

EXPANSIVE LEARNING AS A SYSTEM DESIGN METHOD TO LEARN HUMAN-CENTRED DESIGN IN A MULTI-DISCIPLINARY INDUSTRIAL DESIGN AND BUILT ENVIRONMENT SUBJECT

Mauricio NOVOA MUNOZ and Aaleen PARULEKAR PRASAD HARI
Western Sydney University, Australia

ABSTRACT

This paper primarily discusses teaching human-centred design (HCD) to first-year students in architecture, industrial design, and the built environment. Classes take place in our new state-of-the-art Engineering Innovation Hub (EIH). However, end-users (e.g., students, staff) were not consulted during the design and construction of this vertical campus. Students conducted a challenge-based learning post-occupancy review (POR) of EIH by observing, gathering findings, and ideating through sketching, photography, videos, user experience (UX) tools, participatory design and prototyping face-to-face, and digitally via MIRO collaborations, MyKnowledgeMap (MKM) e-portfolio process diaries and Turnitin. They completed three assessments. First, they audited the building, drawing on their first personal experience and observing people's interactions with IDEO design thinking methods. Second, students recontextualised observations using a nine-step Frame Innovation method to tackle open, dynamic, and networked problems. Third, they translated knowledge from physical to digital infrastructure analysis to propose improvements with a Rapid Contextual Design approach. The paper proposes a framework for ongoing research based on Expansive Learning, its Fourth-Generation Cultural and Historical Activity Theory (4GCHAT), and Activity Systems Analysis (ASA). Research underscore internal and external validity considerations about design education (e.g., effective observation, ideation and design), challenges for Generation Z (Gen Z) students, the capacity of physical and digital built environments and their review to assist critical student-centred learning to future-proof creative disciplines and help designing better architecture, products and services, instead of adhering to traditional design practices and norms prevalent in current corporate building construction, as well as established atelier and project-based learning within design education.

Keywords: Cultural and historical activity theory, design education, expansive learning, human-centred design, user experience

1 INTRODUCTION

HCD is a relatively new discipline for Australian universities. Traditionally, architecture and industrial design education focused on hands-on craftsmanship due to their schools' roots in arts and design and user-centred design (UCD). Similarly, construction and engineering education concentrated on building stability and project management, often overlooking geographic or social impacts. Professor Donald Norman observed that UCD was outdated and introduced HCD at the turn of the century. UCD regarded end-users as consumers in a mass production process. HCD identified end-users as key active participants who influenced design, production, wealth creation and distribution based on local preferences and needs. Additionally, cost reduction potentially allows end-users to utilise new technology and develop products and services independently of designers. It is worth noting that HCD was applied to teach foundational design research methods while highlighting that design education should prioritise life-centred design (LCD) as the current sustainable approach that considers the vulnerabilities of human and natural environments and species [1, 2].

HCD is driven by four principles that emphasise a people-centred approach, fit design to context, investigates and addresses human problems and their root causes rather than prioritising production, and recognises design issues as socially systemic rather than related to disciplinary craftsmanship. It advocates for transforming society through small iterative interventions to change behaviour and rituals.

Recently, Engineering Australia, the official engineering association in the country, proposed to integrate HCD into their education to expand it from teaching basic principles (e.g., physics and calculus) to empathetic research methods that solve societal complex and wicked problems which do not have standard solutions, like climate change, poverty, and resource scarcity [3].

The research originates from the subject Human-Centred Design Research Methods (HCRM) for first-semester students in the first year of courses in architectural design, industrial design, and design and technology. Yet, undergraduate and master's students from business, computer science, construction, education, engineering, humanities, and law have also enrolled. The university supported the subject coordinator in establishing an inverted curriculum that taught design research methods from the first to the fourth year of Honours while he was Director of Academic Programmes. Previously, students learned design research methods only in the final semester of their third-year courses, which left them with no time to gain design research experience for the industry before graduation or to prepare for their individual fourth-year Honours project. This research spans three years (2022-2024) and involves a cohort of 541 students. The new curriculum received backing and mentoring from leading university and industry experts, including the Pro Vice-Chancellor for Learning and Teaching and its Digital Learning unit, which advocated for a university-wide disruptive and transformational curriculum to future-proof graduates for a market offering jobs in new professions for which universities do not currently train. Furthermore, the subject was part of Western Sydney University's 2023 Australian Government's National Priorities and Industry Linkage Fund (NPILF) project aimed at partnering academia and industry. Within it, the CEO of the Design Institute of Australia provided guidance on the traditional and emerging design skills required by today's market.

