ISBN: 978-989-8533-43-2 © 2015

DEVELOPING A DISPOSITION FOR SOCIAL INNOVATIONS: AN AFFECTIVE-SOCIO-COGNITIVE CO-DESIGN MODEL

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ABSTRACT

Advancements in technology and liberalization of educational opportunities have transformed the knowledge landscape into an emergent innovation incubator, where sense-making and creativity in and for ill-structured environments are especially relevant. In addition, opportunities are often "found" or "made." The quality of solutions, however, is mediated by different conceptualizations of contexts. As such, we need new teaching-learning models which help students to become more effective and creative knowledge builders and creative innovators. In this paper, we present a summary of our prior work towards this objective, our framework and the refined assessment rubric derived from our various studies. Our design factors/scaffolds are: design thinking as design methodology, metacognitive reflective scaffolds and formative assessment as framing technique. We hope our findings can be applied to the learning of Science, Technology, Engineering and Mathematics (STEM) and its variants. Future work may involve its application to MOOCs or Cloud Computing.

KEYWORDS

Ontological Affective-Socio-Cognitive Design Model, Inquiry/Problem-based learning, Design thinking, metacognitive reflective scaffolds, formative assessment

1. MOTIVATION

Crucial to the discovery, creation and sustainability of competitive advantage, knowledge diversity has resulted in and encouraged interdisciplinary methodologies. These encompass business, technology and human factors. As such, educators are challenged in terms of teaching-learning beliefs and practices with regards to how they should best equip/prepare students for the workplace. This is true especially in Multi Online Open Coursewares (MOOCs), where students are expected to be independent learners and also where dropout rate is sometimes high.

Rentroia-Bonito, Jorge and Ghaoui (2009) point out that in order to address complex and multidisciplinary challenges, development teams need proper design techniques to build effective learning experiences. Thus far, they find that the literature does not indicate solid quantitative approaches which support learning-centered design where student needs and their immediate and broader contexts are considered. Hence, their study explores motivation to e-learn as a variable to designing technology-supported learning experiences. They aim to identify what motivation-related variables are critical for student engagement in learning online as the basis for a specific, bottom-up and quantitative design technique. Their study on the importance of a set of motivation-to-e-learn variables in a real instructional setting has led to an exploratory two-factor structure explaining 96% of motivation to e-learn.

This two-factor structure (presented in Table 1) contributes towards quantitatively understanding and cost-effectively improving the link among learning design process, supporting systems and students in terms of continuous assessment of what students value most systemically. Courseware accounts for 81% of variance whereas organizational communication, accounts for 16% of the common variance. More importantly courseware factors explains four times more variance than organizational communication, indicating that it has a higher influence on motivation to e-learn and thus deserves more focus and priority due to its potential impact. Organizational communication however, influences readiness to e-learn. Among

these, the three factors with the highest mean are instructor support, accessibility to contents and easy-to-use-interface. We also note that these salient factors include beliefs (the affective domain), indicating that any systemic solution has to involve not only courseware and organizational communication, but also students' beliefs/dispositions. This finding is consistent with Perkins and Salomon's (1992), Bereiter's (1995) and Engle's (2006) propositions on transfer of learning.

Table 1. Rentroia-Bonito, Jorge and Ghaoui's (2009) two-factor structure and factors/variables which load on them.

Courseware	**Organizational communication.**
Accessibility to contents	Resource availability
Security and data protection	Instructor support
Personalized feedback	Institutional support
Easy-to-use interface	Feeling part of learning group
Flexibility in content presentation	Like studying subject matter
Aesthetic content presentation	Belief: E-learning contributes to my learning objectives
Belief: I can learn this subject online.	Belief: Adequate communication with instructors

We are concerned with the design of embedded formative assessment as personalized feedback (part of instructor support, accessibility to contents) due to the above scenario and because of our concern with cognitive access. Cognitive access extends beyond digital access to include comprehension, and interpretation. Interpretation varies depending on the individual's prior learning and culture. As cognitive access (sense-making) becomes more critical, we need to provide structure and scaffolds to help students to develop their own learning initiative and learning path. We next discuss our suggestions towards this end.

