Aug 11th, 12:00 AM

Towards Design-Driven Transdisciplinary Education: Navigating the Challenges and Envisioning the Role of Design as a Facilitator

JiaYing Chew
National University of Singapore

Jung-Joo Lee
National University of Singapore

Miikka J. Lehtonen
Dubai Institute of Design and Innovation

Follow this and additional works at: <https://dl.designresearchsociety.org/drs-conference-papers>

Citation

Chew, J., Lee, J., and Lehtonen, M. (2020) Towards Design-Driven Transdisciplinary Education: Navigating the Challenges and Envisioning the Role of Design as a Facilitator, in Boess, S., Cheung, M. and Cain, R. (eds.), *Synergy - DRS International Conference 2020*, 11-14 August, Held online. <https://doi.org/10.21606/drs.2020.344>

This Research Paper is brought to you for free and open access by the Conference Proceedings at DRS Digital Library. It has been accepted for inclusion in DRS Biennial Conference Series by an authorized administrator of DRS Digital Library. For more information, please contact DL@designresearchsociety.org.

Towards Design-Driven Transdisciplinary Education: Navigating the Challenges and Envisioning the Role of Design as a Facilitator

JiaYing CHEW^a, Jung-Joo LEE^a, Miikka J. LEHTONEN^b

^a National University of Singapore

^b Dubai Institute of Design and Innovation

* Corresponding author e-mail: jiaying.chew@nus.edu.sg

doi: <https://doi.org/10.21606/drs.2020.344>

Abstract: The contemporary society deals with challenges that are complex, dynamic and networked, which requires different knowledge domains to work together beyond their knowledge silos. Transdisciplinarity is one of the responses to this mandate, and universities are increasingly trying to implement transdisciplinary education. Transdisciplinarity, however, is seen disruptive to existing university structures, and there is a need to examine the challenges to inform future directions. This paper presents an exploratory study into the existing challenges towards implementing transdisciplinary education through action research in one graduate degree program. Through a series of interviews, observations and co-design workshops accompanied with frameworks and tools developed, we identify the existing challenges of the curriculum development and delivery. We also explore how design could play a facilitator role in unveiling assumptions and aligning different perspectives among multiple parties in the curriculum development.

Keywords: transdisciplinary education; curriculum development; design; transdisciplinarity

1. Introduction

The contemporary era sees unprecedented interconnected systems, unpredicted disruption and ever-changing currents and trends as forces moving towards solving problems on human and environmental scale (Buchanan, 1992; Hyysalo et al., 2019). As such, the contemporary knowledge landscape witnesses an increasing yield from industry and society for a holistic and cross-disciplinary understanding, rather than focusing solely on the depth of individual disciplinary knowledge (Ramadier, 2004). An acknowledgement to these complex issues is the concept of “transdisciplinarity” that considers not only a relevant mix of disciplinary knowledge, but also external factors like localized domain knowledge, strategic foresight, culture and phenomenology in creating a collective understanding of an issue (Brown et al.,

This work is licensed under a
Creative Commons Attribution-NonCommercial 4.0 International License.

2010; Nicolescu, 2005; Hyun, 2011; Jahn, Bergmann and Keil, 2012).

This outlook challenges the perceptions of the role of the university in contemporary society. The disciplinary barriers in current university structures that were consequentially created in the advancement of individual majors and specializations, have since proved limiting towards innovation (Russell, Wickson and Carew, 2008).

As an answer to this need, many universities are trying to develop and experiment with inter-, cross- or trans-disciplinary programs on a small (e.g. modules and projects) and large scale (e.g. degree programs). What is observed in those attempts is that design is seen as a tool in bridging different disciplines, especially when it comes to dealing with wicked problems (Rittel and Webber, 1973) and organizational change (e.g. Boland and Collopy, 2004; Brown, 2009; Martin 2009; Kimbell 2011). As described by Bremner and Rodgers (2013, p.8), “the terrain of design continues to shift and extend well beyond the boundaries of the (single) discipline. Design now encompasses multiple disciplinary perspectives and entails cross-disciplinary pursuits.”

Most of these programs, however, hover in the domain of multidisciplinary as they remain paradoxically homogenous in their setups as well as curriculum design (e.g. Ertas, Maxwell, Rainey and Tanik, 2003; Tully, 2013; Self and Baek, 2017; Self, Evans, Jun and Southee, 2018). The aspect of transdisciplinarity appears to be challenging for implementation due to various systemic issues present, for example, the persisting focus on individual majors and specializations in universities (Russell et al., 2008) and a lack of integrative platform for knowledge exchange (Jahn et al., 2012).

This paper presents an exploratory study to unveil challenges of developing transdisciplinary higher education and discuss potential roles of design in overcoming the challenges. Design has been increasingly used to facilitate multidisciplinary collaboration, by supporting the creation of collaborative platforms, providing a shared language through visualization, and guiding solution-envisioning activities (Lee et al., 2018; Hyvärinen, Lee and Mattelmäki, 2015). We tap on such qualities of design and explore its role as a facilitator in a transdisciplinary education context.

We illustrate this through the case from one design school in the Nordic region. The intent is not to raise epistemic questions about transdisciplinary pedagogy (Klein, 2008; Hyun, 2011; Gibbs, 2017), but to analyse the challenges in the current institutional setup that may be causing impediment to transdisciplinarity being implemented in higher education.

