DESIGN PEDAGOGY FOR SUSTAINABILITY: DEVELOPING QUALITIES OF TRANSFORMATIVE AGENTIVE LEARNING.

Bruce Snaddon
Design Department, Faculty of Informatics and Design, Cape Peninsula University of Technology District 6 Campus, Box 652, Cape Town, 8000 South Africa, Senior Lecturer, snaddonb@cput.ac.za
Andrea Grant Broom
8 Basil Rd, Plumstead Cape Town 7800, Design Project Imagineer, andrea.broom@gmail.com

ABSTRACT:

For design educators who are developing students readiness as sustainably aware design practitioners, it remains a challenge to create meaningfully transformative learning experiences. We contend that, in tackling this challenge, it is key for design educators to develop compelling pedagogy where students experience their evolving agentive selves in relation to wider systemic relationships. To explore this we examine a project case where Biomimicry was introduced to complement a pilot course promoting a Sustainable Product Service System (S.PSS) view and tools. The question framing this research paper is: What are the qualities of an ecologically immersive pedagogy that is productive of sustainable design dispositions in students? By connecting social learning theory and design for sustainability, we draw together concepts of learning ecologies, and agentive learning. Conducted as participatory action research, the qualitative inquiry process reveals how pivotal learning moments were found to have cultivated attributes of resilience, performative adaptability, and relational awareness.

Key Words: Sustainable design pedagogy, learning ecologies, agentive learning, Biomimicry, S.PSS.

1. INTRODUCTION AND BACKGROUND

This paper reflects the efforts of five design educators in the Cape Peninsula University of Technology (CPUT) in developing pedagogy and curriculum over a five-year period that prepares design students for a world urgently in need of sustainable design practitioners. Against this backdrop we argue for compelling design pedagogy that seeks to enable authentic ontological shifts in a student's sense of self and emergent designing agency in relation to wider human and non-human ecologies (e.g. Snaddon et al., 2017). Bringing about transformative learning experiences for students is the challenge for all educators, but in empowering young designers to move beyond dominant unsustainable anthropocentric habits in designing, this challenge is one of paradigm shift. This requires inventive thinking, practice and methods not commonly found in many design programmes. In our experience such approaches need to expand beyond didactic skills-based agendas to emphasise pedagogy that enables agentive, experiential learning that is transformative for a learning subject. An important aspect of this is situating students' experiential learning within new sites for pedagogy where they are exposed to 'community realities' (Taylor & Fransman, 2004) as a means of locating "individual action within the broader context of its consequences" (Sachdev, 2014, p. 438). In this paper we explore how students negotiate learning as agentive subjects moving across disciplinary, social, environmental and personal learning thresholds.

To do this we present the conceptual framings informing these perspectives, followed by the methodology we have used in provoking the above learning and resultant dispositions. Next we report on learning within a project case as prompt for our analysis and close with a discussion and a set of propositions for what constitutes the qualities of an ecologically immersive pedagogy for sustainable design.

2. THEORY AND CONCEPTUAL FRAMINGS

In adopting a sociocultural perspective on situated and experiential learning (Lave & Wenger, 1991; Leander et al., 2010; Freire, 2015; Shreeve, 2016) we acknowledge processes of learning as not only contained in individual minds but distributed across and mediated by people, tools, language, and learning environments (Leander et al., 2010). The question of the relationship "between an individual with both a mind and a body and an environment in which the individual thinks, feels, acts, and interacts" (Gee, 2008, p.81) is a prompt for design educators to explore potential learning spaces and places that are relationaly agentive. Agency so understood extends beyond localisation within individuals and is considerate of agentive entanglements (Haraway, 2016) that widen a nascent designers relational awareness of self in a wider systems view. To this point, Mathews argues that we as humans are "enmeshed unavoidably in ecological relations with other species and with the biosphere at large" (2011, p. 5). In a previous LeNSes conference, Narayanan (2010) has questioned the conventional starting points in design education for sustainability, and argued for initiating with an "integrated and holistic development of consciousness as core to a new form of design thinking – one that grounds autonomy, experience and agency" (p. 19). Sachdev (2014), also based at the Shrishti School of Art Design and Technology further develops Narayanans pedagogical approach of combining "being with doing and creating capacities for ways of knowing, sensing and seeing our world" (p. 423). He argues for pedagogy that carefully considers "how we interact within the larger dynamic of participation and consequence of actions" (p. 439).