2. LESSONS LEARNT

Based on the learning sciences' literature, we learn that:

a) transfer of learning is important because if students are able to transfer their learning to different contexts, outcomes may be the discovery or creation of opportunities;

b) promotion of transfer of learning based on modelling (e.g. Kolodner's (1995) Learning-by-Design, Engle's (2006) socio-cognitive framework) and visualization (e.g. Bhatta, S. and Goel (1997); Ashok's (2011) study on modelling of the acquarium ecosystem) is encouraged. This is because transfer can occur at different levels from the elemental to contextual;

c) goal-seeking analyses and what-if analyses can lead to drill-down analyses. However, it is the context, which gives meaning to these analyses.

To develop design thinking skills and a disposition for social innovations, we have used metacognitive reflective scaffolds grounded in inquiry-based formative assessment.

2.1 Design Thinking as Design Methodology

Brown and Wyatt (2010) observe that conventional research can point toward incremental improvements. However, these do not usually lead to significant breakthroughs. As such, they point out that conventionally, designers have emphasized on enhancing the look and functionality of products. However, recently, they have begun to utilize design tools in order to address more complex problems. This is because systemic problems require systemic solutions. The change in dynamics necessitates broadening approaches in order to create entire systems to deliver products and services. For example, social challenges require systemic solutions that are grounded not only in the client's or customer's needs, but also form and function, as well as distribution channels. Without considering the whole system, solutions may not be sustainable.

As mentioned earlier, design thinking is inherently optimistic, constructive, and experiential. The beliefs/epistemology underlying design thinking is illustrated in Figure 1.

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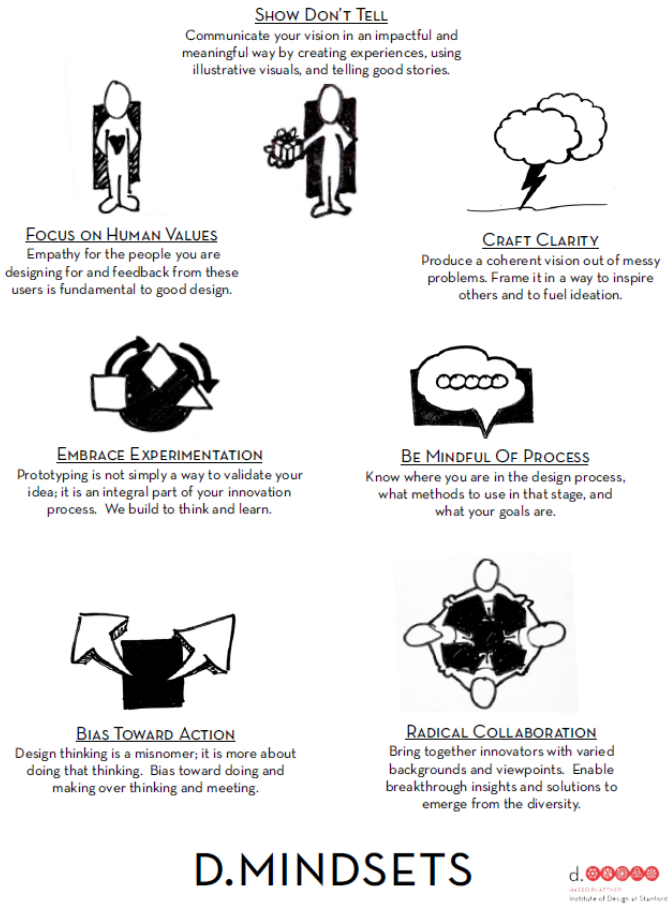

Figure 1. Design thinking mindsets

Source: Stanford's d. school's bootcamp bootleg

Being a Human-Centered Design methodology, design thinking naturally incorporates consumer insights as the first design space. In 2001, IDEO transformed from designing consumer products to designing consumer experiences. With this change, design thinking develops our ability to a)be intuitive; b)recognize patterns; c) construct ideas that have emotional and functional meaning; d) express ourselves in media other than words or symbols. In short, IDEO positions design thinking as the integration of feeling, intuition, and inspiration with the rational and the analytical. The consequent methodology is thus a system of overlapping spaces rather than a sequence of orderly steps. Three main spaces are most well-known: inspiration, ideation, and implementation.

Inspiration emphasizes on empathy through immersive experiences and understanding. These are subsequently validated through in-depth and rapid prototyping. Prototyping (transforming ideas into actual products and services, which are then tested, iterated, and refined) is crucial as it not only validates, but also enables the discovery of unforeseen implementation challenges and unintended consequences; and assesses the feedback and viability of new market approaches critical to more sustainable long-term success.