2 PROBLEM STATEMENT

The paper discusses how students could develop creative curiosity, research skills and critical design process potential to prepare them for work in the 21st century. This requires more than atelier and product-based learning (PBL) teaching. Atelier models promote hands-on teacher-student instruction through imitation and individual expression isolated from broader contexts (e.g., aesthetics, styling). PBL prioritises the creation of tangible outputs (what question) by complying with specific product requirements provided by the lecturer instead of novel solutions to unheard-of complex challenges. These models are important to learn technical skills (e.g., illustration, model making, 3D CAD). However, they are limited when learning to solve wicked societal problems that will determine graduates' future and help them play leading roles in professions that do not exist yet. A clear example of this quandary is observed in first-year university students who suffer skills shortcomings when compared to university expectations in Australia. The OECD Programme for International Student Assessment (PISA) and Australian National Assessment Programme - Literacy and Numeracy (NAPLAN) revealed a decrease in high school outcomes in STEM, critical and manual skills, literacy and numeracy, when 75% of the fastest-growing occupations require these competencies. The Australian Government calculated that 44% of the population has low or very low literacy. These limitations are directly connected to where people live, their ethnic and linguistic background, education, and access to information [4-7].

3 METHODOLOGIES

Methodology was based on an overarching challenge-based learning (CBL) approach, aiming to connect students with real-world problems to help fill the gap between high school and university. CBL was most suitable since it can concentrate on resolving wicked problems, processes and systems that are key competencies for modern professional practice (why and how questions). A POR of our new high-tech campus was a good topic to empower students' personal experiences when confronted with unmapped challenges to promote critical thinking, empathy, contextualisation, identification of root paradoxes, and systemic analysis for behavioural and societal change [8, 9]. The project ran three times for 14 weeks with the support of HyFlex (hybrid-flexible) facilities, physical and e-learning content (e.g., Blackboard, MKM e-portfolio, MIRO, Turnitin), to promote hand-made and digital sketching, visualisation and prototyping individually and in teamwork.

The students completed three scaffolding and complementary cycles of design research from Novice to Advanced Beginner and Competent Beginner levels of Skill Acquisition, as per Dreyfus and Dreyfus [10]. The lecturer and tutor were moderators who taught via dialogue and probing questions. Students were conferred the status of researchers and validated individual experiences through active learning

and collaborative work. They used e-portfolio as a base for autoethnographic reflection, UX tools, and three types of design thinking methods. Students' learning progressed from design thinking methods that position designers as experts and end-users as subjects to culminating with a new view of designers as research-apprentices of end-users' experience as experts of their lives. Assessment 1 focused on auditing EIH to promote empathy towards end-users with IDEO's HCD Design Thinking since reality is relative to end-users' circumstances and interpretation instead of designers' unvalidated assumptions. Unobtrusive (e.g., fly in the wall) and obtrusive (e.g., interviews) tools helped to analyse physical issues and human interaction with them [10]. Assessment 2 used UX templates of concept modelling, storyboard, empathy maps, affinity, user personas, journey maps, taxonomies, and a 4sight strategy (to analyse the present [insight] based on the past [backsight] and concurrent events and processes [cross-sight] as a base to plan ways forward [foresight]), and a Frame Innovation model that re-examined findings, uncover root paradoxes, reframe themes and propose solutions for physical interactions within the built environment [11]. Assessment 3 asked students to independently apply and translate knowledge from physical contexts to digital environments to examine the digital infrastructure on campus. They learned how engineers and programmers borrow design and built environment vernacular to elucidate algorithmic realities. Finally, students combined prior methodologies in a Rapid Contextual Design process to consult, brainstorm, envision and prototype solutions with end-user participants [12].

Expansive Learning was utilised to analyse students' projects as activities- whether individual or group- that are mediated by artefacts (tools, materials) influencing interactions and contradictions in aiming for an object (goal, desired outcome) within human network systems (e.g., interactions between students and teams, students and end-user personas, as well as physical and digital engagement). Here, contradictions refer to the paradoxes, tensions, and breakdowns among two or more activities or system elements that create opportunities for developing new knowledge and learning. 4GCHAT visualised multiple temporary interactions and contradictions within human networks that facilitate collaboration and knowledge sharing across present, asynchronous, distributed, physical, and virtual environments. ASA linked the intricate interplay of actors, artefacts, rules, community, and division of labour to uncover patterns of contradiction, as no two students share identical backgrounds or specific connections to their communities, institutions, regulations, and work (Fig.1) [13-15].

