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All of our issues are published online at *www.sfuedreview.org* and are publicly accessible.

A brief history: The SFU Ed Review published its inaugural first issue in the spring of 2007. Originally, the Ed Review followed a traditional academic journal format; however, in 2012, the Ed Review was redesigned in order to make it more welcoming and accessible. Through these changes the Ed Review hopes to:

- be more inclusive of our academic community;
- promote discussion and reflection;
- provide a medium that better supports diverse scholarship and research;
- provide a format that better supports shorter works.

Ultimately, we are hoping to initiate a medium that will promote better awareness about the current work being pursued in the Educational community, offer a safe environment for peer-to-peer dialogue, and encourage emergent scholars to explore and develop their own voice within academia.

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LETTER FROM THE EDITORS

Dear SFU Educational Review Community,

We are living in unprecedented times. The fact that this phrase is becoming weak and pale from overuse in recent months does not make it any less true!

We would like to welcome you to this regular issue of the SFU Ed Review, which may seem incongruent in a period of pandemic uncertainty and social upheaval. As an editorial team, we would like to address some of the challenges of working during the COVID-19 shutdown, as well as the difficulty - and privilege - of publishing an edition of the journal during this time.

The articles in this issue were written and submitted before the health crisis fully reached us in North America, and the resulting shutdowns came into effect. The journal was temporarily put on hold while the editorial team worked to adapt to new living and working conditions, and is therefore quite delayed in its publication. We have chosen to move forward with the issue at this time, as the quality of scholarship and relevance of the material is undiminished.

We are also aware of the urgency of the global social movements for racial justice, centred in the US and Canada. The massive protests and intense public debate are a response to the most recent instances of horrific police brutality against Black and Indigenous people in our communities. The protestors point out the failure to address issues of systemic racism within public institutions, which includes our field of education. We will absolutely be addressing these issues as a journal, and are currently discussing possibilities for how this can best be done going forward.

***Change in leadership** -- moving towards a more equal and democratic format with a team of Editor(s)-in-Chief.* Transparency and labour divisions have been in place at SFU Ed Review before us, but we recognize that the labels around our names on our website, signatures, etc. display a hierarchical structure, as opposed to a more democratic and egalitarian one. The shift is going to be easy and complicated at the same time. It is very hard work to make decisions as a team, but we endeavour to put in the effort in order to make these changes a reality, both in today's climate, and for the long-term benefit of our authors, readership, and Education community as a whole.

Thank you again, for your continued support and contributions. Please see below for a very brief summary of each article published in this current journal edition.

In **"Educational change and NEXTschool: A review of literature informing innovative approaches to teaching and learning"**, after exploring the literature on school change processes, the authors examine how the possibilities and challenges presented by the literature could be applied to an example of a current school change initiative called NEXTschools. The authors also investigate how their research findings could be applied to the NEXTschools and

provide a conceptual framework that establishes how the NEXTSchool initiative in Quebec is conceptualized.

In the article **"Mental perturbance: An integrative design-oriented concept for understanding repetitive thought, emotions and related phenomena involving a loss of control of executive functions"**, the authors invite us to question our understanding of mental perturbance — the loss of control of executive functions to insistent motivators -- and describe how it calls for an integrative design-oriented (IDO) approach to autonomous agency. In demonstrating this claim, we illustrate the scientific and practical importance of unified theories of mind.

The interview **"Teaching science with intention and connection: An interview with Clarah Menezes"** sheds light on a new approach to teaching science, based on Dr. Poh Tan's Three Visions framework, approaching a perspective of relational connections. The authors engage in an interview with Clarah Menezes, an elementary school teacher from Brazil, in which she tells more about how Dr. Tan's framework transformed her practice and shares some of her experiences in the school where she currently teaches.

The essay **"*Seeking to engage:* re-*placing* Simon Fraser University's Burnaby Mountain campus to help address environmental crisis"** is a call to reimagine learning at SFU through a place-based educational context, in response to the need to address the environmental and climate crisis. The author addresses the colonial roots of SFU's Burnaby campus, and its disconnection from the First Nations lands upon which it is built, suggesting that university classes and instructors could engage with the natural environment as an alternative.

The poem **"Curating a future Earth"** compels us to think about the earth, our connection with it, and asks the essential question "what is alive?"

In the report **"Towards a new teaching approach for scientific literacy: Exploring through a three-vision framework for teaching science"**, the author proposes a three visions framework to conceptualize science education. Drawing on post-humanist theories and Indigenous Hawaiian epistemology, her framework proposes an analytical lens to address the so-called differences between disciplines such as Science, Technology, Engineering, Arts, and Math (STEAM) and to combine them for a move towards a broader understanding of science by recognizing the relations between humans and non-humans.

Sincerely,

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ARTICLES

EDUCATIONAL CHANGE AND NEXTSCHOOL: A REVIEW OF LITERATURE INFORMING INNOVATIVE APPROACHES TO TEACHING AND LEARNING

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Abstract

In this paper, we examine the current literature on whole-school-system change processes, and the ways in which research findings may be applied to schools in Quebec, Canada. Throughout the paper we use a current school change initiative, NEXTschool, to explore the possibilities and challenges that some of this literature presents, applied to a specific context. At the conclusion we offer a conceptual framework that underpins how we conceptualize the NEXTSchool initiative. The review focuses on three fields that have emerged as relevant to current change movements: 21st century educational change/reform, power dynamics, and design thinking as a systems-change process.

Keywords: 21st century, design thinking, educational change, power dynamics, Québec, secondary school

Educational Change and NEXTSchool: A Review of Literature Informing Innovative Approaches to Teaching and Learning

Education is at a pivotal moment. Worksheets, textbooks, desks in rows and the teacher lecturing from the front of the classroom are familiar examples of learning in high school. In today's fast-paced, knowledge-based, global economy, the currencies for success are critical thinking, creativity, and problem solving; none of these can be taught effectively through the aforementioned traditional approaches. Rapidly evolving conditions require schools to employ new ideas to meet the complex educational and societal challenges of the 21st century (Bellanca & Brandt, 2010; Burns, 2017; C21 Canada, 2012; Caldwell, 2007; Khalideen, 2015; McTighe & Seif, 2010; Trilling & Fadel, 2009). Students need an education that supports them in becoming independent and creative. At the same time, this education must continue strengthening the core skills students need. Research has begun to look at these issues in some depth, but the field of school change is very diverse and lacks nuance and cohesion, which at times makes the applicability of the research difficult to understand in specific contexts. In this paper we review the literature on school change and begin to apply it to an example of a current change process in Québec, called NEXTschools. This allows us to better synthesize the research on school change and explore its feasibility in practice.

Context

This article has emerged as part of a research project funded by the Social Science and Humanities Research Council (SSHRC) partnership development fund. A research team of graduate students and professors in Québec are investigating an educational reform initiative in the province that aims for systems-level changes intended to improve student learning in high schools. We address the following question in this review: what does scholarship say about how education can bring substantive reform to fruition that addresses the challenges of an increasingly complex world? Often, educational reforms have survived as standalone innovations because of individual efforts and/or leadership rather than substantive change to an educational system. This review has strived to include research on reform efforts that have aimed higher to produce system-wide educational reforms as related to the context of the NEXTschool initiative.

Educational reform efforts in Québec

It is important to understand the complex reform culture that the NEXTschool initiative emerged from. Our inquiry into educational change revealed diverse perspectives on the last major educational reform introduced in Québec, Québec Education Program (QEP) (Gouvernement du Québec, 2004), and its subsequent implementation (Advisory Board on English Education, 2011; Canuel, 2014; Lenoir & Hasni, 2010; Potvin & Dionne, 2007; Smith & Foster, 1999; Wiener, 1999). The QEP reform began its roll-out around the year 2000 and continued for the next decade, but without a comprehensive implementation strategy or facilitation support from universities in the province (Potvin & Dionne, 2007). Funded by the Ministry of Education and Higher Education and the Ministry of Education, Leisure, and Sport

(MEES/MELS), the project, *New Approaches, New Solutions* (NANS) followed the reform as a means to support its successful implementation (V. Gold, personal communication, February 11, 2019). Another attempt at supporting the QEP reform was the Advisory Board on English Education (ABEE), a ministry committee of education stakeholders across Québec and chaired by an outsider—originally by Gretta Chambers, Chancellor Emerita, McGill University and more recently by Kate LeMaistre, a retired Associate Professor from McGill's Faculty of Education (V. Gold, personal communication, February 11, 2019). Each year the ABEE chooses a theme that will be their focus of exploration, solicits many perspectives from a range of Québec stakeholders, and then compiles a report. ABEE came out of the Chamber's Report (1992), a white paper on English language education commissioned by the MELS/MEES and directed by Gretta Chambers (V. Gold, personal communication, February 11, 2019). A final attempt by the ministry to support the QEP came in June of 2017 when Sebastian Proulx—then Minister of Education in Québec—launched the Policy on Educational Success with ambitious educational goals for the province to achieve. This policy will be upheld by the current Coalition Avenir Québec (CAQ) government. This document reflects the ministry's recommendations and priority areas in supporting the QEP (A. Rosenberg, personal communication, February 11, 2019).

The final version of the QEP, released in 2003, was a response to the changing needs of education in the 21st century and required a profound shift in Québec's basic learning paradigms (Bouchard, 2014). In response to previous educational change movements in the province, the Ministry attempted to shift from the role of *change agent* to that of *facilitator of change* (MEQ, 1992, p. 14) and as such to move the locus of power to the schools themselves, encouraging local or ground-up change efforts (Freeland, 1999; Smith & Foster, 1999). Unfortunately, the public was not ready for this change, as it was presented, and the resulting perception amongst all levels of education was negative (Bouchard, 2014; Canuel, 2014). The QEP reform has endured, though, and sixteen years later, its success has been marred with struggles. Because of those past challenges, we have attempted to examine areas that presented themselves as possible roadblocks in previous reform efforts so as to avoid repeating them.

NEXTschool

Attempts to transform schooling to better respond to 21st century knowledge-based economies are often piecemeal or localized. NEXTschool, on the other hand, assumes that urgent and dramatic systems-level changes are required to meet the needs of the next and future generations of students. Through a design process that brings together multiple educational stakeholders with expert facilitators, the NEXTschool partnership works to transform the delivery of English-language high school education in Québec. The NEXTschool initiative has focused on building connections between educational partners – teachers, students, administrators, community members, policy makers, consultants, researchers, etc. – and facilitating workshops where these stakeholders come together to redesign conventional high school experiences. NEXTschool provides a concrete systems-level response to the changing

needs of high school students that supports our research into evidence-based, user-generated frameworks for facilitating greater student and teacher engagement and in turn greater school success.

Applying research/evidence-based approaches to concrete change efforts is complex and requires thoughtful application of study findings. As we move forward with this research, we demonstrate to other researchers and schools how one might take the diverse literature and understand it for their own contexts. This requires a well-grounded literature review, which will provide the foundation for the core conceptual framework underpinning the research project.

Literature Review

For this literature review, we searched for articles published between 1990 and 2019 in databases including ERIC, Web of Science, the McGill library, and Google Scholar. Specifically, we sought to investigate what research could inform the path of the NEXTschool initiative towards educational change for the 21st century, considering its use of design thinking and the power dynamics involved in educational change. We limited our review to approximately 90 books and peer-reviewed articles that aim at giving context to our exploration of the NEXTschool initiative. We selected articles that addressed multi-stakeholder change processes, school reform in the public sector and anglophone system, and those that were reflective of how the initiative was introduced in the NEXTschool Research and Development report: "Student-Centered, Teacher-Driven, Globally Connected, Community Engagement" (LEARN, 2017, p. 5). In consideration of the design thinking model from the Stanford d.school (Doorley, Holcomb, Klebahn, Segovia, & Utley, 2018) that the NEXTschool design process is following, we focused on results that explore the potential of multi-stakeholder engagement and collaboration for organizational change. To that end, we further narrowed results to reflect the "inside" (Sleeger & Leithwood, 2010), ground-up reform approach taken by NEXTschool through design thinking, although we also included results that investigated the "outside" (Sleeger & Leithwood, 2010) or top-down approach that is more traditionally associated with educational reform. In the following sections, we delve more deeply into (a) educational change, (b) power dynamics, and (c) design thinking aiming to uncover some key concerns and ideas related to how education may be able to bring substantive reforms like the NEXTschool initiative to fruition.

Educational Change

Looking first to educational change, the sources we uncovered focused on the significance of relationships between the diverse partners involved in reforming schools (Rubinstein & McCarthy, 2014; Stroh, 2015). This discussion was enmeshed in considerations of systems and the larger structures of people within organizations working towards educational change (Fullan, 1993; Fullan & Hargreaves, 2009). Articles touched on both the nuances of educational leadership (Bryk & Schneider, 2003; Fullan, 2011; Leithwood, Harris & Hopkins, 2008; Levitan, 2019; Lumby, 2013; Lumby & Foskett, 2011) and the importance of authentic collaboration between stakeholders (Goldstein & Butler, 2010; Hargreaves, Lieberman, Fullan,

& Hopkins, 2010). Technology surfaced as a central aspect of educational change for 21st century learning (Dede, 2010; Partnership for 21st Century Skills, 2014). Also significant was decolonizing Canadian educational spaces and reconciliation with First Peoples as vital considerations for conceptualizing educational change in Canada (Battiste, Bell, & Findlay, 2002; Howell, 2017; Levitan & Johnson, 2020; Munroe et al., 2013). The literature suggests that successful educational change relies on rolling out reform models contextually and attending to concerns about transferring educational models from one place to another (Farley-Ripple et al., 2018, Mukhopadhyay & Sriprakash, 2011; Potvin & Dionne, 2007).

Our review of literature on educational change has been divided into four subsections: educational leadership and systems thinking, or the relationships between various partners involved in a change process; the place of technology in reform; the significance of Indigenous perspectives to educational change processes and models; and the value of learning from other educational models paired with the importance of attending to the new context for rolling-out educational reforms.

Educational Leadership and Systems Thinking

Firstly, exploring educational leadership, we focused on the role leaders play within organizations. Research has suggested that top-down approaches to educational leadership – where administrators and policy makers assert centralized decisions that impact diverse educational stakeholders, usually without consulting them – are less effective at facilitating educational change than collaborative, transparent leadership that values teachers' voices and treats organizations as learning systems (Bryk & Schneider, 2003; Hargreaves & Shirley, 2009; Rubinstein & McCarthy, 2014; Stroh, 2015).

Educational leadership is interwoven with questions about *systems thinking*, particularly the way educational leaders, among others, must come together to affect complex educational change (Fullan & Hargreaves, 2009; Hargreaves, Lieberman, Fullan, & Hopkins, 2010; Stroh, 2015). The multifaceted change processes necessary for complex change rely on navigating uncertainty (IDEO, 2015; Luka, 2014; Plattner, Meinel, & Leifer, 2014), patiently taking time (Schnurer & Hahn, 2009), and incorporating reflection in action (Fullan, 2011; Voogt et al., 2015). Systems thinking includes considerations of how to engage authentically with the diverse perspectives of all those involved in change (Fullan, 1993; Goldstein & Butler, 2010; Rubinstein & McCarthy, 2014; Stroh, 2015). NEXTschool attends to concerns of top-down and systems thinking approaches by employing design thinking, a highly collaborative problem-solving process, as its designated method of change.

Role of Technology

Digital technologies are described in literature on educational change as tools that support 21st century learning goals (Dede, 2010; Partnership for 21st Century Skills, 2014) and nurture autonomous learners (Benson & Voller, 2014; Drexler, 2010; Hafner & Miller, 2011). However, some educational scholars have begun to suggest that reliance on digital devices actually limits

student autonomy; students can become overdependent on digital tools (Baek & Ha, 2018) which causes their memory processes to adapt in ways that obstruct students' abilities to recall foundational pieces of knowledge or figure things out on their own without rushing to the internet (Agbo-Egwu, Abah, & Anyagh, 2018). Some scholars assert that to many students, the internet has become an addiction which they feel is crucial to learning and even survival (Fong, Lo, & Ng, 2015; Yamamoto, Ananou, & Sindlinger, 2013). A critical adoption of digital technologies is therefore necessary to responsibly rethink how and when to embrace and integrate these technologies into classrooms. Thus, in conceptualizing educational change in relation to NEXTschool, thoughtful consideration must be made as to how to use these technologies for learning.

Indigenous Perspectives

The importance of Indigenous perspectives for working towards changing educational structures in Canada continues to be underestimated (Howell, 2017). Provincial curricula in Québec have failed to heed the Truth and Reconciliation Commission's (TRC) call to action around education (Howell, 2017; Russell, 2018). As Howell (2017) argues, many educators feel like they lack the support, knowledge, and time to include Indigenous perspectives in their classes. They cite Québec's provincial curriculum's underdeveloped focus on Indigenous peoples and its primary focus on Québec's unique linguistic and cultural history as the reason for its poor incorporation. Without provincial support, alternative resources and partnerships, it is unlikely that changes will happen. Educational non-profits such as the educational organization behind NEXTschool, Leading English Education and Resource Network (LEARN), therefore can play an important role in realizing the TRC's recommendations (Howell, 2017) to address needs that are often beyond the capacity of usually overburdened, understaffed and under resourced schoolboards. This reflects the importance of resources and relationships for affecting educational change. Other Indigenous scholars have contributed to the conversation on education reform by pointing out that so-called 'new' trends in 21st century learning parallel many traditional philosophies inherent in holistic Indigenous ways of approaching education (Battiste et al., 2002; Munroe et al., 2013).

Other Educational Models

One significant caution associated with educational change relates to the idiosyncratic complexity of each educational system and how this must be attended to—in all its nuanced subtleties—in order to roll-out a context-specific reform (Fullan, 2011; Smith & O'Day, 1990). When transferring reform models from one place to another, the ideas cannot just be borrowed and imposed as they are, but must be translated flexibly for the new context and community; in other words, reform efforts must be contextualized (Farley-Ripple et al., 2018; Mukhopadhyay & Sriprakash, 2011). As a predominantly French-speaking province in a majority English-speaking country, Québec has an especially unique cultural and linguistic character. Therefore, as exemplified in the previous section's discussion around Québec's failure to meaningfully include

Indigenous perspectives in provincial curriculum, reform in this province faces distinct conditions and challenges (Lenoir & Hasni, 2010; Potvin & Dionne, 2007; Wiener, 1999).

Power Dynamics

Our discussion on power dynamics is separated into two sections, one looks at how power dynamics relate to educational change and another considers the role of power dynamics when considering educational leadership.

Power Dynamics within Educational Change

Literature on power dynamics and educational change points to several interconnected determining factors that could inform the implementation of the NEXTschool initiative: school and teacher receptivity to change (Evans, 1996), teacher motivation (Hargreaves, 2005; Waugh & Punch, 1987), and the role of student voice in change processes (Levitan, 2018; Mitra, 2003; Tuck & Yang, 2013). Of further significance were articles that explored systems change (Fullan, 1993) and how globalization and comparative education have power or influence over local models (Hickling-Hudson & Klees, 2012; Zajda & Rust, 2009). Given the complexity of power dynamics, we chose to strike a balance between local concerns (i.e. teacher and student voice) and global issues (i.e. globalization) to ensure that our examination of power dynamics was robust.

School/Teacher Receptivity. When considering change movements in school settings, one must reflect on the underlying power dynamics present in all change processes. Evans (1996) suggested that educational change causes tension in power dynamics in three significant ways. First and foremost, "change almost always causes ambivalence and resistance" because humans are naturally "pattern-seeking" (p. 2). Thus, teacher receptivity to change is a vital consideration, particularly in light of the firmly rooted structures like subject offerings of the mandated curriculum, daily timetabling, age groupings, and the September to June school calendar embedded in schooling. Secondly, change threatens competence by inferring that teachers' current competence is not adequate. Change requires teachers to "abandon something they know how to do and adopt something they don't know how to do" (p. 2). Alterations in practices, procedures, and routines often make teachers feel inadequate and insecure, especially if they have exercised pedagogical skills in a certain way for a long time and even more if teacher performance has been judged as exemplary (Evans, 1996; Hargreaves, 2005). Finally, change almost always involves conflict. If change is seen as being imposed by administrators, creating winners and losers, or reawakening so-called old-wounds of past reform experiences, then it is unlikely to move forwards in a positive manner and conflicts may arise (Evans, 1996; Fullan, 1993; Hargreaves, 2005).

Years of experience is another important factor that influences teachers' receptivity to change and ability to participate in change. Consider early career teachers who take up appointments in schools where the adult culture is centered around a demographically and politically dominant group of experienced colleagues. In such a context, early career teachers can

become isolated, unsupported and prone to concentrate on survival in and compliance with the existing culture (Johnson et al., 2004), thereby making it difficult to engage in change processes. Furthermore, early career teachers' developing sense of their professional identity can create challenges in their ability to collaborate with others around them, lest their sense of self is weakened or invaded (Fuller, 1969; Leithwood, 1992a; Levitan & Carr-Chelman, 2018). Exacerbating the chance of teacher receptivity is the cultural myth that teachers are rugged individuals, born into their roles or self-made, and therefore with no concern for "the social relationships and the context of school structure" (Britzman, 1991, p. 232).

Teacher Motivation. Factors related to power dynamics also affect teachers' motivations when engaging in change (Hargreaves, 2005; Waugh & Punch, 1987). Change that occurs from *inside* focuses on the capacity of schools to transform themselves into supportive environments for change while change from the *outside* concerns the implementation of externally developed reform designs into schools (Sleeger & Leithwood, 2010). This differentiation plays an integral role in many teachers' openness to change (Robinson & Aronica, 2016; Senge, 2006). The involved teachers' emotional geographies (Hargreaves & Shirley, 2009), consisting of the spatial and experiential patterns of closeness and/or distance in human interactions and relationships, also have impact on teacher willingness to engage in change processes. Professional agency in change processes may also affect teachers' motivation to create or engage in change effectively (Vähäsantanen, 2015). In this instance, professional agency refers to the notion that teachers are professionals who have the power to act, to affect matters, to make decisions and choices, and to take stances in relation to their work and professional identities (Vähäsantanen, 2015).

Incorporation of Student Voice. Scholars studying the power dynamics in educational systems stress the value of student engagement and student voice during educational change (Brasof, 2015; Christensen, 2004; Fielding, 2004; Levitan, 2018; Mansfield, 2014; Mitra, 2003; Mitra, 2007; Robinson & Taylor, 2007; Tuck & Yang, 2013). Perceived power and authority affect whether or not student voice is included in change processes. Indeed, including student voice, defined as having presence, power, and agency within democratic contexts, often calls for a cultural shift that opens up spaces and minds not only to the sound, but also to the presence and power of students in change processes (Mitra, 2003; Tuck & Yang, 2013). As our research moves forward, student voice has been increasingly recognized as a key point of engagement for the school community. At the outset of the NEXTschool initiative, focus has been on the role of the teacher and institution; robust student voice had not been engaged which introduces a potential roadblock into the successful implementation of the NEXTschool initiative.

Power Dynamics within Educational Leadership

In terms of power dynamics in relation to leadership, our inquiry points to transformational and distributed leadership as the most popular approaches used in educational reform movements (Bennett et al., 2003; Gunter, 2001; Leithwood, 1992b; Lumby, 2013; MacBeath et al., 2004; NCSL, 2011; OECD, 2011; Seashore Louis et al., 2009; Yu, Leithwood, & Jantzi, 2002). Transformational leadership was offered as a viable alternative to distributed

leadership (Gunter, 2001; Leithwood,1992; Yu, Leithwood, & Jantzi, 2002) but power must be carefully conceptualized so as to engage in change in critical, ethical, democratic, and empowering ways (Blackmore, 2006; Calabrese, 2002; Duffy, 2005; Gallagher, 2003; hooks, 2009; Luke, 2018; Lumby, 2013; Maxcy, 1991; Sergiovanni, 2000; Simpson, 2008). In terms of distributed leadership, scholars discussed the ways in which power was embedded in systems (Fullan, 1997; Hargreaves, 2007), structures (Foucault, 1974), and communities (Arendt, 1970). Furthermore, scholars problematized the ways in which power was theorized and thus distributed (Gronn, 2008; Hall et al., 2011; Hatcher, 2005) as well as the tendency of distributed leadership to maintain the equilibrium of power as opposed to effectively reallocating it, as promised (Lumby, 2013). Considering the NEXTschool initiative's commitment to using a teacher-driven leadership approach to educational change, understanding how power is effectively or ineffectively distributed is important.