2.2 Formative Assessment as Framing and Reflective Technique

Mislevy, Steinberg, Almond and Lukas (2006) point out that effective assessments are key in enabling teachers to gather information about students' knowledge and the depth of their understanding of subject matter. In fact, their studies indicate that assessment experts suggest assessments be designed grounded in evidentiary reasoning, i.e., the assessment activity is specifically designed to elicit evidence about the student knowledge that is of interest.

Based on the above literature, in our prior studies (Lee & Wong, 2013, Lee & Wong, 2014a; Lee & Wong, 2014b), we embedded metacognitive reflective scaffolds (Schon, 1996) as formative assessments, integrated with design thinking within progressive inquiry/problem-based learning. Tangible prototypes are produced for the latter two studies consistent with design thinking. Our assessment rubric refined throughout our prior work is presented in Table 2 below.

Table 2. Refined assessment rubric.

	A	B	C	D
Fun	Users are addicted/ intrinsically motivated	Users find it fun and don't mind spending 2-3 hours per day at the Website/ application.	Users find it somewhat fun but wouldn't want to go to the Website or use the application unless they have to.	Users find it boring and dread to go to the Website or use the application.
Interactivity	Users are actively creating and/or co-creating objects and interactions which will result in higher quality objects and more meaningful interaction.	Users are creating and/or co-creating objects and interactions and the outcome are more objects and more interactions which are beautiful to them.	Users are creating and/or co-creating objects and interactions.	Users are not creating and/or co-creating objects and interactions.
Sustainability	Three to four dimensions of application.	Two to three dimensions of application.	One dimension of application.	Failure to sustain.
Problem-solving	Problem and hypotheses properly formulated across 2-3 domains.	Problem and hypotheses properly formulated across 2 domains.	Problem and hypotheses properly formulated across 1 domains.	Problem and hypotheses improperly formulated.
Significance/ contribution	Outcome can actually be used in society directly.	Outcome needs to be adapted slightly before it can be used in society.	Outcome needs major revision but can be adapted before it can be used in society.	Outcome is purely adoption of an existing solution.
Novelty	The outcome is original in relation to the existing work locally and internationally.	The outcome is original in relation to the existing work locally.	The outcome is original in relation to the existing work in the local community.	The outcome is not original.

The first three criteria are part of what we perceive as contributing to meaningful and sustainable user experience. The subsequent three criteria are research-based. Koster's (2014) theory of fun, analogizes people as amazing pattern-matching machines. Once we recognize a pattern, we seek to see it recur. He further observes that "Fun is the process of discovering areas in a possibility space" and that "We talk so much about emergent gameplay, non-linear storytelling, or about player-entered content. They're all ways of increasing the possibility space, making self-refreshing puzzles". Moreover, for games to be art, they need to be puzzles with more than one right answer, open to the interpretation of the target audience. The challenge increases in multiplayer games where there are many instances with variations in player-entered content.

Elaboration on these metrics is explained in an extended version of this paper, which illustrates the evolution of our studies in the creative industries, contributions and implications, and the refined research model. Another paper compares these findings with the findings from the design of assessment for two Science-based courses, Software design and testing (Lee, Wong and Lau, 2015) and Robotics (unpublished technical report), its research model and the integrated Arts-Science model.

2.3 Summary of Findings

From prior studies, we propose an initial conceptual framework to develop generative designs. Our research model (Figure 2) considers the following:

a) learning environments and systems need to focus on theorizing and high-fidelity prototyping;

b) theorizing can be mediated by framing students' role as active participants of and contributors to a larger intellectual and social community to create intrinsic motivation. This is because the situative perspective contextualizes the design of reflective scaffolds to build on prior knowledge triggered by the need to design with authentic future applications in mind;

c) focusing on framing and reframing the context/problem in order to derive more alternatives and better solutions. This is based on the grounds that hypotheses are best formulated and tested within contexts, driven by the formulation and reformulation of goals/objectives;

d) to sustain theorizing, learning needs to be fun and interactive;

e) high-fidelity prototyping is essential during the theorizing, enactment phase;

f) to be creative, technology needs to allow students to view a problem from different perspectives and abstractions to create more novel insights;.

g) to develop multiple perspectives, we need to extend beyond functional designs to designing user experience;

h) design thinking and metacognitive reflective scaffolds as embedded formative assessments need to be integral during lecture and tutorial;

i) instructors must be brave to allow and look forward to emergent outcomes.

