STALLED PEDAGOGIES: Launching Renewal in Undergraduate Sustainable Building-Design (SB-D) Pedagogy through Multi-protagonist Insight

Alvaro Conti
Acharawan Chutarat
King Mongut's University of Technology, Thonburi

Abstract

Alternative trajectories for Sustainable Building-Design (SB-D) instruction are shaped through multi-protagonist insight. SB-D stakeholders at the School of Architecture & Design (SoA+D), Bangkok, Thailand, become *"protagonists"* in opening future pedagogical trajectories that point towards the next iteration of SB-D instruction.

Data are collected from students, teachers, industry-experts and future employers via four types of research methodology; 1) Questionnaires (using structured and partially-structured questions); 2) Interviews (in-depth, one-to-one, conducted with open and partially-structured questions); 3) Delphi Panel process through 5-point Lickert questionnaire and; 4) Roundtable event (with participant feedback & post-event interviews).

Grounded theory is next used to interpret all questionnaire and interview data from which twelve possible trajectories for future SB-D instruction emerge. A Delphi panel of experts 'rank' all trajectories in order of their viability for future use and the results are presented-back to all stakeholders via a Roundtable Event.

The roundtable debates the proposed directions for future instruction. Their collective insight aspires to a trajectory that uncouples SB-D instruction from its typical *"lesson-plan"* delivery and guides it toward the idea of *"possibility planning"*. In such a scenario, possibility planning allows a greater freedom to compose the teaching and learning experience and provides the conditions for more intriguing instructional ideas to emerge. In this way, protagonists take orthodox instruction and re-animate it as a wholly more compelling and promiscuous vehicle with which to encounter SB-D.

คำสำคัญ: trajectory | pedagogy | platform | possibility-planning | multi-protagonist

1. Introduction

It is acknowledged that [architectural] education must meet the needs of the profession. But education's most important role is to shape the trajectory of exploration after graduation, thus contributing to the future of the profession.

Renée Cheng AIA: Report on Integrated Practice

The above statement encapsulates the relationship between pedagogy and the real-world architectural profession (Cheng 2006). Within the statement, there resonates the responsibility [architectural] education has to provide a particular type of future practitioner, one able to meet the pressing *"needs"* of the profession. More enthusiastically embedded within the statement however, is the *"sensitizing effect"* that education has on the future of a learner. How is it that sensitization to particular issues experienced at the educational stage *"live on"* in a learner, to influence how they, as practitioners, will later come to shape the real-world. It is with this in mind that a positive encounter with Sustainable Building-Design (SB-D) and its pedagogy (methods of instruction, knowledge-transmission techniques and classroom-models) cannot be underestimated. It is here where the learner will form deep architectural motives.

1.1 Pedagogical Challenge

Pedagogy must be constantly re-invented, not endured. To avoid a *"stalling"*, it must continually transform through self-reflexiveness (Gurung 2013; Scott 2015; Gruppe 2004). This research thus seeks fresh trajectories for SB-D pedagogy and its instruction, deepening its appeal and increasing learner engagement. To achieve this will require *"a substantial reconsideration of pedagogical methods"* (EDUCATE 2012a p.4) as evidence suggests that a petrification of SB-D pedagogy (its instructional approach, delivery methods, invariant program etc.) remains a significant cause of the continued disinterest in the subject (Gucyeter 2016; Altomonte 2009; Altomonte et al 2014). Resistance to the embracement of SB-D by learners has followed a perceptible pattern namely; a) SB-D is often seen as an added competence, not main requirement for architectural students; b) its delivery too often tends towards a 'technicist' approach; c) SB-D curricula 'content' is ordinarily transmitted using prescriptive means and; d) it is taught in a reductionist manner within traditional classroom-settings

(EDUCATE 2012b). These factors testify to a continued dislike and disinterest in SB-D (Velazquez et al 2005; Cortese 2003; EDUCATE 2012b) hindering its assimilation and keeping it divorced from consideration as primary architectural interest.

1.2 Research Objectives

In answer to the pedagogical challenge, the major objectives for this research involve; a) the search for more dynamic and viable trajectories for undergraduate SB-D pedagogy and its instruction, ones in which to invest future pedagogical effort; b) the introduction of more vital and compelling instructional strategies, 'sensitizing' learners to sustainability interests and; c) an encounter with SB-D that creates a value shift in a student corpus.

Research is pursued at the School of Architecture & Design, Bangkok, Thailand. The global ambitions of its Thai-parent institution King Mongkut's University of Technology, Thonburi (KMUTT) have led it to employ dual-language instruction (Thai/English) since 1997, with over a quarter of its full-time instructors from outside the Thai Kingdom (KMUTT 2015). Furthermore, its own future 'Roadmap' prioritizes the continued advancement of contemporary *"scientific and technological"* perspectives as core-values. Although research is conducted under highly localized conditions, its emerging conclusions are expected to resonate with other 'stalled' pedagogies and assist educators in fostering productive change.

2. Research Methodology

A three-phase process is used to probe for SB-D pedagogical renewal. The diagram below (Fig. 1) shows the overall relationships between phases and accompanying research methodologies used for data collection.