Much has been written about power dynamics in the context of leadership and school change (e.g. Busher, 2006; Calabrese, 2002; Duffy, 2005; Gunter, 2001; Harris & Spillane, 2008; hooks, 2009; Luke, 2018; Lumby, 2013; Lumby & Foskett, 2011; Yu, Leithwood, & Jantzi, 2002). Leadership serves as a "catalyst for unleashing the potential capacities that already exist" (Leithwood, Harris & Hopkins, 2008, p. 29) in schools. The school leader therefore has power to make changes in structures, processes, and artefacts that can impact positively on how students think about themselves and their future (Lumby & Foskett, 2011, p. 456). As such, choosing the right approach for leadership can irrevocably effect whether educational change moves forward (Leithwood, Harris & Hopkins, 2008; Lumby, 2013; Lumby & Foskett, 2011).

Distributed Leadership. A popular chosen approach to leadership, distributed leadership has emerged as offering "an enticing suggestion of including more [perspectives] in leadership, and even sometimes including staff members equally" (Lumby, 2013, p. 581). It is presented as potentially "replacing previous forms of leadership that are critiqued negatively in relation to their ethics and or efficacy, such as heroic, charismatic, collegial, top-down and transactional" (Lumby, 2013, p. 583). MacBeath et al. (2004, p. 13) asserted that "it creates opportunity for all members of an organization to assume leadership" and "it does not necessarily give any particular individual or categories of persons the privilege of providing more leadership than others". Bennett et al. (2003, p. 162) agreed that "there are no limits built into the concept" in terms of who might be included. Seashore Louis et al. (2009, p.157) concluded that distributed leadership has become "a mantra for reshaping leadership practice" and that official agencies are encouraging schools to adopt such practices (NCSL, 2011; OECD, 2011; Woods et al., 2004). Distributed leadership is also viewed as central to system reconfiguration and organizational redesign which necessitates lateral, flatter decision-making processes (Hargreaves, 2007). However, resulting issues around distribution of power are largely ignored or referred to in passing; a kind of "inclusivity lite" (Lumby, 2013, p. 581). Indeed, in ignoring issues of race and gender while making claims of openness, distributed leadership could be viewed as a new manifestation of colour and gender blindness that serves the purposes of the privileged (Blackmore, 2006; Gallagher, 2003; Simpson, 2008). Lumby (2013) cautioned that distributed

leadership creates a "mirage [of] an apolitical workplace" (p. 582) and becomes "an example of the ever-new ways that emerge to maintain the status quo of power" (p. 582).

To really wrest apart the mechanisms and effects of power and inequality, attention must be drawn towards the inadequate theorization of power in relation to distributed leadership (Gronn, 2008; Hall et al., 2011; Hatcher, 2005). Schools are "fields of power" (Halford and Leonard, 2001, p. 26), "never politically neutral" (Deetz, 2000, p. 144), reflecting the "power laden nature of all human association" (Deetz, 2000, p. 145). What is not fully acknowledged or theorized is the relationship between power and inequalities, and the degree of tension that may lie submerged beneath the dominant normative narrative. Teachers "operate within complex structures of power that create and constrain their opportunities to lead" (Lumby, 2013, p. 584). Indeed, Foucault (1974) suggested that power is deeply embedded in how reality is constructed and in people's acceptance of or resistance to 'truth' and of the structures of society. Arendt (1970) also agreed that power is not enacted by or given to individuals. Power is "never the property of an individual; it belongs to a group and remains in existence only so long as the group keeps together" (p. 44). Thus, by distributing leadership tasks without acknowledging the structural inequalities present, distributed leadership effectively "enrol[s] staff willingly into a regime of control, while appearing to loosen the bonds" (Lumby, 2013, p. 589). Thus, understanding the structural constraints of power distribution is integral to unleashing effective teacher leadership in educational change.

For approaches to power in educational contexts, school leaders are challenged to dynamically balance the commitments of diverse individuals in critical, ethical, democratic, and empowering ways (Calabrese, 2002; Duffy, 2005; hooks, 2009; Luke, 2018; Lumby, 2013; Maxcy, 1991; Sergiovanni, 2000). More specifically, leadership for educational change must navigate: the resistance to change and change-related stress (Calabrese, 2002: Lumby, 2013); the context of school districts (Duffy, 2005; Leithwood, Harris & Hopkins, 2008); negotiating diverse social, racial, and gendered subjectivities (hooks, 2009; Lumby 2013); critical and multiliteracies (Luke, 2018); self and social empowerment (Maxcy, 1991); and the standards and assessment practices (Sergiovanni, 2000). The chief concern is then how leadership is distributed, by whom and with what effect (Harris, 2008).

Transformational Leadership. Transformational leadership is one of the most popular approaches for western leaders (Gunter, 2001). Transformational leadership has become an important touchstone for scholars attempting to articulate the second-order changes that support meaningful educational change (Gunter, 2001; Leithwood,1992; Yu, Leithwood, & Jantzi, 2002). Building on the notion of instructional leadership popular in the 80's and 90's and providing an alternative to transactional leadership that segments power between different stakeholders, transformational leadership goes beyond surface changes to consider how facilitating a collaborative culture that transforms pedagogy and curriculum can be an effective and sustainable way to improve a school (Leithwood, 1992b).

As Leithwood (1992) explained, transformational leadership acknowledges the complex systems inherent in educational institutions and advocates for a collaborative facilitation and

decision-making process that builds towards a shared vision and improves communication amongst all stakeholders. Transformational leadership can mediate factors such as school culture, structure, or environment, and teachers' commitment to change (Yu, Leithwood, & Jantzi, 2002). It can be utilized to set shared directions and expectations collaboratively with a school staff, contribute to staff development, and build relationships amongst them and between staff and the school community (Yu, Leithwood, & Jantzi, 2002). The collaborative nature and distributed authority inherent in transformational leadership reflects systems thinking (Stroh, 2015) and may be a compatible model for the NEXTschool initiative. That same shared control is inherent in design thinking (Liedtka, Azer, & Salzman, 2017). Design thinking has provided a structural approach for the exploration and implementation of NEXTschool.

Design Thinking

Design thinking was the most specific field that we investigated in relation to NEXTschool. We first looked at design thinking as an approach to educational reform then narrowed the review to successes and limitations in the application of design thinking within the field of education. Finally, we explored the works of design thinking authorities and influencers relevant to NEXTschool (Designing a School System, n.d.; IDEO, 2015; Liedtka et al., 2017). The sources we included in our literature review were selected for the purpose of considering the role of design thinking for educational contexts and concerns (Gallagher & Thordarson, 2018; Koh, Chai, & Wong, 2015).

A review of the literature revealed that as a relatively generic process, design thinking is difficult to define (Brown, 2009; Koh, Chai, Benjamin, & Hong, 2015a; Koh, Chai, & Wong, 2015b; Köppen & Meinel, 2015). It is commonly referred to as user/human-centered (Brown, 2009, de Guerre, Séguin, Pace, & Burke, 2013; Kolko, 2010; Köppen & Meinel, 2015; Luka, 2014; Meinel & Leifer, 2013) or a collaborative process or mindset (Anderson, 2012; Bransford et al., 2010; Brown, 2009; Koh et al., 2015b; de Guerre et al., 2013; Meinel & Leifer, 2013; Scheer, Noweski, & Meinel 2012; Voogt et al., 2015; de Guerre et al., 2013; Kangas, Seitamaa-Hakkarainen, & Hakkarainen, 2013; Scheer et al., 2012). Although varying semantically, the design process typically involves cyclical stages of empathy building, brainstorming/ideation, iterative prototyping, and testing innovative solutions for real world problems (Anderson, 2012; Brown, 2009; de Guerre et al., 2013; Gallagher & Thordarson, 2018; Koh et al., 2015b ; Luka, 2014; Kangas et al., 2013; Kouprie & Visser, 2009; Scheer et al., 2012; Voogt et al., 2015).

In the field of education, design thinking has been frequently cited in relation to fostering 21st century skills (Anderson, 2012; Koh et al., 2015a; Koh et al., 2015b, Luka, 2014; Scheer et al., 2012) such as problem solving (Anderson, 2012; Luka, 2014; Kangas et al., 2013; M. Saggar et al. 2015; Scheer et al., 2012), creativity (de Guerre et al., 2013; Köppen & Meinel, 2015; Koh et al., 2015b) and communication (Meinel & Leifer, 2013; Scheer et al., 2012). The educational goals of the Organization for Economic Cooperation and Development (OECD) were also frequently cited as achievable through design thinking (Luka, 2014; Scheer et al., 2012). Many examples of design thinking supported the pedagogical development of pre-service and

practicing teachers (Koh et al., 2015b, Koh et al., 2015a; Scheer et al., 2012; Voogt et al., 2015). Design thinking was also documented as an effective process for knowledge construction in general classroom use (i.e. Anderson, 2012; de Guerre et al., 2013; Kangas et al., 2013; Köppen & Meinel, 2015; Luka, 2014; Scheer et al., 2012; Voogt et al., 2015) as well as curricular sustainability (Voogt et al., 2015).

Conversely, design thinking in education has also been subject to criticism (Koh et al., 2015b). The nebulous nature of the process has been documented to deviate from lesson objectives that are generally tied to curricula and standardized testing (Koh et al., 2015b; Scheer et al., 2012). Although the process of design thinking is characterized as intuitive (Koh et al., 2015b), it is also described as time consuming and requiring scaffolding, modeling, and practice (Kangas et al., 2013, Koh et al., 2015a, Koh et al., 2015b; Luka, 2014; Scheer et al., 2012; Voogt et al., 2015). Gaps in the research include a lack of scholarship on how design thinking skills could be taught in the field of education (Anderson, 2012). More research is needed on the integration of design thinking into teacher education programs (Koh et al., 2015b; Scheer et al., 2012) and professional development (Voogt et al., 2015).

Two leaders in the field of design thinking, IDEO and the Stanford d. School, are particularly relevant for the NEXTSchool initiative. Neither organization has explicitly defined the design thinking process, however, there are many similarities in the fundamental steps that they propose. Shared concepts include embracing ambiguity, collaboration, brainstorming, rapid prototyping, building empathy, and testing and refining solutions (IDEO, n.d.; Stanford d. School, n.d.). Of this list, empathy building, collaboration, and iterative prototyping are identified as critically important and are practices that are commonly seen in educational initiatives that employ design thinking whether intentionally (Koh et al., 2015a) or inadvertently (Voogt et al., 2015).

Conclusion and Research Directions

After a reviewing scholarship on educational change, power dynamics, and design thinking, we found several gaps in the research surrounding these topics, which require further investigation. For example, in educational change literature, only recently has Western scholarship begun to take seriously Indigenous perspectives on education and reform, which is now an area of growing but still underdeveloped literature (Howell, 2017; Munroe et al., 2013). Focusing more on Indigenous ways of considering both education and change will be essential to reforming and decolonizing schools in Canada. As well, the role and value of technology is a vast field within the literature on education and educational change (Benson & Voller, 2014; Dede, 2010; Drexler, 2010; Hafner & Miller, 2011). However, as the development and incorporation of technology into educational spaces continues and changes, more nuanced and critical investigations are required to ensure that digital technologies are utilized in intentional and directed ways that are productive and meaningful. Lastly, considering the unique separation of French and English schooling in Québec's education system, more research is required into how this separation impacts education in this province (Lenoir & Hasni, 2010; Potvin & Dionne,

2007). For the NEXTschool initiative, research that looks specifically into these topics—indigeneity, technology, and Québec's unique educational character—can support flexible, holistic, and relevant reforms. However, critical approaches to these research areas are conspicuously underdeveloped in educational literature and important to investigate in further research.

Looking at power dynamics and educational change, much research has been devoted to specific aspects of power in educational change including but not limited to: teacher receptivity (Evans, 1996); teacher motivation (Hargreaves, 2005; Waugh & Punch, 1987); the source of change (Sleeger & Leithwood, 2010); the emotional geographies (Hargreaves & Shirley, 2009), age (Johnson et al., 2004), and agency of the teachers involved (Vähäsantanen, 2015); the usage of evidence (Biesta, 2007); the inclusion of student voice (Mitra, 2003; Tuck & Yang, 2013); the texts/world views included/excluded in the process (Hickling-Hudson & Klees, 2012; Hargreaves & Shirley, 2009; Zajda & Rust, 2009), and the approach to change used (Fullan, 1993; Senge, 2006). Using a systems approach (Fullan, 2009), similar to that of the NEXTschool initiative, it may be possible to observe a multitude of interconnected ways that power and authority foster and hinder change movements in school settings. These observations will make an important contribution to educational change scholarship.

Power dynamics are also embedded in the leadership practices used in educational reform movements. Currently, transformational and distributed leadership are the most widely lauded in Western contexts (Bennett et al., 2003; Gunter, 2001; Leithwood, 1992b; Lumby, 2013; MacBeath et al., 2004; NCSL, 2011; OECD, 2011 Seashore Louis et al., 2009; Yu, Leithwood, & Jantzi, 2002). In order to fully harness power using these leadership approaches, one must understand the ways in which power is embedded in systems (Fullan, 1997; Hargreaves, 2007), structures (Foucault, 1974), and communities (Arendt, 1970). Regardless of the leadership approach, school leaders can consider these theories of power in order to engage in critical, ethical, democratic, and empowering change efforts (Blackmore, 2006; Calabrese, 2002; Duffy, 2005; Gallagher, 2003; hooks, 2009; Luke, 2018; Lumby, 2013; Maxcy, 1991; Sergiovanni, 2000; Simpson, 2008). By utilizing a systems (Fullan, 1997; Hargreaves, 2007) and inclusive approach (LEARN, 2017) to educational change, the NEXTschool initiative should yield a comprehensive understanding of the power structures influencing both educational change itself and the leadership involved.

Design thinking, which is a central component of the NEXTschool reform design process, serves to weave critical features of both educational change and power dynamics together. The organizing focus on the NEXTschool initiative oriented our review to uncover several major gaps that have emerged in these intersections that warrant further investigation. More research is required to understand whether design thinking attends to supporting contextual concerns (Farley-Ripple et al., 2018, Mukhopadhyay & Sriprakash, 2011; Potvin & Dionne, 2007) and whether it engenders *inside* transformation (Sleeger & Leithwood, 2010) when design thinking stakeholders collaborate on equal footing (Brown, 2009; Gallagher & Thordarson, 2018). Another area that has yet to be explored in depth is whether employing design thinking

has the potential to enable resolutions for educational concerns. These include how to incorporate the meaningful integration of technology or Indigenous approaches in learning. As mentioned, scholars frequently identify a lack of professional development or teacher education related to design thinking, whether in formal education or otherwise (Anderson, 2012; Koh et al., 2015b; Scheer et al., 2012; Voogt et al., 2015). It is thus critical to explore and develop resources that support educators in this area. The collaborative and user-centered nature of design thinking (Brown, 2009) supports the significance of human relationships in enacting educational change (Rubinstein & McCarthy, 2014; Stroh, 2015). Often associated with navigating ambiguity (Brown, 2009; Gallagher & Thordarson, 2018), it is essential to understand whether design thinking empowers educators (and other stakeholders) with skills to overcome the uncertainty necessary for complex change to occur (IDEO, 2015; Luka, 2014; Plattner, Meinel, & Leifer, 2014). As further research and reform happens in Québec and beyond, a systems-oriented understanding of the intersections between these emerging categories has the potential to support effective and sustainable educational change.

References

Action Canada. (2013). *Future tense: Adapting Canadian education for the 21st century*. An Action Canada task force report. Ottawa, ON: Action Canada Foundation. Retrieved from http://www.actioncanada.ca/wp-content/uploads/2014/04/TF2-Report_Future-Tense_EN.pdf

Advisory Board on English Education (2011). *Fostering student success in Québec's English schools: Implications for policy and practice*. Québec, QC: MELS.

Agbo-Egwu, A. O., Abah, J., & Anyagh, P. I. (2018). The influence of smartphone over-dependence on the recall of basic mathematics among mathematics education students in a Nigerian university. *Science & Technology, 4*, 97-105.

Anderson, N. (2012). Design thinking: Employing an effective multidisciplinary pedagogical framework to foster creativity and innovation in rural and remote education. *Australian and International Journal of Rural Education, 22(*2), 43.

Arendt H (1970) *On violence*. London, UK: Allen Lane.

Baek, H. G., & Ha, T. H. (2018). Association between psychological mindsets of university students and Over-Dependency on smartphone. *Indian Journal of Public Health Research & Development, 9*(9), 1323-1327.

Battiste, M., Bell, L., & Findlay, L. M. (2002). Decolonizing education in Canadian universities: An interdisciplinary, international, Indigenous research project. *Canadian Journal of Native Education, 26(*2), 82.

Bellanca, J., & Brandt, R. (2010). *21st century skills: Rethinking how students learn*. Bloomingdale, IN: Solution Tree Press.

Bennett, N., Wise, C., Woods, P., & Harvey, J. (2003). *Distributed leadership*. Nottingham, UK: NCSL.

Benson, P., & Voller, P. (2014). *Autonomy and independence in language learning*. London, UK: Routledge.

Biesta, G. (2007). Why "what works" won't work: Evidence-based practice and the democratic deficit in educational research. *Educational Theory, 57*(1), 1-22.

Blackmore, J. (2006). Social justice and the study and practice of leadership in education: A feminist history. *Journal of Educational Administration and History, 38*(2), 185-200.

Bouchard, J. (2014). Flawed rollout, but sound foundation. In R. Canuel (Ed.), *15 years after 'Québec Education Reform'*. Ottawa, ON: EdCan.

Bransford, J., Mosborg, S., Copland, M. A., Honig, M. A., Nelson, H. G., Gawel, D., & Vye, N. (2010). Adaptive people and adaptive systems: Issues of learning and design. In *Second international handbook of educational change* (pp. 825-856). Dordrecht, Netherlands: Springer.

Britzman, D. P. (1991). *Practice makes practice: A critical study of learning to teach*. Albany, NY: Suny Press..

Brown, T. (2009). *Change by design: How design thinking transforms organizations and inspires innovation*. New York, NY: HarperCollins.

Bryk, A. S., & Schneider, B. (2003). Trust in schools: A core resource for school reform. *Educational Leadership, 60*(6), 40-45.

Burns, A. (2017). A cross Canada inventory: Evidence of 21st century educational reform in Canada. *Interchange, 48*(3), 283-292.

C21 Canada. (2012). *Shifting minds: A 21st century vision of public education in Canada*. Retrieved from http://www.c21canada.org/wp-content/uploads/2012/11/Shifting-Minds-Revised.pdf

Calabrese, R. L. (2002). *The leadership assignment: Creating change*. Boston, MA: Allyn & Bacon.

Caldwell, B.J. (2007). Educational development in the twenty-first century: Reflections on the integration of research, policy, and practice. In R. Maclean (ed.), *Learning and teaching for the twenty-first century* (pp. 145-164). New York, NY: Springer.

Canuel, R. (2014). 15 years after 'Québec Education Reform': Critical reflections. *EdCan Network Magazine*. Ottawa, ON: EdCan.

Cobb, P., & Gravemeijer, K. (2006). Design research from a learning design perspective. In *Educational design research* (pp. 29-63). Abingdon, UK: Routledge.

Darbellay, F., Moody, Z., & Lubart, T. (Eds.). (2017). *Creativity, design thinking and interdisciplinarity*. Singapore: Springer.

Darling-Hammond, L. (2006). Constructing 21st-Century Teacher Education. *Journal of Teacher Education, 57*(3), 300–314. doi:10.1177/002248710528596

de Guerre, D. W., Séguin, D., Pace, A., & Burke, N. (2013). IDEA: A collaborative organizational design process integrating innovation, design, engagement, and action. *Systemic Practice and Action Research, 26*(3), 257-279.

Dede, C. (2010). Technological supports for acquiring 21st century skills. In E. Baker, B. McGaw, & P. Peterson (Eds.), *International encyclopedia of education* (3rd ed., pp. 158-166). Oxford, UK: Elsevier.

Deetz, S. (2000). Discipline. In: K. Grint (Ed.) *Work and society* (pp. 142-162). Cambridge, MA: Polity.

Design Tech High School. (n.d.). *Design thinking playbook.* Retrieved from https://dschool.stanford.edu/resources/design-thinking-playbook-from-design-tech-high-school

Doorley, S., Holcomb, S., Klebahn, P., Segovia, K., & Utley, J. (2018). *Design thinking bootleg.* Santa Clara, CA: Hasso Plattner Institute of Design at Stanford.

Drexler, W. (2010). The networked student model for construction of personal learning environments: Balancing teacher control and student autonomy. *Australasian Journal of Educational Technology, 26*(3).

Duffy, F. M. (2005). *Power, politics, and ethics in school districts: Dynamic leadership for systemic change*. Lanham, MD: Rowman & Littlefield Education.

Evans, R. (1996). *The Human side of school change: Reform, resistance, and the real-life problems of innovation*. San Francisco, CA: Jossey-Bass.

Farley-Ripple, E., May, H., Karpyn, A., Tilley, K., & McDonough, K. (2018). Rethinking connections between research and practice in education: A conceptual framework. *Educational Researcher, 47*(4), 235-245.

Fong, B., Lo, M. F., & Ng, A. (2015). Healthy use of internet for personal knowledge management: An interventionist approach in tertiary education. In *ICICKM - 12th international conference on intellectual capital knowledge management & organisational learning*. Bangkok, Thailand: Academic Conferences and Publishing Ltd.

Foucault, M. (1974). Excerpt from *The eye of power*. Retrieved from: http://foucault.info/documents/foucault.eyeOfPower.en.html

Freeland, E. (1999). Educational reform and the English schools of Québec. *McGill Journal of Education, 34*(003).

Friesen, S., & Jardine, D. (2009). 21st century learning and learners. *Prepared for Western and Northern Canadian Curriculum Protocol by Galileo Educational Network*.

Fullan, M. (1993). *Change forces: Probing the depth of educational reform.* London, UK: Falmer Press.

Fullan, M. (2011). *The six secrets of change: What the best leaders do to help their organizations survive and thrive*. San Francisco, CA: John Wiley & Sons.

Fullan, M. (2016). *Indelible leadership: Always leave them learning*. Thousand Oaks, CA: Corwin Press.

Fullan, M., & Hargreaves, A. (Eds.). (2009). *Change wars*. Bloomington, IN: Solution Tree.

Gallagher, A., & Thordarson, K. (2018). *Design thinking for school leaders: Five roles and mindsets that ignite positive change*. Alexandria, VA: ASCD.

Gallagher, C.A. (2003). Color-blind privilege: The social and political functions of erasing the color line in postrace America. *Race, Class and Gender, 19*(94), 1–17.

Goldstein, B., & Butler, W. (2010). Expanding the scope and impact of collaborative planning. *Journal of the American Planning Association, 76*(2), 238-249.

Gronn, P. (2008). The future of distributed leadership. *Journal of Educational Administration, 46*(2), 141–158.

Gunter, H. (2009). Critical approaches to leadership in education. *The Journal of Educational Enquiry, 2*(2).

Hafner, C. A. & Miller, L. (2011). Fostering learner autonomy in English for Science: A collaborative digital video project in a technological learning environment. *Language Learning & Technology, 15*(3), 68–86.

Halford, S, & Leonard, P. (2001). *Gender, power and organizations*. Basingstoke, UK: Palgrave.

Hargreaves, A. (2005). Educational change takes ages: Life, career and generational factors in teachers' emotional responses to educational change. *Teaching and Teacher Education, 21*(8), 967-983.

Hargreaves, A. P., & Shirley, D. L. (Eds.). (2009). *The fourth way: The inspiring future for educational change*. Thousand Oaks, CA: Corwin Press.

Hargreaves, A., Lieberman, A., Fullan, M., & Hopkins, D. (Eds.). (2010). *Second international handbook of educational change*. Dordrecht, Netherlands: Springer.

Hargreaves, D. (2007). *System re-design – The road to transformation*. London, UK: SSAT

Harris, A. (2008). *Distributed leadership in schools: Developing the leaders of tomorrow*. London, UK: Routledge & Falmer Press.

Hatcher, R. (2005). The distribution of leadership and power in schools. *British Journal of Sociology of Education, 26*(2): 253–267.

