THE DIGITAL DESIGN BUILD

Modes of Experiential Learning in the Pandemic Era

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Abstract. In recent years, academia has deviated from the lecture-based model to a hybridized system of instruction and experiential learning. Experiential learning aids students in understanding collaborative processes in architectural praxis and exposes them to engaging learning opportunities, a critical component of architectural studio education (Nijholt et al. 2013). During the COVID-19 outbreak, students are barred from accessing on-campus facilities. This causes a redevelopment of curricular delivery and disrupts experiential learning which heavily relies on in-person interaction. It is imperative for instructors to retain experiential learning in the transition to virtual instruction. This paper explores experiential learning within virtual platforms for instruction. Through outlining the implementation of technologies, capitalizing on connectivity, and maximizing opportunity for digital problem solving, the authors posit a framework that other educators may adopt. The paper concludes with a case study of a virtual design-build project, and the various techniques implemented in retaining experiential learning during the pandemic.

Keywords. Pedagogy; Experiential learning; Social connectivity; Resilience; Disrupted education.

1. Introduction

Experiential learning has proven to expose students to engaging and rewarding hands-on learning opportunities while also providing them platforms for applications of design thinking that develop over the course of their studies (Nijholt et al. 2013). With social distancing dramatically altering curricular delivery in most architectural institutions worldwide, the lack of contact and hands-on learning has not only created a knowledge gap, but also has dramatically reduced students' engagement in curricular learning. By critically examining conventional pedagogical models and current pandemic experiments, architectural education during these unprecedented times may be enhanced for the sustainability of the practice and quality of learning environments. Along with presenting some key strategies for implementation such as capitalizing on international connectivity, advancing emerging technologies, transporting instruction outside the digital

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classroom, and maximizing opportunity for digital problem solving, the paper examines several examples from Canada's largest architecture program, focusing on modes and alternative methods of experiential learning via virtual platforms during the COVID-19 pandemic.

2. Experiential Learning in Architectural Education

Experiential learning derives from the act of doing or experiencing (Lewis and Williams 1994). The learning tactic is meant to immerse students within methods of education that focuses on the development of new skills and manners of thought in the reflection of 'doing' (Lewis and Williams 1994). Experiential learning focuses on techniques of performance, practice and experimentation that allows students to cognitively understand the implications of their learning subjects in a real-world and meaningful format (Lewis and Williams 1994). Within the context of architectural education, experiential learning is more interactive and engaging than reading, writing, or hearing about design and its concepts. These activities would include field projects, physical construction, and other methods that demand a high level of thinking, analysis, and knowledge in order to carry out activity and ensure success of the project (Kolb 2014). Kolb's Experiential Learning Theory (ELT) involves Reflective Observation, Active Experimentation, Abstract Conceptualization, and Concrete Experience (Hui et al. 2018). While Concrete Experience is essential to experiential education during the pandemic, students are limited in its traditional applications and experimentation. Rather than be mired in a lack of facilities and resources, by taking advantage of digital workflows at home, students are exposed to expanded methods of learning as technology provides opportunity to experiment with design through efficient sharing of ideas that help translate architectural thinking into a tangible reality (Hui et al. 2018). According to Kolb, lifelong learning is derived from experiential learning which exposes students to unique situations of problem-solving, activity, and collaborative environments (Kolb 2014). In the context of the multi-faceted topic of architecture, these areas of education retain the greatest fidelity to the core of the praxis as it addresses constructability, team design processes, cost mediation, model experimentation, and more.

3. Experiential Learning Techniques during Remote Instruction

Due to the COVID-19 pandemic, most post-secondary institutions closed their campuses and transitioned to online learning (Silverman et al. 2020). While access to workshops, and in-person collaborations are restricted during the work from home paradigm, the fundamentals of architectural education can be maintained through the adaptation of current curricula and a focus towards an experiential approach to pedagogy. No longer endowed with access to advanced digital fabrication and simulation facilities on-campus, students are challenged to reduce their idea into its most basic components to develop experimentation techniques that are possible to conduct at home while extremely effective in the learning process.

