in the process has fallen under many titles—participatory design, co-design, user-centred design, etc.—but all recognize that working with—and, not just for—other humans throughout the design process helps to ensure the validity, appropri-ateness, and possibility of design responses (Buchanan, 2004; Noël, 2017).

As noted, the characteristics identified above are neither exhaustive nor required within Design-Based Learning, but this list captures much of the teaching and learning activities that take place in design pedagogy. Identi-fying its key practices creates an opportunity for educators to interrogate these methods, celebrating their characteristics and possibilities but also allowing the opportunity for critique, revision, and improvement.

Work to Be Done: A Concise List

It is important to note that there are many areas within design educa-tion—as in any academic discipline—that require interrogation and improvement (Frascara, 2017; Friedman, 2012). For example, design pedagogy often suffers from a focus on the aesthetics and form rather than the outcomes—how well it works—of the products, systems, and services designed. Cheatham (2017, p. 76) notes that design education models that "focus primarily on form-giving are too ideologically narrow or practically inflexible to address" the complexity of challenges today. Thiessen (2017, p. 148) also notes the need for design to shift away from

what she terms "prioritizing the object" to a broader consideration of design processes and outcomes.

Related, there needs to be further work establishing more rigour in research methods and practices in design education. As discussed in previous work (Rowe, 2020, p. 51), design is a fairly recent addition to academia, and as such it often lacks its own "formal, established research frameworks and theoretical practices". Often, within current design education, research involves a superficial visual collection of existing practice—a reinforcement of Thiessen's "prioritizing the object" (2017, p. 148); there needs to be more work establishing solid research practices, possibly looking to other disciplines and fields—for example, psychology, anthropology, and ethnography—for models.

A third area needing progress is aligning design education with a more culturally and socially responsible practice. Design—as professional practice—has a long history as an artefact–based, consumer-focused, reactive profession and work was often lacking broader considerations of cultural, social, and ecological impact (Margolin & Margolin, 2002; Papanek, 2006). Linked to, and building upon the previously identified needs, further interrogating design education with regard to its cultural and social effects and possibilities is crucial (Burns et al., 2006). There is also a critical need to build upon more recent and important work exploring decolonizing design (for example, the work of Dori Tunstall). Furthering this, Irwin (2016, p. 91) argues that design and its powerful approach to addressing problems can "serve as a catalyst for positive social and environmental change".

Continued work in these areas—and there are others—is needed in design education today, and while there are exemplar programmes and individuals, further effort is needed. As Noël (2020, p. 6) notes the knowledge, models, and exemplars exist to strengthen design pedagogy, what is needed is "a solid implementation strategy to make the change real".

Conclusion

There have been consistent calls for change in higher education teaching and learning practices to address a world of "infinite complexity, endless possibility, and near constant change" (Thomas & Brown, 2009, p. 15). These demands come from many areas including faculty, industry, society, governments, and most importantly, students. Identified

responses include a variety of new and enhanced teaching and learning practices including creating learning environments that embrace collaboration and interdisciplinarity; embedding rich experiential learning opportunities within the curriculum; and, employing a problem-based learning paradigm to encourage active, engaged learning (Bear & Skorton, 2019; Canniffe, 2018; University of Toronto, 2017).

While many of these pedagogic practices are more recent to the majority of academia, they—and other needed practices—have a long history in design pedagogy, particularly as described by Davis (1998) as Design-Based Learning. I have argued here that DBL offers experience with these teaching and learning practices to other areas of the university.

Key pedagogical practices that are found in Design-Based Learning include learning situations framed through a critical stance; employing problem-focused design scenarios; using a range of alternative communication methods in the studio; embedding interdisciplinary and interprofessional learning opportunities often within collaborative and curricular and co-curricular experiential learning situations; and framing design as a hands-on, future-oriented, and human-centred activity.

Naming these practices allows us—as design educators—to further investigate how and where we employ them in our teaching and learning practices. Importantly they also enable opportunities for critique and refinement, recognizing both the possibilities and limitations offered. These practices from Design-Based Learning are not a panacea to address the growing complexity of the twenty-first century, but they do create the prospect for other academic areas and disciplines to look to practices with DBL as inspiration and evidence of effective learning strategies to help educate students to thrive and lead in the twenty-first century.

As Thomas and Brown (2009, p. 15) state there is a stark need to interrogate not only what and who we teach but also why, and that "our approach to education and learning needs to be as rich and complex as the challenges and opportunities we face". Design-Based Learning offers a history of "curricular innovation, proven pedagogy, and student achievement" that places design pedagogy at the centre of higher education's needed transformations (Davis, 1998, p. 13).

References

Bear, A., & Skorton, D. (2019). The world needs students with interdisciplinary education. *Issues in Science and Technology, 35*(2), 60–62.

Birdsall, N. (1999, September 14). *Education, globalization and demands of the 21st century*. Carnegie Endowment for International Peace. https://carnegieendowment.org/1999/09/14/education-globalization-and-demands-of-21st-century-pub-44

Buchanan, R. (2004). Human-centered design: Changing perspectives on design education in the East and West. *Design Issues, 20*(1), 30–39.

Buring, S. M., Bhushan, A., Brazeau, G., Conway, S., Hansen, L., & Westberg, S. (2009). Keys to successful implementation of interprofessional education: Learning location, faculty development, and curricular themes. *American Journal of Pharmaceutical Education, 73*(4), 60.

Burns, C., Cottam, H., Vanstone, C., & Winhall, J. (2006). *Transformation design*. Design Council. www.designcouncil.org.uk/red

Canniffe, B. J. (2018). US design education prepares for careers in the past, is standing on the edge of the abyss, looking away and singing kumbayah. *Graphic Design Journal, 7*, 7.