In terms of design pedagogy, these are important concepts for framing critical inquiry into transformative learning spaces that "forge participation in the times and spaces of relationality between inside and outside" (Ellsworth, 2005, p. 46) as students negotiate self in relation to others. Furthermore, Jackson (2013) develops the concept of an individuals 'learning ecology' comprising "their process and set of contexts and interactions that provides them with opportunities and resources for learning, development and achievement." Importantly for the concept of learning ecologies, Jackson cites Lemke's (2000) argument that for learning processes "each step along a developmental trajectory changes the way the system interacts with its environment at the next step" (p. 284). These are supportive views for design pedagogy that is reflexive and responsive to how meaning is made within an 'eco-social systems view' where a "developing person engages in socially meaningful interactions with others and with the non-human surround" (Lemke, 2000, p. 283).

2.1. Methodology and research methods
The paradigm of inquiry is primarily constructivist while leaning towards advocacy and participatory approaches. We adopt the roles of participatory action researchers within a practice-based action agenda for transitioning curricular and pedagogical reform (Creswell, 2003; Denzin, 2017). That is, we planned and enacted our pedagogy and then through qualitative inquiry methods of participant observation during the coursework, and semistructured post-project interviews we have been able examine and lift up nuanced understanding of emergent learning dispositions. In addition, we draw on survey data contained in the independent observers report which is a mandatory element of a pilot LeNSes course. These methods all contribute to a multivocal and dialoguing approach (Tracy, 2010) and generate a rich contextualisation and recounting of learning experience.

3. CASE STUDY: LEARNING TO DESIGN LIKE AN ECOSYSTEM

The pilot project ran over a period of eight weeks alongside regular coursework as part of CPUT's Industrial Design departments fulfillment of its mission as a member of the LeNSes partnership to integrate S.PSS tools into a curriculated trans-disciplinary course, the first of which dealt with renewable energy alternatives. The challenge was to develop alternative strategies for enabling access to energy for under-developed areas in Cape Town. The student and staff group comprised five educators and 30 undergraduate level students in the Industrial Design and Mechanical Engineering Departments at CPUT. Consent has been given by students for interviews and material generated by the project to be used in this study.

In addressing local challenges of socio-material change in relation to a wider context of complex ecosystems, the methodology and tools of S.PSS[1] and Biomimicry[2] were used. In this way, the pedagogical approach and ethos of Biomimicry was introduced to draw students' social ecologies into closer proximity with local natural ecology. By immersing the group in a natural setting, students were exposed to alternative solutions for energy production based on their observations. After this exploratory phase, a process of abstracting design principles from observed natural strategies followed. The Life's Principles[3] checklist, in conjunction with other biomimetic design tools were used in a series of exercises. This enabled students to explore possibilities for innovative product design by first understanding existing energy systems currently used in rural, peri-urban and urban social contexts, and then to assess the potential for adaptation according to efficient energy systems prevalent in nature. Students then established a relationship with a local community partner to map the existing socioeconomic and environmental context using S.PSS methods. The final outcome was a conceptual product prototype designed using an S.PSS view and tools, achieved through a process of engagement with deep social and environmental sustainability as a benchmark.

A comprehensive analysis of the project outcomes are beyond the scope and topic of this short paper and so we focus now on learning brought about through the inclusion of biomimetic pedagogy, and how students navigated their experience of this approach as a meaningful starting point for sustainability education.