3.1. ACCESS TO VARYING EXPERIENCES AND CAPITALIZING ON INTERNATIONAL CONNECTIVITY

In order to retain a positive learning atmosphere for the students, it is crucial for a variety of experiences to be offered to the students, both within the virtual classroom and through extracurricular initiatives. Such experiences range from the incorporation of guest lectures within course environments, virtual site visits, and individualized learning opportunities for students. To diversify perspectives and draw upon a practical commentary into pedagogy, instructors can begin to incorporate more diversity inviting guests as both reviewers and lecturers. Capitalizing on the opportunity brought about by the lack of a physical learning environment invites a great variety of previously unavailable individuals, due to distance, timing and subject matter. For instance, for a studio with a focus on developing resilient architectural solutions in the COVID-19 pandemic, guest reviewers included medical specialists with the most up-to-date factual information and insight on the subject. Similarly, many industry professionals find themselves with a more flexible daily schedule, thereby increasing the opportunity for professional expertise to play a part in pedagogical discourse. On several occasions, industry experts were invited to give students guidance in their respective areas of skill. Such visits ranged from tutorials given by local visualization firms on the development of architectural renderings, to international firms shedding light on their approaches to modular construction.

3.2. IMPLEMENTATION OF EMERGING TECHNOLOGIES

As education turns to technology, new methods of representation and experience are revealed to enhance the learning experience. Although the conventional typical forms of course delivery during the pandemic have consisted of video conferencing with a slide-by-slide narrative, this format reduces the student from an active participant in their education, to a passive observer. More engaging ways of communication become crucial in retaining students' interest allowing them to contribute in more significant capacities. Such means involve turning to more technologically driven methods, which include the incorporation of varying media into education going beyond videos and imagery. Instead, the focus is on interactive media such as the use of video games and virtual reality (VR).

Video games share several commonalities with the architectural design process such as involving graphical representation, narration of architectural ideas, and collaborative teamwork (Di Mascio 2017). They also demand an interactive approach, where to understand how to 'play', users and designers must have active participation (Di Mascio 2017). The first objective of expressing ideas through video games is to immerse players in a world that is believable, evoking emotions, curiosity, and exploration, that may be indistinguishable from real experiences (Di Mascio 2017). Therefore, the use of video games as an expression of architectural education is an asset to experiential learning during the pandemic through its ability to narrate ideas, manipulate perspectives of design, and demand for details and research to be effective.

The reference of historical architecture in video games requires incredible

detail for the representation of construction, systems, and materiality (Di Mascio 2017). The involvement of existing architecture in video games to develop a contextual understanding of projects requires thorough knowledge and research on the behalf of the students that may otherwise not have been explored given the restrictions to visiting sites during the pandemic. Not only is the player able to navigate through reconstructed architecture and urban environments (of varying fidelity), but they are also able to experience the social context of the buildings and how they were originally occupied, enhancing their understanding of the urban fabric as a whole. The understanding of historical architecture and the construction of buildings through the lens of video games allow for a simulation that will enhance experiential learning and thus the expression of architectural ideas. Video games can simulate the visual appeal of cities and atmospheric quality, approaches to the cityscape, and other details that express the designer's intentions (Di Mascio 2017). The development of a video game in architectural education allows students to thoroughly understand the implications of its existing counterpart from conceptual to technical stages of its design, and even further beyond the concrete experience of the city by the implementation of their own ideas and narration of the world (Di Mascio 2017). For example, in a second year architecture studio, students were directed to examine the fidelity between construction methods of various commercial buildings including the Washington State Convention Centre in Seattle and the design of structural systems in their own performance hall designs.

VR environments allow for students to experience their projects from a participatory means rather than as an exterior observer. Incorporation of VR into pedagogy presents itself on a variety of levels, from the inclusion of interactive virtual field trips (iVFTs) where historical and distant locations and architecture are examined using VR photographs and videos as an alternative to images which are less personally engaging for the students (Tawhai, 2017). For instance, during school trips, students are able to document their excursions through 360° photography and subsequently re-examine the spaces, as well share the experiences with others (Hui, Estrina, Lee, Zhou, & Kinuthia, 2020).

In VR, students are given the opportunity to occupy the spaces they design, thereby taking hypothetical environments represented through orthographic imagery and scale models into 'real' occupiable spaces. Although VR is most typically used in architectural pedagogy through the use of expensive VR headsets for the representation of student's unbuilt work, there are a variety of alterative means of engaging virtual environments. Due to the COVID-19 pandemic, students find themselves scattered throughout the world, and most frequently lack access to the hardware required for navigable VR operation, which are often prohibitively expensive (Snigh, et al., 2020). However, through the implementation of much more affordable solutions such as Google Cardboard, students are able to still interact virtually from their homes. The majority of popular rendering software such as Twinmotion, Enscape, Yulio, and V-Ray allow for not only navigable VR experiences, but also the creation of 360° imagery and videos for students to easily view on their mobile devices (Hui, Estrina, Lee, Zhou, & Kinuthia, 2020). In addition, the aforementioned software packages are able to

generate desktop-based playable environments, placing the student's model into an environment similar to that of a video game. Through this interface, faculty and students alike are able to navigate through student's projects easily and freely without the need for expensive hardware.