Cheatham, D. M. (2017). A multiple intelligences model for design: Developing the ways designers think as design disciplines expand. *Dialectic, I*(2), 75–100.

Davis, M. (1998). Making a case for design-based learning. *Arts Education Policy Review, 100*(2), 7–15.

Dewey, J. (1963). *Experience and education: The Kappa Delta Pi Lecture Series* (First Collier Books Edition). Collier Book.

Egan, A., Maguire, R., Christophers, L., & Rooney, B. (2017). Developing creativity in higher education for 21st century learners: A protocol for a scoping review. *International Journal of Educational Research, 82*, 21–27.

Eyler, J. (2009). The Power of Experiential Education. *Liberal Education, 95*(4), 24–31.

Frascara, J. (2017). Design, and design education: How can they get together? *Art, Design & Communication in Higher Education, 16*(1), 125–131.

Friedman, K. (2012). Models of design: Envisioning a future design education. *Visible Language, 46*(1), 132–153.

Helfand, D. (2014, February 5). We evolve, but the university stands still. *The Globe and Mail*. http://www.theglobeandmail.com/news/national/education/we-evolve-but-the-university-stands-still/article16689680/

Irwin, T. (2016). Redesigning a design program: How Carnegie Mellon University is developing a design curricula for the 21st century. *Solutions, 6*. https://thesolutionsjournal.com/2016/02/22/redesigning-a-design-program-how-carnegie-mellon-university-is-developing-a-design-curricula-for-the-21st-century/

Jamieson, M. V., Ead, A. S., Rowe, A., Miller-Young, J., & Carey, J. P. (2022). Design at scale in a first-year transdisciplinary engineering design course. *International Journal of Engineering Education, 38*(1), 14–24.

Klaassen, R. G. (2018). Interdisciplinary education: A case study. *European Journal of Engineering Education, 43*(6), 842–859.

Loh, P. (2018). Making as pedagogy: Engaging technology in design teaching. In N. Llevot-Calvet & O. B. Cavero (Eds.), *Advanced learning and teaching environments—Innovation, contents and methods* (pp. 137–155). InTech.

Marenko, B., & Brassett, J. (eds.). (2015). *Deleuze and design*. Edinburgh University Press.

Margolin, V., & Margolin, S. (2002). A "social model" of design: Issues of practice and research. *Design Issues, 18*(4), 24–30.

McLaughlan, R., & Lodge, J. M. (2019). Facilitating epistemic fluency through design thinking: A strategy for the broader application of studio pedagogy within higher education. *Teaching in Higher Education, 24*(1), 81–97.

McLuhan, M., & Fiore, Q. (2001). *The medium is the massage: An inventory of effects*. Gingko Press.

Nadelson, L. S. (2021). Makerspaces for rethinking teaching and learning in K–12 education: Introduction to research on makerspaces in K–12 education special issue. *The Journal of Educational Research, 114*(2), 105–107.

Noël, G. (2017). Health design: Mapping current situations, envisioning next steps. *The Design Journal, 20*(sup1), S2304–S2314.

Noël, G. (2020). We all want high-quality design education: But what might that mean? *She Ji, 6*(1), 5–12.

Papanek, V. (2006). *Design for the real world: Human ecology and social change*. Thames & Hudson.

Parker, S. (2009). *Social animals: Tomorrow's designers in today's world*. RSA Design & Society.

Pendergast, S. C. (2020). *Makerspaces in higher education: Student engagement*. University of Calgary.

Postman, N., & Weingartner, C. (1969). *Teaching as a subversive activity*. Dell Publishing.

Rampersad, G., & Patel, F. (2014). Creativity as a desirable graduate attribute: Implications for curriculum design and employability. *Asia-Pacific Journal of Cooperative Education, 15*(1), 1–11.

Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*, 155–169.

Robertson, S. L. (2021). Global competences and 21st century higher education—And why they matter. *International Journal of Chinese Education, 10*(1), 221258682110103.

Rowe, A. (2013). Design pedagogy and cultural interrogation: Considering the international and the anthropological. *Design Principles and Practices an International Journal: Annual Review, 6*, 12.

Rowe, A. (2020). Participatory action research and design pedagogy: Perspectives for design education. *Art, Design & Communication in Higher Education, 19*(1), 51–64.

Schubert, W. H. (1996). Perspectives on four curriculum traditions. *Educational Horizons, 74*(4), 169–176.

Shraiky, J. R., & Lamb, G. (2013). Studio-based learning in interprofessional education. *Journal of Interprofessional Care, 27*(6), 461–468.

Shulman, L. S. (2005). Signature pedagogies in the professions. *Daedalus, 134*(3), 52–59.

Simon, H. A. (1969). *The sciences of the artificial*. MIT Press.

Tapscott, D. (2012, October 15). Discovery learning is the new higher learning. *The Globe and Mail*. http://www.theglobeandmail.com/news/national/time-to-lead/discovery-learning-is-the-new-higher-learning/article4610656/

Thiessen, M. (2017). I don't know, I just like it: Exploring how design students think about criticism. *Art, Design & Communication in Higher Education, 16*(2), 145–156.

Thomas, D., & Brown, J. S. (2009, June). *Learning for a world of constant change: Homo Sapiens, Homo Faber & Homo Ludens revisited*. 7th Glion Colloquium, Los Angeles, University of Southern California.

United Nations. (2015). *THE 17 GOALS|Sustainable development*. https://sdgs.un.org/goals

University of Toronto. (2017). *Rethinking higher education curricula: Increasing impact through experiential, work-integrated*. University of Toronto.

Ward, M. (2015). Rapid prototyping politics: Design and the de-material turn. In W. Jonas, S. Zerwas, & K. von Anshelm (Eds.), *Transformation design: Perspectives on a new design attitude* (pp. 227–245). Birkhauser.