Hickling-Hudson, A., & Klees, S. J. (2012). Alternatives to the World Bank's strategies for education and development. In *The World Bank and education* (pp. 209-226). Rotterdam, Netherlands: Springer.

hooks, bell (2009). *Teaching critical thinking: Practical wisdom*. New York, NY: Routledge.

Howell, L. (2017). *Reconciliation in action and the community learning centres of Québec: The experiences of teachers and coordinators engaged in First Nations, Inuit and Métis social justice projects.* (Doctoral dissertation, University of Ottawa).

IDEO, D. K. (2015). The field guide to human-centered design. Retrieved from https://www.ideo.com/

IDEO. (2014). Designing a school system from the ground up. Retrieved from https://www.ideo.com/case-study/designing-a-school-system-from-the-ground-up

Johnson, S. M., et al. (2004). *Finders and keepers: Helping new teachers survive and thrive in our schools*. San Francisco, CA: Jossey-Bass.

Kangas, K., Seitamaa-Hakkarainen, P., & Hakkarainen, K. (2013). Design thinking in elementary students' collaborative lamp designing process. *Design and Technology Education: An International Journal, 18*(1).

Khalideen, R. (2015). Leading in the 21st century learning environment. In S.E. Elliott-Johns (Ed.), *Leadership for change in teacher education* (pp. 43-47). Rotterdam, Netherlands: Sense Publishers.

Koh, J. H., Chai, C. S., & Wong, B. (2015b). *Design thinking for education: Conception and applications in teaching and learning.* Singapore, Singapore: Springer.

Koh, J. H., Chai, C. S., Benjamin, W., & Hong, H. Y. (2015a). Technological Pedagogical Content Knowledge (TPACK) and design thinking: A framework to support ICT lesson design for 21st century learning. *The Asia-Pacific Education Researcher, 24*(3), 535-543.

Kolko, J. (2010). Abductive thinking and sensemaking: The drivers of design synthesis. *Design Issues, 26*(1), 15-28.

Köppen, E., & Meinel, C. (2015). Empathy via design thinking: Creation of sense and knowledge. In *Design thinking research* (pp. 15-28). Cham, Switzerland: Springer.

Kouprie, M., & Visser, F. S. (2009). A framework for empathy in design: Stepping into and out of the user's life. *Journal of Engineering Design, 20*(5), 437-448.

LEARN. (2017). NEXTschool: Learning – decompartmentalized. Montreal QC: LEARN.

Leifer, L., Plattner, H., & Meinel, C. (Eds.). (2013). *Design thinking research: Building innovation eco-systems.* Cham, Switzerland: Springer Science & Business Media.

Leithwood, K. (1992a). Principal development and teacher development. In M. Fullan, & A. Hargreaves (Eds.), T*eacher development and educational change*. Lewes, UK: Falmer Press.

Leithwood, K. A. (1992b). The move toward transformational leadership. *Educational Leadership, 49*(5), 8-12.

Leithwood, K., Harris, A., & Hopkins, D. (2008). Seven strong claims about successful school leadership. *School Leadership and Management, 28*(1), 27-42.

Lenoir, Y., & Hasni, A. (2010). Interdisciplinarity in Québec schools: 40 years of problematic implementation. *Issues in Integrative Studies, 28,* 238-294.

Levitan, J. (2018). The danger of a single theory: Understanding students' voices and social justice in the Peruvian Andes. *Teachers College Record, 120*(2).

Levitan, J. (2019). Incorporating participant voice in culturally responsive leadership: A case study. *Leadership and Policy in Schools.* doi.org/10.1080/15700763.2019.1585546

Levitan, J., & Carr-Chellman, D. (2018). Learning, selfhood, and pragmatic identity theory: Towards a practical and comprehensive framework of identity development in education. *Journal of Educational Thought. 51*(2).

Levitan, J., & Johnson, K. M. (2020). Salir adelante: Collaboratively developing culturally-grounded curriculum with marginalized communities. *American Journal of Education, 126*(2). https://doi.org/10.1086/706921

Liedtka, J., Azer, D., & Salzman, R. (2017). *Design thinking for the greater good: Innovation in the social sector.* New York, NY: Columbia University Press.

Luka, I. (2014). Design thinking in pedagogy. *Journal of Education Culture and Society, 2*,63-74.

Luke, A. (2018). *Critical literacy, schooling and social justice: The selected works of Allan Luke.* New York, NY: Routledge.

Lumby, J. (2013). Distributed leadership: The uses and abuses of power. *Educational Management Administration & Leadership, 41*(5), 581-597.

Lumby, J., & Foskett, N. (2011). Power, risk, and utility: Interpreting the landscape of culture in educational leadership. *Educational Administration Quarterly, 47*(3), 446-461.

MacBeath, J., Oduro, G.K.T. & Waterhouse, J. (2004). Distributed leadership in action: A study of current practice in schools. Nottingham, UK: NCSL. Available at: http://www.nationalcollege.org.uk/distributed-leadership-in-action-report.pdf

Maxcy, S. J. (1991). *Educational leadership: A critical pragmatic perspective.* New York, NY: Bergin & Garvey.

McTighe, J., & Seif, E. (2010). An implementation framework to support 21sr century skills. In J. Bellanca & R. Brandt (eds.), *21st century skills: Rethinking how students learn* (pp. 149-172). Bloomingdale, IN: Solution Tree Press.

Ministère de l'Éducation du Québec. (1992). Joining forces: Plan of action on educational success. Québec, QC: Gouvernement du Québec.

Mitra, D. (2003). Student voice in school reform: Reframing student-teacher relationships. *McGill Journal of Education, 38*(002).

Mukhopadhyay, R. & Sriprakash, A. (2011). Global frameworks, local contingencies: Policy translations and education development in India. *Compare: A Journal of Comparative and International Education, 41*:3, 311-326.

Munroe, E., Borden, L., Murray Orr, A., Toney, D., & Meader, J. (2013). Decolonizing Aboriginal education in the 21st century. *McGill Journal of Education, 48*(2), 317-337.

National College of School Leadership (NCSL) (2011). The importance of distributed leadership. Available at: http://www.nationalcollege.org.uk/print/index/interactiveinfo.htm?id.146274

OECD. (2011). Improving school leadership policy and practice: Pointers for policy development. Available at: http://www.oecd.org/education/preschoolandschool/49847132.pdf

Ontario Ministry of Education. (2014). *21st century teaching and learning: What research tells us*. Ottawa, ON: Government of Ontario.

Partnership for 21st century learning. (2014). *Framework for 21st century learning*. Retrieved from http://www.p21.org/our-work/p21-framework

Partnership for 21st century learning. (n.d.). The intellectual and policy foundations of the 21st century skills framework. Washington, DC: Partnership for 21st Century Learning. Retrieved from: http://www.p21.org/storage/documents/docs/Intellectual_and_Policy_Foundations.p

Plattner, H., Meinel, C., & Leifer, L. (Eds.). (2014). Design thinking research: Building innovators. Cham, Switzerland: Springer.

Potvin, P., & Dionne, E. (2007). Realities and challenges of educational reform in the province of Québec: Exploratory research on teaching science and technology. *McGill Journal of Education, 42*(3).

Robinson, K., & Aronica, L. (2016). *Creative schools: The grassroots revolution that's transforming education.* New York, NY: Penguin Books.

Rubinstein, S. A., & McCarthy, J. E. (2014). *Teachers unions and management partnerships: How working together improves student achievement.* Washington, DC: Centre for American Progress.

Russell, M. (2018). *An Analysis of the Québec history examination: Validity and historical thinking.* (Doctoral dissertation, University of Ottawa).

Scheer, A., Noweski, C., & Meinel, C. (2012). Transforming constructivist learning into action: Design thinking in education. *Design and Technology Education: An International Journal, 17*(3).

Schleicher, A. (2012). *Preparing Teachers and Developing School Leaders for the 21st Century: Lessons from around the World,* OECD Publishing.Retrieved from *http://dx.doi.org/10.1787/9789264xxxxxx-en*

Schleicher, A. (2014). *The case for 21st-century learning*. Retrieved from http://www.oecd.org/general/thecasefor21st-centurylearning.htm

Schleicher, A. (2015). *Schools for 21st century learners: Strong leaders, confident teachers, innovative approaches*. International Summit on the Teaching Profession, OECD Publishing. DOI: 10.1787/9789264231191

Schnurer, M. & Hahn, L. K. (2009). Accessible artifact for community discussion about anarchy and education. In R. Amster, A. DeLeon, L. A. Fernandez, A. J. Nocella, & D. Shannon (Eds.), *Contemporary anarchist studies: An introductory anthology of anarchy in the academy* (pp. 147-158). New York, NY: Routledge.

Seashore, L.K., Mayrowetz, D., Smiley, M. & Murphy, J. (2009). The role of sense making and trust in developing distributed leadership. In Harris, A. (ed.) *Distributed leadership: Different perspectives*. London, UK: Springer.

Senge, P. M. (2006). *The fifth discipline: The art and practice of the learning organization* (2nd Ed.), New York, NY: Doubleday/Currency

Sergiovanni, T. (2000). *The lifeworld of leadership: Creating culture, community and personal meaning in schools.* San Francisco, CA: Jossey-Bass.

Simpson, J.L. (2008). The color-blind double bind: Whiteness and the (im)possibility of dialogue. *Communication Theory, 18*, 139–159.

Smith, M., & O'Day, J. (1990). Systemic school reform. *Journal of Education Policy, 5*(5), 33-267. doi:10.1080/02680939008549074

Stanford d. School. (n.d.). Retrieved from https://dschool.stanford.edu/

Stroh, D. P. (2015). *Systems thinking for social change: A practical guide to solving complex problems, avoiding unintended consequences, and achieving lasting results.* White River Junction, VT: Chelsea Green Publishing.

Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times*. San Francisco, CA: Jossey-Bass

Tuck, E., & Yang, K. W. (2013). Thinking with youth about theories of change. In Tuck, E., & Yang, K. W. (Eds.), *Youth resistance research and theories of change* (pp. 125-138). New York, NY: Routledge.

Vähäsantanen, K. (2015). Professional agency in the stream of change: Understanding educational change and teachers' professional identities. *Teaching and Teacher Education, 47*, 1-12.

Voogt, J., Laferrière, T., Breuleux, A., Itow, R. C., Hickey, D. T., & McKenney, S. (2015). Collaborative design as a form of professional development. *Instructional Science, 43*(2), 259-282.

Waugh, R. F., & Punch, K. F. (1987). Teacher receptivity to system-wide change in the implementation stage. *Review of Educational Research*, 57(3), 237-254.

Wiener, M. (1999). Québec teachers: Submerged in a sea of reform. *McGill Journal of Education, 34*(003).

Woods, P., Bennett, N., Harvey, J., & Wise, C. (2004). Variabilities and dualities in distributed leadership. *Educational Management Administration & Leadership, 32*(4), 439-457.

Yamamoto, J., Ananou, S. & Sindlinger, J. (2013). Internet addiction: Research trends and directions for further study. In J. Herrington, A. Couros & V. Irvine (Eds.), *Proceedings of EdMedia 2013 world conference on educational media and technology* (pp. 2389-2393). Victoria, Canada: Association for the Advancement of Computing in Education (AACE).

Yu, H., Leithwood, K., & Jantzi, D. (2002). The effects of transformational leadership on teachers' commitment to change in Hong Kong. *Journal of Educational Administration, 40*(4), 368-389.

Zajda, J., & Rust, V. (Eds.). (2010). *Globalisation, policy and comparative research: Discourses of globalisation* (Vol. 5). Los Angeles, CA: Springer Science & Business Media.

MENTAL PERTURBANCE: AN INTEGRATIVE DESIGN-ORIENTED CONCEPT FOR UNDERSTANDING REPETITIVE THOUGHT, EMOTIONS AND RELATED PHENOMENA INVOLVING A LOSS OF CONTROL OF EXECUTIVE FUNCTIONS

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Abstract

Understanding intrusive mentation, rumination, obsession, and worry, known also as "repetitive thought" (RT), is important for understanding cognitive and affective processes in general. RT is of transdiagnostic significance—for example obsessive-compulsive disorder, insomnia and addictions involve counterproductive RT. It is also a key but under-acknowledged feature of emotional episodes. We argue that RT cannot be understood in isolation but must rather be considered within models of whole minds and for this purpose we suggest an integrative design-oriented (IDO) approach. This approach involves the design stance of theoretical Artificial Intelligence (the central discipline of cognitive science), augmented by systematic conceptual analysis, aimed at explaining how autonomous agency is possible. This requires developing, exploring and implementing cognitive-affective-conative information-processing architectures. Empirical research on RT and emotions needs to be driven by such theories, and theorizing about RT needs to consider such data. Mental perturbance is an IDO concept that, we argue, can help characterize, explain, and theoretically ground the concept of RT. Briefly, perturbance is a mental state in which motivators tend to disrupt, or otherwise influence, executive processes even if reflective processes were to try to prevent or minimize the motivators' influence. We draw attention to an IDO architecture of mind, H-CogAff, to illustrate the IDO approach to perturbance. We claim, further, that the intrusive mentation of some affective states— including

grief and limerence (the attraction phase of romantic love) — should be conceptualized in terms of perturbance and the IDO architectures that support perturbance. We call for new taxonomies of RT and emotion in terms of IDO architectures such as H-CogAff. We point to areas of research in psychology that would benefit from the concept of perturbance.

Keywords: repetitive thought, emotions, executive functions, cognitive architectures, autonomous agents, affective computing

Mental Perturbance: An Integrative Design-Oriented Concept for Understanding Repetitive Thought, Emotions and Related Phenomena Involving a Loss of Control of Executive Functions

> I hope that moving toward a general theory of motivation will help psychology as a whole acknowledge and embrace the fundamental importance of motivation in the grand scheme of integrative psychological theory. (Baumeister, 2015, p. 9)

This paper discusses an important type of human mental state, dubbed *perturbance* (Beaudoin, 1994), which is defined in *integrative design-oriented* (IDO) terms. Perturbance is a mental state in which *insistent* motivators or alarms distract or otherwise influence executive processes in a manner that is difficult for reflective processes to suppress or control. The concept of perturbance provides a rich, design-oriented way of understanding some of the attentional aspects of emotion-like states, wherein an autonomous agent, with a certain type of computational architecture, is subject to loss of control of its deliberative processes. We claim that the concept of perturbance can theoretically unify many important mental phenomena that are characterized by repetitive thought (RT), such as worry (Watkins, 2008), obsessions (Macatee et al., 2015), and emotional episodes involving intrusive mentation (Sloman, 1987). This paper also claims and subsequently illustrates our claim that the IDO approach can shed light on multiple phenomena, which is indeed that necessary for a complete understanding of the minds of autonomous agents, be they natural or artificial.

Sloman and Croucher (1981a, 1981b) claimed that future robots will exhibit human-like emotional mentation not because emotional mechanisms were explicitly implemented in them, but as a necessary emergent *biproduct* of interacting information-processing mechanisms that are designed to meet requirements that would later be referred to as requirements of autonomous agents (Beaudoin & Sloman, 1993; Beaudoin, 1994; Thórisson & Helgasson, 2012). The Cognition and Affect (CogAff) project was launched in 1991 to better understand the requirements of autonomous agents, and the space of real and possible minds that meet, or would meet, these requirements. See Sloman (2008a) for a review. This paper builds on that project, extending and adapting its methodology and theory.

The concept of perturbance does not stand alone. It is grounded in the specification of information-processing architectures resulting from an IDO approach to understanding possible and actual minds. This means that one cannot specify the concept of perturbance, or adequately study it empirically, without familiarity with IDO. This approach, as we shall see, contrasts with what Watkins (2008) claims is the scientific allure of the concept of repetitive thought, namely that it is an *atheoretical* concept. Physicists acknowledge that even empirical constructs are deeply theoretical (Lakatos, 1980) —even speed is a theoretical concept specified in relation to other concepts. The theoretical richness of the concept of perturbance, the difficulty of the IDO methodology, and the fact that few researchers pursue the IDO approach might explain why the concept of perturbance has largely been overlooked in psychology.

One of the main objectives of this paper is to whet its readers' appetite for the IDO approach by making them curious about its potential for unifying many literatures with the concept of perturbance and the theory on which it depends. However, the ambitiousness of the IDO approach also presents the chief difficulty of this paper: to concisely explain a complex, old (in relation to the history of computational psychology) yet still nascent, computational research program.

Accordingly, we begin by describing the IDO approach and a class of IDO agent architectures (H-CogAff) that were developed with the aim of supporting the requirements of autonomous agency. We then summarize an argument according to which certain classes of agents, natural or robotic, will *necessarily* be subject to perturbance as an *emergent* phenomenon. We then describe two major classes of 'emotional' phenomena that may be understood as involving perturbance, namely grief and limerence. We then do a quick survey of other psychological phenomena which, we argue, need to be understood in terms of perturbance.

The integrative design-oriented (IDO) Research approach

The IDO approach recognizes Artificial General Intelligence as the general science of intelligence, proceeding primarily from the 'designer stance' (McCarthy, 2008; Sloman, 2008b; Sloman, 1993). From the *designer stance,* one seeks to understand the environmental niches in which the systems one seeks to explain will operate. One specifies the requirements said systems will satisfy. Then, one explores a set of possible designs that are intended to satisfy the requirements. One then seeks to implement the designs in working systems (simulated and real environments), minding the possibility of different implementations. The result of each stage should be analysed in relation to the previous stage, such as the extent to which the implementations matches the design. The entire procedure is iterative. The designer stance is more concerned with the specification and explanation of competence than with prediction. One should resist the urge to jump prematurely to predictions. IDO theories can be more or less agentic, i.e., deal more or less specifically with the requirements of autonomous agency. For instance, the theory presented here is quite agentic. The somnolent information processing theory (Beaudoin, 2014c; Beaudoin et al. 2019; Lemyre, Belzile, Landry, Bastien, & Beaudoin, 2020), while addressing the sleep onset control system in an IDO manner is less agentic: it deals with specific functions which, while grounded in a broader, agentic IDO theory, are essential to autonomous agency (adaptively controlling the onset of sleep).

The definition and requirements specification of autonomous agency are themselves theoretical. Following Sloman and Croucher (1981a, b), Beaudoin (1994) and Hawes (2011), we posit that autonomous agents have multiple top level complex motives; they operate under real-time and (physical and processing) resource constraints in a rapidly changing and partially unpredictable world that they cannot fully control, and which is not necessarily friendly to their motives. They can generate their own top-level and derivative motives, and are capable of pursuing them. From these abstract specifications of autonomous agency many implications

follow, such as limited parallelism of high level 'management' functions (Beaudoin,1994; Simon, 1967) and the possibility of perturbance, the main topic of this paper.

IDO theories are integrative in two main ways. First, fundamental IDO theories must specify a broad collection of information processing functions, towards the design of relatively complete agents. This means that the theories will specify many 'cognitive', 'conative' (motivational), 'affective', 'executive' and ancillary functions. Whereas it is often assumed that there is a sharp boundary between cognitive and affective functions, which at most *interact*, in IDO systems mechanisms can be both cognitive and affective (Beaudoin, 1994, 2014a; Pessoa, 2008, 2013; Sloman & Croucher, 1981; Sloman, 1989; Todd, 2020). It is noteworthy that recent arguments in favor of modularity of vision (Firestone & Scholl, 2016) is based largely on criticisms of 'top down' theories of perception and criticizing empirical paradigms that were purported to produce illusions, biases and errors that do not replicate. We would agree with those criticisms. However, a third design class of designs (apart from sharp 'top down' vs. 'bottom up' modular designs) is possible: Sloman (1989) argues that perception is not modular but labyrinthine, with many inputs and outputs. Beaudoin (1994) discusses several types of *valenced* perception and knowledge, including the perception of threats and opportunities as such. The perception and computation of valence may be blended.

This type of integration, which we call *functional* integration, typically calls for information processing (computational) architectures. The expression 'computational architecture' seems to have been introduced in the Artificial Intelligence (AI) literature by Sloman (1978). The computational architectures proposed in cognitive science are typically *cognitive* architectures (Cooper, 2007; Newell, 1990; Rosenbloom, Demski, & Ustun, 2016), which are not concerned with the requirements of autonomous agency. For example, they do not necessarily deal with affective considerations and multiple sources of motivation with real-time constraints. While purely cognitive architectures are not truly IDO models, they are an important starting point in understanding computational architectures, particularly since their simpler requirements facilitate computational implementation and analysis. Below we briefly present H-CogAff, which is an IDO architecture developed by Sloman and colleagues (Sloman, 2003, 2011).

Secondly, IDO theories will typically be integrative in the more traditional sense that they combine multiple theories. Moors (2017) presents such an integrative theory, which combines theories and proposes a simple architecture. Not fully an IDO theory as it is exclusively developed from an empirical perspective rather than from the design-stance, it is nevertheless relevant to agentic IDO research.

In the IDO approach one aims to understand real and possible minds in an authentically interdisciplinary manner. This involves the disciplines traditionally associated with cognitive science (computer science and AI, philosophy, psychology, neuroscience, biology, linguistics, anthropology and education). The IDO approach aligns with the grand program of cognitive science as "the interdisciplinary study of mind, informed by theoretical concepts drawn from computer science and control theory" (Boden, 2008, p. 12).

It is important to emphasize a particularly important set of techniques drawn from philosophy, namely conceptual analysis, that aim to make explicit and exploit the rich knowledge built into human language and conception. Conceptual analysis is not to be confused with the factor analytic approach (Osgood, Suci, & Tannenbaum, 1957) which is central to many empirical theories of affect, such as the component process model (Fontaine, Scherer, & Soriano, 2013) and core affect psychological construction theory (Russell, 2003). Those theories capture some of the actual usage of terms, i.e., the *logical geography* of conceptual space, whereas conceptual analysis may go beyond actual usage to explore the space of possible concepts, i.e., *logical topology* (Sloman, 2010). As Ortony, Clore and Foss (1987) suggest, conceptual analysis should be done before factor analysis is performed; but it often is not; and in fact, conceptual analysis is not traditionally taught in education or psychology programs. Albert Einstein used conceptual analysis of space and time in developing the theory of relativity (Disalle, 2006). We claim he could not have produced his theory based on factor analysis. Several authors have articulated the need for conceptual analysis in understanding actual and possible minds, and provided tips for this process (Sloman, 1978; Ortony, Clore, & Foss, 1987; Beaudoin, 1994, 2014). A conceptual analysis of motivators and goals presented by Beaudoin (1994) underpins our theory of autonomous agency and perturbance. That analysis, which to our knowledge is the most detailed theoretical specification of goals and motives, illustrates that the lines between engineering, philosophy and science are blurred — the conception of goals presented there includes insights from all three approaches. For other specifications of the concept of goal, see Boden (1978), Moors & Fischer (2018), Pervin (1989), Higgins (2011), Huang & Bargh (2015), and Toomey (1992).

The IDO approach ultimately requires specifying its models in terms of virtual machinery (Sloman, 2002). However, this paper does not delve into that aspect of mind. Readers who do not understand or are not convinced by the relevance of a design-oriented approach to understanding real and possible minds might not be sufficiently illuminated by the brief defense of this approach that this paper provide. We would like at least to single out one of the purposes of this approach, which is also an argument for the pertinence of AI to psychology, namely that "The problem is not that we do not know which theory is correct, but rather that we cannot construct any theory at all which explains the basic facts" (Power, 1979 pp. 109). For instance, one can select a random theory of emotion and ask oneself: can this theory be used as a design for a working system that explains behavior? If the answer is 'no', then the theory is incomplete or incorrect. To answer the essential question requires taking the design stance. One of the earliest and still pertinent books on the relevance of AI to explaining autonomous agency is Boden (1978). The approach is also helpfully explained and justified in Boden (1987, 1988, 1989, 2006), Dennett (1994), Marcus & Davis (2019), Minksy (1985) and Sloman (1978, 1993).

H-CogAff: An Autonomous Agent Architecture

The concept of perturbance emanated from a design-oriented research program that proposed a class of mental architectures (CogAff schema) whose subclass, H-CogAff, is the

backdrop of this paper (Sloman, 2008a). H-CogAff is designed to meet the human autonomous agency requirements as specified above. In Figure 2, the CogAff schema is depicted based on (Sloman, 2008a).