3.1. Suspension and inspiration

Our project work commenced with a detailed overview of Biomimicry, its methodology and methods along with inspirational examples of the use of this approach in various disciplinary domains ranging from healthcare to architecture and product design. We then shifted our studio to the biodiverse Kirstenbosch Botanical Gardens to intitiate the first phase of scoping and discovering, which would prove to be a key step in expanding ecological awareness that would enable students to sense and see the world differently. As students learned, with assistance from a biologist, about the strategies evolved by local fauna and flora to sustain life over billions of years, they entered "unfamiliar territory, in a process of discovery" (Fendler, 2013, p. 787). One student commented on how this phase levelled hierarchies often prevalent in the studio: "When you are taken out of the class environment and into nature you let all of that drop… everything is new to you, everyone is on the same level". In being introduced to a new language of how natural systems work and 'quieting' their designing cleverness, an egalitarian trans-disciplinary space was opened up. In one students words, "It was like first year all over again, you felt uncomfortable because everything was new". Students learnt how to suspend their usual competitive rush for task completion, listen to each other and also widen their view of where inspiration might come from. This would be a significant move towards seeing nature as mentor, as an immense resource for modelling, and as an existing measure for sustainable solutions.

3.2 Application and evaluation

A second phase challenged students to apply their new learning in a designerly way involving two exercises known as 'Design to Biology' and 'Biology to Design'. In the latter exercise, drawing on deeply observed biology and selected natural 'champions' would later move students to consider how evolved symbiotic processes can inspire design solutions[4]. For example, observing a Strelitzia flowers 'valve' petal which acts as a perch for a bird pollinator by releasing pollen due to its weight, inspired one group of students to later emulate this valve release action in a design concept for a biogas stove. Gas only flows with the weight of a pot, thereby preventing fire if knocked over.

Student reflections on their experience go beyond the strictly procedural and highlight interesting threshold crossing moments where socially meaningful learning ecologies were forming. Some commented on the confidence gained as their groups community of practice started functioning like an ecosystem, where unexpected resources were shared and the groups interdependence ensured that no member would be left behind as progress was made.

One student reflected that Biomimicry was a catalyst for her creative process and that along with "dreaming and motivation helped her come up with wild ideas for real world problems". Another confided that, being such

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[1] Sustainable Product-Service Systems (S.PSS) is a promising model to couple environmental protection with social equity, cohesion and economiprosperity in different contexts around the world (LeNSin Project, n.d.).

[2] Biomimicry is the conscious emulation of tried and tested strategies found in nature to develop sustainable solutions to human challenges (Benyus, 2002).

[3] Life's Principles are drawn from overarching patterns and strategies evident among species thriving on earth. By learning from these deep design lesson that have evolved over 3.8 billion years, students can model innovative strategies, measure their designs against these sustainable benchmarks and be "mentored by natures genius using Life's Principles as… aspirational ideals" (DesignLens: Life's Principles, 2016).

[4] Students used the AskNature website to explore a library of biological strategies that have been mapped to design challenges (AskNature, 2018).

a turning point in her young design career, she would find it difficult to go back to previous ways of thinking and working. Others commented that even though they were bewildered and scared by the complexity of working beyond their disciplines, they found motivation and confidence in how the evaluative Life's Principles tools could support their creative imaginings and the viable sustainability of their designs. "It was a dramatic performance as we

shared ideas" said one student as she described a sense of euphoria in her group as they explored an expanded space for design possibilities. In summing up her experience one student said, "It made you think critically about things you wouldn't normally consider, it gave me the chance to think like a different type of designer". These reflections give some indication of transitioning steps towards trans-disciplinary thinking where students were able to move beyond habitual and siloed practices.

[Figure 1] Close observation of a biological 'champion' coupled with the S.PSS mapping tool enabled this student group to address the socio-economic and environmental challenges within a particular peri-urban community context. Images: Andrea Grant Broom.