2. Transdisciplinarity and Design

2.1 Transdisciplinary Higher Education

As described by Land (2012a, p.38), university curriculum have typically been developed in “their own conceptual worlds” to deal with issues that have a clear demonstration of causality— often coupled with solutions that have been tried and tested. However, since

society's most significant challenges are complex, ever-changing and cannot be definitively described (Buchanan, 1992; Rittel and Webber, 1973; Dorst, 2015), the concept of crossing disciplinary boundaries is increasingly welcomed in attempts to break free from knowledge silos, and to provide more holistic and comprehensive solutions to global challenges.

Yet, the concept of transdisciplinarity is loosely understood and rarely adopted in higher education as observed by Gasper (2010). By synthesizing the earlier definitions that have been the most consistently established on the cross-disciplinary spectrum (Nicolescu, 1999; 2005; Ramadier, 2004; Gasper, 2010; CERI, 1972), we interpret the different notions around mixing disciplines as follows:

- *Multidisciplinarity* refers to the juxtaposition of more than one discipline. In a project setting, this suggests separate input from each discipline, typically presented independently with no interaction.
- *Interdisciplinarity* thrives at the crossroads of multiple disciplines and sets of practical demands. In a project, this describes interaction between disciplines and can range from simple communication of ideas, to the mutual exchange of understandings and organization of research.
- *Transdisciplinarity* concerns not just interaction across multiple disciplines, but also looks at diversity in background, experience and prior knowledge. It is an approach which is at once between the disciplines, across the disciplines and beyond all disciplines. The goal is to work within and beyond the constraints rather than creating a mega-silo, thus emphasizing understanding and embracing disciplinary differences.

The challenge surrounding interdisciplinarity stems from the difficulty to transcend or break out of the existing setups that have already been deeply in place, since there are little academic incentives to share resources or engage in discourses for mutual deconstruction of frameworks (Gasper, 2010; Land, 2012b). This results in resistance and renders it even more challenging to develop and deliver transdisciplinary curriculum, as it not only requires instructors exchanging viewpoints, but going back and forth disciplinary and transdisciplinary standpoints (Nicolescu, 2005; 2006). Furthermore, it also means that the level of understanding and the depth of knowledge of individual actors— instructors and students, will be different (Nicolescu, 2010).

2.2 Design in a Transdisciplinary Setting

Within transdisciplinarity, design's role is two-fold: design as a problem-solving logic and design as a method. For the former notion, design can provide a shared logic to approach complex problems for multiple actors in a transdisciplinary setting. This acts as a platform that reduces resistance to interaction and exchanges. According to Bremner and Rodgers (2013, p. 8), design can be "characterized by fluid, evolving patterns of practice that regularly traverse, transcend, and transfigure disciplinary and conceptual boundaries". As design is employed in a wide range of making and planning disciplines, extant literature around

transdisciplinary discussion and applications in education often surface with the term design or design thinking as a problem-solving logic, bonding different tools and thinking processes of different disciplines (Jahn et al., 2012; Hyun, 2011; Ertas et al., 2003; Garbuio et al., 2018).

Recently the role of design has been addressed in a co-creation settings with heterogeneous knowledge groups (e.g. see Lee et al., 2018). Extant research (Lee et al., 2018; Hyvärinen, Lee and Mattelmäki, 2015; Bason, 2010; Junginger and Sangiorgi, 2009) has focused on design's innate qualities that are human-centered, collaborative, and future-oriented. Through analysis of 13 co-creation projects, Lee et al. (2018) explained how design can facilitate co-creation by multiple actors with heterogeneous knowledge, power and interests: visual and narrative components of design help actors construct and articulate their knowledge and expectations; creative collaboration tools help them negotiate their different views and form a shared goal; future-oriented components of design allow them to imagine future scenarios.

Tapping on these qualities, design has been recognized as a method to organizational transformation (e.g. see Junginger, 2009; Sangiorgi, 2011; Bason, 2010). Junginger and Sangiorgi (2009) suggested that design enquiry can be used as a conversational tool within an organization to unveil organization's deeper assumptions and show how such assumptions frame its current situation and actions. Similarly, Hyvärinen et al. (2015) illustrated the roles of design approaches in helping organizations externalise their different views and expectations in a cross-sector collaboration. Bason (2010) advocated the role of design in achieving the public sector transformation from expert-oriented, siloed ways of working to more collaborative one.

The emerging roles of design in multidisciplinary collaboration and organizational transformation hint us at its potential to be used in transdisciplinary curriculum development where multiple actors with different knowledge backgrounds gather. As the above-mentioned studies indicate, design can facilitate creative collaboration among different disciplines and challenge the existing structure of universities. Design tools could help identify different views and knowledge gaps among educators from different disciplinary backgrounds, as well as between educators and students, during the curriculum development process. Upon the mutual understanding achieved, design could facilitate to co-create shared goals and action plans for transdisciplinary education.

In the following sections, we first present the challenges observed from one graduate program whose aim is to embed transdisciplinarity in their education, and then map the challenges with possible opportunities from design.

