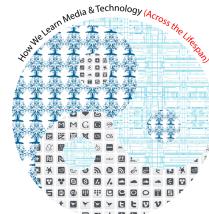




How We Learn (Media & Technology Across the Lifespan)

Funded by the Social Science and Humanities Research Council of Canada



STEM 2014 Symposium Proposal

Design and Engineering Cognition and Design-Based Research

Stephen Petrina, Franc Feng, Mirela Gutica, Peter Halim, Yu-Ling Lee, Lesley Liu,
PJ Rusnak, Yifei Wang & Jennifer Zhao

University of British Columbia

Symposium Chairs: Yifei Wang (Sheila.wang@gmail.com) &
Stephen Petrina (Stephen.petrina@ubc.ca)

Abstract:

This symposium aims to generate discussion and understanding of design-based research (DBR) in design and engineering cognition. Seven empirical reports exploring design and engineering cognition or using DBR give the symposium depth and structure: Studies of 1) thirty tweenage girls in designing a mother's day game, media, and robots; 2) fifteen elementary students testing a new educational video game; 3) nineteen young adults within an immersive virtual environment; 4) four teen students on the design of games; 5) six nursing students involved in a simulated learning environment; 6) Conceptual paper exploring technology and the "design" in DBR; and 7) Methodological paper connecting DBR with design and engineering cognition and ethical know-how. Arguably, new technologies along with a return of DIY or maker culture invite or configure everyone to employ inventive practices or "designerly ways of knowing." Design now marks interaction with new technologies, making DBR increasingly important and relevant for STEM.

Keywords: STEM; learning; design and engineering cognition; design-based research; ethical know-how; gaming; learning analytics; DIY; maker culture

STEM 2014 Symposium Proposal

Design and Engineering Cognition and Design-Based Research

Abstract:

This symposium aims to generate discussion and understanding of design-based research (DBR) in design and engineering cognition. Seven empirical reports exploring design and engineering cognition or using DBR give the symposium depth and structure: Studies of 1) the complex relationship between design and the sacred, framed by matters of concerns; 2) thirty teenage girls in designing a mother's day game, media, and robots; 3) nineteen young adults within an immersive virtual environment; 4) fifteen elementary students testing a new educational video game; 5) four teen students on the design of games; 6) the evolution of the e-book and the new direction in which e-reading is beginning to follow; 7) Six nursing students involved in a simulated learning environment; and 8) Methodological paper connecting DBR with design and engineering cognition and ethical know-how. Arguably, new technologies along with a return of DIY or maker culture invite or configure everyone to employ inventive practices or "designerly ways of knowing." Design now marks interaction with new technologies, making DBR increasingly important and relevant for STEM.

Symposium Objectives, Issues, and Themes:

The key objectives of this symposium are 1) to profile methodological advancements and insights in DBR derived from lab and field-based studies; 2) to explore connections between DBR and design and engineering cognition; and 3) to prompt discussion on DBR in context of new technologies and the design turn in DIY or maker culture.

Increasing interest in DBR and fundamental challenges in employing DBR make this symposium relevant and timely. Similarly, given that new technologies seemingly empower users to be designers, DBR methods become increasingly important. Providing empirical examples, this symposium introduces advancements in DBR and connects interest in DBR with understandings of design and engineering cognition.

The symposium proceeds as follows (90 Minutes):

- 1) Brief introduction of the symposium
- 2) Research Analysis: Designing for Good Life (Yu-Ling Lee)
- 3) Research Report: Girls Designing Games, Media, Robots, Selves and Culture (PJ Rusnak)
- 4) Research Report: Village: Virtual Immersive Language Learning and Gaming Environment (Yifei Wang)
- 5) Research Report: Designing an Educational Game (Heroes of Math Island) for Modeling Adaptive Emotional Agents (Mirela Gutica)
- 6) Research Report: Teen Designs on Gaming in the Classroom (Peter Halim)
- 7) Research Report: Re-conceptualizing Digital Reading (Lesley Liu)
- 8) Research Report: Simulated Learning Environment in Nursing (Jennifer Zhao)
- 9) Research Analysis: DBR, Design and Engineering Cognition, and Ethical Know-How (Stephen Petrina, Franc Feng & Yifei Wang)
- 10) Audience discussion

Abstracts of Individual Reports:

Designing for Good Life (Yu-Ling Lee)

This presentation examines the complex relationship between design and the sacred, framed by matters of concerns. It is the culmination of a yearlong ethnographic research project in the lives of Christian undergraduate students in Vancouver, Canada. Focal concerns in the form of things and practices have disclosive power if they are designed for the good life. The task of the designer, then, is to purposefully move away from matters of fact towards matters of concerns. In this way, designers are conservators of values, demonstrators of care for concerns, while at the same time innovating new forms of engagement in the pursuit of a more sacred design. Similarly, these Christian students enact this mode of sacred design as they become curators of technological content, which enhances and transforms their embodied spiritual experiences. They demonstrate that it is possible to authentically design their sacred focal practices through the technologizing of their faith.