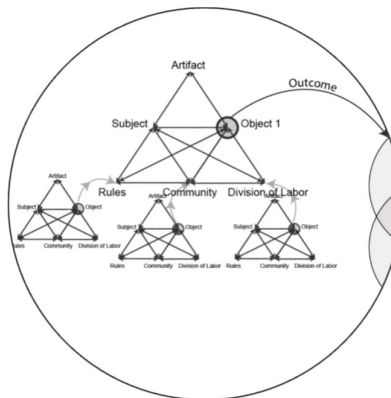


Figure 1. Student's Expansive Learning module to understand design, learning and research based on activities, artefacts, objects, outcomes, cultural and historical context

4 RESULTS AND DISCUSSIONS

This research presented an opportunity to reassess design education and its research. As a public institution, our university is one of the largest in the country, with more than 45,000 students. It is also under pressure to cover overheads by running large classes and two-hour tutorials with a lecturer-to-student ratio of 1:32, which makes it difficult for personalised learning. Research analysis confirmed national statistics about a connection between likely outcomes and students' home location, cultural, ethnic and linguistic background, previous education, and access to information. University data showed that 77% of students hail from the fastest-growing area of Western Sydney. Many are first-generation university students from middle-class, low-socioeconomic, blue-collar, migrant, or multicultural families. The cohort includes 170 culturally and linguistically diverse (CALD) backgrounds. Students

often start with below-standard performance, and academics are expected to bridge any graduate skill gaps to meet industry benchmarks.

Today, our new students are Gen Z. Born at the turn of this century and impacted by COVID-19; students were initially disengaged. In discussions, they said to feel disempowered and have either mental, financial or climate concerns because of an uncertain future. They were digital natives. Yet, they were superficial users or consumers of social media apps. That know-how did not translate well to using learning management systems (LMS) such as Blackboard and its add-ons. Similar to specific technology Australian studies, males said to check social media for an average of 3 hours, and women mentioned an extra hour or more per day [16], while their average Blackboard use in the subject originally was 3.5 hours per week. At the time of Assessment 1 submission, several students attempted to submit work with little elaboration and reverted to recalling rote memorisation or simplistic hearsay not based on informed and validated observations and deep understanding. They could not critically navigate and evaluate briefs, visual, physical and online sources and narratives [17]. However, the Hyflex plan for the subject indicated that the cohort was already using our Blackboard LMS twice as much as the average usage in our school. Assessments 2 and 3 online use increased to three times as much as the school. The university did not data mine MKM since it worked as an add-on with a server elsewhere. Students increasingly used MKM over the 14 weeks to work in their weekly e-portfolio process diary. Generally, they used shortcuts and browser bookmarks to access, work, and share e-portfolios directly.

The CBL and Expansive Learning approach of the subject was fundamental to break the ice and open students up to bounce ideas and discuss in groups and with the lecturers (Fig.2, Fig.3). They felt empowered to see that they were not considered as one generic type of passive student, just a number. Their formation and background were appreciated. They realised their first impressions as end-users (naïve experience) were as valid as those from a design research expert, since many professional projects start from there and build iteratively towards informed observations, knowledge discovery, and proposal of novel solutions. Assessment 2 welcomed students to re-examine the audit in Assessment 1 to find the root cause of the problems and propose solutions. They could resubmit if they had failed the first submission, as they understood they had to present arguments based on evidence. Assessment 3 pushed the bar higher by asking students to translate the knowledge and findings acquired to practical applications in another field, the digitally embedded technologies in the building. Many enthusiastically criticised various digital systems, including Blackboard, for not being as user-friendly as social media, as well as issues with laptop and printer connections, access, and cybersecurity in EIH

Despite the inherent complexities in a subject requiring interactive and student-driven pedagogy, the outcomes aligned favourably with traditionally easier transmission methods of instruction. Final marks showed a good standard deviation spread and desirable levels of variability, compared with teacher-centred subjects in the school. The Students Feedback on Subject (SFS) data and psychometric surveys also indicated increased satisfaction among students over three years (2022-2024), above a previous delivery of the same subject (2021) and often close to the best results in the school. Characteristically, a 70% favourable overall agreement average about the subject, its delivery, and content, and high peaks relating to groupwork and critical learning support the advantages of CBL and the Expansive Learning philosophy that was also talked about with students in class to explain learning, cultural issues and design research (Fig.4).