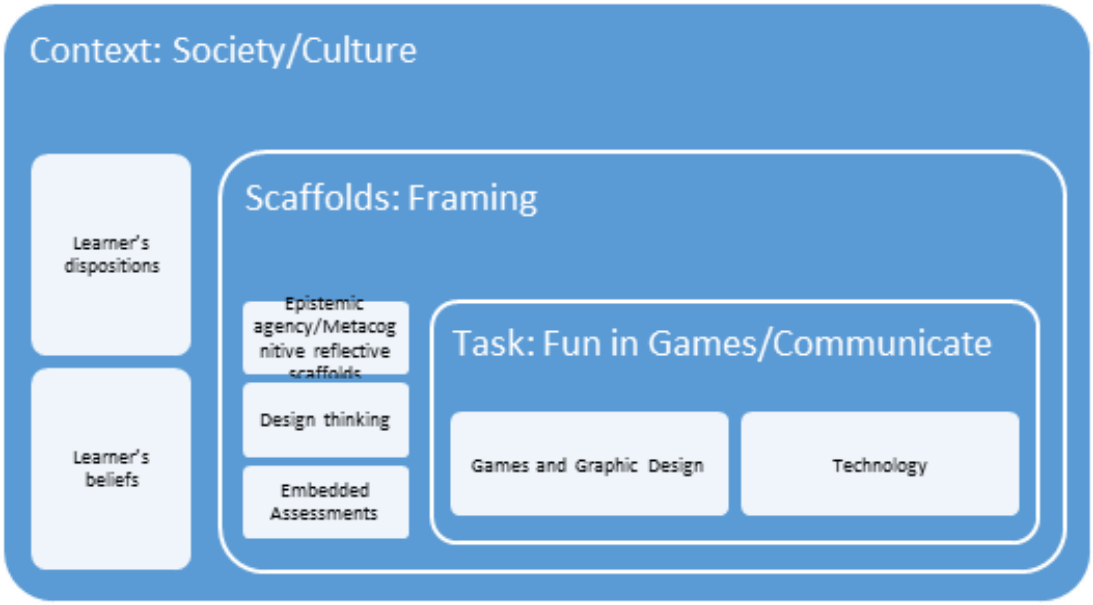

Figure 2. Research model for this study

2.4 Conclusion

According to Brown (2008), thinking like a designer can transform the way we develop products, services and even strategy. In our series of investigations, our objective is to develop a disposition for Social Innovations.

To achieve this, we have aimed to:

1) investigate whether our assessment rubric can be a means to motivate students/designers to learn, to model, to analogize, to theorize and to transfer learning through and to different contexts;

2) develop an ontological affective-socio-cognitive model for context-aware interaction which cares – one which will intrinsically motivate and self-direct them to be more open, critical and creative.

Subsequently, we hypothesize that if we utilize design thinking as our framing methodology, students are more likely to emphasize on user experience above functional requirements. However, our sample size is small. Hence, findings are not generalizable at that stage. As such, we do not make generalizable claims regarding the effectiveness of our scaffolds. At this moment, we can only claim that based on evidential findings, our scaffolds (design thinking, metacognitive reflection as embedded assessments and framing), help students to be more aware of the context and its relation with their prior knowledge, helps them to think broader, make more hypotheses and consider more alternative solutions.

With this paper, we end our research into the creative industries. We hope to test our initial conceptual model in different domains, via different frameworks, interaction platforms and different devices, with diverse interdisciplinary collaborators, especially with regards to Science, Technology, Engineering and Mathematics and its variants.

We are keen to collaborate with others within the gamification entrepreneurial framework, continuing with our investigations into Web modelling and engineering for the Sciences (Software design and testing) and Web modelling and craft for the creative industries while focusing on user experience. UPenn's eCrafting.org and the Mixed Media Lab are referred to as examples. Possible areas of collaboration are:

a) Enhancing youth's digital lifestyle through social-media-mediated co-creation [Media and engagement]
b) Gamification to improve quality of life to the disabled (visual, learning, auditory). [Assistive tech]
c) eCrafting for fun, convenience, lifestyle [DigiStyle tech] simulating UPenn's ecrafting.
d) Improving comprehension of programming language concepts through the integration of games, Lego and programming through visual functional gamified co-design [STEM]
e) Technology-assisted affective-socio co-design as driver for e-commerce [Media and engagement]

Ultimately, we hope that our findings in discovering an ontological Affective-Socio-Cognitive Co-Design Model and in developing a disposition for Social Innovations can be used to develop a Symbiotic Context-Aware Recommender suitable for IoT or Cloud Computing.