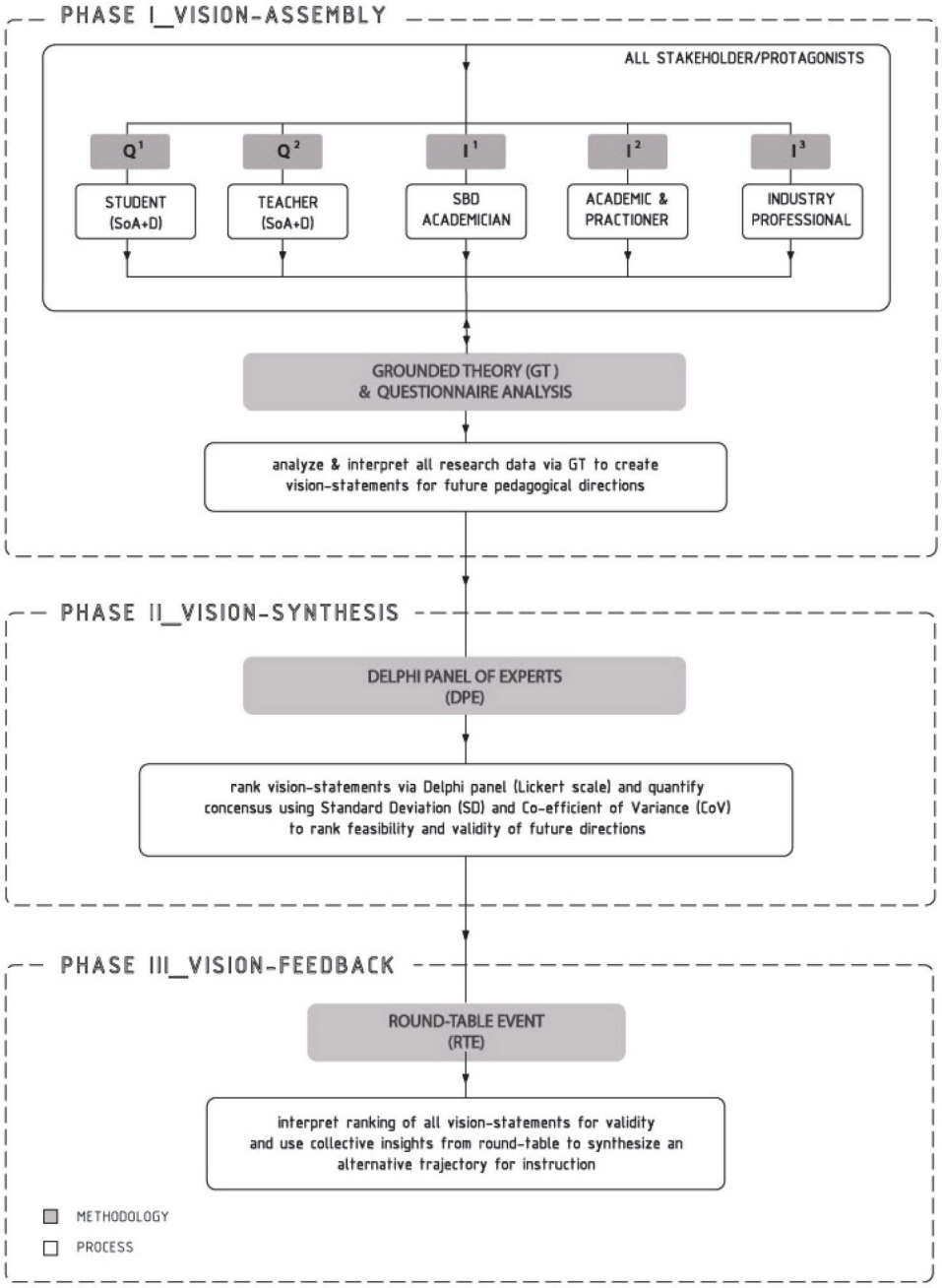

Fig. 1: Three-phase process to probe for pedagogical renewal

2.1 Phase Descriptions

Phase I of research is ‘vision-assembly’. Here, a SoA+D 'vision' for a future SB-D pedagogical trajectory is built from intersecting views of its stakeholders. Stakeholders become ‘protagonists’, assuming a catalytic-role to help open future initiatives for SB-D instruction. Data are collected from students, instructors, industry-experts and practicing professionals via quantitative Questionnaires (Q) and in-depth qualitative Interviews (I) that help uncover the existing status, current limitations and possible future ambitions for SB-D instruction.

Phase II is ‘vision-synthesis’. In this phase, the totality of data are interpreted (‘quantitative’ data via 5-point Lickert scale and ‘qualitative’ data via Grounded Theory) and synthesized into 'vision-statements' expressing possible future trajectories for pedagogical renewal. These statements are in-turn submitted to a Delphi panel of experts (DPE), who assess the validity of each 'vision-statement' as a possible future trajectory. Their consensus then helps rank all statements in order of the strongest plausible direction for future SB-D instruction.

Phase III involves ‘vision-feedback’. Delphi panel findings are presented back to original stakeholders via a ‘Roundtable Event’ (RTE). Here, participants are invited to vigorously debate earlier Delphi panel ‘rankings’, and add additional insight in an attempt to collectively crystallize the most viable trajectory in which to invest future pedagogical effort.

2.2 Identifying Stakeholders

To set the whole research process in motion, SB-D stakeholders were identified. A ‘purposive’ sample, spanning from academia to industry was selected and sub-divided into three categories (Table 1). The limited sample-size for data-collection was expected to be compensated by in-depth qualitative data afforded by specialist participants (Etikan et al 2015 p.3).