3.3. TRANSPORTING INSTRUCTION OUTSIDE OF THE DIGITAL CLASSROOM

Due to restrictions of material resources and access to workshops, students can continue to develop and experiment with physical models by producing smaller scale elements with more common materials. This sustains the experiential learning aspect of sketch and final models in the architectural design process by demonstrating how large projects may operate on a miniaturized level. Through an assignment that involved students to propose designs of light fixtures, physical models were created using stationary materials and techniques such as the use of corrugated cardboard and paper in modular forms. This approach to design during the pandemic provides an alternative but effective approach to construction without the necessity of workshop machinery or complex materials. By simplifying architectural ideas in these sketch models, students are able to have a more direct representation of their design, develop a stronger grasp of the necessary components of their concept, and maintain the experiential learning component of the design process.

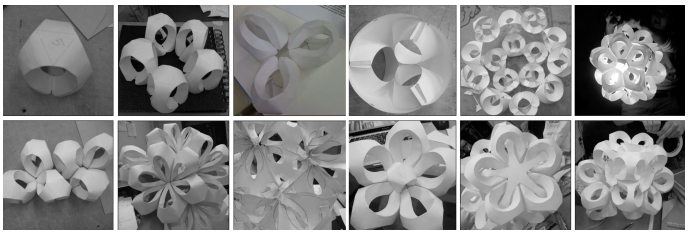

Figure 1. Paper models for light fixture project.

In another example, a student's independent study initiative with the involvement of memory shape alloys, led the student to design an installation proposal incorporating 3D motion using these wires. Although the student was unable to fabricate their entire proposal due to workshop access restrictions, they conducted a full-scale testing as both a means to experiment and as a proof of concept. Through this process the student was able to, with very little access to resources, problem solve and learn from the fabrication and testing process.

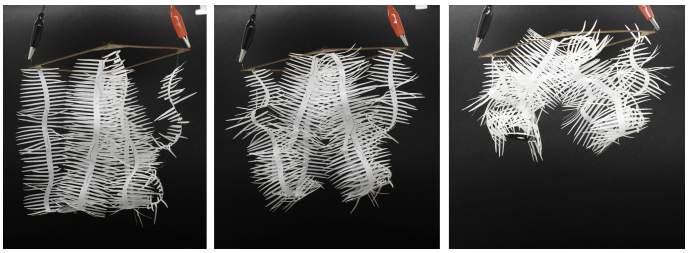

Figure 2. Students' experiments with memory shape alloys.

A common pedagogical paradigm in architectural education is to undertake design projects that simulate design-builds but do not conclude with physical construction of the project itself. Through this process, students experience the procedure of composing an architectural structure that will be brought into reality by addressing issues such as client, site, cost, transportation, and buildability in great detail. In an initiative where students were tasked to propose pavilions as a part of the annual Winter Stations Festival on Toronto's beaches, the project specified an in-depth analysis and presentation of how the structures were to be constructed if chosen as a winner. This demanded that students to develop applied knowledge of required components of structure necessary to withstand harsh Canadian winters, conjecture how it would be constructed, and explore the possibilities and efficiencies of the project's production. While the pandemic can limit students' ability to construct their designs due to limited workshop access and prevention of large gatherings, the outline of student projects may be adapted to incorporate more detailed exploration of the design process to enhance experiential learning in architectural education.

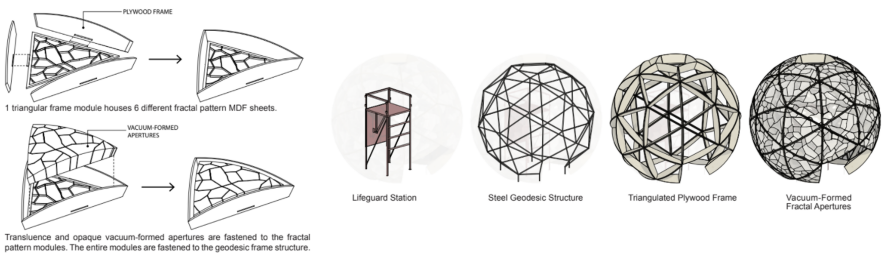

Figure 3. Assembly exploration for Winter Stations Festival proposal.