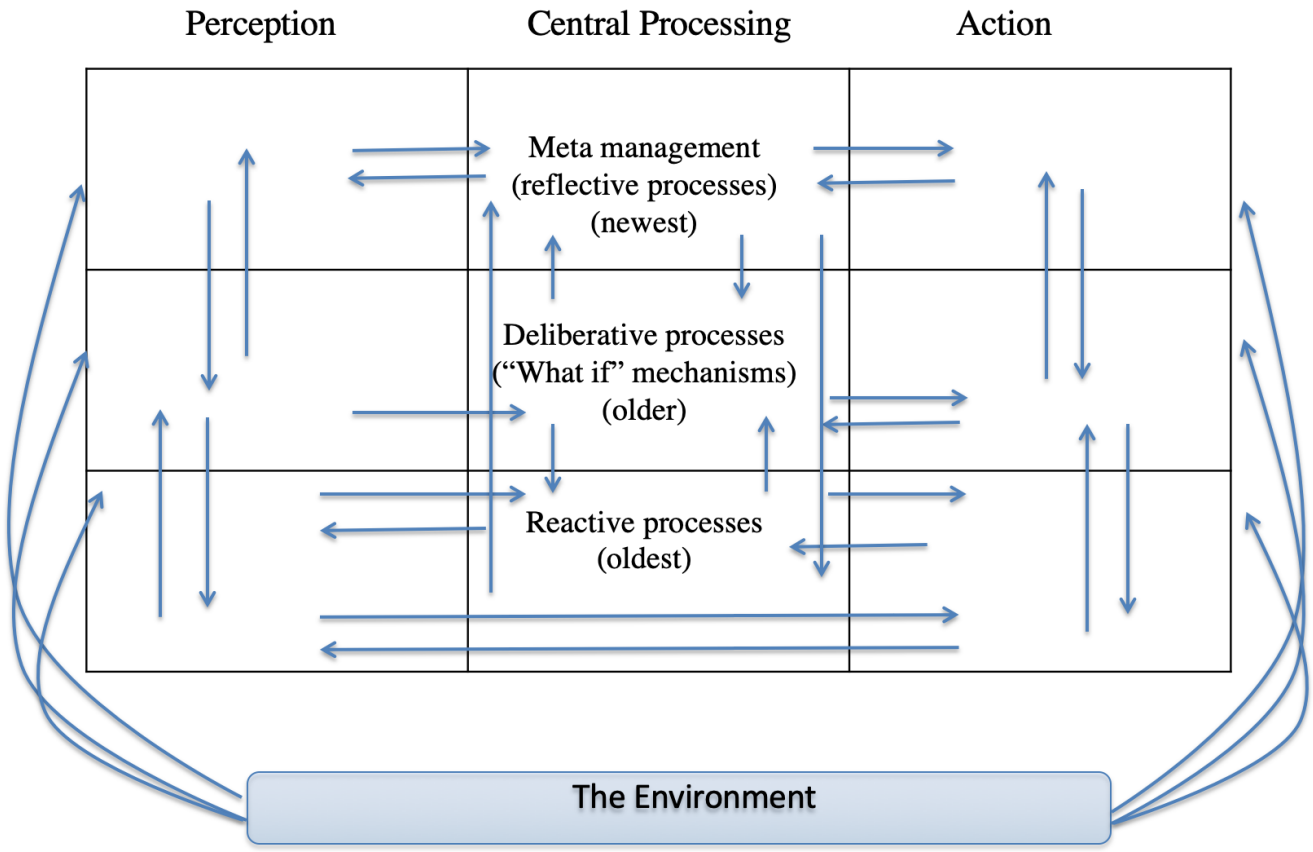

Figure 1. CogAff schema adapted from Sloman (2008a).

In Figure 2, a sketch of H-CogAff is presented, again based on Sloman (2008a). The middle layer in this diagram is dubbed 'management processes', in line with Beaudoin (1994) and Wright, Sloman & Beaudoin (1996), and its functions are slightly generalized compared to Sloman (2008a).

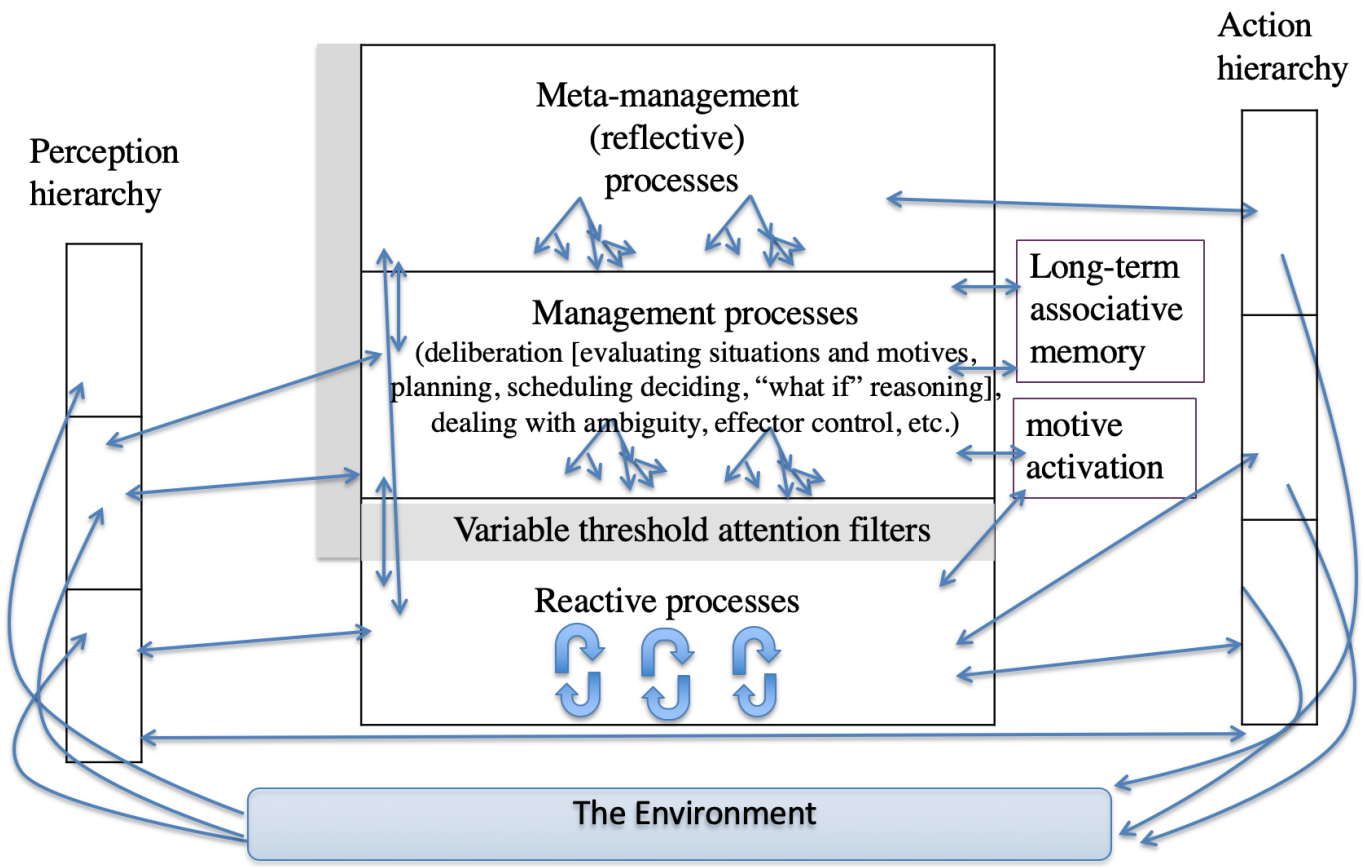

Figure 2. H-CogAff architecture diagram adapted from (Sloman, 2008a).

The highly internally connected H-CogAff architecture includes *reactive* mechanisms for perceiving and affecting the environment, creating and activating motivators in real-time, and generating alarms, all of which happens asynchronously from executive processes. The simplified architecture diagram is neither meant to imply sharp discontinuities between functions nor correspondence between function and biological layers.

We define motivators as an extension of Sloman (1992) definition of affective states, namely as (a) dispositional control states (long term and short term) that: (b) exist at various levels in a control hierarchy, (c) include positive or negative evaluations of something, (d) have at least a tendency to distract executive functions, (e) produce or trigger explicit motives, which in turn, (f) have a tendency to influence behaviour. We view the three forms of subjective value discussed in Ortony, Clore & Collins (1988) (goals, standards, and attitudes) as motivators. Here we use goals and motives interchangeably. In this paper motivators are states of a virtual machine (Sloman, 2002), rather than the external objects (such as foods) that may indirectly trigger them and to which they might refer. We realize these recursive concepts make communication difficult, but software can produce and process recursive representations, and so can the minds we are trying to understand.

In this article, we are chiefly concerned with motives, which specify or imply states towards which the agent has a motivational attitude (to make true, make false; make true faster, etc.), which are described in more detail below and great detail in Beaudoin (1994). Still, more precise and numerous concepts implemented in software will be required.

The H-CogAff architecture supposes two layers of higher-order mental processes which, to more closely align this model with psychology, we refer to as *executive* processes (Diamond, 2013). In so doing, we provide a way to understand some executive functions in terms of H-CogAff in particular and autonomous agent architectures more generally. The two executive layers are (1) *management* processes for interpreting situations and deliberating (e.g., evaluating motives, planning, scheduling, deciding, reasoning, problem solving, etc.), dealing with ambiguity, and various forms of motor control; and (2) *meta-management* processes (reflection and control of management processes). The meta-management layer could, for instance, postpone the consideration of a newly activated goal till some juncture, an example of deliberation scheduling. The reactive layer is more closely coupled to the environment than executive layers are; the latter can reason with contents of sensory memory, working-memory, short-term memory and long-term memory (Donald, 2001). The reactive layer is also more modular and more capable of parallel processing than the executive layer. Some reactive processes, however, can also respond to working memory contents.

Insistence Assignment and Motive Filtering

Given their limited parallelism, not every activated motive can be considered simultaneously by deliberative processes. Therefore, when a motive is generated or re-activated, there must be mechanisms, with similar computational constraints as reactive mechanisms have, that determine whether the deliberative processes may be interrupted (or otherwise influenced) by the motive. Therefore, H-CogAff architecture includes (a) insistence assignment mechanisms that *heuristically* assess the importance and urgency of motives as they are activated; (b) variable threshold filtering mechanisms which only allow a motive to *surface* (i.e., be considered by deliberative processes) if they are sufficiently insistent. For example, if a hungry autonomous agent that implements this architecture detects a rare opportunity to consume an energy source, a new motive to approach the source may be triggered. This motive will be assigned an insistence value that heuristically reflects its importance and urgency. However, for this motive to even be considered, it needs to be sufficiently insistent to penetrate the attention filter and interrupt current executive processing (and potentially behaviour). If the agent is under attack, its executive processes might not even notice its motive to approach the source of energy because the filter threshold will have been raised higher than the insistence level of the motive to approach the source of energy. Designing complex systems always involves trade-offs. Thus, it is impossible to design perfect insistence and filtering mechanisms. Because the purpose of insistence assignment is to protect the precious, resource-limited, deliberative processes, insistence mechanisms use rough and ready heuristics that do not involve deliberation. Sometimes, the agent will tend to be distracted by its own insistent motives even though it has

previously rejected them (e.g., to approach an appealing agent the pursuit of whom would violate its norms or other motives—conflicted robot or natural love.)

Whereas for simplicity the foregoing described insistence as a quantitative value and interrupt filtering as simply doing a numeric comparison between an insistence value and a global filter threshold, different forms of motivator filtering and attention switching or allocation are possible; insistence may be implicit rather than explicitly represented (Beaudoin, 1994). There could be different filtering criteria or rules for different objects and situations. For instance, one might learn to perceive certain situations as inherently dangerous to one's child, and implicitly perceived threats to one's child might become inherently capable of garnering management resources. Moreover, as discussed in the next section, interruption is not the only way in which motivators may *influence* executive functions; for instance motivators may consume executive resources, which some refer to as "attentional resources" (Pessoa 2013, Todd et al, 2020).

Computational Alarm Systems

Further addressing requirements of autonomous agency, and further accounting for psychological phenomena (such as aspects of 'emotional' and stress reactions), H-CogAff assumes mechanisms for generating and processing alarms. Alarms are control information-processing signals that have global effects in the architecture. At a physiological level, alarms can activate the sympathetic nervous system (Buck, 2014). We assume they can parameterize executive processes, such as leading to more vigilance, changing the level of abstraction of thinking, or make deliberation more or less careful. They may have other effects on management processes and "action readiness" that more precise formulations of the theory may specify.

The H-CogAff architecture distinguishes between 1) alarms triggered by perceptual information, such as an angry glare or the unexpected appearance of the object of one's infatuation; and 2) alarms triggered by noticing significant issues in executive layer content e.g., suddenly realizing a plan of action may have a disastrous side-effect (Sloman, 2003; Sloman, Chrisley & Scheutz, 2005).

Selye originally described stress as an *alarm reaction* (1936)—an idea that before the current paper had not been linked to computational alarms. Alarms have also (briefly) been posited in theories of consciousness (Baars & Franklin, 2009), emotion (Oatley, 1992) and pain (Eisenberger & Lieberman, 2004). We believe the IDO conception of alarms, modernizing Selye's concept (1936), is worthy of future IDO and empirical research.

Perturbance

Before specifying the concept of perturbance, it is relevant to consider its historical background. The *term* perturbance was introduced to the literature on emotion by Beaudoin (1994) to refer to the concept of emotion that was introduced by Sloman and Croucher (1981a, 1981b) and Sloman (1987, 1992. There was so much confusion and fruitless debate in emotion research about the proper meaning of 'emotion', Beaudoin proposed the term *perturbance* so that

researchers could focus not on what the term 'emotion' ought to mean in psychology and AI, but on the concept of perturbance and the theory that makes the concept relevant (Sloman, Beaudoin & Wright, 1994).

Sloman and Beaudoin used the term 'perturbance' in several publications (Sloman, Beaudoin & Wright, 1994; Wright, Sloman & Beaudoin, 1996; Beaudoin, 1994). But after Beaudoin left the field for a period of time, Sloman defined two new types of control states (named 'primary emotions and 'secondary emotions') and labeled 'perturbance' as 'tertiary emotion'. We are reintroducing the term 'perturbance' for the same reasons as before: a technical term better suites this unique and important concept. Similarly, we reject parlance of 'primary emotions' in favor of 'alarms'. Names do matter.

We are not alone to express concern about the plethora of concepts of emotion and to propose solutions. For instance, Izard (2010) survey of 34 emotion researchers found a wide variety of definitions of emotion. He suggested that "the topic of an abstract information-processing architecture for all mental functions [...] may be quite appealing to the growing number of scientists who postulate continuous interaction of emotion and cognition" (p. 368). The key idea of the concept of perturbance is that even if the reflective layer were to postpone consideration of an insistent motivator, the motivator still tends to penetrate the filter, consume some management resources, potentially distract management processes and or otherwise maintain control of executive processes. Perturbance is an emergent phenomenon. In fact, Sloman & Croucher (1981a, 1981b) claimed perturbance (which they called 'emotion') will emerge as side-effects in minds designed to meet the requirements of autonomous agency. They drew an analogy with thrashing in a computer operating system. One does not design a computer operating system to thrash. Thrashing is something that can emerge as a side-effect of needing to handle too many tasks with insufficient computational resources. Adaptiveness and function are attributes of the architecture and its constituent mechanisms. What *does* need to be designed into the system (by evolution, learning and or a designer) are mechanisms specified in the architecture (motive generators, insistence determiners, filters, executive processes, etc.) In that respect, perturbance is different from most concepts of emotion which assume that emotions serve a function.

The Component Process Model (Scherer, 2009) is another major computationally inspired model that claims emotion-like episodes are emergent. Its concept of emotion episodes differ from perturbance in several ways, one of which is that it necessarily involves a functional synchronization of major components (motivation, cognition, communication, experience, and physiological). Perturbance, in contrast, is an afunctional concept. Moreover, like Moors (2017), the CogAff model does not assume that in emotions (which we call 'perturbance') the agent enters in a stimulus-driven mode. Perturbance is a state in which executive functions are biased by and towards particular insistent motivators, though we allow for the possibility of alarms, discussed below, to be generated before a motivator is activated.

However, while perturbance is emergent and afunctional, it is of considerable adaptive significance because it is a modulation of executive processes. That which controls executive

functions controls the agent. Our focus as researchers and designers of autonomous agents interested in perturbance needs to be on the IDO of the mechanisms that give rise to adaptively meeting requirements of autonomous agents, how they may lead to perturbance, and how perturbance can be detected and dealt with. .

Simon (1967) developed the first influential computational (nearly IDO) theory of emotion known as the 'interrupt theory of emotion'. Noting the similarities and differences between perturbance and Simon's theory may help one to better understand Simon's theory and the concept of perturbance. This is particularly relevant because some emotion theorists, such as Scherer (1984), have summarily rejected Simon's interrupt theory without discussing the richer perturbance theory that improves upon Simon's theory. Simon's theory, like the perturbance theory, is based upon an analysis of the requirements of autonomous agency. They both emphasize the ability to activate, prioritize and pursue multiple motives. Simon (1967) assumes a highly serial central processor, whereas H-CogAff assumes more parallelism (e.g., between reflective and management processes). Simon's theory identifies emotions with interrupts of a central processor, whereas interruption is just one of the forms of perturbance. We envision that a CogAff design could be specified that includes continuously varying resources (Kruglanski et al, 2012; Pessoa, 2013), where deliberative and reflective processes could independently be consumed by different motivators. This means there are forms of perturbance (modulation of executive processes) that do not entail interruption. For instance, deliberation may be directed towards a certain goal, G, while another asynchronously activated motivator may consume some of the executive resources. This may affect deliberation about G without outright interrupting it. Insistent motivators may cause executive processes to proceed in a careful mode, more slowly or more quickly, as discussed in Sloman & Croucher (1981 a, b), or thinking may become more concrete or abstract. More generally, in perturbance a motive may *parameterize* executive functions. For instance, an asynchronously activated 'off task' motive may cause the agent to engage in social signaling (for instance to impress a potential mate or express sadness in grief). Simon's theory did not include the notion of insistence or dispositional control states. In comparing and contrasting Simon's work on motivation and emotion with ours, it is also worth noting that Simon (1967) was not explicit about computational architecture; moreover, his theory was focused on human information processing, rather than examining the space of possible minds.

Our characterization of perturbance has emphasized insistent *motivators*. However, there are two special cases that need to be considered with respect to perturbance. First, a motivator may be very insistent without being objectively or subjectively important, urgent (temporally pressing) or intense (driving behaviour). At the limit, a motivator could have zero importance, zero urgency and zero intensity and yet still be insistent. These dimensions are specified by Beaudoin (1994). An earworm would be an extreme example of this. This illustrates our claim that the distinction between cognition, emotion and affect is not sharp. Secondly, the concept of perturbance can be extended to apply to 'tertiary alarms' (Sloman, 2003), i.e., control signals that

disturb executive processes but unlike motivators do not necessarily contain semantic content (Oatley, 1992).

Moors (2017) described two sets of theories (psychological constructionism and dimensional appraisal) and her own, each of which deny the usefulness of the concept of emotion as a control *mechanism* while maintaining the concept of emotional *episodes*. She proposes that to understand emotional episodes one must provide an architecture-based theory of all kinds of behavior that involves both motivated and stimulus-driven mechanisms, where the architecture is biased towards goal-directed behavior, and where emotional episodes involve a goal-directed mechanism. Whereas Moors (2017) did not mention the CoffAff project, those postulates were also central to the theory of perturbance Sloman, 1981, 1987, 1992; Sloman, Beaudoin & Wright, 1994; Wright, Sloman & Beaudoin, 1996). For instance, the theory of perturbance also originates in an attempt to explain behavior. Mental perturbance, also, is not a mechanism but an emergent (episodic) state of a mental architecture involving insistent motivators. Reactive mechanisms in H-CogAff parallel 'stimulus' driven ones in her model. In addition to other similarities that space precludes us discussing here there are also several differences between Moors (2017) and the theory of perturbance. Moors (2017) has related her theory in more detail to psychology with a focus on experimentation and prediction, whereas work on perturbance and CogAff more generally has been more concerned with accounting for a broad spectrum of motivated competence.

The potential of a theory of perturbance for psychology derives partly from the IDO research approach that gave rise to it. This stance can help address a deep issue that surrounds psychology's "replication crisis" (Maxwell, Lau & Howard, 2015; Muthukrishna & Henrich, 2019), which is focusing too narrowly on *predicting* behaviour rather than *explaining* competence (Sloman, 2008; McCarthy, 2008). We call for (1) a better explicit characterization of human capabilities (competence), an exploration of mental architectures (designs), and implementations (Sloman, 1993); and (2) empirical research driven by unified theories of mind (Newell, 1990; Wells & Mathews, 1994). Cognitive architectures, still not prominent enough in psychology, require more attention, while motivational and affective processes require more consideration in computational architectures in psychology.

Two Common Classes of Perturbance

Let us briefly consider two types of perturbance that can, even without pathology, last for long periods of time and that have been overlooked by leading general theories of affect (Russell, 2009 ; Scherer, 2005 ; Moors, 2017), namely grief and limerence. These two states do not fit neatly in psychological theories that assume emotions are brief, lasting at most a few hours (Scherer, 2005; Verduyn & Lavrijsen, 2014; Verduyn et al, 2015). In contrast, grief and limerence (like many other perturbances) can last for weeks and months, without being pathological. As these examples illustrate (and the specification of the concept makes clear), perturbances are not moods, affect dispositions, preferences or interpersonal stances (the other categories described in emotion theories (Scherer, 2005). They involve insistent mental content

that tends to come to mind, even without proximal evaluations assumed by appraisal theories (activation and triggering of prior motives is often a better conceptualization than appraisal), regardless of our decisions to postpone their consideration.

Grief. When grieving, one tends to be assailed by memories and motives pertaining to the lost one. Wright, Sloman and Beaudoin (1996) offered a design-oriented reinterpretation of experienced episodes in terms of perturbance which was illustrated by a case study of grief. They claimed grief is (often) "an extended process of cognitive reorganization characterized by the occurrence of negatively valenced perturbant states caused by an attachment structure reacting to news of the death." (Wright, Sloman & Beaudoin, 1996, pp. 31). That theory addresses important questions such as: Why does grief consume the mourner? Reasons could be that executive processes have limited capacity and become swamped by highly insistent motives generated by a structure of attachment to a highly valued individual; in addition, re-learning and detachment require extensive rumination, which can maintain perturbance.

Limerence. The nearly universal attraction phase of romantic love is technically known as *limerence* (Reynolds, 1983; Tennov, 1979). It is noteworthy that whereas psychologists, as mentioned above, cannot agree on how emotion should be construed scientifically (Moors, 2017), let alone that it involves perturbance, those who study romantic love seem to agree that a necessary and defining feature of limerence is repetitive and intrusive thinking about the limerent object (Fisher, 1998; Reynolds, 1983; Tennov, 1979).

Limerence is of evolutionary significance as it enhances the likelihood of mating—and, in m dost cultures, of attaching to the limerent object, which helps offspring survive (Fisher, 1998). While it may be tempting to cast limerence as a pathological form of romantic love (Reynaud, Karila, Blecha & Benyamina, 2010; Wakin & Vo, 2008), this would distort the original and common academic conception of limerence (van Steenbergen, Langeslag, Band & Hommel, 2013). This would also overlook the near universality and evolutionary significance of the experience. Like other long-term affective states, limerence involves several continua, including intensity (Hatfield & Sprecher, 1986), and may or may not be pathological. We believe the casting of limerence as pathological should be resisted by scholars; instead other terms should be used to describe pathological limerence. We also recommend that scientific literature on the intrusive mentation aspect of attraction converge on the term 'limerence', to help focus research attention, and conceptualization, and to help shape popular psychology.

Perturbance, more generally, is diminishment of the already limited human capacity to control one's own attention with respect to a particular cluster of motives. Consider a limerent's diary entry "This obsession has infected my brain. I cannot shake those constantly intruding thoughts of you. Every thought winds back to you no matter how hard I try to direct its course in other directions." (Tennov, 1979 p. 49). Thus, a key feature of limerence is that meta-management processes cannot easily suppress motives nor prevent them from holding one's attention once they surface. Deliberation scheduling fails systematically in perturbance. Many, perhaps most, limerent minds are aware of this lack of self-control. This awareness is only

possible because (unlike most species) humans can, to a limited extent, monitor and voluntarily control their management processes (i.e., execute meta-management functions).