Stakeholders and Research Methodologies

	Category	Stakeholder/Protagonist	Research Methodology	Participant (*n*)
1.	**Core:**	SoA+D Students & Instructors	Questionnaire (Q) (quantitative/qualitative)	65 (Stud. *n*=45, Inst. *n*=20) (94% of available pool)
2.	**Liminal:**	University Academicians working in both Academia & Industry	In-depth Interview (I) (qualitative/grounded theory)	15
3.	**Peripheral:**	SB-D professionals working in industry	In-depth Interview (I) (qualitative/grounded theory)	15

Table 1:. Three stakeholder categories & research methodologies

'CORE' stakeholders consisted of SoA+D, SB-D Students and Instructors (total n=65), with Students (n=45) and Instructors (n=20) accounting for 94% of total available respondents. 'LIMINAL' stakeholders worked at the intersection of academia and industry (n=15), simultaneously teaching as academicians and working in professional practice and/or consultation. Finally, 'PERIPHERAL' stakeholders (n=15) were from the professional building-sector and included architects, building-contractors, project and facility managers.

2.3 Data Collection

Data were collected via four types of research methodology; 1) Questionnaires (using structured and partially-structured questions) with all questionnaires being initially tested via 'pilot-study' for their communicability and comprehension; 2) Interviews (in-depth, one-to-one, conducted with open and partially-structured questions); 3) Delphi Panel process via 5-point Lickert questionnaire and; 4) Roundtable event (with participant feedback & post-event interviews). Key insights from each of the four collection methods were progressively combined to inform the shape of a viable trajectory for future instruction.

3. Results

Results from each research group (Student, Instructor, Academician/Professional and Industry Professional) are arranged below.

3.1 Student/Instructor Questionnaire

The Student and Instructor Questionnaires (compiled to ascertain the status and efficacy of current SB-D instruction) immediately affirmed a petrification of teacher transmission-techniques and an incapacity to escape the more dominant circuits of knowledge-transfer (Table 2).

Key Insights from Student/Instructor Questionnaire Findings	
Student & Instructor Questionnaires (Q)	▪ Predominant use of typical classroom-based activities for knowledge transfer, in-house/guest-lecturing, rote-learning, case-study evaluation, and brainstorming. ▪ Two-thirds of students (66%) expressed desire to immediately change some aspect of their SB-D instruction (content, different teacher, types of instruction, media, same location/classroom, mathematical depth) ▪ The promotion of more radical 'transmission-techniques' & 'classroom-models' (involving research & design fieldwork, real client contact) requested from both student & instructor ▪ Over 80% of students indicated factors reducing their current interest in SB-D (i.e. no space for our ideas, typical instruction, transmission-techniques, single location, lack of technology, mathematization, unintegrated in other classes)

Table 2: Key insights from student & instructor questionnaire data

Data revealed a desire for more radical knowledge-transfer techniques and classroom models for SB-D instruction. Demand was in the form of more investigative and research-intensive classroom-models, where students could encounter more atypical knowledge-transmission techniques than those being currently experienced (i.e. typical solution-based exemplars, case-studies, rote-learning, lecture-delivery, brainstorming and model-making).

3.2 Interviews

To help disclose valuable insights for a future SB-D instructional trajectory, the entirety of data from one-to-one, in-depth interviews (Students, SBD Instructors, Academicians/Professionals, and Industry Professionals) were interpreted using grounded theory (Glazer & Strauss 1967). The choice of grounded theory was suitable for interpreting qualitative data extracted from a broad spectrum of participants relating to this particular topic of study (Etikan et al 2015 p.3).

3.2.1 Underlying Stakeholder Axioms

After the initial 'open-coding' of all interview data, the use of 'axial-coding' and accompanying 'memoing' (Charmaz 2006) revealed a number of underlying themes resonating across all stakeholders (Table 3). These themes were considered 'underlying axioms' that were perceptible - to varying degrees - by all stakeholder groups. The axioms emerged as a realistic background of pedagogical concerns, against which any argument for future trajectories should be gauged.

Underlying Stakeholder Axioms		
1	**emergent/enforcement**	pedagogical changes in SB-D instruction instigated via institutional legislation or from independently-driven change emerging intrinsically (self-organization)
2	**didactic/heutagogic**	communication of a pre-determined body of knowledge prepared for students in-advance or learn heutagogically creating knowledge and information from which to learn
3	**practitioner/academic**	taught by instructors currently active in industry (practitioners with commercial experience) or academicians with greater theoretical and research ambitions
4	**skill/awareness**	teach learners a conventional repertoire of skills for detailed SB-D knowledge and calculations or general principles and precepts to position awareness and overall sustainable building-design literacy
5	**industry/academia**	learner skill-sets predominantly serve current industry demands/expectations or support more theoretical and/or academic and inspirational ambitions
6	**integration/separation**	SB-D taught separately or through diverse levels of integration across studios, electives and other adjacent faculty
7	**BA/MA**	at what educational level to introduce complex SB-D skills and knowledge (Bachelor/Master)

Table 3: Underlying axioms emerging from stakeholder data

3.2.2 Vision-Statements

Grounded theory was then used to extrapolate *"vision-statements"* from all interview data (Table 4). As each vision-statement progressively surfaced from grounded theory, its eligibility for inclusion as a future trajectory was predicated on an ability to engage with some aspect of an underlying axiom. This inductive process lead to twelve vision-statements submitted to the Delphi panel.