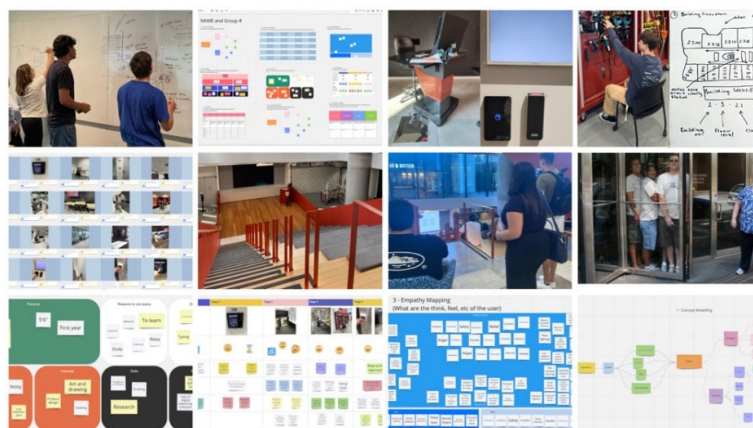


Figure 2. CBL and Expansive Learning normal tutorial and autoethnographic records

Dreyfus Model	Novice: A1	Beginner: A2	Competent Beginner: A3
POR	Audit: First Glance	Reframing: Root Problem	Knowledge Translation
	Physical Environment	Physical Env Solutions	Digital Infrastructure / Solutions
Student Researcher Role	Naive Experience	Deep Dive	Transformation / Integration
	Researcher-Expert		Researcher-Apprentice
End-User Role	Subject		Discerning Participant
Expansive Learning Network System and Stages			
	UX tools	Sketching, Affinity Maps, Journey Maps, 4sights Strategy	Sketching, Affinity Maps, Concept Modelling, Storyboards, Empathy Maps, User Personas, Journey Maps, Taxonomy, 4sights Strategy
Methods	IDEO Guide to HCD	Frame Innovation	Rapid Contextual Design
	<ul style="list-style-type: none"> Frame Design Challenge Create Project Plan Build a Team Recruiting Tools Secondary Research Literature Review First-hand <ul style="list-style-type: none"> Non-Obtrusive E.g., fly in the wall Obtrusive Interview Individual Group Expert 	<ul style="list-style-type: none"> Archaeology Paradox Context Field Themes Frames Futures Transformation Integration 	<ul style="list-style-type: none"> Capture Contextual Inquiry Interpretation Modelling Affinity diagram Set Direction Persona Development Visioning Design Storyboarding Product & System Requirements User Env Design Iterative Design and Systems Prototyping Interaction Visual Design

Figure 3. CBL and Expansive Learning complementarity and iterative scaffolding methods

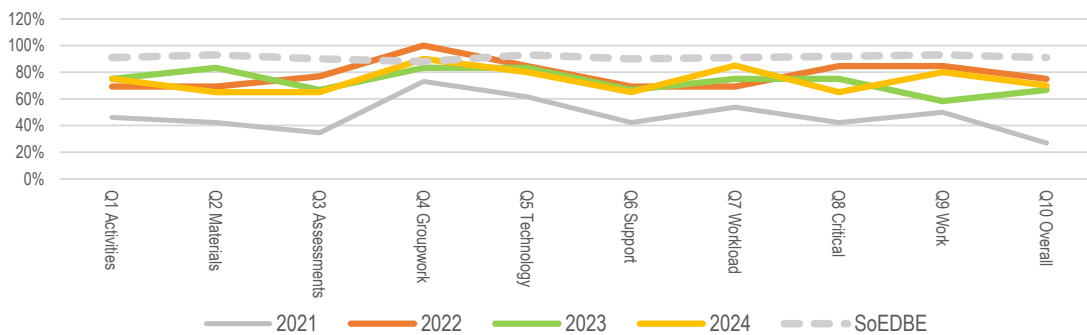


Figure 4. Student Feedback on Subject 2021 – 2024 (2021 reference of previous delivery)

5 CONCLUSIONS

This paper presents the account of a three-year research project and curriculum for a subject on human-centred design research methods, critical thinking and making for architectural design, industrial design, and design and technology. The first author implemented an approach that was a first for our school and institution. Challenge-based learning and Expansive Learning present a viable view for a systemic perspective that could help prepare students for future industry demands personal and social benefits. Marks, SFS and psychometric surveys show that an inverted curriculum that introduces a design research programme in the first semester of the first year of those courses is feasible and can contribute to bridging the gap between high school outcomes and university expectations. With that, set the foundation for undergraduate research-based courses that focus on solving the wicked challenges of our era. As important, it can facilitate that Gen Z students feel valued and heard. Students awoke their designer's eye by instinctively recognising and appreciating good and flawed design in EIH based on their first campus experience. Then, they trained their gaze to see and examine case studies to propose potential improvements. Finally, they learned about the importance of knowledge translation as a competency that will allow them to bridge the gap between design research findings and their practical application in the same or other fields, as new wicked challenges and professions are created.

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