The H-CogAff framework seems to be at least as promising for limerence as it is for grief—two types of perturbance that normally involve attachment structures changing in opposite ways. Limerence, the attraction phase of romance (Fisher, 2004; Fisher, Aron & Brown, 2006), involves establishing attachment structures: motives, motive generators, insistence assignment rules, other reactive processes, plans, etc. Grief is an extended process of dismantling attachment structures. Limerence and grief overlap in heartbreak and lovelornness, which all require the dismantling of attachment structures. Also, like grief, limerence can loosen prior attachment (facilitating the abandonment of one's current partner for a new one, or forgetting a prior love). Accounting for attachment processes is important given that emotions seem to have evolved in large part to enable individuals to indirectly manage each other via commitments and attachments (Aubé, 2009). Perturbance has been examined in relation to attachment (Petters, 2016; Petters & Beaudoin, 2017).

Understanding limerence as perturbance allows the obsessive nature of limerence to be characterized in IDO terms, in a way that can account for similar (potentially long lasting) states. It encourages questions to be raised progressively about mental states in terms of whole-mind design (motive generators, attachment structures, etc.), leading to further requirement and design specification.

The perturbance theory of limerence can also be used to extend, in IDO terms, Miller's (2001) influential theory of human evolution through sexual selection. Producing limerence *qua* perturbance in a desired mate is an advantageous strategy. That is, it is advantageous to trigger the creation and activation of motive generators in the other mate that produce insistent attraction-related motivators towards oneself. Whether the mating motivators are triggered in the other is by one's socially signaling intelligence (Miller, 2001) or other forms of fitness (wealth, pro-social attitudes, etc., Simler & Hanson, 2017), the motivators in limerence hijack the other person's mind. Conversely, signaling that one is in a limerent state (which may be hard to fake) implicitly tells the potential mate that she or he is so valuable, because it indicates that one is dedicating (and, crucially, perhaps *committing*, Aubé, 2009) to him or her one's most precious resources: one's executive resources. For these and other reasons, the ability to signal and interpret perturbance in others is of evolutionary significance, whether the perturbance underpins limerence, grief or other conditions.

Emotion theorists in psychology have not considered loss of control of executive functions, and related attentional processes, as centrally pertinent to emotion, let alone from the designer stance. For instance, while it flirts with concepts of attention and is integrative, the Component Process Model (Scherer, 2005, 2009) does not deal with perturbance. This might partly be because this model views emotion as a special reactive mode of functioning, as argued by Moors (2017), which is relatively short term. Ironically, it is in a *biological* theory of emotion that a related disturbance is highlighted, in what Panksepp and Biven (2012), as well as Sloman (2003), call *tertiary* emotions. If the concept of emotional episode is to be retained in

psychology, we suggest that theoretical psychologists inquire as to why and how perturbance is possible in emotion (not simply whether they empirically tend to co-occur).

Repetitive and Intrusive Mentation Involve Perturbance

Watkins suggested that an important attentional phenomenon should be conceptualized as "repetitive thought" (RT). He echoed a definition of RT as a "process of thinking attentively, repetitively or frequently about one's self and one's world [forming] the core of a number of different models of adjustment and maladjustment" (Watkins, 2008, p. 163). Under the banner of RT, Watkins included such varied phenomena as cognitive and emotional processing of persistent intrusions, depressive rumination, perseverative cognition, rumination, worry, planning, problem solving, and mental simulation, mind wandering, counterfactual thinking, post-event rumination, defensive pessimism, positive rumination, reflection, habitual negative self-thinking. To this list we would add obsessive and compulsive mentation, cravings and preoccupation. Watkins (2008) notes that worry, for instance, was defined as "a chain of thoughts and images, negatively affect-laden and relatively uncontrollable" and as "an attempt to engage in mental problem-solving on an issue whose outcome is uncertain but contains the possibility of one or more negative outcomes" (p. 164). Watkins's reasons for favouring RT as the overarching concept were that it is more inclusive than the alternatives, atheoretical, clearer, highly correlated with measures of worry and rumination, and non-evaluative (constructive or unconstructive).

We agree that RT phenomena are scientifically significant. RT is a feature of normal self-regulation—everyone experiences intrusive mentation. Furthermore, some forms of RT are transdiagnostic (Harvey, Watkins, Mansell, & Shafran, 2004). In other words, they represent a common feature across a number of diagnostic categories of mental health dysfunction. For instance, high levels of rumination are associated with depression and anxiety (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Below, we briefly discuss insomnia which often involves bedtime RT and is itself of transdiagnostic significance (Dolsen, Asarnow, & Harvey, 2014).

However, there is room for amelioration in Watkins' (2008) conceptualization of RT. Firstly, whereas the expression "RT" suggests that the repetitive content is cognitive in the traditional sense (thinking and imagining), it often involves affectively charged motives and it often triggers motive-processing (e.g., assessing and deciding.) 'Repetitive mentation' would be a more inclusive expression. Further, the criterion of being atheoretical is unrealistic and counterproductive (as suggested in the discussion of IDO above); it also runs against Watkins's other criterion of being conceptually clear. One needs a general theory, beyond folk psychology, in relation to which intrusions and the executive processes that respond to them are specified.

Whether or not authors are explicit and clear about their theory, the concepts at play when RT is discussed scientifically require grounding in a functional architecture. Something must be generating motives; something must be interrupting when there are intrusions; something must be considering motives; something must be prioritizing them; etc. These mechanisms need to be named and specified in relation to an architecture. The theory ought to

"cut nature at its joints" and be amenable to a progressive research program of simulation, further theoretical development and cumulative empirical research (Cooper, 2007). Furthermore, the all-inclusive RT conceptualization comes at the cost of papering over significant differences, for instance between reflection and rumination. The farrago of RT concepts requires conceptual analysis and functional specification, which we expect will lead to much pruning and reclassification. In addition, the phenomena of RT are too global, involving too many diverse wide-ranging mechanisms of mind, to be understood without reference to a computational architecture. Moreover, one must understand the *how* of normal information processing (IP) to assess mentation as constructive or unconstructive.

Unfortunately, the RT literature has failed to adopt or develop architectural models of mind. For instance, in describing a highly studied phenomenon of RM, affective biases, Mathews, Mackintosh & Fulcher (1997) invoke interrupt signals, attentional vigilance, effortful suppression and intrusions. The concepts of cognitive and attentional 'biases' are currently cast mainly in terms of 'external and internal stimuli' (Mathews et al., 1997; Todd, Cunningham, Anderson & Thompson, 2012) and 'affective salience' (Schweizer et al., 2019) rather than in terms of motivators, insistence or motive processing, i.e., the mechanisms that are being 'biased' and that process them. The attentional bias and RT literatures fail to invoke an overall model of mind which, for instance generates motives, filters them, prioritizes, them and acts upon them, i.e., that addresses the types of capabilities with which H-CogAff is concerned.

Watkins (2008) and others point to control theory as an explanatory framework for RT and self-regulation. While some of these models are promising (Nafcha, Higgins & Eitam, 2016), they too need to be integrated within an IDO approach. They need to address rich qualitative control states and mechanisms that follow from the requirements of autonomous agency (Sloman, 1995).

H-CogAff provides a theoretical framework in relation to which classification and modelling of RT may proceed. This framework has the advantage of being constructed to explore how human minds might solve real world problems of autonomous agency. It is by no means a complete or detailed specification; but it has proven to be useful for generating and exploring models, many of which have already been implemented (Sloman, 2008a).

H-CogAff offers a path towards a deeper conceptualization of RT. According to Watkins (2008), intrusive thought (IT) is not considered a category of RT, likely because it is an essential aspect of RT. IT is better, and more generally, conceived as intrusive mentation (IM), and more deeply as perturbance. The concept of perturbance is based on the dispositional concept of insistence of mental content: a motive may be insistent and yet not disrupt processing. To understand IM as perturbance we must specify in terms of an architecture (like H-CogAff) the ways in which insistence assignment, interrupt filtering and attention switching are effected.

This may also help address the need in the RT literature for a design-oriented taxonomy of patterns of executive processes. Beaudoin (1994) and Wright (1997) put forth several categories, such as oscillation between decisions, manifest perturbance, digressions and maundering. Several other patterns have been identified in the CogAffect project (e.g., Petters,

2014 ; Wright, 1997). These, and several types of phenomena labelled by Watkins as RT (such as worry and rumination) need to be systematically characterized in terms of patterns of interaction between management, reflective and reactive processes in H-CogAff

Insomnia

Various forms of repetitive thought at bedtime (such as "racing thoughts" and worry) seem to delay sleep onset (Lemyre et al., 2020). In a review of the literature on pre-sleep cognition, Lemyre et al. (2020) concluded "Importantly, better characterizing cognitive activity in insomnia might help to develop more effective pre-sleep cognitive strategies to facilitate sleep onset. While research on such strategies is still scarce, it remains a promising avenue to help patients who are resistant to the conventional cognitive and behavioral therapy for insomnia" (p. 10). Dominant cognitive theories of insomnia (Espie, 2007; Harvey, 2005) invoke affective terminology, such as 'arousal', without commitment to theories to interpret the terms (e.g., Russell, 2003), and do not appeal to fundamental IDO theories. Beaudoin (2014) and Beaudoin et al. (2019) have put forth a prolegomenon towards an IDO theory of sleep onset and insomnia based on H-CogAff, dubbed *the somnolent information processing* (SIP) theory, which attempts to reverse engineer the human sleep-onset control system. The theory postulates that perturbance is insomnolent, meaning that it tends to delay sleep onset.

According to SIP theory, insistent motivators can trigger deliberative processing with respect to the motivators. Controlling one's deliberative processes in bed can be particularly difficult: when there are no other distractors, insistent motivators can loom large. Moreover, it supposes that fatigue (due to homeostatic sleep drive and circadian factors, (Borbély, Daan, Wirz-Justice & DeBoer, 2016) can make deliberation scheduling more difficult. This can make it difficult to postpone consider of insistent motivators. In SIP, insistent motivators are deemed to be insomnolent (a signal to the sleep onset control system to delay the onset of sleep). Executive processing of motivators can maintain the insistence of motivators. Moreover, the theory assumes that the imagery rich, diverse, fluid mentation that is characteristic of a successful sleep-onset period (Nielsen, 2017) is not merely a consequence of sleep onset, it is pro-somnolent (a signal to the sleep onset control system that progression towards sleep is appropriate). During perturbance, insistent motivators capture executive processing, and thus prevent such (presumably) pro-somnolent mentation.

From this theory, Beaudoin (2014c) derived serial diverse imagining, a 'cognitive shuffling' technique, that aims to facilitate sleep onset. This involves deliberate mentation with features of sleep onset (e.g., imagining diverse scenes and/or oneself moving, drawing on diverse episodic memory, incoherent mentation). The various forms of cognitive shuffle, including serial diverse imagining, are meant to work partly by interfering with bedtime perturbance, i.e., being counter-insomnolent, as proposed by Beaudoin (2014c) and Beaudoin, Digdon, O'Neill, and Rachor (2016). It is also meant to be pro-somnolent, partly by emulating sleep-onset like mentation. Whether or not this technique stands the test of thorough experiments, it illustrates the potential to understand ancillary brain mechanisms (here the sleep-onset control system) that

integrate motivational information from reactive and deliberative layers, that involve relatively cognitive processes (such as imagining scenes), and also involve meta-management processes. It also illustrates how from an IDO theory of mind and theory of perturbance one can derive techniques for self-help (regarding insomnolence) and clinical concerns (insomnia).

Other Psychological Phenomena

Several research problems need to be reinterpreted specifically with architecture-based models of autonomous minds that can support perturbance. In this section, we consider a wide variety of them.

Motivation tends to be conceived in psychology simply as directing and energizing behaviour (Danziger, 1997) (determining the goals people choose; and when, why, and how intensely they pursue them), rather than in terms of motive processing (how motives can be processed and pursued by autonomous agents). For instance, none of the peer responses to the Selfish Goal theory in *Behavior & Brain Sciences* (Huang & Bargh, 2015) noted its lack of explicit architecture nor that its goal specification and processes are bare (e.g., what about motive generators and insistence?) Higgins (1997, 2011) notes that pleasure and avoidance of pain are still normally assumed to be *the* final ends, or more generally that behaviour seeks to maximize expected value, while the deeper, more subtle and generative possibility of architecture-based motivation (Beaudoin, 2014b; Sloman, 2009, 2019) is often ignored. In architecture-based motivation, through innate mechanisms, ontogenesis or learning — though not necessarily through reward-based mechanisms, nor hedonic mechanisms, nor means-ends analysis —minds can produce new motivator generators and new motivators. Hence, many of the 'hidden motives' described in Simler & Hanson (2017) as fundamental to human nature, are not, and need not be, explicitly represented at all, not even unconsciously. The concept of architecture-based motivation, which follows from H-CogAff and related designs, can help bridge the intentional stance (Dennett, 1987, where from the outside one ascribes representations that are not implemented in the observed agent) and the design stance. It also helps to understand the incommensurability of motivators (Beaudoin, 1994; Sloman, 2009, 2019).

Stanovich (2011) developed a promising theory to explain successes and failure in rationality, and to improve rationality. It contains a three-level architecture which refers to H-CogAff. Perturbance theory is also meant to account for apparent breakdowns in rationality (Sloman & Croucher, 1981). We think there is potential to combine Stanovich's framework with H-CogAff to better understand success and failure of rationality. For instance, Stanovich's framework could be augmented by affective constructs, such as motive generators and alarms. Meanwhile, the recent theory of cognitive energetics (Kruglanski et al., 2012), which is meant to explain all instances of goal-directed thinking in a quantitative way, also lacks an architecture. The related, quantitative, concept of economy of mind (Wright, 1997) was developed from the designer stance.

Given that perturbance is an underlying construct to explain RT, and some forms of RT are transdiagnostic, it stands to reason that the concept of perturbance is relevant to

transdiagnostic approaches. For instance, addictions involve motives that are both insistent (tend to capture attention) and intense (control behaviour). Obsessions and compulsions must also involve perturbance at their core. More generally, a design-oriented approach is required for transdiagnostic understanding (Hudlicka, 2017). Even more generally, to understand abnormal psychology and apparent breakdowns in rationality we must understand normal psychology in design-oriented terms.

Perturbance is also quite relevant to human memory. Following Anderson's (1991) adaptive explanation of memory, Beaudoin (2014a) proposed the heuristic relevance-signaling hypothesis from the designer stance. On a daily basis, humans process enormous amounts of information. The brain cannot deeply interpret it all, nor store all of its interpretations. Nor can the cortex explicitly signal relevance as a top down command to the hippocampus. (The direct command "I shall remember this phone number" does not work.) The brain needs implicitly to answer the question: what information should be persisted in memory? Testing effects are among the most well documented findings in empirical psychology: repeatedly recalling information potentiates memory of it (Roediger & Karpicke, 2006). The heuristic relevance-signaling hypothesis states that deliberative layer recall attempts are implicit cues to the brain's heuristic memory indexing mechanisms to prioritize access to information (memories) related to the perturbance—information (interpretations, narratives, etc.) that the deliberative layer has at least attempted to recall (reconstruct). Perturbances are hijackings of these mechanisms by insistent motives, potentiating memories related to the perturbant objects (e.g., the limerent object).

On another note, psychology has struggled with the question: in what respect can the experience of music in particular and art more generally be affective (Juslin & Vastfjall, 2008). From the designer stance we might similarly ask how can great art rivet us and reverberate within us, from catchy ear worms to more? It has been argued that a great story is one that holds one's attention (Boyd, 2009). This brings us close to the mark. The *architecture-based* concepts of insistence and perturbance suggest ways of deepening such explanations. We speculate that music and fiction can trigger an illusion of perturbance: the reflective-layer impression that the agent is experiencing a genuine perturbance (as if self-generated motives were insistently being activated, captivating management processes). More obviously, art likely often operates by increasing the insistence of one's own latent motives (triggering limerence and grief, for instance). Among the many reasons that limerence and grief are two of the most popular themes of art is that they are implicitly about perturbance and they trigger perturbance. Furthermore, for a work of art to have a social impact, it must affect individuals over periods of time, taking hold of their executive processes, and prompt them to think in its terms and to communicate about it. One way to explore these hypotheses would be to model responses to high-caliber, multi-modal art depicting limerence and grief that uses repetition in provocative ways, as is common in musical theatre.

We also believe a design-oriented theory of autonomous agency whose architectures can support perturbance can be applied to positive psychology and self-help. For example, focusing and flow are arguably essential to cognitive productivity and hence to knowledge economies.

Distraction is largely a motivational phenomenon —i.e., executive functions are captured not just by facts, but motives. Yet theories of attention —and knowledge translation on the subject (Gallagher, 2009; Levitin, 2014)— do not deal with motive processing and fail to consider, let alone account for, perturbance. Theories of learning, expertise and productive practice need to explain how humans can deliberately develop their mental architectures, e.g., creating new motive generators (Beaudoin, 2014a, 2014b).

In short, a broad range of previously studied phenomena and problems can systematically be revisited from the designer stance as involving perturbance.

Conclusion

In this paper, we have argued that perturbance is a major feature of the human mind that deserves to be thoroughly investigated. This concept has the advantage of being firmly rooted in AI and of involving a flexible, extensible architectural framework meant to account for requirements of autonomous agency. This enables research problems to be considered in terms of models of entire minds.

Many areas of interdisciplinary research on perturbance and autonomous agency more generally can fruitfully be pursued. Some have already been alluded to in this document. The concept of perturbance has the potential to unify several areas of study, including attention, emotional episodes and self-regulation, repetitive mentation, and psychopathological conditions such as depressive rumination, obsessive worrying and addictions. There is a rapidly growing number of instruments to automatically recognize emotions and to measure emotion perception (Adolphs, R., 2017). It is no surprise that there has yet to be research on whether or how humans tacitly perceive perturbance or how machines could do so, both of which would be challenging tasks that could advance theory. It may be helpful to integrate Moors' (2017) two-level architecture with H-CogAff, drawing on their respective strengths. There is a need for detailed modeling of mental processing in insomnia, for which the somnolent information processing theory provides a framework. Beaudoin (2014a) has argued in detail that the important concept of 'effectance', proposed by White (1959), which roughly means motivation for competence, needs to be modernized in terms of architecture-based motivation. Detailed IDO models of grieving and limerence as prolonged perturbance could be developed.

We urge resisting the temptation of *assimilating* the concept of perturbance to related concepts, such as obsession, rumination, infatuation, repetitive thought, or even emotion. Perturbance is not a phenomenological or descriptive concept, though the theory behind it is meant to also account for experience. What ultimately makes perturbance of interest are the IDO theories and approach in relation to which perturbance is to be understood.

The IDO approach is directly relevant to the education of educators, psychologists and cognitive scientists. In this paragraph we focus on psychology since it is, or should be, a requirement for the training of educators and cognitive scientists. There was a day when psychology students were virtually guaranteed to graduate knowing an overall model of the human mind, though they did not tend to believe it or use it. That model was based on the wrong

metaphor, hydraulic systems, as computers had not yet been invented. We are referring of course to Freud's id, ego, superego model of mind. In rejecting the model, psychology threw out the baby with the bathwater (Minsky, 2013). Fortunately, psychology students are trained to apply many theories to the same phenomena. Unfortunately, they are not yet typically trained to think about themselves, other humans and possible (AI) minds in terms of an IDO information-processing architecture with multiple interacting virtual machines — let alone, as they should, multiple such theories. Yet this is teachable and important (Borsboom et al., in press; Sloman, 1993; Beaudoin, 1994). Here we have focused on H-CogAff, but there are other relevant IDO models, such as Baars & Franklin (2009). We also recommend students be trained in conceptual analysis (Ortony, Clore, & Foss, 1987; Sloman, 1978), which is part of the IDO approach, as they are in empirical research methods. We are not suggesting a one-way flow of influence from a design-oriented perspective to phenomena-based methods. Instead, we advocate a progressive theory-driven research program to propose and improve IDO models. There is a need for more AI researchers to consider broad, integrative, multi-layered, affective autonomous agency. We believe psychology and AI researchers need to work more closely together, not only on purely cognitive problems but affective ones as well. AI and psychology must blend more (Reisenzein et al., 2013).

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References

Adolphs, R. (2017). Emotion perception from face, voice, and touch: comparisons and convergence. *Trends in Cognitive Sciences, 21*(3), p. 216–228. doi:10.1016/j.tics.2017.01.001

Anderson, J. R. (1991). Is human cognition adaptive. *Behavioral and Brain Sciences, 14*(3), p. 471–485. doi:10.1017/S0140525X00070801

Aubé, M. (2009). Unfolding commitments management: A systemic view of emotions. In J. Vallverdú & D. Casacuberta (Eds.), *Handbook of research on synthetic emotions and sociable robotics: New applications in affective computing and artificial intelligence*, p. 198–277. New York, NY: IGI Global.

Baumeister, R. F. (2015). Toward a general theory of motivation: Problems, challenges, opportunities, and the big picture. *Motivation and Emotion*, *40*(1), 1–10.

Baars, B. J., & Franklin, S. (2009). Consciousness is computational: The LIDA model of global workspace theory. *International Journal of Machine Consciousness, 1*(1), 23–32. doi:10.1142/S1793843009000050

Beaudoin, L. P. (1994). *Goal processing in autonomous agents* (Doctoral dissertation). Birmingham, England. Retrieved from http://www.cs.bham.ac.uk/research/projects/cogaff/Luc.Beaudoin_thesis.pdf

Beaudoin, L. P. (2014a). *Cognitive productivity: Using knowledge to become profoundly effective*. Pitt Meadows, BC: CogZest. Retrieved from https://leanpub.com/cognitiveproductivity/

Beaudoin, L. P. (2014b). Developing expertise with objective knowledge: Motive generators and productive practice. In J. Wyatt & D. Petters, *From Robots to Animals and Back* (pp. 161–189). Springer.

Beaudoin (2014c). A design-based approach to sleep-onset and insomnia: super-somnolent mentation, the cognitive shuffle and serial diverse imagining. Retrieved from https://summit.sfu.ca/item/17237.

Beaudoin, L. P., Digdon, N., O'Neill, K., & Rachor, G. (2016). Serial diverse imagining task: A new remedy for bedtime complaints of worrying and other sleep-disruptive mental activity (pp. A209). Denver. Retrieved from http://summit.sfu.ca/item/16196

Beaudoin, L. P., Lemyre, A., Pudlo, M. & Bastien, C. (2019). *Towards an integrative design-oriented theory of sleep-onset and insomnolence from which a new cognitive treatment for insomnolence (serial diverse kinesthetic imagining, a form of cognitive shuffling) is proposed*. World Sleep Congress 2019, Vancouver, BC.

Beaudoin, L. P., & Sloman, A. (1993). A study of motive processing and attention. In A. Sloman, D. Hogg, G. Humphreys, A. Ramsay, & D. Partridge (Eds.), *Prospects for Artificial Intelligence* (Proceedings AISB–93), (pp. 229–238). Birmingham: IOS Press.

Boden, M. A. (1978). *Purposive explanation in psychology*. Cambridge, MA: Harvard University Press.

Boden, M. A. (1988). *Computer models of mind*. Cambridge University Press.

Boden, M. A. (1989). *Artificial Intelligence in psychology*. Bradford Books.

Boden, M. A. (2006). *Mind as machine: A history of cognitive science* (2 volumes). Oxford University Press.

Boden, M. A. (2008). *Mind as machine: A history of cognitive science*. Oxford University Press.

Borbély, A. A., Daan, S., Wirz-Justice, A., & DeBoer, T. (2016). The two-process model of sleep regulation: a reappraisal. *Journal of Sleep Research, 25*(2), 131–143. doi :10.1111/jsr.12371

Borsboom, D., van der Maas, H., Dalege, J., Kievit, R., & Haig, B. (2020). Theory Construction Methodology: A practical framework for theory formation in psychology. https://psyarxiv.com/w5tp8/

Boyd, B. (2009). *The origin of stories*. Harvard University Press.

Buck, R. (2014*). Emotion: A biosocial synthesis*. Cambridge University Press.

Cooper, R. P. (2007). The role of falsification in the development of cognitive architectures: Insights from a Lakatosian analysis. *Cognitive Science, 31*, 509–533.