12 VISION STATEMENTS DERIVED FROM STAKEHOLDER DATA	
VS_01	**DEVELOP SB-D 'PATENTS' UNDER RESEARCH INTERESTS OF INSTRUCTORS** SB-D instruction occurs through 'patent-centric' exploration (i.e. lighting, thermal, sound, products and components etc.). This is conducted under the personal research interests of SB-D instructors with all students' output evaluated by real-end users and/or clients.
VS_02	**STUDENTS INVITED TO EXPLORE LIMITS OF INDUSTRY TECHNOLOGY** The future SB-D classroom is a 'cutting-edge' environment exploring the potential and limits of industry technology. SB-D industry collaborates with university, allowing its technology to be explored by students and instructors i.e. fabrication strategies, software, devices, products and materials. All outputs from students are reported back to industry for advancement of real-world applications.
VS_03	**AUGMENT & ENHANCE EXISTING SB-D INFRASTRUCTURE & FACILITIES** The existing SB-D learning environment is reappraised. All supporting infrastructure (e.g. facilities, material library, heliodrome, lightbrary, youtube-database-channel) is consolidated and cross-referenced to make SB-D instruction more coordinated, efficient and dynamic.
VS_04	**DECENTRALIZE SB-D INSTRUCTION ACROSS ENTIRE UNDERGRADUATE CURRICULUM** The delivery of SB-D into the Architecture & Interior Architecture curriculum is re-examined. SB-D instructors aim to distribute smaller and more easily digestible SB-D course material and principles across all teaching areas (i.e. Studio, Lecture, Electives, Construction, Materials, Construction, Professional practice, software etc.) as opposed to teaching larger isolated blocks of knowledge.
VS_05	**ORGANIZE CO-DISCIPLINARY THESIS ACROSS ALL UNDERGRADUATE FACULTIES** SB-D instruction is geared to culminating in a final-year 'interdisciplinary thesis'. Thesis is taught across different SoA+D faculties (architecture, interior architecture, industrial design, communication design) anticipating a collaboration-rich future work environment and processes.
VS_06	**INDUSTRY SPECULATION IS RESEARCHED BY INSTRUCTORS & STUDENTS** SB-D is taught through 'research-centric' semester-long projects in alignment with SB-D industry speculation. Research is facilitated by SB-D instructors with students assisting as investigators.
VS_07	**SB-D EXTENDED INTERNSHIPS USED TO GAIN REALISTIC KNOWLEDGE/EXPERIENCE** Extended SB-D internships (co-ordinated between architectural practices and university) allow students to gain SB-D knowledge by alternating between architectural office 'practice' & university classes over the year.
VS_08	**MULTI-SPECIALIST STUDIO WITH SB-D AS DRIVING ENGINE** Multi-specialist studios are run by SBD instructors with a range of invited specialists. Together, instructors, specialists and students converge lighting, thermal, sound and construction issues into a single, semester-long, integrative-design project driven by SB-D concerns.
VS_09	**INTERNAL SB-D CERTIFICATION DESIGNED BY SoA+D SB-D INSTRUCTORS** SB-D instructors combine their knowledge to create their own internal 'undergraduate SBD collegiate 'certification' for students' work and final thesis (similar to a simplified LEED). All SBD course-outlines encountered by students are geared to teaching them about the pre-requisites that will earn their design work and final thesis project its 'in-house' certification (and recommendation to future employers).
VS_10	**ON-LOCATION WORK-INTEGRATED LEARNING STRATEGY** SB-D is taught through work-integrated learning. This is conducted at an external location emphasizing 'practice-based' learning and SB-D professionalism. Students collaborate with external SB-D practitioners, experiencing being part of an integrated professional design environment. All student output is evaluated by their SB-D team at point of practice and in contact with real clients.
VS_11	**ECOLOGICAL AWARENESS USING SYSTEMIC 'RULES OF THUMB', NOT CALCULATION** SB-D courses teach students 'ecological awareness' of general principles, rather than a discrete body of SBD knowledge. Basic scientific and cultural knowledge is communicated to undergraduate students in a 'systemic' way using specially constructed ('rules of thumb') as opposed to detailed numerical calculations typically aimed at solving SB-D design problems.
VS_12	**STUDENT PURSUES OWN EMERGING INTERESTS** SB-D students are encouraged to pursue personal SB-D interests. They are 'self-directed' with instructors helping students' entrepreneurial ideas to flourish. SB-D instructors act as facilitators directing students to external contacts (new clients, investors, manufacturers etc.) and relevant knowledge sources to help realize their ideas.

Table 4: Vision-statements derived from total stakeholder data

3.3 Delphi Analysis

All vision-statements were submitted to a Delphi panel of experts (via Lickert questionnaire) to help rank their plausibility for use as future trajectories for instruction.

3.3.1 Ranking

To 'rank' vision-statements, the level of consensus between panelists was calculated using SPSS (Table 5). Standard Deviation (SDEV) and Co-efficient of Variation (CoV) was used to measure and assign values to the level of consensus between panelists. The greater the consensus for a vision-statement, the stronger the plausibility for its use as future trajectory (NCERT 2015).

