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Exploring the Neurological Basis and Motivation for Learning to Design during the Covid-19 Pandemic

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Abstract
Architectural design curriculum is based on the premise that students want to learn Architecture. However, there is a significant decline in the motivation and enthusiasm of Architecture students for designing projects within the studio courses. This phenomenon can be the natural result of the Covid-19 pandemic that locked young architect candidates down, forcing them to attend courses online. However, the motivation behind the act of designing is loosely related with the designers' physical or online presence. This study aims to understand the basic motives underlying the desire to design by examining online architectural design education processes. The paper looks into cognitive processes, neuroscientific knowledge around the act of design, and pedagogical knowledge around learning to design. The main question of the research is to see whether the motivation to design can be explained in association with neurological aspects and whether it can shed light on methodologies on learning to design.
Keywords: Design motivation; Neuroscience in Architecture; Online education; Covid-19.

1. Introduction

In 2020, a pandemic caused by a virus called the COVID-19 spread rapidly throughout the world. Several measures were taken to prevent the spread. All workers, employees, students, educators etc. had to keep a physical distance and work remotely. The design field also witnessed reinforcement of these regulations. Student members of higher education institutions had to stay home and learn online. It did not take students and some educators too long to adopt digital tools to use for communication purposes. However, the delivery of knowledge remained as something more than what could be transferred to students with the lack of physical presence. All means of communication and design production were bound by computers and the Internet. Since March 2020, online communication improved fairly well. Some events and meetings went on air which would otherwise not have been possible due to physical restrictions. To some extent there had been some students who benefited from the new way of educational communication while others lost any motivation they had for learning or participating at all. For some parties commuting issues were waived and they enjoyed the comfort of reaching the learning source without any loss of the time and energy they would otherwise spend on the road.

The goal of courses needed re-evaluation. Whether the students were expected to demonstrate knowledge, to interact with peers, process delivered information orally or textually; visually in our case of design studios was an important decision. Conversion from face-to-face to asynchronous discussion forums and video recordings, open book exams required getting out of the in-person mindset (Benander, 2020).

Architectural design education assumes that students have strong desire to learn Architecture and are motivated to become architects. However, the motivation and enthusiasm of Architecture students taking the studio courses has fallen significantly according to the observations of faculties involved in online teaching in higher education. This comment is made based on observation of student behaviour in terms of attending the online studio critiques and submitting weekly assignments. Students are less inclined to do thorough research on given design problems nor are they excited to come up with novel conceptual ideas.

Several studies on design education and practice display the necessity of communication for decision making purposes. Therefore physical presence is not required for communication. However, for remote collaborative communication digital platforms need improved translation of physicality into digitization (Wenzel, Gericke, Thiele, & Meinel, 2016). Designers have unique backgrounds, skillsets, values and their own circumstances that they own and demonstrate in practice (Lawson&Dorst, 2013). Hence, the paradoxical character of design education (Schön 1985, 1987) where the student does not initially have the skillset required for the task that s/he needs to perform while learning to design may be quite confusing for the novice.

For students learning to design, it is important to understand the role of sketching and modelling. Especially when they start, they consider designing as thinking, an act in the mind, and as coming up with a solution. Sketching and modelling, in their view, are meant for presenting the result. However, sketches and models function as a laboratory; they are the (three dimensional) tryouts during which the process of experimentation, of exploration and decision

making takes place. Especially the three dimensional character of sketches (perspectives) and models and the process of abstracting in diagrams have to be encouraged despite the fact that many learners may initially be discouraged by the hardship of mastering these communication tools. The hardship in concern causes demotivation for some students since as they master one level they move to the next one where level complexity increases due to levels of expertise(Dorst,). The main question of the research is to see whether the motivation to design while mastering required skills can be viewed in association with neurological aspects and whether it can shed light on methodologies on learning to design.

A more recent difficulty was added to the equation with the coming of non-optional online learning due to lock-downs for eliminating Covid-19. This research is done while the lock-down processes are still at play causing impact (Table 1) on learning systems and parties.