Danziger, K. (1997). *Naming the mind*. SAGE.

Dennett, D. C. (1971). Intentional systems. *The Journal of Philosophy*, *68*(4), 87–106.

Dennett, D. C. (1987). *The intentional stance*. Cambridge, MA: The MIT Press.

Dennett, D. C. (1994). Cognitive science as reverse engineering. In D. Prawitz, B. Skyrms, & D. Westerstahl (Eds.), *Proceedings of the 9th International Congress of Logic, Methodology and Philosophy of Science*.

Diamond, A. (2013). Executive Functions. *Annual Review of Psychology, 64*(1), 135–168. doi :10.1146/annurev-psych-113011-143750

Disalle, R. (2006). *Understanding space-time: the philosophical development of physics from Newton to Einstein*. Cambridge University Press.

Dolsen, M. R., Asarnow, L. D., & Harvey, A. G. (2014). Insomnia as a transdiagnostic process in psychiatric disorders. *Current Psychiatry Reports, 16*(9), 471. doi:10.1007/s11920-014-0471-y

Donald, M. (2001). *A mind so rare: The evolution of human consciousness*. W. W. Norton & Company.

Espie, C. A. (2007). Understanding insomnia through cognitive modelling. *Sleep Medicine*, 8, S3–S8. doi:10.1016/S1389-9457(08)70002-9

Eisenberger, N. I., & Lieberman, M. D. (2004). Why rejection hurts: a common neural alarm system for physical and social pain. *Trends in Cognitive Sciences*, *8*(7), 294–300. doi:10.1016/j.tics.2004.05.010

Firestone, C., & Scholl, B. J. (2016). Cognition does not affect perception: Evaluating the evidence for "top-down" effects. *Behavioral and Brain Sciences*, 39.

Fisher, H. (1998). Lust, attraction, and attachment in mammalian reproduction. *Human Nature*, *9*(1), 23–52. doi:10.1007/s12110-998-1010-5

Fisher, H. (2004). *Why we love: The nature and chemistry of romantic love*. New York, N.Y.: Henry Holt & Company.

Fisher, H., Aron, A., & Brown, L. L. (2006). Romantic love: A mammalian brain system for mate choice. *Philosophical Transactions of the Royal Society of London*. Series B, Biological Sciences, 361(1476), 2173–2186. doi:10.1098/rstb.2006.1938

Fontaine, J. R. J., Scherer, K. R., & Soriano, C. (2013). *Components of emotional meaning*. Oxford University Press.

Gallagher, W. (2009). *Rapt*: *Attention and the focused life.* The Penguin Press.

Harvey, A. G., Watkins, E., Mansell, W., & Shafran, R. (2004). *Cognitive behavioural processes across psychological disorders*. Oxford University Press, USA.

Harvey, A. G. (2005). A cognitive theory and therapy for chronic insomnia. *Journal of Cognitive Psychotherapy, 19*(1), 41–59.

Hatfield, E., & Sprecher, S. (1986). Measuring passionate love in intimate relationships. *Journal of Adolescence, 9*(4), 383–419.

Hawes, N. (2011). A survey of motivation frameworks for intelligent systems. *Artificial Intelligence*, *175*(5-6), 1020–1036. doi :10.1016/j.artint.2011.02.002

Higgins, E. T. (1997). Beyond pleasure and pain. *American Psychologist 52*(12). 1280-1300.

Higgins, E. T. (2011). *Beyond pleasure and pain*. OUP USA.

Huang, J. Y., & Bargh, J. A. (2015). The Selfish Goal: Autonomously operating motivational structures as the proximate cause of human judgment and behavior. *Behavioral and Brain Sciences*, *38*(01), 121–135. doi :10.1017/S0140525X13000290

Hudlicka, E. (2017). Computational modeling of cognition-emotion interactions: Theoretical and practical relevance for behavioral healthcare. In M. P. Jeon (Ed.), *Handbook of affective sciences in human factors and HCI* (pp. 1–62). Waltham, MA : Elsevier.

Izard, C. E. (2010). The many meanings/aspects of emotion: Definitions, functions, activation, and regulation. *Emotion Review*, *2*(4), 363–370. doi :10.1177/1754073910374661

Juslin, P. N., & Vastfjall, D. (2008). Emotional responses to music: The need to consider underlying mechanisms. *Behavioral and Brain Sciences*, *31*(05), 65–63. doi :10.1017/S0140525X08005293

Kruglanski, A. W., Bélanger, J. J., Chen, X., Köpetz, C., Pierro, A., & Mannetti, L. (2012). The energetics of motivated cognition: A force-field analysis. *Psychological Review*, *119*(1), 1–20. doi :10.1037/a0025488

Lakatos, I. (1980). The methodology of scientific research programmes. *Philosophical papers*, 1. Cambridge University Press.

Lemyre, A., Belzile, F., Landry, M., Bastien, C. H., & Beaudoin, L. P. (2020). Pre-sleep cognitive activity in adults: A systematic review. *Sleep Medicine Reviews*, *50*, 101253. doi :10.1016/j.smrv.2019.101253

Levitin, D. J. (2014). *The organized mind: Thinking straight in the age of information overload*. Dutton Penguin.

Macatee, R. J., Allan, N. P., Gajewska, A., Norr, A. M., Raines, A. M., Albanese, B. J., et al. (2015). Shared and distinct cognitive/affective mechanisms in intrusive cognition: An

examination of worry and obsessions. *Cognitive Therapy and Research*, 40(1), 80–91. doi:10.1007/s10608-015-9714-4

Marcus, G., & Davis, E. (2019). *Rebooting AI: Building artificial intelligence we can trust.* Pantheon.

Mathews, A., Mackintosh, B., & Fulcher, E. P. (1997). Cognitive biases in anxiety and attention to threat. *Trends in Cognitive Sciences, 1*(9), 340–345.

Maxwell, S. E., Lau, M. Y., & Howard, G. S. (2015). Is psychology suffering from a replication crisis? What does « failure to replicate »" really mean? *The American psychologist, 70*(6), 487–498. doi:10.1037/a0039400

McCarthy, J. (2008). The well-designed child. *Artificial Intelligence, 172*(18), 2003–2014. doi:10.1016/j.artint.2008.10.001

Miller, G. (2001). *The mating mind: How sexual choice shaped the evolution of human nature*. Anchor.

Minsky, M. L. (1985). *The society of mind*. New York, NY: Simon & Schuster.

Minsky, M. (2013). Why Freud was the first good AI theorist. In M. More & N. VitaMore (Eds.), *The transhumanist reader* (pp. 167–176). Oxford: John Wiley & Sons. doi:10.1002/9781118555927.ch16

Minsky, M., Singh, P., & Sloman, A. (2004). The St. Thomas Common Sense Symposium: for Human-Level Intelligence. *AI Magazine, 25*(2), 113–124.

Moors, A. (2017). Integration of two skeptical emotion theories: Dimensional appraisal theory and Russell's psychological construction theory. *Psychological Inquiry, 28*(1), 1–19. doi:10.1080/1047840X.2017.1235900

Moors, A., & Fischer, M. (2018). Demystifying the role of emotion in behaviour: toward a goal-directed account. *Cognition & Emotion*, 1–7. doi:10.1080/02699931.2018.1510381

McCarthy, J. (2008). The well-designed child. *Artificial Intelligence*, *172*(18), 2003–2014. doi:10.1016/j.artint.2008.10.001

Muthukrishna, M., & Henrich, J. (2019). A problem in theory. *Nature Human Behaviour*, *3*(3), 221-229.

Nafcha, O., Higgins, E. T., & Eitam, B. (2016). Control feedback as the motivational force behind habitual behavior. In *Motivation - theory, neurobiology and applications*, *229* (pp. 49–68). Elsevier. doi :10.1016/bs.pbr.2016.06.008

Newell, A. (1990). *Unified theories of cognition*. Cambridge, MA : Harvard University Press.

Nielsen, T. (2017). Microdream neurophenomenology. *Neuroscience of Consciousness*, *3*(1), 1–18. doi:10.1093/nc/nix001

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science*, *3*(5), 400-424.

Oatley, K. (1992). *Best Laid Schemes*. Cambridge: Cambridge University Press.

Ortony, A., Clore, G. L., & Foss, M. A. (1987). The referential structure of the affective lexicon. *Cognitive Science: A Multidisciplinary Journal*, *11*(3), 341–364.

Ortony, A., *Clore*, G. L., & *Collins*, A. (*1988*). *The cognitive structure of emotions.* Cambridge University Press.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). *The measurement of meaning*. University of Illinois Press.

Panksepp, J., & Biven, L. (2012). *The archaeology of mind: neuroevolutionary origins of human emotions (Norton series on interpersonal neurobiology)*. WW Norton & Company.

Pervin, L. A. (1989). Goals concepts: themes, issues, and questions. In L.A. Pervin (Ed.), *Goal concepts in personality and social psychology*, pp. 473–479. Lawrence Erlbaum Associates, Inc.

Pessoa, L. (2008). On the relationship between emotion and cognition. *Nature Reviews Neuroscience*, 9(2), 148-158.

Pessoa, L. (2013*). The cognitive-emotional brain*. MIT Press.

Petters, D. (2014). Losing Control Within the H-Cogaff Architecture. In D. Petters (Ed.), *From animals to robots and back: Reflections on hard problems in the study of cognition*, *22* (pp. 31–50). Springer International Publishing. doi :10.1007/978-3-319-06614-13

Petters, D. (2016). An encounter between 4e cognition and attachment theory. *Connection Science*, *28*(4), 387–409. doi:10.1080/09540091.2016.1214947

Petters, D., & Beaudoin, L. P. (2017). Attachment modelling: From observations to scenarios to designs. In P. Erdi, B. S. Bhattacharya, & A. Cochran (Eds.), (pp. 227-271). *Computational Neurology and Psychiatry*.

Power, R. (1979). The organisation of purposeful dialogues. *Linguistics*, *17*, 107–152.

Reisenzein, R., Hudlicka, E., Dastani, M., Gratch, J., Hindriks, K., Lorini, E., & Meyer, J.-J. C. (2013). Computational modeling of emotion: toward improving the inter- and intradisciplinary exchange. *IEEE Transactions on Affective Computing*, *4*(3), 246–266. doi:10.1109/T-AFFC.2013.14

Reynaud, M., Karila, L., Blecha, L., & Benyamina, A. (2010). Is love passion an addictive disorder? *The American Journal of Drug and Alcohol Abuse*, *36*(5), 261–267. doi:10.3109/00952990.2010.495183

Reynolds, S. E. (1983). « Limerence »: A new word and concept. *Psychotherapy: Theory, Research and Practice*, *20*(1), 107–111.

Roediger, H. L., & Karpicke, J. D. (2006). The power of testing memory: Basic research and implications for educational practice. *Perspectives on Psychological Science, 1*(3), 181.

Rosenbloom, P. S., Demski, A., & Ustun, V. (2016). The Sigma cognitive architecture and system: Towards functionally elegant grand unification. *Journal of Artificial General Intelligence*, *7*(1), 1–103. doi :10.1515/jagi-2016-0001

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review*, *110*(1), 145–172. doi:10.1037/0033-295X.110.1.145

Russell, J. A. (2009). Emotion, core affect, and psychological construction. *Cognition & Emotion*, *23*(7), 1259–1283. doi:10.1080/02699930902809375

Scherer, K. R. (1984). On the nature and function of emotion: A component process approach. In K. R. Scherer, Scherer, & P. Ekman (Eds.), *Approaches to Emotion* (pp. 293–317). Hillsdale, NJ.

Scherer, K. R. (2005). What are emotions? And how can they be measured? *Social Science Information*, *44*(4), 695–729. doi:10.1177/0539018405058216

Scherer, K. R. (2009). Emotions are emergent processes: they require a dynamic computational architecture. *Philosophical Transactions of the Royal Society*. Series B, Biological Sciences, 364(1535), 3459-3474.

Schweizer, S., Satpute, A. B., Atzil, S., Field, A. P., Hitchcock, C., Black, M., et al. (2019). The impact of affective information on working memory: A pair of meta-analytic reviews of behavioral and neuroimaging evidence. *Psychological Bulletin, 145*(6), 566–609. doi:10.1037/bul0000193

Selye, H. (1936). A syndrome produced by diverse nocuous agents. *Nature*, *138*(3479), 32-32.

Simler, K., & Hanson, R. (2017). *The Elephant in the brain : Hidden motives in everyday life*. Oxford University Press.

Simon, H. A. (1967). Motivational and emotional controls of cognition. *Psychological review*, *74*(1), 29.

Sloman, A. (1978). *The computer revolution in philosophy: Philosophy, science and models of mind*. Harvester Press. doi:10.2307/2184449

Sloman, A. (1987). Motives, mechanisms, and emotions. *Cognition and Emotion*, *1*(3), 217-233.

Sloman, A. (1989). On designing a visual system. *Journal of Experimental and Theoretical AI*, *1*(4), 289–337.

Sloman, A. (1992). Prolegomena to a theory of communication and affect. In A. Ortony, J. Slack, & O. Stock (Eds.), *Communication from an artificial intelligence perspective* (pp. 229–260). Heidelberg, Germany.

Sloman, A. (1993). Prospects for AI as the general science of intelligence. In A. Sloman, D. Hogg, G. Humphreys, D. Partridge, & A. Ramsay (Eds.), *Prospects for Artificial Intelligence*, (pp. 1–10). IOS Press: Amsterdam. Retrieved from http://www.cs.bham.ac.uk/research/projects/cogaff/Aaron.Sloman_prospects.pdf

Sloman, A. (1995). Beyond Turing equivalence. In P. Millican, A. Clark (Eds.). *Machines and thought: The legacy of Alan Turing*, vol I: 179-219. First published 1990, revised 1995.

Sloman, A. (2002). Architecture-based conceptions of mind. *Synthese Library*, 403–430. Retrieved from https://www.cs.bham.ac.uk/research/projects/cogaff/sloman-lmpsfinal.pdf

Sloman, A. (2003). How many separately evolved emotional beasties live within us? In R. Trappl, P. Petta, & S. Payr (Eds.), *Emotions in humans and artifacts* (pp. 35–114). Cambridge, MA: MIT Press.

Sloman, A. (2008a). *The Cognition and Affect Project: Architectures, architecture-schemas, and the new science of mind* (pp. 1–34).

Sloman, A. (2008b). The well-designed young mathematician. *Artificial Intelligence*, *172*(18), 2015–2034. doi:10.1016/j.artint.2008.09.004

Sloman, A. (2010). *Two notions contrasted: 'Logical geography' and 'logical topography' variations on a theme by Gilbert Ryle: the logical topography of "logical geography"*. Retrieved from https://www.cs.bham.ac.uk/research/projects/cogaff/misc/logical-geography.html.

Sloman, A. (2011). Varieties of meta-cognition in natural and artificial systems. In M. T. Cox & A. Raja (Eds.), *Metareasoning: Thinking about Thinking* (Vol. 5144, pp. 307–322). Boston, MA: The MIT Press. doi:10.1007/978-3-540-85110-3_45

Sloman, A. (2009). Architecture-based motivation vs. reward-based motivation. *Newsletter on Philosophy and Computers* 9.1,10-13. (pp. 1–9).

Sloman, A. (2019). Architecture-based motivation vs. reward-based motivation. Retrieved from https://www.cs.bham.ac.uk/research/projects/cogaff/misc/architecture-based-motivation.html

Sloman, A., Beaudoin, L. P., & Wright, I. (1994). Computational modelling of motive-management processes. In N. H. Frijda (Ed.). *Proceedings of the 1994 Conference of the International Society for Research on Emotions*, Cambridge, UK.

Sloman, A., Chrisley, R., & Scheutz, M. (2005). The architectural basis of affective states and processes. In *Who needs emotions? The brain meets the robot* (pp. 203–244). New York: Oxford University Press.

Sloman, A., & Croucher, M. (1981a). Why robots will have emotions. In *Proceedings IJCAI 1981*, Vancouver. Retrieved from https://www.cs.bham.ac.uk/research/projects/cogaff/81-95.html

Sloman, A., & Croucher, M. (1981b). You don't need a soft skin to have a warm heart: Towards a computational analysis of motives and emotions (No. 004). *Cognitive Science Research Papers*, Sussex University. Retrieved from https://www.cs.bham.ac.uk/research/projects/cogaff/sloman-croucher-warm-heart.html

Stanovich, K. E. (2011). *Rationality and the reflective mind*. Oxford University Press, USA.

Tennov, D. (1979). *Love and limerence*. Scarborough House. doi :10.1037/018287

Thórisson, K., & Helgasson, H. (2012). Cognitive architectures and autonomy: A comparative review. *Journal of Artificial General Intelligence, 3*(2), 1–30. doi:10.2478/v10229-011-0015-3

Todd, R. M., Cunningham, W. A., Anderson, A. K., & Thompson, E. (2012). Affect-biased attention as emotion regulation. *Trends in Cognitive Sciences, 16*(7), 365–372. doi:10.1016/j.tics.2012.06.003

Todd, R. M., Miskovic, V., Chikazoe, J., & Anderson, A. K. (2020). Emotional objectivity: Neural representations of emotions and their interaction with cognition. *Annual Review of Psychology, 71*(1), 25–48. doi:10.1146/annurev-psych-010419-051044

Toomey, C. N. (1992). When goals aren't good enough. In J. Hendler (Ed.), *Artificial intelligence planning systems*, (pp. 311-312). College Park, Maryland: Morgan Kaufmann Publishers.

van Steenbergen, H., Langeslag, S. J. E., Band, G. P. H., & Hommel, B. (2013). Reduced cognitive control in passionate lovers. *Motivation and Emotion*, 444–450. doi:10.1007/s11031-013-9380-3

Verduyn, P., Delaveau, P., Rotgé, J.-Y., Fossati, P., & Van Mechelen, I. (2015). Determinants of emotion duration and underlying psychological and neural mechanisms. *Emotion Review*, 7(4), 330–335. doi:10.1177/1754073915590618

Verduyn, P., & Lavrijsen, S. (2014). Which emotions last longest and why: The role of event importance and rumination. *Motivation and Emotion*, *39*(1), 119–127. doi:10.1007/s11031-014-9445-y

Wakin, A., & Vo, D. B. (2008). Love-variant: The Wakin-Vo IDR model of limerence. Inter-Disciplinary – Net. 2nd Global Conference: Challenging Intimate Boundaries.

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin*, *134*(2), 163–206. doi:10.1037/0033-2909.134.2.163

Wells, A., & Mathews, G. (1994). *Attention and emotion: A clinical perspective*. Hillsdale, NJ: Lawrence Erlbaum Associates Publishers.

White, R. W. (1959). Motivation reconsidered: the concept of competence. *Psychological Review*, 66(5), 297–333.

Wright, I. P. (1997). *Emotional agents* (Doctoral dissertation). University of Birmingham.

Wright, I., Sloman, A., & Beaudoin, L. P. (1996). Towards a design-based analysis of emotional episodes. *Philosophy, Psychiatry & Psychology*, *3*(2), 101–126. doi:10.1353/ppp.1996.0022

INTERVIEW

TEACHING SCIENCE WITH INTENTION AND CONNECTION: AN INTERVIEW WITH CLARAH MENEZES

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Introduction

Science education is a large field of research and to this date, there are numerous articles and publications about how science is taught in the classroom. Understanding teacher practices within a science classroom gives a glimpse on how science is interpreted and learned by her students and in addition, how the teacher interprets and teaches science to her classroom. "The meaning of the *nature* of science education is to enhance scientific literacy...towards responsible citizenry based on enhancing scientific and technological literacy" (Holbrook & Rannikmae, 2007). Within the context of this interview, we will focus our discussion on scientific literacy. Briefly, the field has used both science literacy and scientific literacy to describe the outcomes of science education. Although these two terms have been used synonymously, they present different attributes that define a scientifically literate person. As Roberts and Bybee (2014) discussed in the seminal chapter in the *Handbook of Research on Science Education*, science literacy is described as scientific knowledge built from pre-existing techniques and methods and scientific literacy lists attributes of a person who "reflects critically on information and appreciates and understands the impact of science on everyday life" (p. 547). These two descriptions are labelled as Vision I and Vision II, respectively. For a more in-depth discussion about science and scientific literacy, refer to the *Handbook of Research on Science Education* and for a review, refer to Science Education: Defining the Scientifically Literate Person (Tan, 2016). Each Vision can be viewed as extremes of a scientific literacy spectrum and the dynamic relationship between Vision I and II are often practiced in the classroom, with more educators focusing their practice within Vision I. "In the [teaching] world of practice, the choice facing science educators is Vision I versus a combination of Visions I and II" (Aikenhead, 2007, p. 64).

As we progress through the 21st century, the idea of scientific citizenship is evolving to include a global perspective. Bybee (2018) acknowledges and insists that scientific citizenship must now include a move towards global scientific citizenship where perspectives from **other disciplines are considered** to realize the "interrelatedness of individuals, environments and communities" (p. 61, emphasis added). Through these conversations, and further discussion of

working through different definitions of scientific literacy (Roberts, 2007, Bybee & Roberts, 2014, Tan, 2016), Vision III (Tan, 2018) extends on the meaning of scientific literacy, specifically weaving Indigenous Hawaiian epistemology on the importance of relationality, emotion and connection (Kealiikanakaoleohaililani & Giardina, 2016, Meyer, 2008) with scientific knowledge. We call this different approach, the Three-Visions-Framework (TVF). Vision III challenges current paradigms for teaching science from both the objective and subjective perspective and more importantly, to give an awareness towards a different type of relationship between nature/culture, human/non-human, and subject/object.

Poh first met Clarah on a collaborative research trip to Unisinos University in Porto Alegre, Brazil with Dr. Maria Eduarda Giering's research group. Clarah teaches Grades 4-5 at Arnaldo Grin elementary in Novo Hamburgo. The school is located at the periphery of a community that struggles with drug and substance abuse, violence, racism, and poverty. Her students had varied levels of literacy and numeracy and 9% of her students had hearing, vision, or speaking challenges. For many of Clarah's students, it was their first time being in a science classroom. During my research trip, I spoke to Clarah about her challenges, struggles and successes about teaching science. She talked about her struggles of identifying the most effective ways to create science lessons that were relevant to her students and often spent endless hours searching the internet for the "perfect" science activities to engage her students. Clarah wanted to "show [her] students how science can be applied to their lives and that it can have a significant contribution to change the way they make choices for themselves" (personal communication, 2018). I have so much gratitude and appreciation for Clarah's enthusiasm, dedication, and motivation towards using science for giving hope to her students. In the next few months after my visit, we continued our conversation and we discussed the importance of relationality when teaching science. We quickly determined that Clarah's science curriculum were focused mainly within Vision I. Through TVF, Clarah began to weave the understanding of relationality through her lessons and instead of staying within the confines of Vision I, she began to asked questions about her teaching practices within the framework.

In this interview, Clarah shares her experiences, responses, struggles, and reflections into applying TVF to understand and develop her lesson plans for her class and how relationality shapes how we learn and how we ***connect and relate to*** what we learned.

The Interview

Authors*: Clarah, first thank you for sharing your time to share your experiences and what you've learned about your practice in the classroom with the framework. I'd like to start with an introduction question. Tell us about yourself and your educational background. How many years have you been a teacher, and what teaching means to you?*

Clarah (Clarissa Paz de Menezes): I am an elementary school teacher and I specialize in teaching children with special needs. My aspirations to be a teacher began when I was in the eighth grade. Throughout my teaching career I have always focused my work and practice with children of different abilities and, today, I am a teacher working with students and schools to

create a more inclusively classroom and create more inclusion focused curriculum. One of the most important aspects of being an effective teacher and maintaining motivation through sometimes difficult times come from having healthy professional relationships with colleagues and teachers. I believe that relationships are key for the construction of quality learning relationships. From my own experience, I realize that my classroom practices were more satisfying when I developed a deep relationship with my peers and students. I think this link positively influences the teaching of all subjects in the classroom, because, in this way, the teacher is able to understand the demands of teaching and learning where the teacher teaches. The relationships of exchange and affection between the child and the reference adult, whether parents, guardians, the teacher or other school professionals, strengthens the learning process. When teachers engage with the school environment and foster a collaborative culture amongst coworkers and students, they are capable of understanding the school's climate and needs and hence improve their teaching techniques. From my own experience, I realize that my best learning relationships were when there was an emotional bond with teachers and/or colleagues. I think that this link influences the learning relationships of every subject, especially in Early Childhood Education, when children have a heteronomous relationship with adults. The relationships of exchange and affection between the child and the reference adult, whether parents, guardians, the teacher or other school professionals, strengthen the learning process.