Delphi Panel of Experts Statistical Analysis (SPSS)

Statement		01	02	03	04	05	06	07	08	09	10	11	12
(*n*)	Valid	5	5	5	5	5	5	5	5	5	5	5	5
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		4.0	4.8	3.8	4.2	4.2	4.4	4.0	4.6	3.4	4.2	4.2	4.6
Median		4.0	5.0	4	4.0	4.0	5.0	4.0	5.0	4.0	4.0	4.0	5.0
Mode		3a	5	5	4a	4a	5	3a	5	4	4a	4a	5
SDEV		1.000	.447	1.304	.837	.837	.894	1.000	.548	1.342	.837	.837	.548
CoV		0.250	0.093	0.343	0.199	0.199	0.203	0.250	0.119	0.395	0.199	0.199	0.119
Minimum		3	4	2	3	3	3	3	4	1	3	3	4
Maximum		5	5	5	5	5	5	5	5	5	5	5	5
Percentiles	25	3.00	4.50	3.00	3.50	3.50	3.50	3.00	4.00	2.50	3.50	3.50	4.00
	50	4.00	5.00	5.00	4.00	4.00	5.00	4.00	5.00	4.00	4.00	4.00	5.00
	75	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	4.00	5.00	5.00	5.00

Table 5: SPSS statistical table measuring Delphi panel consensus

CoV values – expressing final levels of consensus - were dispersed along a numerical continuum 0.093-0.395 with values approaching 'zero' indicating highest consensus. The use of quartile demarcation (Table 6) offered an upper (0.093-0.166), inter (0.167-0.318) and lower quartile (0.319-0.395) range within which to group statements.

12 Delphi Statements (ranking in order of strongest expert consensus)

UPPER QUARTILE CoV [0.093–0.166]	[CoV*=0.09]	VS_02	STUDENTS INVITED TO EXPLORE LIMITS OF INDUSTRY TECHNOLOGY
	[CoV*=0.119]	VS_08	MULTI-SPECIALIST STUDIO WITH SB-D EMBEDDED (with construction classes)
	[CoV*=0.119]	VS_12	STUDENT PURSUES OWN EMERGING SB-D INTERESTS
INTER QUARTILE CoV [0.167–0.318]	[CoV*=0.199]	VS_10	ON-LOCATION WORK-INTEGRATED LEARNING STRATEGY
	[CoV*=0.199]	VS-05	ORGANIZE CO-DISCIPLINARY THESIS ACROSS FACULTIES
	[CoV*=0.199]	VS_11	ECOLOGICAL AWARENESS USING SYSTEMIC 'RULES OF THUMB', NOT CALCULATION
	[CoV*=0.199]	VS_04	DECENTRALIZE SB-D INSTRUCTION ACROSS ENTIRE UNDERGRADATE CURRICULUM
	[CoV*=0.203]	VS_06	INDUSTRY SPECULATION IS RESEARCHED BY INSTRUCTORS & STUDENTS
	[CoV*=0.25]	VS_01	DEVELOP PATENTS UNDER RESEARCH INTERESTS OF INSTRUCTORS
	[CoV*=0.25]	VS_07	SB-D EXTENDED INTERNSHIP USED TO GAIN REAL KNOWLEDGE/EXPERIENCE
LOWER QUARTILE CoV [0.319-0.395]	[CoV*=0.343]	VS_03	AUGMENT AND ENHANCE EXISTING SB-D INFRASTRUCTURE & FACILITIES
	[CoV*=0.395]	VS_09	INTERNAL SB-D CERTIFICATION DESIGNED BY SoA+D SB-D INSTRUCTORS

Table 6: Vision-statement ranking based-on strength of Delphi panel consensus

3.3.2 Statistical Trends from Delphi Stage

Delphi panel consensus produced a distinctive partition in terms of viable trajectories for future SB-D instruction.

Upper quartile vision-statements (CoV_0.093-0.166) propel future instruction towards collaboration-rich initiatives with industry-domains. Instruction and industry are in co-evolution through interplay with cutting-edge technology and software (Table 7). They promote student interests through heuristic and heutagogic activities. Moreover, learners are now expected to work with external parties on interests that emerge between them, with opportunistic support in the form of ‘patent-centric’ development and monetization of SB-D learner concepts.

Vision-statements occurring at the interquartile range (CoV_0.167-0.318) are an innovative mix of instructional strategies that include 'patent-centric' development; ‘monetized student-startups' (students working-through a financialization of personal SB-D concepts) and; pursuit of instructors' own privatized SB-D agendas in tandem with students. Delphi panelists commented that these strategies - although more dynamic - offered an opportunistic role for instruction, but were reluctant for them to form the basis of a future SB-D pedagogical trajectory.

Vision-statements appearing in the lowest quartile (CoV_0.319-0.395) all indicate 'insularity'. Their lack of connection to other design-domains is cited as main factor for low rankings. Panelists indicate that future SB-D instruction should not develop internally (i.e. *“VS-11_Develop Internal SB-D certification designed by SoA+D SB-D instructors”* and *“VS-03_Augment and Enhance Existing SB-D Infrastructure and Facilities”*) demonstrating instead a desire for outward connectivity, not the insular transmission of knowledge from within an SB-D disciplinary boundary.

Key-Insights from Delphi Panel Ranking Process	
Delphi Panel (DPE)	▪ Co-evolution of SB-D with industry-domains and their technology i.e. products, software, materials etc. ▪ Collaboration-rich investigation with multiple external parties proactively sought ▪ Heuristic & heutagogic learning strategies preferably employed ▪ Opportunistic instruction to include: 'patent-centric' development by students; monetized 'student-startups and; pursuit of instructors' own personal SB-D research. ▪ Avoidance of discipline ‘insularity’ is imperative

Table 7: Delphi panel: Summary of key-findings

These pedagogical characteristics for a future trajectory - progressively surfacing from research data and further shaped by Delphi Panel ranking - were presented back to initial stakeholders via Roundtable Event for reactions and insights on their legitimacy.