3. Case: IDBM Curriculum Redesign for Transdisciplinarity

3.1 Introduction to the Case and Research Process

We illustrate the challenges surrounding networked actors - program management, faculty member and students - within a potential transdisciplinary setup, through the case of Aalto University's International Design Business Management (IDBM) graduate

program. Established as a multidisciplinary minor program in 1995, and conferred as an interdisciplinary two-year major program in 2010; the IDBM program hosts an equal-part setup across the Design, Business and Technology schools. Through equal disciplinary-representation, cultural backgrounds and work/ industry experience, the program's heterogeneous conditions (Lawrence and Després, 2004; Ramadier, 2004; Klein, 2004) across the student body and faculty put it in an ideal position to be developed towards transdisciplinarity. The program's unique structure allows for a dynamic exchange across disciplines beyond the typical siloed structure of traditional institutes of higher learning.

The program curriculum is structured such that during the first year, students take a series of mandatory courses aimed at equipping each cohort with a foundational understanding in Design, Business and Technology disciplines, respectively. Thereafter, finishing the first year of their studies with a six-month long industry-based project designated by an industry collaborator: for the project, students are assigned to multidisciplinary teams where they get to apply their cumulative knowledge.

This structure remains core to the program, thus resembling a "threshold concept (Land, 2012b, p. 176)" to transdisciplinarity that "lead to a transformed way of understanding, or interpreting, or viewing something without which the learner finds it difficult to progress". In the case program, this is facilitated through mandatory exposure to different disciplinary perspectives, in hopes that students embrace the differences when collectively navigating the uncertainty and ambiguity within diverse teams.

Yet, despite the program's long-standing history of experimenting with mixing disciplines in curriculum setups, it was observed that it has been consistently difficult for students to articulate their learnings or break out of their comfort zones beyond their disciplinary experiences when working on team projects. Guided by an action research approach, this research leverages on insights from observations, in-depth interviews and co-creation workshops based upon the process of the program's curriculum development (Figure 1). Overall, the action research was conducted over the span of six months (October 2018 - March 2019).

Figure 1 Research process and methods adopted based on phases of action research

We adopted Lewin's (1958) changing in three steps model: 'unfreezing' in action research aims to uncover and bring attention to the underlying issues that the group is facing; the 'changing' phase entails an understanding of the issues and introducing an intervention to be tested; and finally 'refreezing' looks at the application and evaluation of the intervention introduced.

The first author played a "stewarding role" following the research and intervention process, to which we describe as the person appointed to supervise or direct the process. In the 'unfreezing' phase archival records served as a foundational understanding of how the program's design and legacy transpired, while faculty and student interviews surfaced challenges and issues with existing practices. Synthesis of the interview findings led to the development of a framework that navigates the influences for transdisciplinary course design and development. The framework was later developed into a tool, 'curriculum alignment canvas', as an intervention to test out the framework and delve into deeper knowledge and challenges around.

Introduction of the tool in a planning meeting with all faculty members marked the 'changing' phase, as it allowed for intervention at program level but also on an individual course level through a series of four co-design workshops. Thereafter, the 'refreezing' phase looked at implementation of interventions in a collective setting, by integrating the various modules into a holistic transdisciplinary curriculum. Finally, an analysis of the implementation challenges and future considerations were mapped in relation to the qualities of design.

3.2 Stewarding the Curriculum Design Process through Action Research

As opposed to the "consultative" review that qualitative research adopts in providing analysis and commentary from outside-in (Muratovski, 2015), the emic-etic (Pike, 1967)

outlook of action research enabled a situated response and reflection in and around the context. Waterman, Tillen, Dickson and De Koning (2001, p. iii) described action research as “a group activity with an explicit value basis and is founded on a partnership between action researchers and participants, all of whom are involved in the change process”. The focus of action research is in the improvement of an existing practice that is based around a problem, dilemma, or ambiguity from the situation in which practitioners find themselves in (Muratovski, 2015). As such, it makes a dual commitment to study a system and concurrently, collaborate with members of the system in changing it together, to what is regarded as a desirable direction (Huntjens et al., 2014).

We initiated the data collection by the first author conducting 13 in-depth interviews with the key actors of the program: two members of management (program directors who also taught courses); five faculty members (two program administration and the three instructors who taught the design, business and technology courses) and selected first-year students across the various disciplines (two Design, two Business, two Technology). Each interview lasted 45- 60 minutes, focusing on key themes presented in Table 1. All interviews were recorded and transcribed verbatim.

Table 1 Key themes of interviews

To the Faculty Members	To the Students
<ul style="list-style-type: none">• Their understanding of transdisciplinarity and its implications for the program• Program’s goals, aims and directions• Experiences in course and program planning, design and delivery• Student expectations towards the program• Their understanding of how individual courses fit into the larger picture of the program• Challenges and opportunities for the program from a faculty perspective	<ul style="list-style-type: none">• Rationale for choosing a cross-disciplinary graduate program• Their understanding of transdisciplinarity• Program experience thus far vs expectations when they applied for the program• Experiences with individual courses and learning outcomes• Mapping their transdisciplinary understanding of the program based on the courses• Challenges and opportunities for the program from a student perspective

In these interviews, participants were first asked to reflect on their individual experiences of the program. They were also asked to provide suggestions for future improvements and were encouraged to talk about their past educational experiences, backgrounds and expertise so as to allow the interviewer to better understand their frame of mind and possible disciplinary approaches and cultural influences.