ACKNOWLEDGEMENT

We thank the Faculty of Creative Industries, Universiti Tunku Abdul Rahman, Malaysia for the opportunity to conduct the studies while the first author was a Faculty there and the students for their wonderful interactions.

REFERENCES

Bereiter, C. 1995. In *Teaching for Transfer: Fostering Generalization in Learning*. (Eds, McKeough, A., Lupart, J. And Marini, A. Lawrence Erlbaum Associates, Mahwah, NJ, pp. 21–34.

Bhatta, S. and Goel, A. 1997. An analogical theory of creativity in design. Case-based Reasoning and Development. *Lecture Notes in Computer Science*, 1266, pp. 565-574.

Bransford, J., Brown, A., and Cocking, R. (Eds). 2000. *How people learn: Brain, mind, experience and school*. Washington, DC: National Academy Press.

Brown, T. 2008. Design thinking. *Harvard Business Review*, June.

Brown, T. and Wyatt, J. 2010. Design Thinking for Social Innovation**.** *Stanford Social Innovation Review*. Winter 2010, pp. 30-35.

Engle, R. A. 2006. Framing interactions to foster generative learning: A situative explanation of transfer in a community of learners classroom. *The Journal of the Learning Sciences*, Vol. 15, No. 4, pp. 451-498.

Hakkarainen, K. 2003. Progressive Inquiry in a computer-supported biology class. *Journal of Research in Science Teaching*, Vol. 40, No. 10, pp. 1072–1088.

Garud, R. Gehman, J. and Giuliani, A. P. Contextualizing Entrepreneurial Innovation: A Narrative Perspective. *IEEE Engineering Management Review*, Vol. 43 Number 1, 2015, pp. 80-102.

Goel, A. 1997. Design, Analogy and Creativity. *IEEE Intelligent Systems, 12* (3), pp. 62-70.

Keohane, G. L. 2013. *Social entrepreneurship for the 21st century: Innovation across the non-profit, private, and public sectors*. McGraw-Hill, New York.

Kolodner, J. 1994. Understanding creativity: A case-based approach. Topics in Case-based Reasoning. *Lecture Notes in Computer Science*, 837, pp. 1-20.

Lee, C. S. and Wong, K. D. 2013. The role of framing in scaffolding near and far transfer: A case study. *IEEE International Conference on Advanced Learning Technologies*, Beijing, China, July 15 to 18, 2013, pp. 401-402.

Lee, C. S. and Wong, K. D. 2014a. Designing framing and metacognitive reflective scaffolds to develop design thinking and transfer of learning: Theorizing for pre-school. *IEEE International Conference on Advanced Learning Technologies*, Athens, Greece, July 7-9, 2014, pp. 81-82.

Lee, C. S. and Wong, K. D. 2014b. Developing transfer of learning through reflective framing and design thinking: An Engineering-games Design Approach. *International Conference on Industrial Engineering and Engineering Management*, December 9-12, 2014, Malaysia.

Lee, C. S. and Wong, K. D. 2015b. Design thinking and metacognitive reflective scaffolds: A graphic design-industrial design transfer case study. International Conference on Cognition and Exploratory Learning in Digital Age (in press)

Mislevy, R. K., Steinberg, L.S., Almond, R. G., and Lukas, J. F. 2006. Concepts, terminology, and basic models of evidence-centred design. In D. M. Williamson, I. I. Bejas & R. J. Mislevy (Eds). Automated Scoring of Complex Tasks in Computer-based Testing. Lawrence Erlbaum, Mahwah, NJ.

Mixed Media Lab.

Perkins, D. N. and Salomon, G. 1992. Transfer of learning. International Encyclopedia of Education (2nd ed.). Pergamon Press, Oxford, UK.

Rentroia-Bonito, M. A., Jorge, J. A. and Ghaoui, C. 2009. Motivation-to-e-learn: A quantitative design technique.

Schon, A. 1996. Educating the reflective practitioner: Toward a new design for teaching and learning in the professions, Jossey-Bass, Inc., San Francisco.

UPenn. eCrafting.org