Girls Designing Games, Media, Robots, Selves and Culture (PJ Rusnak)

The participants include 30 girls in two summer camps (2009 and 2011) that included learning labs in animation, movie making, robotics, and web design. The research focused on artifacts and stories that are generative or catalytic. For example, the *momMe* game designed is an exemplar of the generative nature of specific artifacts and serves as one artifact among others that were similarly catalytic for storymaking. Findings focus on the girls' design of their own identities, cultures, and knowledge (e.g., using technology to independently create artifacts that express their concerns, desires, and pleasures).

Village: Virtual Immersive Language Learning and Gaming Environment (Yifei Wang)

The purpose of this study was to explore affordances of a 3D virtual world platform designed as an immersive language teaching and learning environment. Focusing on designing virtual worlds as a catalyst for change, three design phases (development of artifact, low fidelity prototyping, and high fidelity prototyping) were detailed and documented in this study. Nineteen students from a pre-service teacher cohort, two technicians and eight language learners from high schools in Vancouver as well as eighty language learners from universities in China were involved in this study. Findings showed that embodiment through an embodied avatar, community of practice through co-presence, and situated learning through simulation had a greater impact on the immersive virtual learning design.

Designing an Educational Game (*Heroes of Math Island*) for Modeling Adaptive Emotional Agents (Mirela Gutica)

The mathematics game *Heroes of Math Island* developed for this study is intended for grade 5-7 students. The game has a narrative and activities happening on an island employing as a central site a castle where students get "quests" from a king or queen. Game design started in June 2010 and experiments began in March 2012. The problem of this study was to identify learners' emotional states triggered for or during gameplay. The study used mixed methodologies and included: pre-test, intervention (game play), post-

test, post-questionnaire, and interviews. The participants were 15 students (13 boys and 11 girls) grade 5-7. Findings report on our understanding of Intelligent Tutoring Systems (ITSS), educational gaming software, and learning.

Teen Designs on Gaming in the Classroom (Petri Halim)

For this research, four high school aged teenagers participated in an intensive one week video gaming camp, at which time they articulated their attitudes and ideas about mainstream video games and their place in education. The purpose was to explore strategies for utilizing mainstream commercial video games for educative purposes in the classroom. The participants' insights along with observations made on their interaction with video games were analyzed through Rogers' Diffusion of Innovation and the General Aggression Model. In summary, the participants, more or less experts in gaming, enjoyed video games and described them as one of their favourite activities. Furthermore, it was found that video games played both a positive and negative role in the participants' lives. For example, their responses also indicated that they experienced limits to video games and did *not* see innovation from market and home to school as a smooth, trivial process. Rather, they provided key insights into aligning specific games with specific content, curriculum, and courses.

Re-conceptualizing Digital Reading (Lesley Liu)

This paper will present the rationale for a Master's Thesis in the Department of Curriculum and Pedagogy: Reconceptualizing Digital Reading. E-book readers have been key to the introduction and development of portable digital reading devices in the past; however, the concept of the e-book reader has become stagnant and unremarkable. This paper will first examine the history and current state of e-book reading devices, such as the Kindle, Kobo Reader, and the iPad. The second portion of this paper will examine the evolution of the e-book and the new direction in which e-reading is beginning to follow. These new e-books will allow for a different experience of the text and lead to a different relationship between the reader, the electronic reading device, and the text.

Simulated Learning Environment in Nursing (Jennifer Zhao)

This study draws on DBR within immersive virtual learning environments for nursing clinical education. As an add-on to clinical practices in hospitals and clinical labs, simulation in virtual worlds helps new nurses find easier connections between knowledge learned from classrooms and real clinical settings through a simulated contextual layer. The paper reports on understandings of complex learning environments to inform the design of new technologies in nursing curricula.