Authors: *Tell us a about the school you currently teach at. What are the teachers and students like? Specifically, what does a typical science lesson look like in your class. How do you currently teach science?*

Clarah: I teach at an elementary school with grades from 1st to 9th year, that is, all elementary school grades in Brazil. Unfortunately, the school is located within an area where social economy is low and thus, parent participation is low as well. Due to current social economic status of this city, teachers like me are solely responsible for teaching, curriculum development, resource creation, maintenance of the school's facilities and in some cases, adopting a parenting role to the students. As a teacher, and along with my colleagues, I feel that, although we are tasked with responsibilities that go beyond teaching in the classroom, we believe that we are able to influence and improve education in the classroom, reduce school drop-out rates and violent incidences and work towards creating a positive school space for the community.

For myself, when you visited our school in 2018 and after talking to her about her research and work on scientific literacy, I realized that I am able to teach science in a different way. Let me first tell you about how science classes are currently being taught at my school. Science classes are very structured, and most teachers uses a teaching method to solely meet the mandated and technical objectives of the ministry's curriculum. Unfortunately, science lessons do not go beyond textbook learning and assignments provided by the government. In some classes, students have the opportunity to participate in hands-on experiments, however this is not always the case. Prior to working with you, I often taught science this way because this is the way that my colleagues taught and how I was trained to teach science. For example, I often tried

to look for different and more exciting activities on Pinterest or Google in hopes of creating a little a more engagement with my students. In other words, I followed what others did without specific and well-thought out intentions for why I was teaching a certain scientific topic. In addition, from the school's mandate, we were often asked to focus more on Math and language. In other words, I was teaching science from a place of knowledge transmission.

Authors: *We've been working together for over a year now with the three Visions framework. Can you tell us a little bit about how you've used the framework to teach science differently and how you've used it to understand your teaching practice?*

Clarah: When I first learned about your work, it was difficult for me to adapt because it was a new way of teaching science. It meant that I had to do something different from my colleagues, to go against traditional ways of teaching science and more importantly, to go beyond the prescribed curriculum and the assigned textbook. The framework showed me that science education goes far beyond what is in science textbooks alone. Working collaboratively with you and the framework from your research, led me to a better understanding of the processes and stages of science teaching. More importantly, I understood the importance of having a clear intention for the different subjects I was teaching in class. As I worked through the framework, I realized that I was teaching mostly from Vision I, which I felt, made my classes meaningless. We, as teachers, often stay within the constraints of textbook activities and it's rarely that we engage with Vision II. Activities and engaging projects with the students are conducted often when it is convenient with the teacher or rarely conducted due to lack of materials and access to resources. What I am saying is that my practice went from teaching science as a segregated and isolated piece of knowledge to seeing a bigger picture where every piece of knowledge is intentional and contributes to the bigger picture.

Working with you and the framework helped me create intentional hands-on science activities and gave me the courage and will to go beyond the textbook. I am so impressed with my students because, compared to previous years they became more interested in the learning process and began to participate more in class. The biggest difference was with my deaf students, who showed the most significant progress in their grasps of scientific knowledge. It was evident in the moment that the deaf student, realizing the interest of his colleagues in communicating, started his literacy process, as well as showing that he acquired new specific knowledge in other subjects, especially science and history. The students who found learning extremely difficult, began to make daily developments and increased their desire to learn more on their own. I feel that working through this framework has not only developed my practice for teaching science but also in the other subjects that I teach.

Authors: *That is fascinating. Can you give me a couple of examples and elaborate further?*

Clarah: The framework helped me to reflect on how I was teaching science and how my students were learning from classroom curriculum that was created with intentionality. I changed my approach to teaching science and from this change, it gave my students more autonomy and

ownership of what, how and WHY they were learning a certain topic. I want to briefly tell you about two specific times in my classroom where I observed my students applying scientific knowledge from an emotional origin, from Vision III. The first time we explored bacteria and viruses in the classroom, we learned about the anatomy and how they make us sick. I was surprised that after learning about the relationship between humans and bacteria, the students volunteered to help clean the school bathrooms. Due to the lack of easy access to cleaning materials and the high cost of purchasing them from the store, the students, independently took an initiative and used the computers at school to research on making their own disinfectants and soaps. They decided that they wanted to share their knowledge with others in the school and with a little guidance from me, they presented to their classmates about the relationship between us and germs. I was deeply impressed with their concern for their friends. In another example where I focus my science lessons in Vision III, was when I was introducing technology in the classroom. My aim was to show them different types of technology and how technology can impact our daily lives. Part of this lesson was for the students to identify a complementary technology with their interest. For this particular lesson, I emphasized on the importance of using technology to help another person who may need extra help. We talked about the importance of empathy as well. As a result, a group of students created an application that makes possible to learn sign language from games created by them to improve communication between deaf students and able listeners. This was the first time in my teaching experience that my students moved from applying scientific knowledge to meet class objectives to something that's more meaningful for their peers. In both examples, I focused my activities and lesson plan within Vision III and then building the knowledge and application that supports the outcome of Vision III. In this way, knowledge from Vision I and application from Vision II is developed and built, with guidance from me, by the students. In this way, scientific knowledge and application is more meaningful and specific.

Authors: *As a result of how you've changed your approach to teaching science, what difference have you noticed in the classroom? Did you see any changes or impact on your students' learning and understanding about the topic of science?*

Clarah: Now that I design my scientific lesson plan by using the framework, I observe that my students have more autonomy and ownership over what they are learning. This gives them a sense of their abilities within and outside of the classroom and more importantly, they realized that they are part of this world and they allow themselves to dream and to wish to seek for a different future from the family. The framework provides a clear intent between knowledge, application and relationality to the world and through this introduces possibilities for students to make a difference. Vision III, for example, gives them a framework that allows them to think, learn and act beyond the classroom and in my opinion validates their role within their community.

I want to remind you that my students come from families who are poor, illiterate and marginalized and thus my students' views and perspective of their role within the community,

the world is limited and often school and learning is the last thing they want to participate in. I've seen firsthand, after working with the framework that some of my students find meaning in what they are learning about. They see value and meaning because they are learning and experiencing more than just the textbook or what I am lecturing about. Working through Vision III provides that meaning. I can see that my students feel that they can make a difference despite of their socioeconomic status.

Authors: *Many educators like yourself will be reading this interview and may identify with some of the struggles that you've presented. To those educators, what would you like to say them?*

Clarah: My experiences and reflections through the application of the framework, I found answers to many of my initial questions. In the past year of working with the framework and you, new questions arose, pointing to the need to continue seeking greater theoretical and practical deepening, constantly transforming my teaching practice. I realized the importance of the contribution of Visions I, II and III as a teacher, I viewed the students' learning process differently by paying attention to students individually and as a collective.

The application of the framework in the school provided a space for the reconstruction of learning for both students and teachers, in which it became possible to adapt practice in order to meet the collective and individual needs of children. The framework helped me to teach students how to have an investigative look, in order to discover their needs and to assist them in the construction of their learning, overcoming learning difficulties and more importantly, have the students realize the importance of connecting to what they are learning about.

The three visions framework helped me build a new perspective and a new pedagogical practice and approach and having a clear intent for what I want for my students. Moving forward, there is no doubt that I will still have questions and explorations about my teaching practice, students and my classroom, and working through the framework has given me more direction on how I can navigate my questions the next time I teach science in my classroom.

Authors: *Thank you so much for sharing your experiences and reflections with us about how TVF has helped you shaped your teaching practices. I hope the readers are able to take away one or two messages from our interview. Thank you again.*

Clarah's Grade 4-5 science class during Dr. Tan's research visit to Arnaldo Grin Elementary in Novo Hamburgo, Brazil. Clarah is standing on the far left, Dr. Maria Eduarda Giering to the right and Dr. Poh Tan on the far right of the picture.

Dr. Poh Tan with two of Clarah's students who gave a tour of their school.

Two students are showing Dr. Poh Tan and her translator (on the left) where they collected their samples and what they observed in the petri dishes. Clarah explains how the activity gave the students more awareness about pathogens that are visible to the naked eye.

The students were working as a team to understand the roles and effects of pathogens found in their classroom and around their school, and how their immune system played a role in defending their body. Students took turns collecting samples from around the school. Collection materials (e.g. swabs, disposable lab coats, masks, petri dishes and bacterial medium) were a combination of donated, borrowed and teacher purchased.

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References

Baker, W. (2016). English as an academic lingua franca and intercultural awareness: Student mobility in the transcultural university. *Language and Intercultural Communication, 16*(3), 437–451. doi:10.1080/14708477.2016.1168053

Baumann, J. F., & Graves, M. F. (2010). What is academic vocabulary? *Journal of Adolescent & Adult Literacy, 54*(1), 4-12.

Benson, P., Barkhuizen, G., Bodycott, P., & Brown, J. (2013). *Second language identity in narratives of study abroad*. Basingstoke: Palgrave.

Blair, B. (2006). At the end of a huge crit in the summer, it was 'crap'— I'd worked really hard but all she said was 'fine' and I was gutted. *Art, Design and Communication in Higher Education, 5*(2), 83–95. doi:10.1386/adch.5.2.83/1

Coxhead, A. (2000). A new academic word list. *TESOL Quarterly, 34*, 213–238. doi:10.2307/3587951

Dunworth, K., Drury, H., Kralik, C., & Moore, T. (2014). Rhetoric and realities: on the development of university-wide strategies to promote student English language growth. *Journal of Higher Education Policy and Management, 36*(5), 520–532. doi:10.1080/1360080X.2014.936088

Evans, S., & Morrison, B. (2012). Learning and using English at university: Lessons from a longitudinal study in Hong Kong. *The Journal of Asia TEFL, 9*(2), 21–47. Retrieved from http://www.asiatefl.org/main/download_pdf.php?i=96&c=1419300097&fn=9_2_02.pdf

Folse, K. (2011). Applying L2 lexical research findings in ESL teaching. *TESOL Quarterly, 45*(2), 362–369. doi:10.5054/tq.2010.254529/epdf

Hamp-Lyons, L. (2001). English for Academic Purposes. In D. Nunan, & R. Carter (Eds.), *The cambridge guide to teaching English to speakers of other languages* (pp. 126-130). Cambridge, New York, Melbourne, Madrid: Cambridge University Press.

Holliday, A. (2016). *Doing and writing qualitative research* (3rd ed.). London: Sage.

Humphreys, P., Haugh, M., Fenton-Smith, B., Lobo, A., Michael, R., & Walkinshaw, I. (2012). Tracking international students' English proficiency over the first semester of undergraduate study. *IELTS Research Reports Online Series, 1*, 1–41.

Hyland, K., & Hamp-Lyons, L. (2002). EAP: Issues and directions. *Journal of English for Academic Purposes, 1*(1), 1-12.

Jenkins, J. (2013). *English as a lingua franca in the international university: The politics of academic English language policy*. Abingdon: Routledge.

Kinginger, C. (2009). *Language learning and study abroad: A critical reading of research.* Basingstoke: Palgrave Macmillan.

Kinginger, C. (2013). Introduction: Social and cultural aspects of language learning in study abroad. In C. Kinginger (Ed.), *Social and cultural aspects of language learning in study abroad* (pp. 3–15). Amsterdam: John Benjamins.

Knoch, U., Rouhshad, A., Oon, S. P., & Storch, N. (2015). What happens to ESL students' writing after three years of study at an English medium university? *Journal of Second Language Writing*, *28*(1), 39–52.

Lillis, T. M. (2001). *Student writing: Access, regulation, desire*. Literacies. UK: Routledge.

Norton, B., & Toohey, K. (2001). Changing perspectives on good language learners. *TESOL Quarterly*, *35*(2), 307–322. doi:10.2307/3587650

Peters, P., & Fernández, T. (2013). The lexical needs of ESP students in a professional field. *English for Specific Purposes*, *32*, 236–247. doi:10.1016/j.esp.2013.05.002

Storch, N., & Hill, K. (2008). What happens to international students' English after one semester at university? *Australian Review of Applied Linguistics*, *31*(1), 04.1–04.17.

Waters, J. L., & Leung, M. (2013). Immobile transnationalisms? Young people and their in situ experiences of 'international' education in Hong Kong. *Urban Studies*, *50*(3), 606–620. doi:10.1177/0042098012468902

WORKS OF ART AND OTHER ACADEMIC PIECES

SEEKING TO ENGAGE: RE-PLACING SIMON FRASER UNIVERSITY'S BURNABY MOUNTAIN CAMPUS TO HELP ADDRESS ENVIRONMENTAL CRISIS

MICHAEL MASER

Simon Fraser University

Abstract

Simon Fraser University, from the time of its opening in the 1960s, has striven to be a modernist and progressive educational institution. These characteristics are reflected in the architectural designs of its campuses, its epistemological orientations and offerings, and its policies. The university also states an ambition to be "Canada's most engaged university" on its website (sfu.ca/about.html). It is in considering this last point that this paper questions and considers SFU's 'engagement' in the context of the emerging environmental crisis. In particular, this paper focuses attention on the Burnaby Mountain campus and considers its place - geographically, architecturally, and culturally, and how these considerations of place intertwine and contribute or detract from a sense of engagement. Overall, this author posits that Simon Fraser's Burnaby Mountain campus is critically alienated from the in-situ forest that surrounds it, through character and gesture, and this is most unfortunate given a stated need by experts and educators to deepen engagement with natural environments in this time of crisis. Insights from place-based education identify that in-situ ecological knowledge, and insights arising from First Nations peoples, can help to grow new knowledge and awareness, deepen resiliency, and affect positive cultural change. The author suggests that Simon Fraser's Burnaby Mountain campus is an appropriate location to grow such a place-based education program and deepen its engagement in new, valuable ways.

Keywords: environmental crisis, sustainability, modernism, place-based education, First Nations education

***Seeking to Engage*: re-Placing Simon Fraser University's Burnaby Mountain Campus to Help Address Environmental Crisis**

> *Disastrous climate change and energy shortages are near certainties in this century and global societal collapse a growing possibility that puts billions at risk.*
>
> – Rees, 2019, para. 44

***Author's note**: This essay was originally written in early 2020, just as the COVID-19 pandemic was emerging as a global threat. It has been revised and includes some closing reflections on the pandemic, the largest disruptive event to K - post-secondary education, and western society, in generations.*

Throughout 2019, global environmental news consistently dominated headlines: searing droughts triggered raging wildfires, microplastics fouled vast marine ecosystems, warming temperatures melted huge ice sheets, and more. The dire reports, produced by scientific organizations like the International Panel on Climate Change, the United Nations Environment Programme, and the World Wildlife Fund, were clear in linking perilous situations and trends to human activities or 'anthropogenic' sources. And all of these problems were identified as contributing to predicted "global societal collapse" referenced in the quote above by Bill Rees, a respected academic (emeritus) and co-creator of the concept of 'environmental footprint'[1], while working at UBC in the 1990s.

As portentous as these reports were, I noted little recognition of them in the surficial activities at SFU's campus sites or the 'university life' in which I have engaged as an SFU graduate student. In fact, excepting a visit to British Columbia by Swedish climate change teen activist Greta Thunberg, which triggered campus walkouts throughout BC, any substantive news about environmental problems and the threats they pose to global health and welfare has largely been absent from university life since I began PhD studies in 2017. Walking the hallways of SFU campuses, checking out bulletin boards and websites and reading administrative email advisories, I have seen negligible evidence of any environmental issues that presage "societal collapse." Rather, I have seen much encouragement for students to get involved in campus life, register for social events, or consider bright futures in STEAM subjects where opportunities are pitched as plentiful. In other words, the predominant messaging is to maintain a *status quo* reflecting a singular agenda, as girded by messaging from official channels characterized in this style and substance: *Come to university, have a good time while you're here, graduate into a professional-oriented job*. A gap of acknowledging anything about the environmental crisis implies a conjectured message: *While here as a student, don't worry too much about bigger issues like the climate crisis or planetary ecocide, not while you're engaging in university life.*

[1] In 1996, Bill Rees, a professor in UBC's 'Environment and Resource Planning' department, published *Our Ecological Footprint* (New Society) with his-then graduate student, Mathis Wackernagel. The idea of calculating an ecological or environmental 'footprint' rested on tallying the energy and resource inputs associated with a lifestyle or aspect of lifestyle (e.g. trip, consumer choices, etc.). The concept has proved enduring.

I wish to make deeper sense of this situation, pondering whether this may be an oversight or gesture that seeks to obfuscate an uncomfortable truth. In doing so, I acknowledge that SFU, like other universities, has mounted some response to mounting environmental problems. For example, each of BC's main universities have 'Sustainability' offices and staff dedicated to pertinent issues and campus policies addressing things like recycling, transportation and energy use. These appointments, and the actions they undertake, demonstrate a willingness to show some sensitivity to emerging issues and to take some responsive action. But I can't help wonder if these are enough to substantively address looming environmental issues that potentially presage 'global society collapse.' For example, I question whether recycling stations are going to curb excessive production of single-use materials and significantly reduce waste? Will riding the bus or Skytrain to attend one of SFU's campuses help offset proliferating greenhouse gas emissions linked to university conferences in which thousands of participants fly-in and fly-out for a few days of meetings?

I pose these questions, and others, not seeking objective truth in answering them, but to help identify how these issues and actions matter in the context of a rising, global environmental crisis. And, while they may be rooted in only a small snapshot of 'university life,' I posit that my university life, as shaped by events, experiences and transmission of official knowledge, reflects a broad attitude that ignores and overlooks a responsibility that can be traced to a sense of *place*, to more substantively address the aforementioned environmental issues, about which society was warned by world leaders in the1980s.[2]

The notion of *place* has etymological roots in medieval language of the 13th century, when it was used to designate a "particular part of space, extent, definite location, spot, site," and in years following, as "position or place occupied by custom, etc.; position on some social scale," "to know one's place," and "to put one in one's place."[3] Thus, the notion of place is rooted in two references, one defining a location, the other, a social and administrative connotation of responsibility.

Our alienation, our dis-engagement, from environments and *places* that sustained us began thousands of years ago (ironically, where the first 'civilizations' are noted as arising), but the modern technocratic worldview — as espoused by and through contemporary education — has deeply accelerated this movement. Today, this alienation is driving thinking and behaviours that will not address root problems of our environmental crisis, but more likely increase them. To address these problems, education needs to redress the alienating characteristics it has baked into its design and processes.

In this essay I wish to show how the *place* of Simon Fraser University, and especially its Burnaby Mountain campus, intertwines both meanings of *place*, and that an integrated meaning arises as an important new and timely concept applicable to the university in the context of the environmental crisis. To clarify this argument, I will first present some general history of *the*

[2] 1987 marked the release of *Our Common Future*, following the Brundtland Commission. This report voiced many concerns about global environmental indicators and marked a watershed moment in raising public and academic awareness about mounting problems, and options to address them.
[3] Reference: https://www.etymonline.com/word/place

university. Next, I will explicate some of the notions on which contemporary universities are predicated. Third, I will specifically hone in on notions of *place* specific to Simon Fraser's Burnaby campus, which offers a remarkable crucible of contrasting notions of place: at once exemplifying a thoroughly modern[4] university at the same time it ignores and overlooks the geographical rootedness of the rich forest surrounding it and the cultural rootedness of First Nations people it has dis-placed, or mis-placed.

As a final thread I will integrate some ideas from both environmental and First Nations' perspectives on what 'place-based-education' (PBE) might offer SFU's mountaintop campus. PBE, increasingly emerging in experimental form in K-12 schooling across North America, encourages active learning in-place, beyond school buildings and classrooms. Its roots may be traced to notions of 'Forest School' that emerged in some educational sites in Scandinavia in the 1950s, promoting nature-based literacy and exposing elementary and kindergarten-age students to natural environments. Forest school programs have endured in Scandinavia and also been adopted by Canadian schools, as I will reference later.

The environmental crisis we all face is not a passing trend and many educators spanning different disciplines are responding and rising to help meet the challenges of this crisis, and hopeful signs and movements are emerging, some of which are shared in this paper. This is a time to support promising initiatives, stimulate pertinent conversations and challenge assumptions about collective beliefs, values and actions. This path is daunting, but ignoring it or leaving it for others, including future generations, is more perilous. Through this essay, I wish to contribute to stimulating dialogue and movement in suggesting an initiative by which Simon Fraser University might deepen its response to this emerging crisis.

A key to navigating this path lies in discerning patterns hanging and braiding together as *gestalten*[5] that, according to philosopher and poet Jan Zwicky (2019), can help reveal "all understanding - not only of what logic is, but of what science is" (p. 4). In this case, it is also important to reflect on the provenance and scope of such logic and science and so deepen our understanding of *why we do what we do*. The importance of such analysis is paramount, according to the noted anthropologist Clifford Geertz (1973), who asserted every culture is underlain by patterns influencing the organization and behaviours of social and psychological processes, "much as genetic systems provide such a template for the organization of organic processes" (p.216).

[4] By modern, and modernism, both of which appear in this essay, I am referring to the philosophical and artistic underpinnings of these terms which thread back through a quest for rational knowledge (The Oxford Companion to Philosophy; 1995, p. 583) and are also considered as "a socially progressive trend of thought that affirms the power of human beings to create, improve and reshape their environment with the aid of practical experimentation, scientific knowledge, or technology" (Wikipedia, https://en.wikipedia.org/wiki/Modernism).

[5] *Gestalten* (Ger) is defined as a perceptual pattern or structure possessing qualities as a whole that cannot be described merely as a sum of its parts; Collins Eng. Dictionary.

University and *Place*

The rise of the university as an educational institution is traced by scholars to the academies of ancient Greece in its Classical period. Hundreds of years later, and overseen by religious authorities, its presence grew in medieval European culture where facilities were established in many European countries and cities. Curricula from this time mainly focused on religious (Christian) studies but grammar, rhetoric, arithmetic, geometry, music and astronomy were also taught as contributing to developing societies and cultures. Scholasticism mingled with religious ideology in these early universities until the tenets of the scientific revolution began to undermine the authority of the Monarchy and the Church, marking the beginning of the Enlightenment in the 1600s and 1700s. Universities soon became allies in the quest for, and promotion of, scientific knowledge, supported with government funding, new academies and private benefactors. This marked the beginning of the modern university, which distanced itself from religious doctrine in favour of the new, natural, physical sciences, the rules of which were defined in mathematical formulae and demonstrated in laboratory experiments. New technologies - girded by mechanical processes and discoveries like electricity - seeded the Industrial Revolution of the 1800s and established the utility of the modern university as its handmaiden. In the 1900s, industrialization spawned quests for new knowledge to learn about, and extend the projects of modernity from the sub-atomic to the macro-cosmic and, seemingly, everything in between, including the study of human society and its behaviours. Every project became linked to a university department, worldwide, and university knowledge - rooted in the epistemologies of engineering and human sciences - came to be seen as foundational to prosperous, professional life.[6] This new sentiment helped universities of the 20th century secure their new *place* in the modern world - each one being linked to a geographic location where professors and students met to exchange knowledge, and also an imaginary locus that helped crystallize the revered character of the knowledge they imparted.

Placing Simon Fraser University, ca. 1960

In the context of a growing province and expanding need for professional knowledge, Simon Fraser University's Burnaby Mountain campus was built in the 1960s. Its design, conceptualized by Arthur Erickson, BC's renowned modernist architect, featured a self-contained, cement-steel-glass-and-asphalt colossus that displaced approximately 170 hectares (420 acres) of first and second growth coastal temperate rainforest atop Burnaby Mountain. The university's lofty perch afforded spectacular views, when visible, of the mountains of the north shore, the waters of Burrard Inlet, the Fraser Valley, and a western glimpse of the Salish Sea beyond West Vancouver and Stanley Park.

First Nations authorities confirm the region, and the mountain, were traversed and occupied for thousands of years before colonization by at least four tribes of the Salish Coastal Peoples,: the Səl̓ílwətaɬ (Tsleil-Waututh), Skwxwú7mesh (Squamish), the xʷməθkwəy̓əm

[6] Reference: Wikipedia: https://en.wikipedia.org/wiki/University

(Musqueam) and the kʷikʷəƛ̓əm (Kwikwetlem) Nations. In 'Indigenous History in Burnaby: A Resource Guide' published by the City of Burnaby (2019) and distributed throughout the local school district, the authors report that indigenous inhabitants of the region developed knowledge hundreds of years ago to sustain communities year round, utilizing as many as 145 different species of plants for food, medicine and technology.