One of the key findings from the interviews was that the curriculum intent and learning

outcomes were loosely interpreted and sometimes mismatched. As it turns out, the instructors had independently designed their course curriculum and learning outcomes in response to societal and industry needs and trends, yet the students found difficulty in navigating their expectations and applying learning experiences. The interview findings indicated that the students had attempted to make sense of the courses as part of a collective program experience, rather than individual instructional settings. Due to the independent design of the curriculum, both students and faculty members shared their confusion and struggle to map out their understanding of the program and its core components. It was evident that interrelations between the courses were critically missing. Identifying these aspects of dissonance enabled a clearer overview of the influences and processes that shape curriculum development.

3.3 Framework for Transdisciplinary Curriculum Development and Application

Based on our data, we crafted a framework that navigates the various influences, phases and key stakeholders of transdisciplinary curriculum (Figure 2). This framework illustrates the factors that influence course design and development on multiple levels, as well as the actors involved in each level.

Figure 2 Influences for Transdisciplinary course design and development

At a “meta” level, universities aim to equip students with the necessary skills and knowledge for employment upon graduation. Industry and societal needs thus become the external influences that greatly impact faculty’s decisions and considerations, which in turn frame and provide inputs to the syllabus and course design.

On the receiving end, students’ expectations and learning experiences are key indicators that demonstrate whether or not the intended learning outcomes have been met, and whether the curriculum design is successful. Since students learn through the circumstantial environment and tangible material, the course curriculum and delivery then become the “matter”, a product of course design and development. The mismatch between meta and matter could be bridged by redesigning the process of course design and development.

The framework was broken down into more actionable items to facilitate transdisciplinary curriculum design, which in turn were developed into a tool, “curriculum alignment canvas”. Built upon Biggs’ (1996) constructive alignment model as the common denominator across the various disciplines, the tool (Figure 3) was designed to encompass the following six elements:

- **Syllabus:** Breaking down the context of which the course operates in, as well as the trends and external influences that drive this.
- **Levels of ‘Difficulty’:** Acknowledging that there are varied levels of knowledge within the diverse student body is critical. ‘Difficulty’ here refers to the considerations for evaluation in correlation to the individual’s relative prior experience and knowledge. In a way, this means that students are evaluated on their individual growth and learning rather than on a yardstick.
- **Intended Learning Outcomes (ILOs):** Identifying the skills and knowledge that the course is intended to equip the students with.
- **Theoretical Learning Artefacts:** Grounded in theory and literature, students will use these materials in relation to the activities to achieve the ILOs.
- **Practical Learning Activities:** The format in which learning, and teaching will take place. These activities provide the environment to which the artefacts will make sense for achieving the ILOs.
- **Evaluation and Assessment:** The teaching methods used and the assessment tasks, have to be aligned with the learning activities assumed in the intended outcomes. As a result, the learner is in a sense “trapped”, and finds it difficult to escape without learning what he or she is intended to learn (Biggs, 1996).

These elements were crystallised through the analysis and review of past and existing syllabus archives. Most of these elements were present in individual course designs, however, the approach and attention to each component varied depending on instructor. The format of each syllabus was also presented differently, depending on the instructor’s preference and focus. As such, the tool was designed to provide the instructors with a shared vocabulary in the process of program development and their individual course redesign.

1. Syllabus What are the hard facts that students should be learning about this subject? (e.g., Design Methodology, Business Models)		2. Levels of "Difficulty" How to ensure that the course balances new knowledge with existing knowledge regardless of background?	
		3. Intended Learning Outcomes How will they utilise the skills and knowledge? What should they be able to navigate/ articulate after this course? How will this translate into the different aspects of a course? What will be taught in theory/ practical?	
1a. Program Specific	1b. X-Disciplinary Format Is it multi-/inter/transdisciplinary? What's the best format to learn this subject?	4. Theory (e.g. Readings, Videos, Lectures)	5. Practical (e.g. Group Project, Workshop)
1c. Pre-requisites? What kind of knowledge do we expect students to already have?	1d. Industry Trends What information in this syllabus is subject to change based on trends?	6. Evaluation on ILOs (e.g. Learning Diary, Final Presentation)	

Figure 3 Curriculum Alignment Canvas

Taking shape in the format of a canvas to be used in collaborative settings with faculty members for the redesign of the program's foundational courses, the tool played a central role in navigating an understanding of the key concerns and periphery considerations for each of the courses (Comi and Whyte, 2018).

First used in co-design workshops with individual faculty members, the three instructors teaching the foundational Design, Business and Technology courses were tasked to fill out the canvas by reflecting on their own curriculum plans and existing practices. The filled-out canvases were then used as a focal point for discussions in a co-design workshop with the rest of the faculty, framed as a strategy meeting.

In the individual setting, key issues of resonance were ironed out for each course by going over the format of the current curriculum. The goal here was to allow the instructors to articulate their rationales around their course design and discuss curriculum delivery challenges. Thereafter, the instructors engaged in ideation to suggest improvements to their existing curriculum. In these sessions, the instructors had not made significant changes to what they were intending to teach, but verbalizing their thoughts allowed them to sound out what the main priorities were, as well as the pitfalls for the existing curriculum. The one-to-one sessions also allowed the *steward* to seed a shared vocabulary through the canvas as a platform for discussion.