3.4 Roundtable Event

The roundtable event elicited valuable insights from all stakeholders on the twelve newly-determined SB-D vision-statements. Participants debated the validity of emerging directions for instruction and how to further pursue, develop, implement and/or dismiss them.

3.4.1 Roundtable Debate & Findings

After careful deliberation of the Delphi panel's selected trajectory, roundtable protagonists jointly acknowledged the current SB-D pedagogical format as ill-suited to support a shift towards change. To carry-forward the new ambitions arising from research, debate converged on the following propositions for transition:

a. Instruction takes the form of evolving platform tripping a widening of what learner, instructor and classroom can be

To better-engage with the preferred trajectory inherited from the Delphi Panel, the roundtable perceives a shifting role for future Student, Instructor and Classroom. They propose the student as originator of knowledge, not repository. The instructor is re-interpreted as an orchestrator of *"learning events"*, putting parties with similar interests into proximity to create innovative educational alliances. Classroom space is itself reconceived as mutable *"platform"*, giving collaboration more oxygen by offering a locus where diverse parties can step into each other's orbit. In this way, the new SB-D 'classroom' is projected as an unrestricted space of alliance for new pedagogical enterprise at the intersection of academia and industry.

b. industry adjacency and investigative consultancy

SB-D instruction must venture beyond the transmission of a *"perennial"* body of knowledge. Engaging in a mutual exploration of cutting-edge technologies with industry-partners becomes a kind of *"investigative consultancy"* where industry is helped to advance in otherwise unanticipated directions, and academia gains exposure to newly-emerging technologies, the co-financing of projects and an ascent of student enterprise.

c. a 'non-whole-institution' approach

A vision for future SB-D instruction cannot be implemented as part of an orchestrated whole-institution approach. Instead, it should set-up the conditions for its own emergence

"incrementally" by forming new premises on which to progress. Pedagogical momentum based-on a holistic compliance from all personnel has been eclipsed by the rewards of putting independent parties into a 'seductive proximity', outside of institutional boundaries and in-between authoritative bodies.

d. a halt to content delivered from within a SB-D disciplinary envelope

Future SB-D trajectories must escape content-delivery from within the disciplinary boundary currently in-situ. A future trajectory must operate beyond 'inelastic', compartmentalization of SB-D knowledge, foreclosing learning in a pre-existing body of knowledge. Research affirms students are seeking to study SB-D not as 'a means to an end', but as 'a means to a beginning'. Shedding its disciplinary boundary will avoid the instructional 'insularity' that is currently triggering profound disinterest from students.

e. heuristic & heutagogically-driven classroom-models

Research reveals student preference for an SB-D *"exploratory scaffold"*, accommodating openendedness within constraint. Setting an indeterminate challenge for learning, rather than an overly-determined one, will allow students a margin of maneuverability to pursue their own lines of inquiry within and outside classroom space.

f. hard-wired expectations preclude opportunities

Instructor and student must suspend their current *"expectations"* of each other and of what should be imparted/taken-away from SB-D instruction. This would mark a critical first-step in transforming SB-D pedagogy. The current inability to dissolve expectations is confining the capacity to think *"other"* opportunities and possibilities for SB-D instruction away from much of the prescriptive didacticism currently in-place.

g. networked intelligence built upon the instructors' social-network of peers

The informal *"social channels"* of instructors are seen as an untapped pedagogical resource offering points of ingress to commercial entities (industry contacts, sponsors, suppliers, manufacturers etc.). Engaging in an intensification of relations with external parties will form a more *"networked intelligence"* for SB-D pedagogy. The SB-D faculty must then insert a more formal structure to mature new relationships and create a longevity of partnership.

3.4.2 Possibility Planning

The next iteration of instruction being shaped by roundtable protagonists (Table 8) seems to be leading towards a kind of 'possibility planning' as SB-D pedagogical trajectory. In this scenario, the desire for the agency to 'assemble' diverse ideas may be more significant for future instruction than encountering existing ones. The panel's positing of a more

"receptive platform" as SB-D model for instruction could allow students and instructors to evolve diverse projects and learning encounters, with a freedom to generate progressive affiliations to various parties.

Some relevant precedents exist (Chatti 2013, Tan et al 2010, Chatti et al 2010, Sinai & Yaskina 2012, Fullan & Langworthy 2014) and in particular Twining et al (2007) who argue that instructors move-away from planning lessons to organizing systems that set-up students and instructors to think together (p.7 *"creating a structure to think out of"*). In such scenarios, students are looking to become involved in a re-wiring of their own SB-D interests to intersect more profitably with other attractive sources of knowledge (i.e. industry, family-business, technology, media, crowd-funding etc.). This calls into existence a need for greater informality, customization and inventiveness of SB-D projects and ways of achieving them. In such a situation, the goal of instruction is building and managing synthesis (students, clients, content, media, encounters etc.) not lesson-plan delivery. The instructor's role might then be to initiate contact with, and choreograph, the necessary external affiliations to achieve the direction requested. The classroom – typically a standardized space of convention - in turn deregulates (time, location, presence etc.) to accommodate these intentions.

By intimating towards such a strategy, roundtable protagonists - having earlier agreed on the direction inherited from Delphi Panel - have deepened the dimension for its instruction through an openly-evolving, diversity-oriented 'platform' rather than idea of lesson. What protagonists are promoting is a wholly more flexible and promiscuous vehicle with which to encounter SB-D.