4. DISWCUSSION AND CONCLUSION

We have briefly shown in descriptions of the case above and through reflective comments how the intensive and sometimes uncertain process yielded valuable experience in becoming self-regulated learners capable of handling risk and ambiguity (Edwards, 2014, p. 25). Educators involved in planning, coordinating and running this pilot course reflected that the Biomimicry methodology/tools and the S.PSS method/tools shared similarity in both having a systems thinking approach, while each brought different strengths i.e. a Biomimicry focus on the ecological and S.PSS focus on tools for economic and socio-political aspects of design for sustainability. Even though logistics prevented an extended immersive phase commonly used in biomimetic pedagogical approaches, the survey and interview data showed that students responded more positively to the experiential pedagogy than the S.PSS taught method which was handled in a lecture format in studio on campus. The early beta version of the LeNSes website also contributed as a barrier for students trying to engage with the material. The biomimetic approach was inspirational for them enabling them to 'own' their learning in a socially and ecologically mediated process. They learnt that 'sustainability' means deep consideration of designing agency within planetary limits and boundaries, and that Life's Principles may be relied upon as a set of pinciples that can complement the S.PSS approach and add a deeper ecologically sensitive dimension to the analytical toolkit.

We now present an overall framing of what we call the qualities that are core to ecologically immersive pedagogy. These qualities are interdependent and individually significant as they collectively describe learning experience that is transformative of design dispositions relevant to complex contexts. Moreover, these qualities are seen as unfolding and about doing pedagogy with students that activates the present and empowers "a situation with capacity to provoke new relations", co-creating a space where students can be in the presence of emergent values and their consequences (Tironi, 2018, Chapter 5, Section 3, para. 2). These qualities comprise:

Opening – spaces for suspending and deterritorialising in a spatio-temporal move away from anthropocentric environments. Thinking–feeling in a non-threatening trans-disciplinary mode encourages local attunement and noticing of what is already thriving in a real-world project context, socially and ecologically.

Becoming – affording design students opportunity to build their own learning ecologies through critically expanding their current knowledge (episteme) of sustainability through immersive being (ontology) in close proximity with living ecologies.

(Re)connecting – remembering that we are part of nature and not as disentangled from other species as we have come to believe (Mbembe, 2016). This is an ethical move that enables design students to operate with conviction and shared agency "within a wider realm of care" (Sachdev, 2014, p. 437). In this way students perform a move away from ego towards becoming ecosocially aware of their designing agency.

Integrating – by integrating the unexpected and being open to more than one narrative, cooperative relation-

ships may be recognised and cultivated that enrich the design process. This includes a pedagogy of integration that draws together knowing, being and doing in ways that have the "ideals of social and ecological justice as its basis" (Sachdev, 2014, p. 423).

Emulating – enactive emulation (rather than appropriation or extraction) of natural strategies (rather than resources) through a process of learning with nature as model, mentor and measure, effects respectful design that is better suited to thriving futures for all.

Measuring – by evaluating creatively innovative design possibilities against a set of living principles, motivation and confidence to challenge the unsustainable status quo may be cultivated in young designers.

In conclusion, by reading this case through the literature; our position is that immersive, situated design pedagogy that is enacted with our students produces pivotal moments during the learning process which have been found to have been effective in transforming students' dispositions, cultivating attributes of thoughtfulness, self-awareness, resilience, adaptability, and shared agency. These are moments that effectively enable design students to understand and more confidently create their social learning ecologies through collaborative interactions with their design peers, other disciplines, local communities and natural ecologies. These pivotal learning moments are consistent with the skills and agency desired for knowing how to be sustainable designers in a rapidly transitioning world.

Cape Town's particular socio-economic and political complexity, together with its biodiverse natural environment provides a rich landscape within which we as educators are able to draw on and dynamically situate our pedagogy. In this paper we hope that in sharing this experimental pedagogical approach in the spirit and ethos of the LeNSes network, that we are contributing to and learning from a diversity of place-based methodological approaches that are unique to different parts of the world. In this way we can continue to develop the concept of ecologies for learning where the network learns as an ecosystem does.

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