In another example, an Ontarian camp for children with disabilities collaborated with students to design an animal paddock which involved a thorough analysis of client-influenced parameters. This method empowered students to participate in an experience that simulates the demands of a client, their requirements towards program, budget, and more importantly, that addresses the implications of a real-world experience. This type of project can be easily applied to several architectural remote learning assignments through a flexibility of program and site that facilitates conversation between designer and client

throughout the education of an architect.

3.4. MAXIMIZING OPPORTUNITY FOR DIGITAL PROBLEM SOLVING

The online learning environment provides many challenges, especially through the implementation of more digital workflows and tools. While this provides a steep learning curve for many older generations, younger students are very much accustomed to adapting to new technologies rapidly (Hui et al. 2020). In order to keep students engaged and to continually expand their digital problem-solving capacities, a range of individual and collective problem-solving opportunities need to be provided. These digital learning conditions can be represented on a chart, categorized by team size and difficulty on the axis, respectively.

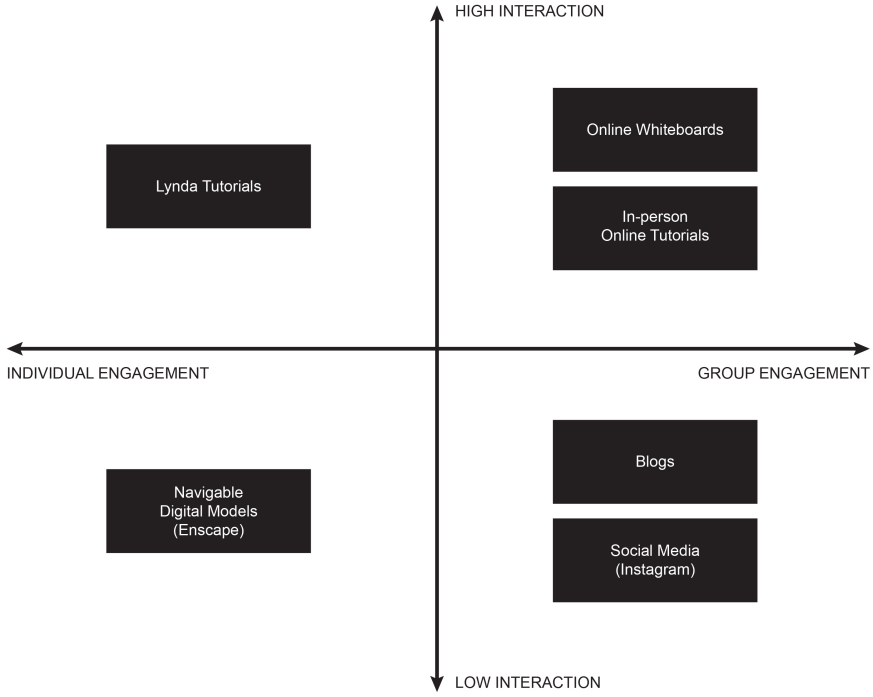

Figure 4. Graph representing the classifications of the various types of digital learning .

For instance, the adaptation of new communication platforms, such as the whiteboard software *Miro*, serve as a low intensity and collective learning effort. This allows studio groups to work together to incorporate the tool into their workflow. In contrast, learning the coding language *Python* and its implementation into *Unity*, would be an individual, high intensity learning goal. A mixture of various challenges scattered throughout the chart's four quadrants (Figure 4) provides the most engaging opportunities for students to not only collaborate and learn from one another, which serves as a large portion of architectural learning (McClean and Hourigan 2013), but also delivers a variety of

difficulty within the learning journey. Although typical studio building projects may help engage students in various digital challenges, such as 3D modeling and manipulation of graphic imagery, it does not offer a platform for students to truly engage in experimentation with reality the way design build projects do. This is where the approach of 'digital design builds' comes into play. By pivoting the end goal for the project from a typical 'build' installation or physical experienced space to a digitally experienced environment instead. Such an approach alleviates many impediments that come about with remote learning, such as limited fabrication and manpower capabilities. Instead, these projects aim to challenge students with the design and development of digital environments, allowing for both individual and collaborative work to take place in tandem with low and high intensity learning. The students, operating in small groups, are able to not only experiment with their ideas of space, but also exceed the constraints the physical would place in order to fully embrace the virtual interactivity of the project. In addition, these projects allowed students to individually hone into digital skill sets of interest to them, while through the combination of such various strengths the projects emerged multi-faceted.