Key Insights from Roundtable Protagonists Contributing to SB-D Trajectory	
Roundtable Event (RTE)	▪ Re-conceptualize role of student / instructor / classroom; with *student* seen as co-creator of knowledge, *instructor* as orchestrator of learning events; and *classroom* as investigative platform-locus and new pedagogical location for industry/academia enterprise ▪ Mutable 'platform' creates the conditions for more atypical knowledge-transmission and/or knowledge creation and offers a basis for an alternative classroom-model ▪ Instruction operates beyond inelastic compartmentalization of SB-D knowledge and creates space for parties to enter into a 'seductive proximity' ▪ SB-D instruction warrants an 'exploratory scaffold', with margin of maneuverability for student to pursue their own lines of inquiry ▪ Interplay and experimentation with industry technology paramount ▪ Intersect other design-domains to produce collaboration-rich initiatives beyond the usual envelope of discipline ▪ Use instructors social-network of peers to build 'networked' intelligence and increase potential of instructors to enter into relationships ▪ Move beyond the classroom as main 'knowledge delivery' location

Table 8: Round Table: Key insights for a future pedagogical trajectory

By re-imagining a greater plasticity to the typical SB-D classroom via open "platform", roundtable stakeholders have authored a gathering of greater instructional enterprise. The *"platform"* appears as a co-evolving *"staging ground"* upon which diverse pedagogical experimentation can more rapidly form and venture-out into new dimensions. The more informal freedom accompanying this classroom-model could accommodate the alternative requests for instruction surfacing from within this research (i.e. project-creation, interplay with new external partners, heuristic and heutagogically-driven investigation, diverse knowledge-transmission techniques, construction of novel learning partnerships etc.) and is free to evolve and meet more dynamic learner demands. Through its use, it may be possible to exit the impasse currently limiting how a classroom's contribution to SB-D instruction is typically viewed. Re-interpreting current instruction through SB-D platform may help *"tempt"* - both student and instructor - towards more 'elastic' conditions, where alternative instructional possibilities could proliferate rather than remain unassimilable. Instruction could then derive its impetus from a continuous process of change, challenging the habitual and testing the uncommon. In this way, SB-D instruction can remain unrelentingly current.

4. Conclusions and Discussion

The table below is a synthesis of key insights shaping the lineaments of a future SB-D pedagogical trajectory at SoA+D (Table 9).

4.1 Stalled Pedagogies

From the outset of research, Student and Instructor questionnaires supported a unanimous request for less-conventional instruction and the desire to enter into more unorthodox, transmission-techniques, classroom-models and client relations. As research unfolded, existing SB-D instructional strategies appeared petrified and inadequate for a contemporary, digitally-versatile student corpus, one anticipating a more *"mediagenic"* learning experience. Questionnaire data revealed an appeal for more investigative classroom-models and transmission-techniques where ideas (and the methods for communicating them) could cut-across one another and not remain within disciplinary envelopes.

Interviews further revealed instructors and students as being *"hardwired"* in their expectations (i.e. their role in the classroom, the subject-matter awaiting to be encountered, what knowledge to take-away, the confines of the classroom, type of project-brief etc.) all of which continue to leave current SB-D instruction rather one-dimensional; the possibility of alternative models for its instruction at bay; and a desensitization of students towards

SB-D in the process. What is relevant in this picture of instruction is that the traditional academic assumptions regarding the role of student, instructor and classroom continue to underpin a *"determinism"* to SB-D instruction foreclosing (for both student and instructor) the very experience of the subject they are about to engage-in.

Key Insights from all Research Stages	
Questionnaires (Q)	▪ Predominate use of 'classroom-based' activities, in-house/guest-lecturing, rote-learning, case-study evaluation, and brainstorming. ▪ Two-thirds of students (66%) want to immediately change some aspect of their SB-D instruction (content, different teacher, types of instruction, media, same location/classroom, mathematical depth) ▪ The promotion of more radical 'transmission-techniques' & 'classroom-models' (involving research & design fieldwork, real client contact) requested from both student & instructor ▪ Over 80% of students indicated factors reducing their current interest in SB-D (i.e. no space for our ideas, typical instruction, transmission-techniques, single location, lack of technology, mathematization, unintegrated in other classes)
In-depth Interviews (I)	▪ Interview data underpins the creation of 12 'vision-statements' with 'VS_02 "Students Invited to Explore the Limits of Industry Technology" selected as baseline pedagogical trajectory with greatest potential
Delphi Panel (DPE)	▪ Co-evolution of SB-D with industry-domains and their technology i.e. products, software and materials ▪ Collaboration-rich investigation with multiple external parties proactively sought ▪ Heuristic & heutagogic learning strategies preferably employed ▪ Opportunistic instruction to include: 'patent-centric' development by students; monetized 'student-startups and; pursuit of instructors' own personal SB-D research. ▪ Avoidance of discipline 'insularity' is imperative
Roundtable Event (RTE)	▪ Re-conceptualize role of student / instructor / classroom; with *student* seen as co-creator of knowledge, *instructor* as orchestrator of learning events; and *classroom* as investigative platform-locus and new pedagogical location for industry/academia enterprise ▪ Mutable 'platform' creates the conditions for more atypical knowledge-transmission and/or creation and offers a basis for an alternative classroom-model ▪ Instruction operates beyond inelastic compartmentalization of SB-D knowledge and creates space for parties to enter into a 'seductive proximity' ▪ SB-D instruction warrants an 'exploratory scaffold', with margin of maneuverability to pursue own lines of inquiry ▪ Interplay and experimentation with industry technology paramount ▪ Intersect other design-domains to produce collaboration-rich initiatives beyond the usual envelope of discipline ▪ Use instructors social-network of peers to build 'networked' intelligence and increase potential of instructors to enter into relationships ▪ Move beyond the classroom as main 'knowledge delivery' location