Design & Engineering Cognition, Ethical Know-How and Law (Stephen Petrina, Franc Feng & Yifei Wang)

One of the more troubling concerns of design and engineering cognition over the past century is how it is or is not mediated by ethical and moral cognition. What are the relationships between these two distinct cognitive processes? What role does legal cognition and the regulation of law play? How and why are designers, engineers, physical scientists, and technologists relatively insensitive to cultural, environmental, and social dimensions of practice (Cech, 2014)? Are these professionals taught or are they more

naturally predisposed to this insensitivity? Do novice designers, engineers, and technologists express similar insensitivities? If so, which of their media and technologies are amoral or immoral and inclined toward insensitivity? Which of these are not regulated by law? In this realist scenario, extensions of media and technologies (artifacts, processes, systems) afford and prime novice and professional designers, engineers, and technologists toward insensitivity. Does insensitivity beget insensitive processes and products? And vice versa? What distinguishes the good from the bad or ethical from the unethical in craft, design, engineering, media, and technology (CDEM&T)? For all the research into instrumental and technological rationality over the past century we know very little about technological cognition, including design and engineering cognition (Petrina, 2010). We know even less about interrelationships with ethical and moral cognition.

References

- Aikin, O. (2001). Variants in design cognition. In C. M. Eastman, W. M. McCracken & W. C. Newstetter (Eds.), *Design knowing and learning: Cognition in design education* (pp. 105-124). New York: Elsevier.
- Arthur, W. B. (2007). The structure of invention. *Research Policy*, 36, 247-287.
- Ashcraft, M. H. (1998). *Fundamentals of cognition*. New York: Addison-Wesley.
- Brown, A. L. (1992). Design experiments. *Journal of the Learning Sciences* 2(2), 141-178.
- Cross, N. (1982). Designerly ways of knowing. *Design Studies*, 3(4), 221-227.
- Cross, N. (2001a). Designerly ways of knowing: Design discipline versus design science. *Design Issues*, 17(3), 49-55.
- Cross, N. (2001b). Design cognition: Results from protocol and other studies of design activity. In C. M. Eastman, W. M. McCracken & W. C. Newstetter (Eds.), *Design knowing and learning: Cognition in design education* (pp. 79-104). New York: Elsevier.
- Cross, N. (2004). Expertise in design: An overview. *Design Studies*, 25(5), 427-441.
- Cross, N. (2006). *Designerly ways of knowing*. London: Springer.
- Eastman, C. (2001). New studies in design cognition: Studies of representation and recall. In C. M. Eastman, W. M. McCracken & W. C. Newstetter (Eds.), *Design knowing and learning: Cognition in design education* (pp. 147-198). New York: Elsevier.
- Kolodner, J. (1991). The *Journal of the Learning Sciences*: Effecting changes in education. *Journal of the Learning Sciences*, 1(1), 1-6.
- Kolodner, J. (2002). Learning by design™: Iterations of design challenges for better learning of science skills. *Cognitive Studies* 9(3), 338-350.
- Kolodner, J. (2004). The learning sciences: Past, present and future. *Educational Technology*, 44(3), 37-42.
- Lambie, T. (2005). Cognitive engineering. In W. Karwowski (Ed.), *International encyclopedia of ergonomics and human factors, volume III* (pp. 22-24). New York: Taylor & Francis.
- Lawson, B. (1980/1990). *How designers think: The design process demystified* (2nd ed.). London: Butterworth Architecture.
- Norman, D. A. (1987). Cognitive engineering—Cognitive science. In J. M. Carroll (Ed.), *Interfacing thought: Cognitive aspects of human-computer interaction* (pp. 325-336). Cambridge, MA: MIT Press.
- Perkins, D. (1986). *Knowledge as design*. Hillsdale, NJ: Lawrence Erlbaum.
- Petrina, S., Feng, F. & Kim, J. (2008). Researching cognition and technology: How we learn across the lifespan. *International Journal of Technology and Design Education*, 18(4), 375-396.
- Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.
- Simon, H. A. (1969/1981). *The sciences of the artificial*. Cambridge, MA: MIT Press.
- Simon, H. A. (1980). Cognitive science: The newest of science of the artificial. *Cognitive Science*, 4(1), 33-46.
- Varela, F. (1999). *Ethical know-how: Action, wisdom, cognition*. Stanford: Stanford University Press.
- Wertsch, J. V. (1998). *Mind as action*. New York: Oxford University Press.