Table 1. (Impact of mandatory lock-downs on learning, by the author, 2020)

Impact	**Previous**		**Current**	
Challenge	Instructor/Lecturer	Student	Instructor/Lecturer	Student
Pace of Change	Face-to-face		remote/ distant/online	
Required Computer skills	word processing, computer graphics	gaming, word processing, computer graphics	technological grit	
Required Soft skills	knowledgeability, integrity	in-person communication, time management, self-discipline	Creativity	online specific communication, time management, self-discipline
Environment	Studios/Labs/Lecture rooms/Corridors		video conferencing	
Attendance	names called out	valid for each session	names called out	need to be recalled at frequencies
Knowledge transfer	personal, one-to-one, one-to-many		less personal	
Visual communication	Controllable, clear and convenient		Uncontrollable, Freezing, unclear body language; more exhausting	
Keeping the students involved	teacher -centered		student-centered	
Connection	social		Synthetic	
Synchronicity	synchronous		both asynchronous and synchronous	

Attendance to online communication platforms by April 2020 have been reported to have increased around 30 fold during the lock-downs throughout the world even leading to the introduction of a new term called the "Zoom fatigue" (Wiederhold, 2020). The term refers to the consequences and the subconscious implications of online communication causing stress and fatigue.

2. Background

Within the last decade, EEG studies on design have focused on the neurophysiological aspect of the act of design (Liu et al., 2018; Vieira et al., 2019). Liu's research explores cognitive behaviour and corresponding brainwave patterns in response to three different problem statements namely (open-ended (OE), decision-making (DM), and constrained CO) and comes up with four hypotheses: *"(1) designers in different problem statements will show different patterns of brain activity during the phase of idea generation; (2) the OE statement is more conducive to problem solvers' divergent thinking, so as to get more innovative solutions; (3) both DM and CO statements are more propitious to convergent thinking, and the solutions to such problems are more feasible; (4) the DM statement can reduce problem solvers' mental workload, which is helpful for solving problems effectively.*" (Liu et al., 2018) The domain of design neurocognition gained new tools for exploration from neuroscience. The study on the comparison of design neurocognition of architects and mechanical engineers can measure brain activation using EEG. The experiment is designed around a sequence of three tasks: problem solving, basic design and open design using a physical interface which then leads to a fourth task of free-hand sketching. The output was a collection of 36 brainwave recording of mechanical engineers and architects while designing. Results illustrated design cognition differences between the two domains in task-related power between the problem-solving task and the design tasks, in temporal resolution and transformed power. (Vieira, S., et al, 2019) Another research studying design thinking suggests three paradigmatic approaches to measure processes of design cognition; (1) design neurocognition; using electroencephalography, functional near infrared spectroscopy and functional magnetic resonance imaging(fMRI) ;(2) design physiology; eye tracking, electrodermal activity, heart rate and emotion tracking; (3) design cognition; through protocol analysis, black-box experiments, surveys and interviews. In this study results are expected to give feedback to the design community tackling design thinking (Gero & Milovanovic, 2020) Another current experimentation focusing on neurophysiological activations suggests that preliminary evidence shows that the

neurophysiological activations of experienced and novice professional designers when problem-solving and designing differ significantly from each other (Vieira et al, 2020). Even this study promises a new understanding of design students' point of view.
While the field has generated ways to understand and measure design thinking in terms of reasoning, creativity, analysis, evaluation, cognitive processes and etc. the methodologies concerning architectural learning should be fed with these research outcomes.

3. Material and Methods

This research aims to understand the basic motives underlying the desire to design by examining online architectural design education processes. Cognitive processes, neuroscientific knowledge around the act of design (Eberhard, 2009), and pedagogical knowledge around learning to design, are explored. The study is run under the remote education circumstances and the scope is kept within online design studio environment.

3.1. Neuroscience in Architecture

Neuroscience focuses on the study of the brain, and suggests that behaviour is controlled by the brain. Our brains are made up of domains such as *control vision, somatic sensory experiences*, and *motor output*, as well as areas that help us navigate through novel environments. There are two major domains in architecture that neuroscience can contribute to, immensely. The Occupant and the architect. Understanding the occupant is extremely important in evaluating the built environment from the user's point of view. There is extensive research in the field of building performance evaluation. However, psychological and neurological aspects are not fully explored in detail and in scientific measures yet, due to the lack of metrics and specific tools. The field is expanding and integration of sensors, networks (IoT etc.) and online machine learning systems point out to a greater understanding of the occupant navigating the built environment. Soon to be expected are architectural systems that address multiple aspects of inhabitants. The latter to gain immensely from the field of neuroscience is the architect. As mentioned earlier, this study focuses on what neuroscientific approach can provide for architectural design cognition and for architecture students.