Thereafter, in the co-design workshop where all ten key faculty members were present, the agenda was broadly listed as curriculum planning for the following academic year. This

provided a frame of mind for participants as they anticipated discourses around roles, rescheduling and improvements to the existing curriculum. In this setting, the filled-out canvases were put up on the walls to facilitate sharing around the existing syllabus and curriculum format of individual courses (see Figure 4).

Figure 4 **Canvases in use during Strategy Meeting Workshop**

A blank timeline of the academic year was also provided, as it allowed for visualization of individual course components. This setup as a tangible artefact for instructors to express the intent and pedagogy within and around their courses, as well as identify synergistic opportunities that were present in the larger context of the transdisciplinary program.

Although the same canvas was introduced to the individual instructors, they had filled them out differently, as each instructor had a different concern for their courses. This was especially evident when the canvases were put up adjacent to one another. Moreover, having familiarised themselves with the canvas' six elements in the earlier individual co-design sessions, the three instructors reflexively partook as co-facilitators in leading the collective co-design workshop. This allowed them to articulate their individual concerns and rationales, while creating a common understanding for the rest of the faculty. The workshop also provided an exemplified understanding of the nuances and underlying tensions that persist within existing siloed structures.

As such, the canvases acted as a starting point for discussions to be built upon. It was also the medium that enabled transparency and the acknowledgement of challenges between the various layers, actors, and elements of curriculum design as it provided a common platform for discussion and comparison.

4. Challenges in Transdisciplinary Curriculum Development and Future Opportunities

Our data reveals multiple challenges in transdisciplinary curriculum development. Through thematic analysis (Braun and Clarke, 2006) we observed that challenges that were pertinent across various levels of the program's operations can be categorized as follows:

- The need for initiation and stewardship
- Lack of collective understanding towards transdisciplinarity
- Syllabi Incompatibility

In the following, we discuss our findings under each theme, explaining why and how these challenges persist.

4.1 *The need for collaborative initiatives and stewardship*

Having the instructors fill out the canvas and verbalize their thought processes behind the course development revealed that the course development is often done solitarily and disciplinarily, based on existing norms and practices within a discipline. However, this results in courses designed to be standalone, much like courses offered in various disciplinary-based programs. It is due to discipline-dominated administrative structures and reductionism within institutions (Ertas et al., 2003; Klein, 2008), where bottlenecks often occur in transcending disciplinary silos (Mieyeville et al., 2015; Ramadier, 2004). Customarily, curating the design and development of any education program is perceived as the role of the program's steering committee that decides the teaching directive. However, design and development in a transdisciplinary program demands the contribution of various expertise, and thus requires community efforts.

In transdisciplinary programs where diversity and representation are vital to its success, facilitation of such settings requires a “*steward*”. Comparable to “*innovation champions*” (Kotter, 2007; Cooper, Junginger and Lockwood, 2013), who are seen as key agents who extend beyond their formal role to engage in innovation (Bankins et al., 2016) and implement the use of design in an organization to bring creative ideas to life; the steward's primary role is to guide collective curriculum development (cutting across the different disciplines) by putting the intended learning outcomes at the forefront. This process is referred to as “*designing backwards*”, by first establishing what the level of outcomes and standards were required and then deciding on the logistical details (Angelo, 2012).

Alongside the program director whose role is to make strategic decisions, the steward facilitates transdisciplinary discussions by identifying and harnessing the synergistic opportunities between stakeholders while navigating tensions. This role can be akin to an “*insider-consultant*”, best portrayed by a non-partisan personality unbound by disciplinary limits and hierarchy. This role requires a certain level of familiarity with the program structure, but also agility and flexibility within the organisation (i.e., non-teaching staff,

program manager, coordinator or researcher). The appointed person often has to rally support and interests from within the institution and play the mediator role.

4.2 Lack of collective understanding towards transdisciplinarity

Through the co-design workshops, all participants agreed that the concept of transdisciplinarity is best communicated through the program structure. As discussed in the case section, the goal is to provide students with an opportunity to build a repertoire of understanding through exposure to individual disciplinary perspectives within course contexts.

However, because the topic of transdisciplinarity is so loosely understood, it is critical to set up the threshold concept (Land, 2012b) through curriculum design. In this setting, the threshold concept refers to crafting the liminal boundaries within each course— depth of individual subjectivity and scope of perspectives to consider (e.g., what are the distinct or overlapping boundaries between design and business?). These parameters allow students to navigate what may be counterintuitive for them, as they encounter unfamiliar discourses in the process of acquiring new knowledge and relinquishing old knowledge (Land, 2012a).

This is critical not just for the students, but also for the faculty members, as the alignment amongst instructors creates the basis for students' understanding and in turn affects the collective crafting of learning objectives of the program. Fundamentally, the concept of transdisciplinarity looks at tackling complex challenges by having a well-rounded understanding of the present world, of which one of the imperatives is the unity of knowledge (Nicolescu, 1999). Thus, identifying a shared ground or “boundary objects (Star and Griesemer, 1989)” becomes a mandate. As such, the program curriculum could provide a platform whereby viewpoints are explored through different disciplinary lenses; and encompasses the recognition of diverse views, experiences, and cultural backgrounds.