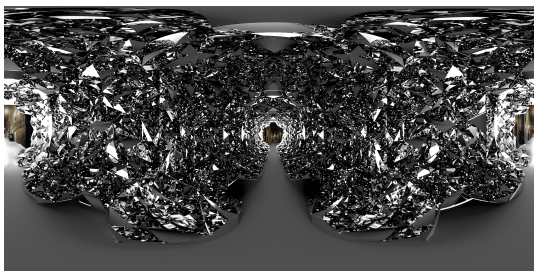

Figure 5. A digital VR environment designed by students when challenged for a digital design build.

4. Case Study - Blended digital design build

Emerging from the challenge of experiential learning during remote education, the new typology of a blended digital design build arose. Typically, extracurricular design-build projects are carried out by groups of students aiding with the fabrication and installation. However, this was no longer a valid typology as access to the building became limited with the rise of COVID-19 cases in the area. As an alternative, the students turned to the blended digital design build typology, where larger emphasis was placed on the digital component of the project as opposed to the physical as is typically done. Rather than fabricating architectural propositions for applications of robotics, this project focused on the possibilities of digital projection mapping, challenging students to explore the opportunities of the combination of interactive media and projected digital environments (Figure 6).

The project's development was composed of two portions. The first consisted of a digital and interactive component, which integrated the motion tracking of

any passersby to create a responsive digital projection. The second constituent involved the physical structure itself, which served as the medium to be projected upon. In order to reduce the extents of fabrication demands, the physical components were computer numerically controlled (CNC) routed foam panels, optimizing cost, fabrication time, and reducing personal contact among the team members. This work division not only allowed much of the work to be digital and more ideal for remote completion, but also permitted for the fabrication to be outsourced without the requirement for students to fabricate on their own. This paradigm mandated that students design with an even greater sensitivity on logistics and feasibility. By adopting a procedural prototyping model, students incrementally developed modest full scale samples of a modular system before proceeding to a larger execution. The team focused on creating an array of 2'x2' sample forms with which they are able to test materials and projections. In adopting this incremental strategy, the students were able to focus on digitally generating both the virtual and physical components at a controlled scale while simultaneously testing various interactions and possibilities of interplay between the two.

Although working remotely proved to be a challenge due to hardware limitations and difficulty in communication, students continued to successfully collaborate in the remote context. Once the students landed upon the software *Touchdesigner* as the most appropriate to accomplish their design goals, the group was able to adapt to the relatively straight forward software collectively. Within the group, several students became interested in more technical exploration, and began to explore the possibilities of raymarching within the projection in order to facilitate the possibility for complex 3D geometries to be manipulated and projected live. This required the students to learn the coding language *GLSL* and its incorporation within the *Touchdesigner* ecosystem as well as its integration within the *Azure Kinect* feedback loop. In contrast, other students were more inclined to further develop their parametric modeling skillsets and investigated the possibilities for the CNC'ed portion of the project through the use of the *Grasshopper* and *Rhinoceros* interfaces. Such a staggering of skillsets not only provided students with opportunities for more individualized explorations of their own interests, but also allowed for a variety of collaborative, individual, high and low-intensity digital learning to take place throughout the course of the project.

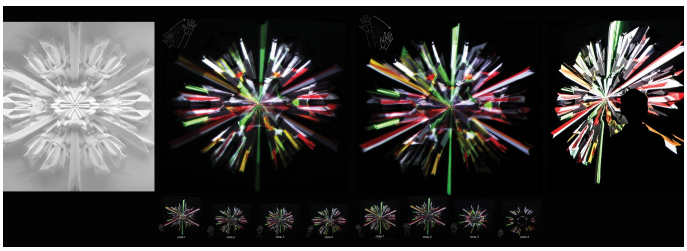

Figure 6. Physical sculptural element (right), motion-responsive projections (center) and an impression of the installation (left).

5. Conclusion

While the pandemic forces students and professors to feel restricted to the confines of their homes, it provides an opportunity to expand the techniques of architectural education through technology and domestic experimentation that would not have been possible in different conditions. Undoubtedly architectural education is dramatically different during the pandemic however the experiential learning capacities need not diminish; if anything, they will merely evolve and adjust via the technological resources available. Architecture has always adapted and adopted technological innovation in not only the design of the built environment, but the materials, methods, and models of production. This is yet another challenge and milestone for architectural pedagogy. Through remote learning and its capitalization of international connectivity, implementation of emerging technologies, transporting instruction outside of the digital classroom, and maximizing opportunity for digital problem solving, the value of experiential learning is enhanced through a multitude of facets that have yet to be explored during the COVID-19 pandemic.

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