3.2. Framing a Research Platform

The research was planned to run in two phases (Table 2). First phase involves a questionnaire to run online among architecture students from around the world. The second phase was planned as the acquisition of EEG or gaze tracking data that will be interpreted in relation with the results of the questionnaire. The questionnaire which is introduced under next subheading is left active to continue collecting responses until the setup of the second phase.

Table 2. Phases of research on motivation of architecture students with neurocognitive approach.

PHASES					
Phase 1. Subjective Inquiry			**Phase 2.** Objective Inquiry		
Questionnaire	Interpretation		Neuroimaging	Comparison	
Reason-based			Interaction/neural activity-based		
TOOLS					
Online/Offline entry			Portable EEG headsets / Gaze tracking web applications		
VARIABLES					
Motivation	Communication	Skills	Motivation	Cognition	Multi-sensory integration(Alexiou et al. 2010)

Activity in and around the brain can be recorded at very fine levels and can therefore be interpreted quite accurately (Bullmore, 2009). The research field however, is gravitating towards an understanding of social experimentation rather than in isolation (Dikker et al, 2017). This is because scientists witnessed instances of synchronization between brains in a classroom setting. This realization further led to neuroscience research involving crowdsourcing where the findings displayed coupled neural activity during random and dynamic social interaction (Dikker et al, 2021). Such research implies a possibility that a research platform can therefore be set in a more flexible field in terms of running brain scanning experimentation for design studio environments online.
While considering the possibility of giving students portable EEG headsets to record brain activity during design studio hours, some issues raised such as the risks of close interaction with the students during the pandemic. The measures taken did not allow in person interaction. However, the students could not be expected to do any calibration by themselves and that they had to be monitored. The results however, would be a version of the acquired scan (figure 1) where the EEG study of the comparison among design problem statements and cognitive behavior during conceptual design were displayed. A web based platform where online eye tracking with web cam would be possible was searched and some possible technologies were found. However, the main development focus

of those hardware and software was for marketing purposes. Gaze tracking technology however, is now being explored by the author to be used for neurocognitive understanding of design learning processes.

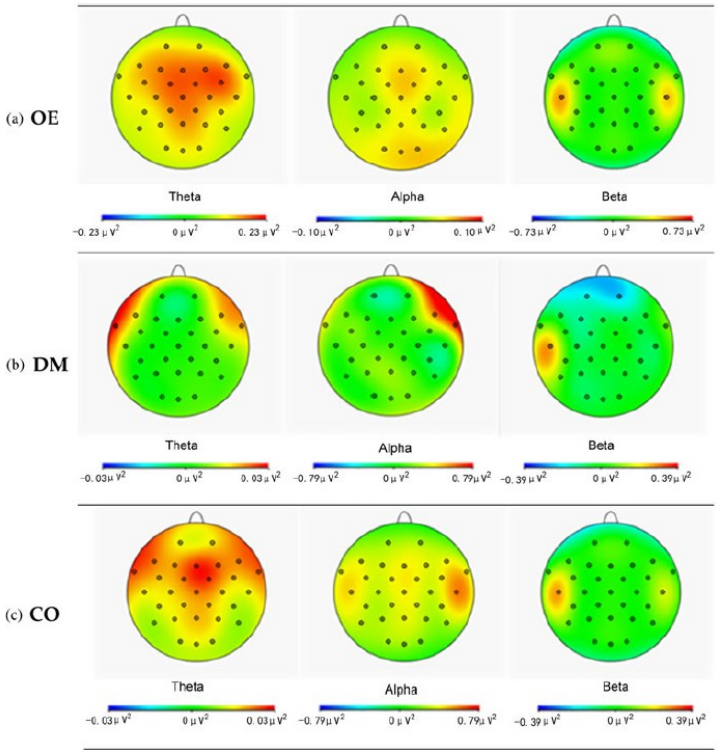

Figure 1. EEG study of the relationship between design problem statements and cognitive behaviors during conceptual design (Liu, et al, 2018).