Table 9: Key research insights contributing to future SB-D pedagogical trajectory at SoA+D

4.2 New Horizon?

As research data combines to shape a more tangible pedagogical trajectory, stakeholders are aware of potential impediments to its implementation. If the more typical *"didactic role"* of the SB-D classroom is subordinated to the multiple-learning possibilities found within "platform" and *"possibility planning"*, students will primarily experience ways to collect and create knowledge - over-and-above - the acquisition of a well-established body of knowledge (as authorized from within the SD-B discipline itself). A new learning experience may indeed increase a student's capacity to create knowledge and offer them collaboration-rich encounters. However for some instructors, this type of instruction cannot yet guarantee that SD-B learners encounter *"relevant"* content, or be compensated for many of the *"capabilities"* currently viewed as valuable outcomes of existing SB-D instruction. For instructors faithful to a fundamental body of knowledge, the level of risk to student learning is seen as too great, especially as it may leave SB-D students severely weakened in terms of their executable knowledge.

Clearly, pursuing these more dynamic instructional trajectories carries consequences. Such trajectories possess alive boundaries external to the educational institution, open to success, failure, learning and unlearning. Any new trajectory diverting-away from what is seen as a current benefit of SB-D instruction will trigger strong reservations. For instructors preferring the strengths of a tried-and-tested pedagogy, the introduction of such a trajectory could affect their level of commitment toward it and consequently its implementation.

The role of finance is also noteworthy here. The academic budgets typically set-aside for more dynamic learning trajectories are often deemed insufficient to meet the demands of valuable collaborators. However, with the more recent creative forms of academia/industry budgeting (i.e. CSR, crowd-funding, micro-sponsors, royalties, grants, venture-funding etc.) benefits and incentives for involvement are being worked-out on a case-by-case basis. Often, publicity itself is a sufficient *"currency"* to ensure involvement of potential collaborators.

In spite of issues such as these, what is placed on the horizon by multi-protagonist insight is an approach to SB-D instruction that exchanges the 'known-quantities' of typical didactic instruction, for a greater freedom to compose the teaching and learning experience. Stakeholders sense that the trajectory they are giving rise to (possibility planning - via platform) could be established as a more pliant and powerful learning mechanism, one allowing a putting-in-place of conditions for more intriguing instructional ideas to emerge. Should this be the case, allegiance to a pre-existing body of knowledge, communicated over the course of a semester will be increasingly eroded.

When cast in the light of earlier *"underlying axioms"* arising from research (see 3.2.1), an emerging trajectory for future SB-D instruction points to an independent, heutagogic experience that emerges more opportunistically than in-line with whole-institution legislation. It chooses to fuse industry and academia (rather than treating them as mutually exclusive) and opens-up instruc-

tion to integration across all areas of university instruction (and the richness of associations this could entail). Ultimately, it avoids any distinction between MA/BA level to treat the complexity of each evolving project on its own merits.

4.3 Unlocking Change

The most transformative trait for future SB-D instruction thus ventures towards a reconceptualization of the roles of 'student', 'instructor' and 'classroom'. Roundtable protagonists promote a future trajectory that cedes more orthodox conceptions for instruction with a view to students originating instructional directions; instructors choreographing the necessary learning-encounters to fulfil those directions; and the classroom lowering its institutional boundary for something unprecedented to occur. Inviting this widening of agency intends to open-up a new repertoire of prosperous interactions for instruction. Students and instructors could be empowered to strategically 'assemble' their own productive relationships for SB-D instruction whilst igniting the overall pedagogical terrain in partnership.

An unmooring from a stricter disciplinary approach anticipates - for both SB-D pedagogy and its instruction - a way of learning in previously unforeseen ways, for a future that cannot yet be clearly defined. What can however be forecast from the spectrum of stakeholder insights is that their desired transition to more adaptive and explorative models of instruction can enable learners, instructors and classroom space more freely engage with contemporary forces and future imperatives in much more animated ways.

Such a conception, put simply, could enrich the entirety of SB-D pedagogy, ensuring it transition to a less insular, more seductive, vibrant and versatile model with which to engage learners.

4.3 End Note

With current SB-D instructional strategies and classroom-models accused of not meeting the evolving needs of students, this compact body of research aspires to build a transformative momentum for instruction. In this way, research findings aim to accelerate the perishability of past SBD practices (currently congealing SB-D pedagogy to what already exists) and transition towards a *"possibility planning"* whose *"platform"* reconciles a greater receptivity of projects with expressivity of instruction.

At best, research conclusions could help activate an appetite for SB-D, with the aim of adrenalizing learning and inspiring a deeper and more profound attachment to SB-D itself. Alternatively, it might simply contribute to a more credible 'evidence base' for future pedagogical recommendations by providing an effective starting-point for SB-D pedagogical enhancement.

Research thus affirms its original intention, that of better-shaping the experience of SB-D learning towards a viable and more compelling future trajectory for instruction. In their newly established 'protagonist' role, stakeholders have called for an expiry of past SB-D practices and an ushering-in of wider communicative 'platforms' for as yet unscripted roles and alliances. Researchers hope that this document can incite a new pedagogical trajectory, one that will reach escape velocity.

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