4.3 Syllabi Incompatibility

Unlike disciplinary-based programs that typically use similar metrics for evaluation and intended learning objectives, it is critical to recognize that different disciplines have different approaches in teaching and learning (Land, 2012a). One of the main struggles we identified in the co-design workshops, was the lack of shared practices for reviewing and crafting the program's syllabi collectively as each school and individual has their own *modus operandi*: this poses a considerable obstacle in developing a transdisciplinary program curriculum as there are diverse viewpoints.

In a transdisciplinary curriculum, it is critical to leverage on synergistic opportunities across disciplines to create a collective understanding of the topic/ challenge. As such, the syllabus of each individual course is no longer standalone, instead it provides one facet to a multi-dimensional understanding.

Due to the lack of shared platforms or standardisation in the way the syllabi and curriculum are structured for individual disciplinary courses, the dissimilarity and incompatibility made

it extremely difficult to cross-reference and make comparisons across the course descriptions (assessment modes, session formats, content and study material). Not only were the syllabi varied in format, presentation and choice of platforms for dissemination; there was use of jargons and discipline-specific terminologies and frameworks that made it difficult for communication, much less an avenue to design and develop the curriculum together. As such, it is essential to distil commonalities or leverage on existing pedagogical frameworks (i.e., Biggs' (1996) Constructive Alignment as we have used here), in order to create shared platforms or standard practices for the development of syllabus and curriculum.

4.4 Opportunities for Design

Breaking down the layers of tensions and challenges that are causing impediment to implementation, we recognized that the issues listed here are interlaced and occur on several levels of transdisciplinary program's operations. While navigating the existing practices of curriculum development through action research, we identified the challenges around the need for collaborative initiatives and stewardship and lack of shared grounds for exploring varying viewpoints and syllabi development. At the same time, we also find opportunities for design in tackling these challenges (Table 2), especially because the existing siloed structures often call upon design's strengths in navigating organizational challenges and creativity in difficult situations (Junginger and Sangiorgi, 2009).

Table 2 Challenges in implementation of Transdisciplinary (TD) Curriculum and Opportunities for Design

Type of Challenge	Challenges in implementation of TD Curriculum	Qualities of TD Curriculum	Opportunities for Design
The need for collaborative initiatives and stewardship	Inertia from faculty to navigate current hierarchical and siloed institutional structures	Equal representation across participating disciplines (Faculty and Student body)	Playing the stewardship role in engaging stakeholders at the start of the co-creation process to elicit a sense of ownership amongst (potential) participating members

	Differences in curriculum design and needs across disciplines. Lack of understanding and platform to enable tangible contribution across disciplines	Real life challenge-based curriculum that allows for integration of various disciplinary perspectives	Identifying and sharing the needs of the involved parties (educators, students and management) through a co-design process Framing and re-framing the challenge brief to facilitate learning activities (Dorst, 2015)
	Lack of institutional support and autonomy/ flexibility	Need for institutional and management support in experimentation of curriculum design	Engaging the management level through a co-design process and presenting the needs and challenges of the students and educators Simulate future benefits through scenarios to actors and stakeholders
Lack of collective understanding towards transdisciplinarity	Challenge/ Project brief needs to be well-framed to allow students to operate within “threshold concept”	Intended level of ambiguity that facilitates the students’ understanding of transdisciplinarity within set parameters	Identifying and sharing the needs of involved parties (educators, students and management) through a co-design process Framing and re-framing the challenge brief to facilitate learning activities
	Curriculum needs to be designed backwards and together	Creating Transparency, Structure and Clarity in Curriculum Design and Assessment through identification of collective intended learning outcomes	Visualizing/ navigating parallel goals and mapping a common understanding through visualization and co-design (e.g., Blueprinting)

	Assumptions due to lack of understanding, use of discipline-specific jargon. Lack of commitment and shared values	Shared platform/ understanding of transdisciplinarity and vocabulary, goal alignment and learning objectives	Revealing tensions and prejudices between actors through visualizations and co-design workshops Setting common/ compatible goals and experimenting collaborative platforms through a co-design process
Syllabi Incompatibility	Leveraging on different teaching and learning styles, varying levels of understanding and domain knowledge/ expertise	Distilling commonalities or leveraging on existing pedagogical frameworks to develop a shared platform for curriculum development	Visualizing instructors' thought processes for syllabi development and identifying common denominators through visualizations and co-design workshops
	Goals alignment and foundational understanding amongst all faculty members as a crucial starting point for developing strategy and processes that are complementary	Strategy is a key guiding factor for TD programs due to the heterogeneity of participants. A guiding document serves as a framework for the team Coherence, relevance and resonance are by-products of structural and processual clarity	Visualizing/ navigating parallel goals and mapping a common understanding through co-design (e.g. Blueprinting)

Moreover, the sticky nature of transdisciplinarity gives rise to circumstances where there is a constant need to engage stakeholders, resolve underlying tensions for framing, and creating a collective understanding. As such, we translate the challenges identified from the case study into qualities that transdisciplinary curriculum should consider and embrace, thereby suggesting a list of opportunities for design to play the facilitation role in transdisciplinarity.