3.3. The Questionnaire

This questionnaire (https://forms.gle/cgKY5z8rf3Zfn9Ku8) is designed as the initial phase of the research. The outcome forms a base template for identifying implications of neuroscience in architectural design education. The online questionnaire was sent to students around the world and initial questions collected identity. Students were asked to respond to eighteen questions.

The neurocognitive approach however, brought about some issues that could be identified during the present lack of appropriate scanning tools. For example, the respondents were asked to pick among two statements whether they would prefer being in studios working with their peers or being alone at the computer and concentrating on their work. Twenty per cent of respondents were in favour of staying at home, which would be worth inquiring (figure 2).

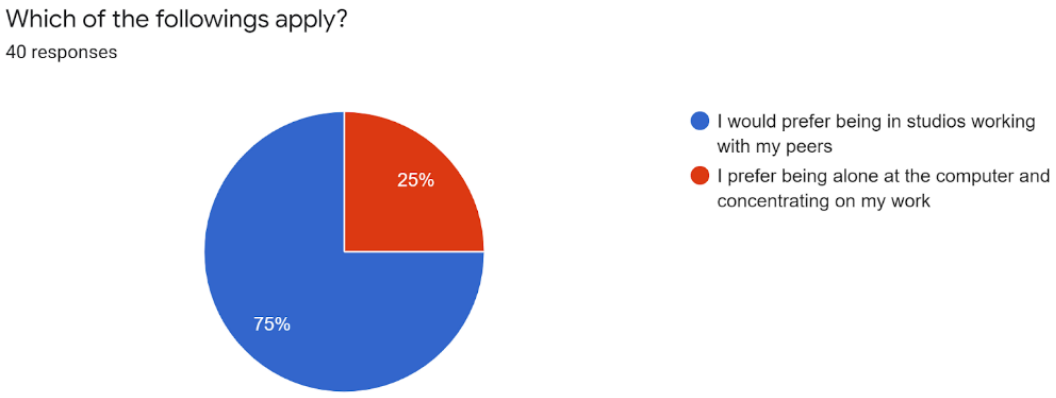

Figure 2. EEG study of the relationship between

3.4. Results

The main motivation of the author for integrating neuroscience into this research is based on the premise that *"the reasons are not necessarily the causes of behaviour"* (Kahneman, 2011) Questionnaires give us reasons while monitoring or measuring practices have the potential to disclose causes. The students' motivation for learning to

design is partly inquired by questions such as: *Would you consider yourself a determined candidate to become an architect? Why did you choose to study architecture?* Where the latter received responses that are worth analysing:

- *Because I was into both science and art, I thought that I can combine my two different interests in architecture. Also it is a satisfying profession with different career opportunities.*
- *My family suggested that I chose architecture of the study to sign architectural changes and silhouettes that will positively affect the environment. To make new, sustainable, different designs.*
- *Ability to change people's life with the power of designing spaces amazes me*
- *I always wanted to be an architect. I can see my future in this career. And it is pleasant, I love to design things*
- *Working facilities and I interested in architecture and design before I was choose it*
- *Because i am interested in architecture since I was a little kid.*
- *Have interests*
- *I believe that I will be successful in architecture because of my parent insistence*
- *I was thinking it was the ideal department to study for me since I was 12.*
- *Touching the social structure by learning the language of design*
- *Since I interested in this discipline and I feel belong to architecture*
- *To touch people dreams*
- *It's my dream job I was always interested in design and buildings have always fascinated me, i was always interested in how they are made and designed.*
- *I love to create and design. That's why I chose this profession.*
- *I like thinking 3 dimensional and designing spaces.*
- *Based on my interests and it is my father's profession*
- *It wasn't my first option. I wanted to be a doctor, but I couldn't. Then, I didn't want to experience the same stress again. So, I explored other options. I was interested in drawing and discovering new places and observing architectural treasures. I just wanted this interest to turn into a profession.*
- *I like to analyze creative architectural building.*
- *Dream job*
- *Because architecture contains several disciplines. And it is related with art and creativity.*
- *It was the only major of my interest.*
- *I have been doing my higher secondary education when we were building our new house. I was inspired to create affordable houses for the masses, without having to compromise on the quality.*

Another significant inquiry was whether the feedback they get during critiques in design studio clear and beneficial for them? They responded: No:27, Yes: 10. Followed by: "I am motivated to revise my design suggestions and learn more, because: The feedback I get is clear and beneficial **10,** I feel more like in-person and can concentrate on the critique I get through the computer. **8,** I can follow feedback that my peers are getting for their designs **6,** I can watch the feedback more precisely and repeatedly from the recordings **1** as well as: *I am not motivated because: I don't understand the feedback given by the instructors **4,** I cannot connect with the instructor **2** and; I don't feel like I'm learning when I see that I keep having mistakes* scored **15.**

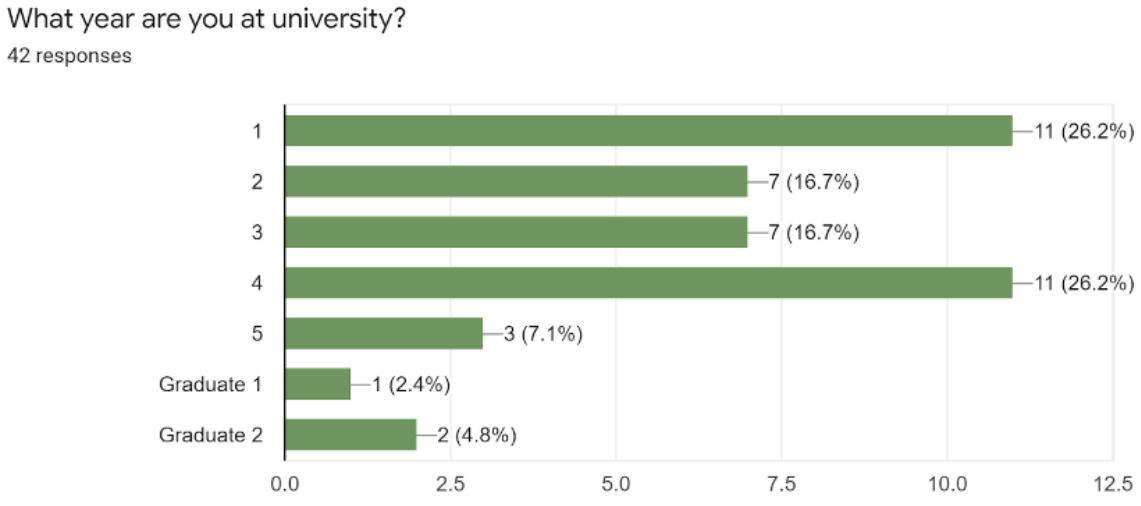

Figure 3. Distribution of respondents to years at the university (Developed by Author).

Out of 42 respondents, only 13 responded to what was problematic from their perspective and commented on how the online learning can be improved. Among the 13, only one suggested a social solution "Regrouping after official class hours with fellow students" indicating a need for connecting with peers. 41 out of 42 respondents stated that they attend the online studio courses among which, 81% consider themselves as determined candidates to become architects. It can be interpreted that a majority of respondents are fairly motivated novices.
The respondents can be considered as volunteer candidates for a neurocognitive study to discover further means that students are tackling when learning to design through online education.

4. Discussions

The next step of this research study will be the setup of an experimentation for architectural design students to supply the results of the survey that currently reveals conflicting result with the observation that students' motivation during the Covid-19 has dropped significantly. This conflict may be explained by the possibility that already demotivated students have not responded to the survey at all.

5. Conclusions

The understanding of human behavior cannot be reduced to neuron spikes. Neither can the desire to design be interpreted only in terms of neurological happenings. However, there is a link between the motivation of architectural designer and the firings of synapses in the brain. This link needs to be explored in further detail by focusing on our imaging capabilities. As the brain scans and EEG gadgets improve the design research can improve immensely. This improvement can lead to better understanding of the motives underlying the designed environment as well as the education of new architects to build under the "new normal" conditions of the world.
Depending on the current outcome of many neurocognitive research on various aspects of design the newly adopted communication paradigm can find motives that architectural design learning can take on and benefit. To keep the motivation of learners high is a major factor in education in the new way the world operates. In an environment where students have infinite options to learn skills. The learning options that employ the most motivating models will contribute the best. Motivation and other intrinsic qualities that are active in learning can be identified through neurocognitive measurements and experiments more efficiently that surveys that involve deliberate responses rather that direct intrinsic values.

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Conflict of Interests

The Author declares no conflict of interest.

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