5. Conclusion and Future Work

This paper presents our exploration into the existing challenges of the development of transdisciplinary education, and how design could play a role as a facilitator in aligning different expectations and knowledge among the involved parties. As the transdisciplinary nature of problems has gained currency, universities also ought to follow suit in equipping

their students with relevant skills to solve such problems and challenges. We see transdisciplinary higher education as the medium, and thus have mapped the opportunities from design for facilitating a shared understanding and developing transdisciplinary curriculum.

In terms of limitations, our study took place only within a time period of six months, and as such we followed a temporal snapshot of an ongoing process towards transdisciplinarity. Moreover, the program we studied did not face as much inertia as other, more uni-disciplinary programs and therefore our analysis might be skewed with less resistance and administrative challenges experienced. Therefore, future research should include longitudinal cases in different institutional contexts. Finally, on a more practical level, our propositions on the opportunities for design should be developed into design interventions and tested in future inquiries.

6. References

- Angelo, T. (2012). Designing Subjects for learning: Practical research-based principles and guidelines. In Hunt, L., and Chalmers, D. (Eds.), *University Teaching in Focus: A learning-centered approach* (pp. 93-111). London: Routledge.
- Bankins, S., Denness, B., Kriz, A. and Molloy, C. (2017). Innovation agents in the public sector: Applying champion and promotor theory to explore innovation in the Australian Public Service. *Australian Journal of Public Administration*, 76(1), (pp.122-137).
- Bason, C. (2010). *Leading public sector innovation: Co-creating for a better society*. Bristol, UK: Policy Press
- Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher Education*, 32(3), 347-364.
- Boland, R. J., and Collopy, F. (2004). *Design matters for management* (pp. 3-18). na.
- Braun, V., and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77-101.
- Bremner, C., and Rodgers, P. (2013). Design without discipline. *Design Issues*, 29(3), 4-13.
- Brown, T. (2009). *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*. New York: Harper Collins
- Brown, V. A., Deane, P. M., Harris, J. A., and Russell, J. Y. (2010). Towards a Just and Sustainable Future. In *Tackling Wicked Problems: Through the Transdisciplinary Imagination* (pp. 3-15). New York, NY: Earthscan.
- Buchanan, R. (1992). Wicked problems in design thinking. *Design Issues*, 8(2), 5–21. <http://doi.org/10.2307/1511637>
- CERI (Centre for Educational Research and Innovation), 1972. *Interdisciplinarity: Problems of Teaching and Research in Universities*. Paris: OECD.
- Comi, A., and Whyte, J. (2018). Future Making and Visual Artefacts: An Ethnographic Study of a Design Project. *Organization Studies*, 39(8), 1055-1083. <https://doi.org/10.1177/2F0170840617717094>
- Cooper, R., Junginger, S., & Lockwood, T. (Eds.). (2013). *The handbook of design management*. A&C Black.
- Dorst, K. (2015). *Frame innovation: Create new thinking by design*. Cambridge, MA: MIT Press.

- Ertas, A., Maxwell, T., Rainey, V. P., and Tanik, M. M. (2003). Transformation of higher education: the transdisciplinary approach in engineering. *IEEE Transactions on Education*, 46(2), 289-295.
- Garbuio, M., Dong, A., Lin, N., Tschang, T., and Lovallo, D. (2016). Demystifying the genius of entrepreneurship: How design cognition can help create the next generation of entrepreneurs. *Academy of Management Learning and Education*, 17(1), 41-61. <https://doi.org/10.5465/amle.2016.0040>
- Gaspar, D. (2010) Interdisciplinarity and Transdisciplinarity. Diverse purposes of research: Theory-oriented, situation-oriented, policy-oriented. In P. Thomson and M. Walker (Eds) *The Routledge Doctoral Student's Companion*. London and New York: Routledge.
- Gibbs, P. (Ed.). (2017). *Transdisciplinary higher education: A theoretical basis revealed in practice*. Springer.
- Hadorn, G. H., Bradley, D., Pohl, C., Rist, S., and Wiesmann, U. (2006). Implications of transdisciplinarity for sustainability research. *Ecological economics*, 60(1), 119-128.
- Huntjens, P., Eshuis, J., Termeer, C. J. A. M., van Buuren, M. W., and van Vliet, M. (2014). *Forms and foundations of action research*. Routledge, London.
- Hyun, E. (2011). Transdisciplinary higher education curriculum: a complicated cultural artifact. *Research in Higher Education Journal*, 11, p.1.
- Hyvärinen, J., Lee, J.-J., and Mattelmäki, T. (2015). Fragile liaisons: Challenges in cross-organizational service networks and the role of design. *The Design Journal*, 18(2), 249–268.
- Hyysalo, S., Marttila, T., Perikangas, S., and Auvinen, K. (2019). Codesign for transitions governance: A mid-range pathway creation toolset for accelerating sociotechnical change. *Design Studies*, 63, 181-203. <https://doi.org/10.1016/j.destud.2019.05.002>
- Jahn, T., Bergmann, M., and Keil, F. (2012). Transdisciplinarity: Between mainstreaming and marginalization. *Ecological Economics*, 79, 1-10. doi:10.1016/j.ecolecon.2012.04.017
- Junginger, S. (2009). Designing from the Outside In: The Key to Organizational Change. In *Proceedings of the 8th Conference of the European Academy of Design*, Aberdeen.
- Junginger, S. and Sangiorgi, D. (2009) 'Service design and organizational change: Bridging the gap between rigour and relevance'. In *3rd IASDR Conference on Design Research*, Seoul, Korea.
- Kimbell, L. (2011). Rethinking Design Thinking. *Design and Culture*, 3(3): 285–306.
- Klein, J.T. (2004). Prospects for transdisciplinarity. *Futures*, 36, 515–526. <https://doi.org/10.1016/j.futures.2003.10.007>
- Klein, J.T. (2008) Education. In: Hadorn G.H. et al. (eds) *Handbook of Transdisciplinary Research*. Springer, Dordrecht
- Land, R. (2012a). Discipline-based Teaching. In Hunt, L., and Chalmers, D. (Eds.), *University Teaching in Focus: A learning-centered approach* (pp.38-55). London: Routledge.
- Land, R. (2012b). In Trowler, P., Saunders, M., and Bamber, V. (Eds.), *Tribes and territories in the 21st-century: rethinking the significance of disciplines in higher education* (pp. 175-185). New York: Routledge.
- Lawrence, R. J., and Després, C. (2004). Futures of transdisciplinarity. *Futures*, 4(36), 397-405.
- Lewin, K. (1958). *Group decision and social change*. New York Holt, Rinehart and Winston.
- Lee, J.-J., Jaatinen, M., Salmi, A., Mattelmäki, T., Smeds, R., and Holopainen, M. (2018). Design choices framework for co-creation projects. *International Journal of Design*, 12(2), 15-31.
- Mieyeville, F., Gaultier, R., Péché, J. P., and Silberzahn, P. (2015, April). A design-based approach research on innovation: from multidisciplinary to transdisciplinarity. In *EAD11: 11th Conf of the European Academy of Design: The value of design research* (pp. 1-13).

- Kotter, J. (2007). Leading change: Why transformation efforts fail. *Harvard Business Review*, 86, (pp.97-103).
- Martin, R. (2009). *The Design of Business: Why Design Thinking Is the Next Competitive Advantage*. Cambridge, MA: Harvard Business Press.
- Muratovski, G. (2015). *Research for designers: A guide to methods and practice*. Sage.
- Nicolescu, B. (1999). The transdisciplinary evolution of learning. In *Symposium on Overcoming the Underdevelopment of Learning at the Annual Meeting of the American Educational Research Association*, Montreal, Canada.
- Nicolescu, B. (2005). Towards transdisciplinary education. *TD: The Journal for Transdisciplinary Research in Southern Africa*, 1(1), 5-15.
- Nicolescu, B. (2006). Transdisciplinarity: past, present and future. Moving Worldviews: Reshaping sciences, policies and practices for endogenous sustainable development. *ETC/COMPAS, Leusden*, 142-166.
- Nicolescu, B. (2010). Methodology of Transdisciplinarity—Levels of Reality, Logic of the Included Middle and Complexity. *The ATLAS Transdisciplinary-Transnational-Transcultural Bi-Annual Meeting*.
- Pike, K. L. (1967). Etic and emic standpoints for the description of behavior.
- Ramadier, T. (2004). Transdisciplinarity and its challenges: the case of urban studies. *Futures*, 36(4), 423-439.
- Rittel, H., and Webber, M. (1973). Dilemmas in a General Theory of Planning, *Policy Sciences*, Vol. 4, pp. 155–169.
- Russell, A. W., Wickson, F., and Carew, A. L. (2008). Transdisciplinarity: Context, contradictions and capacity. *Futures*, 40(5), 460-472. doi:10.1016/j.futures.2007.10.005
- Sangiorgi, D. (2011) 'Transformative services and transformation design', *International Journal of Design*, 5(2), pp. 29-40.
- Self, J. A., and Baek, J. S. (2017). Interdisciplinarity in design education: Understanding the undergraduate student experience. *International Journal of Technology and Design Education*, 27(3), 459-480.
- Self, J. A., Evans, M., Jun, T., and Southee, D. (2018). Interdisciplinary: challenges and opportunities for design education. *International Journal of Technology and Design Education*, 1-34.
- Star, S. L., and Griesemer, J. R. (1989). Institutional ecology, translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social studies of science*, 19(3), 387-420.
- Tully, R. (2013). Design education; at the crossroads of different disciplines. Paper presented at the Proceedings of the 15th International Conference on Engineering and Product Design Education: Design Education - Growing our Future, EPDE 2013, 830-835.
- Waterman, H., Tillen, D., Dickson, R., and De Koning, K. (2001). Action research: a systematic review and guidance for assessment. *Health technology assessment (Winchester, England)*, 5(23), iii.

About the Authors:

JiaYing Chew is an Education Design Strategist at the Division of Industrial Design, National University of Singapore. Her current research interests focus on design-driven transdisciplinary higher education, social innovation and the role of design in systems-level transitions.

Jung-Joo Lee is an Assistant Professor and Deputy Head of Research in the Division of Industrial Design, National University of Singapore. Since 2014 she heads Service Design Lab Singapore and her research focuses on service design for organisation transformation.

Miikka J. Lehtonen is an Assistant Professor at Dubai Institute of Design and Innovation and one of the co-founders of the Nordic Rebels movement. He earned his PhD from Aalto University School of Business in 2014. Miikka's current research interests focus on visual methodologies, design management, and the game industry.