In a recent profile of Indigenous habitation of the region, SFU's *The Peak* newspaper described the four nations sharing resources acquired through hunting and gathering, and that nearby waters were sites of fishing and shellfish gathering (Puzon, 2017). The article further reports that when the university was being built in 1965, Burnaby Mountain was not part of any First Nations reserves, although people from many nations lived on reserves nearby. In the same article, William Lindsay, director of the Office for Aboriginal Peoples at SFU, says local First Nations, "weren't asked for their input on building the university. The First Peoples had no say, really, on what was happening on the mountain at that particular time" (Puzon, 2017, para. 12).

Likewise, the knowledge of the Coast Salish peoples who inhabited the region of Burnaby Mountain prior to colonial expropriation and the building of the university, is rooted in generations of accumulated wisdom about living sustainably *in-situ*, or *in-place*. First Nations perspectives are increasingly being integrated into university life, especially as part of reconciliation efforts adopted by the university, but it remains a work-in-progress. In 2017, SFU's Convocation Mall (Burnaby campus) was the site of a *Kwis Ns7eyx̱,* or witnessing ceremony led by elders of the Coast Salish First Nations. This event was organized to make public SFU's promise to honour the Aboriginal Reconciliation Council, or ARC's, *Walk this Path With Us* report public, and keep the university accountable to 33 actions it had committed to, including acknowledging that SFU stands on unceded territories through art and signage, investing in safe and culturally appropriate spaces as well as ceremonial spaces, and providing funds for teachers who seek to indigenize their courses (Pabico, 2018).

Placing **SFU, Today**

> *I respectfully acknowledge that we are on the traditional, unceded territories of the xʷməθkʷəy̓əm (Musqueam), Sḵwx̱wú7mesh (Squamish, Sel̓íl̓witulh (Tsleil-Waututh), and Kwikwetlem (kwikwəƛ̓ əm) Nations.*
>
> – common SFU acknowledgement in gesture of reconciliation

> *Our vision? To be Canada's leading engaged university*.
>
> – aspiration posted on SFU website[7]

Students attending Simon Fraser University today, or in recent years, will have encountered a version of the acknowledgement in the first quote above, and likely many times. Shaped by SFU administration, it has near-universal presence in all university greetings and on

[7] https://www.sfu.ca/about.html

all forms of university correspondence. Its purpose is to set a context of recognition and movement, to move beyond its colonial roots.

For a university defined by a history bound to modernist strictures, the gesture of reconciliation is important, and implies an aspiration of engagement. Engagement is also the stated intention of the second quote, and so pertinent to reflecting on the inter-relationality between the university's engagement and its *placement* on Burnaby Mountain. To state the obvious, there is practically no engagement with its surrounding environment. The university complex is encapsulated by various ring roads and sidewalks that act as *de facto* barriers from encountering or engaging with the surrounding forest. Included within what is designated as the university are classrooms, parking lots, laboratories, stores, offices, etc., all comprised of cement, asphalt, glass, steel and laminate. Within, there are 'green spaces' and fountains, hedges and gardens, all pleasing architectural 'accents' maintained by sweeping and snipping groundskeepers. It's everything and more one might encounter on a modern university, and similar to any modern edifice you might find in a city or suburb.

And modernism sometimes comes with a price. In this case, a huge and costly renovation to the university's flat-roofed, Burnaby Mountain campus infrastructure - deemed award-winning when it was unveiled in 1968 - following the discovery that much of the campus has deteriorated in the temperate, rainy climate of the Pacific northwest (DH Vancouver Staff, 2017).

This disconnect between the university's design and the known climate bespeaks an attitude rooted in a modernist drive to control nature or manipulate it to its own ends. Sometimes, as in the case of constructing housing developments, even nuclear power facilities, in known flood or fire zones, results have been catastrophic.

But SFU's main campus isn't a housing development or nuclear power plant; its main purpose is educative, and around twenty thousand students attend classes there each year. Each student's experience of the university reflects the artifacts and sensibilities of its design; if something has been set aside or ignored in this, then, logically, there's little opportunity for engagement. Therein lies the crux of a loss that calls out for recognition and redress.

Educator and author Gregory Smith, writing in *Education and the Environment* (1992), describes modern schooling as accomplice to an alienating force not only from the natural world, but also our historic roots: "The modern industrial worldview," he writes, "has led to our detachment from a sense of participatory relatedness to the natural environment, from our own concrete experience of that environment, and from the collective wisdom about how to interact with that environment we inherited from our ancestors" (p. 32).

Smith further asserts how abstracted knowledge transmitted through modern schooling teaches, by inference, "real learning happens inside school buildings and is composed of something other than (students') own natural observations." Smith also warns that through emphasizing detached, abstracted knowledge, modern schooling aligns itself with a delusional underpinning of technocracy, through which "people conflate intellectual detachment with the possibility of actually liberating ourselves from our fundamental embeddedness in the physical matrix of our own existence" (p. 32).

Environmental activist Bill McKibben describes this alienation a little differently. Writing in *The Age of Missing Information* (1992), McKibben says,

> We believe that we live in the "age of information," that there has been an information "explosion," an information "revolution." We also live at a moment of deep ignorance, when vital knowledge that humans have always possessed about who we are and where we live seems beyond our reach. An Unenlightenment. An age of missing information.... Human beings—any one of us, and our species as a whole—are not all-important, not at the center of the world. That is the one essential piece of information, the one great secret, offered by any encounter with the woods or the mountains or the ocean or any wilderness or chunk of nature or patch of night sky. (p. 9)

Figure 1. Sky-Roads – Photo depicting the imposition of a modernist, technocratic mindset upon an environment, characteristic of a manner of being that is minimally engaged with existing, natural features, if at all. Simon Fraser's Burnaby Mountain campus demonstrates a similar impositioning. (images source: author)

Place-Based Education

More recently, Smith has become an advocate of 'place-based education' (PBE), which comprises deliberate educative gestures designed to promote learning anchored in the knowledge of the local, the neighbourhood, the immediate bio-region. Such learning, Smith (2012) says, can foster community and environmental renewal and enhance "wise stewardship and protection of natural resources and areas" (p. 213). Teachers of PBE, Smith continues, leverage learning opportunities by engaging with natural phenomena arising outside the classroom door. In this way, he says, "community and place become additional 'texts' for student learning." (p. 213).

With the help of Smith and many other educators, PBE has grown into a rising force in K-12 schools, worldwide, promoting content learning, extended field trips and immersion

projects. In British Columbia, several school districts offer full-time enrollment in elementary 'Nature' or 'Forest School' programs in which learning takes place, rain, shine or snow, outside the school walls in local fields, forests, ravines and beaches. One national organization advocating such programing, Child & Nature Alliance of Canada, counts dozens of formal and informal place-based learning programs linked to schools, parks and other initiatives across the country. A guidebook produced by the Alliance, *Forest and Nature Schools in Canada* (2014), lists physical and mental health improvements as benefits of attending a nature-based program, as well as learning new skills and knowledge about natural environments. The Alliance also says it encourages its educators to incorporate ecological and stewardship knowledge from indigenous peoples wherever possible.

SFU's Faculty of Education, in coordination with First Nations educators, assists in the training of educators wishing to develop professional skills in environmental education, including 'nature school' programming. This training is available to school districts requesting it on behalf of educators, through district-based and online offerings, and it is also available through summer residency programming in provincial locations such as Haida Gwaii.

In my perambulating SFU's Burnaby Mountain campus in recent years — both the built environment and surrounding trails— I have never encountered any evidence the natural environment is or has been engaged as a learning environment, or 'forest classroom.' Neither have I seen or received any notice promoting a learning activity extending into the surrounding forest. This is a regrettable oversight. If elementary and secondary schools value 'nature schools' and other kinds of immersive environmental learning, those same values are worthy of adoption at a post-secondary level, and they are needed more than ever. SFU's mountaintop forest, moreover, affords an opportunity to gain valuable ecological and cultural knowledge as surely as any interior classroom environment.

SFU's Burnaby Campus and Sense of *Place*

In his recent book, *Place and Experience: A Philosophical Topography*, author Jeff Malpas (2018) says, place is "that within and out of which experience arises. Any experience of the world, along with the appearing of things within the world, will thus always be from within the embrace of place" (p 202). Later, he writes,

> place appears as the first and most primordial form of liminality, the latter term deriving from the Latin for threshold, *limen*, and connecting with the Latin *limitem* or *limes*, meaning limit our bound; and place appears as essentially adventual, as in 'arrival', 'event', 'happening', or, more literally, a 'coming to'. To be in place is therefore to be *at the threshold of the world* and to be taken up *in the happening of world*. (p. 209)

Malpas' phenomenological expression of place can be extended to the *experience of being* at SFU's mountaintop campus. Here, the "happening of world" is defined by what is experienced in this place; physically, the experience is shaped by the materials each person sees, feels, hears and touches. Given some experience of human voice and touch, almost all of these are synthetic, built, mass-produced. The liminality or boundedness is, quite literally, defined by the ring roads

and sidewalks that separate the university from the surrounding, nearly-impenetrable forest; any threshold to step beyond, into the forest, is not easily discernible. On circumnavigating the ring roads, I have discovered a couple of portals onto gravel trails leading into the forest which is designated as conservation land, but signage depicts the forested areas as barren, even "dangerous". Thus, any opportunity to engage or "embrace" this place is largely imaginary.

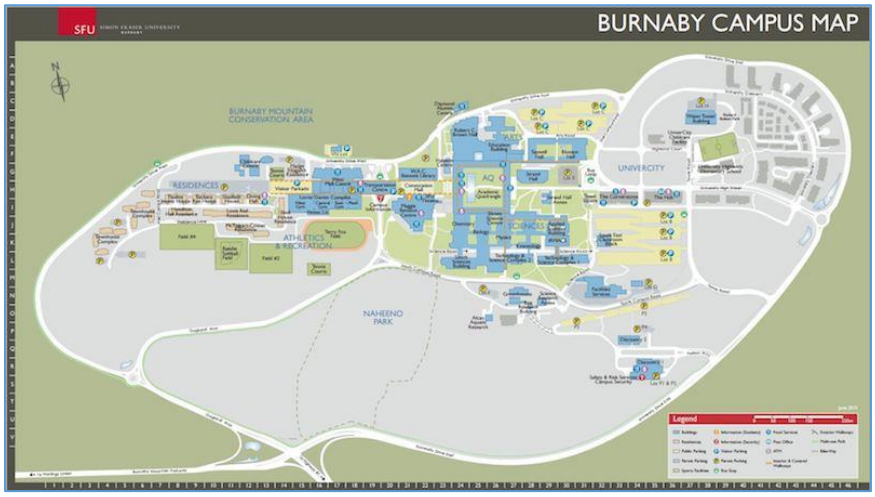

Figure 2. SFU Burnaby Campus Map – SFU's Burnaby Mountain campus is surrounded by a lush forest in which First Nations traveled and lived for thousands of years. However, campus maps detail the sterile, built environment while excluding any evocation of the forest's vitality and history. One map that is posted around campus identifies the forested area as "dangerous." (image source: Simon Fraser University)

Two years ago, while attending the mountaintop campus, I started 'crossing the threshold' and dipping into the forest beyond the ring roads. Mainly, I moved freely through the bush, gently walking 'off-trail'. I encountered a little bit of garbage and one abandoned site where someone had been camping out but otherwise I experienced what the forest offered: towering hemlock, spruce and cedar trees, blackened tree carapaces from historical fires, a shintangle of intergrowing salal, salmonberry and swordtail ferns, and alder trees, mainly decaying and yielding to a new succession of conifers. The air is soft, fragrant and filled with birdsong, especially in spring. On the ground, in any square meter, are vast swatches of microfauna: lichens and fungi, and any handful of soil yields white threads of mycelia, the forest's 'biochemical internet' that help circulate nutrients among trees and plants. Centipedes, spiders and slugs abound.

Having lived and worked in 'the bush' earlier in my life I am very comfortable in this environment, and comforted by knowing that whether I step two or two hundred meters into this forest, I easily discover what local First Nations refer to as "Earth's Blanket", the vital, terrestrial covering that constitutes, for them, the basis of life on earth. Ethnographer Nancy J. Turner (2008), writing in her book, *The Earth's Blanket: Traditional teachings for sustainable living*, says the concept comes from the depths of being of the Salish people of the southwest interior of

BC, a "deeply held belief in the integrity of their world and from the insightful understanding of the fragile and reciprocal relationship humans have with their environments" (p. 19). Helping protect the Earth's Blanket, Turner writes, was considered by First Nations as a sacred duty sustained over multiple generations.

Turner says the concept of the Earth's Blanket is similar to theories of interdependency rooted in the ecological sciences. And she asserts it is in direct contrast to an attitude of exploitation promoted by settlers and colonizing governments that have marginalized BC First Nations communities and cultures (p. 21). This attitude has driven a rush to log forests, create mines and dams, establish towns and cities, and build modern universities.

Conclusion: re-*Placing* SFU's Burnaby Mountain Campus

The difference in attitudes about engaging or embracing the environment, as exemplified by First Nations and ecological sciences, or ignoring and exploiting earth's resources, as exemplified in many modernist practices, demarcates a boundary, a *limitem*, as tangible as the boundary between SFU's mountaintop ring roads and the forest 'beyond,'

This boundary, I posit, is human-made and therefore changeable. And at this time, when global societies are predicted to be on a collision course with cascading environmental problems arising because of exploitation, excessive waste production and consumption of resources, and other human-related causes—it is essential that we change course to have any potential of averting disaster.

Education offers a key to this change, a point highlighted in a 2019 report by the International Panel on Climate Change. Focused on predicted vast effects of a further-warming climate, the authors of this *Special Report on the Ocean and Cryosphere in a Changing Climate*, are nonetheless clear in recommendations to build awareness and resiliency and help mitigate disaster:

> Investments in education and capacity building at various levels and scales facilitates social learning and long-term capability for context-specific responses to reduce risk and enhance resilience (*high confidence*). Specific activities include utilization of multiple knowledge systems and regional climate information into decision making, and the engagement of local communities, Indigenous peoples, and relevant stakeholders in adaptive governance arrangements and planning frameworks (*medium confidence).* Promotion of climate literacy and drawing on local, Indigenous and scientific knowledge systems enables public awareness, understanding and social learning about locality-specific risk and response potential (*high confidence*)". (International Panel on Climate Change, 2019, p. 42).

SFU presents itself as one of Canada's foremost institutes of higher learning, striving to be "Canada's leading engaged university" and "an institutional leader in building a sustainable society." It offers many remarkable learning experiences for students and it has shown much leadership through its progressive policies. But these policies stop short of helping its students more deeply engage with *learning-in-place* beyond the university edifice.

As this essay detailed in its introduction, the emerging environmental crisis portends looming disasters, worldwide. Post-secondary institutions have important roles to play in disseminating knowledge about this and responding pro-actively to address the issues meaningfully. This extends to SFU which can do more and especially with respect to its self-promoted aspiration of "engagement." To this end, it must re-assess and re-*place* its physical and imaginary constraints of *place*, and especially its Burnaby mountaintop campus. A suggestion is for the Burnaby Mountain campus to re-conceptualize and enable its own, hands-on, *in-situ* place-based education program in which it deeply engages its surrounding forest environment – a magnificent natural classroom if ever there was one – and invites First Nations educators to lead in-place, *in-situ*, learning programs, sharing their knowledge about how to live, sustainably, in this place. This learning isn't found atop the asphalt or along the cement plazas and synthetic corridors of the built university but it is found in the living earth and the spirit and attitude held in the First Nations concept of "Earth's Blanket". I urge SFU leadership to activate this kind of learning, which will serve to deepen the university's aspiration of engagement.

Engaging meaningfully in and with SFU's natural environment on Burnaby mountain as a *learnscape* will expand notions of place for all who partake. Stepping beyond the edge of the sidewalk, you will encounter new knowledge, and patterns and *gestalten* will be revealed offering critical knowledge about the natural world and how First Nations lived in relation to it and sustained themselves for thousands of years. This world beyond the ring roads and sidewalks holds such knowledge and it surely offers keys to our survival as well. *This place* — waiting for us to get as curious about it as we are about engineering science, macroeconomics, linguistics and a thousand other subjects holding our fascination — will expand our notions of who we are and, especially, what we value, going forward in an uncertain future. Let's take that step.

Figure 3. Where the sidewalk ends – The author, stepping beyond the sidewalk into the forest surrounding SFU's Burnaby Mountaintop campus. This 'living classroom' — home to myriad forms of life and living processes — holds vital knowledge that is not learnable in a synthetic classroom. *Are you ready to engage?* (image source: author)

More Pictures

SFU Burnaby Mountain Forest – all photos taken by author

Figure 4. A burned-out Douglas Fir tree still stores large amounts of carbon, and will provide nutrients for many future plants and other organisms.

Figure 5. Colonies of mushrooms help to decompose leaves and trees and branches; some you can even eat!

Figure 6. 2nd or 3rd growth alder trees sharing the ground with sword ferns; these will yield to conifers in 20-30 years

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Author's closing note: *The pandemic of 2020, wrought by COVID-19, has forced human societies, worldwide, to adjust to many new realities. Obviously, we are changed and continue to change, because of it. The climate crisis and all other looming environmental issues, say many experts, pose equally if not larger risks. Reconceptualizing a sense of place, as I posit in this essay, is a way to awaken to new ways of being that may well help ensure our health during the time of this pandemic and beyond.*

References

Brundtland Commission (1987). *Our common future: The world commission on environment and development*; Oxford University Press.

City of Burnaby (2019). *Indigenous history in Burnaby: A resource guide*. Retrieved from http://www.burnabyvillagemuseum.ca/assets/Documents/Teachers~Guides/Indigenous%20History%20in%20Burnaby%20Resouce%20Guide.pdf

DH Vancouver Staff (2017, December 19). SFU campus is crumbling, fix required as high as $700 million. *The Daily Hive*. https://dailyhive.com/vancouver/sfu-campus-crumbling-700-million-fix

Geertz (1973). *The interpretation of cultures*. New York: Basic Books.

International Panel on Climate Change (2019). *Special Report on the Ocean and Cryosphere in a Changing Climate; Summary for Policymakers*, sec. C.4.4. Retrieved from https://www.ipcc.ch/srocc/chapter/summary-for-policymakers/

Malpas, J. (2018). *Place and experience: A philosophical topography*. 2nd ed. Routledge.

McKibben, B. (1992). *The age of missing information*. Random House.

Pabico, J. (2018, July 4). Moments of SFU's history with the Indigenous community. *The Peak.* https://the-peak.ca/2018/07/moments-of-sfus-history-with-the-indigenous-community/

Puzon, B (2017, February 28). The History of the Coast Salish Peoples on Burnaby Mountain. *The Peak*. https://the-peak.ca/2017/02/the-history-of-coast-salish-peoples-on-burnaby-mountain/

Rees, W. (2019, November 12;). Memo from a Climate Crisis Realist: The Choice Before Us (part 1). *The Tyee*. https://thetyee.ca/Analysis/2019/11/12/Climate-Crisis-Realist-Memo/

Rees, W., & Wackernagel, M. (1996). *Our ecological footprint*. New Society.

Smith, G. (1992). *Education and the environment: Learning to live with limits.* SUNY.

Smith, G. (2012). Place-based education: Practice and impacts. In R. B. Stevenson, M. Brody, J. Dillon, & A. E. J. Wals (Eds.), *International Handbook of Research on Environmental Education* (pp. 213-220). Retrieved from http://ebookcentral.proquest.com

Turner, N. (2008). *The Earth's blanket: Traditional teachings for sustainable living*. Douglas & McIntyre.

Zwicky, J. (2019). *The experience of meaning*. McGill-Queen's University Press.

CURATING A FUTURE EARTH

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Abstract

In fall 2019, I enrolled in SFU's President's Dream Colloquium course, Creative Ecologies: Reimagining the World. One of the scholars we read was anthropology professor Dr. Shannon Mattern. My creative response to Mattern's paper—"The Big Data of Ice, Rocks, Soils, and Sediments"—offered an alternative way to engage with her scholarship. In searching for poetic and concise turns of phrase, I noted how her word choice and image-making related to her essay's construction. I sought out bits of data from her paper, re-arranged them into a cohesive unit, and from this garnered a deeper meaning of her intent and expertise. I also noted what was absent or lacking, and this deficit of words, specifically toward 'should we be exploiting the planet for research?' inspired me to emphasize this in my found poem.

Keywords: poetic inquiry, creative ecologies, climate science, Shannon Mattern, climate crisis

Curating a Future Earth*

muddy icy soggy
library of the earth
matter out of place
saturated with ironies

layers of abstraction
mud and rocks on a shelf
lakes that have evaporated
icebergs that no longer exist

arks of the apocalypse
await digitization

ASCII text
floppy disks
phosphates
phytoplankton
precipitation
fertilizers
non-relational flat-file

graceful degradation
suspended life
entangled in
terrestrial transformation

stalactites
stalagmites
particulates

follow epistemological protocols
questions no one ever thought to ask

boreholes
ice cores
pollen spores
megafonds
freezer farms

what do the rocks say?
over and over again
window to the Earth's past
dirtier the deeper you go

the old ontological question

what is alive?

dredged petroleum contamination
building becomes the end in itself
the unbearable becomes inevitable

leaky boats
ride the rising waves

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[*] All phrases and words taken from Shannon Mattern, "The Big Data of Ice, Rocks, Soils, and Sediments," Places Journal, November 2017. Accessed 22 Oct 2019. https://doi.org/10.22269/171107

REPORTS

TOWARDS A NEW TEACHING APPROACH FOR SCIENTIFIC LITERACY: EXPLORING THROUGH A THREE-VISION FRAMEWORK FOR TEACHING SCIENCE

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Abstract

Through the three-visions framework, a science educator approaches her science lessons and her practice from a more purposeful and intentional place and building and understanding the relation to the subject of study beyond an objective view can potentially bring more meaningful learning for the students.

Keywords: science literacy, vision I, vision II, vision III, scientific literacy, relationality

Towards a New Teaching Approach for Scientific Literacy: Exploring through a Three-Vision Framework for Teaching Science

Research on science education is diverse and there are different perspectives and accepted classroom practices on teaching and learning science. The broadly accepted idea about science education is that it contributes to two main areas of development: social agency and agency in the material world. Social agency provides a sense of respect for knowledge and skills to allow an individual to do useful work (Anderson, 2007). Agency in the material world contributes to an individual's ability to effectively explain phenomena and to influence both natural and technological systems. Essentially, science has been taught through conceptual change theories, which presents scientific concepts with the intention to change a student's current conceptual framework about a topic to cultivate and create a critically thinking citizen (Anderson, 2007).

There are two terms to describe a scientifically inclined person: science literate and scientific*ally* literate; and each has its own sets of "criteria". These criteria are segregated into two visions, Visions I and II, which describe the difference between a science literate (Vision I) and a scientifically literate person (Vision II) (Roberts & Bybee, 2014) and reviewed in (Tan, 2016). Building on critical work by Roberts and Bybee, I will briefly describe Vision I and Vision II in the following sections. Briefly, Vision I's principles are about curriculum, knowledge built from pre-existing techniques and methods that are well tested with explanations for the events and objects of the natural world. Science literacy is said to be important to enable one to sift through the massive amount of information and to decipher fact from fiction. In part, the role of science literacy is to encourage critical reading related to one's welfare and democracy (Fischer, 2011). Vision II's principles were developed later (based on elements from Vision I) and encourage an understanding of science through a more holistic lens to consider human endeavour and life situations as part of the solution to creating a scientifically literate person (Roberts & Bybee, 2014). Specifically, Vision II points to a scientifically literate person as someone who "reflects critically on information and appreciates and understands the impact of science on everyday life" (p. 547). It is important to note that there are multiple interpretations of Vision I and Vision II of the science literate and scientifically literate person depending on the organization or group who defines it. According to Roberts, (2007) each Vision can be viewed as extremes of a scientific literacy spectrum. Within a classroom, an educator may teach using a science infused curriculum that adopts and integrates elements from each Vision to support the student's learning and not necessarily solely focused on Vision I or II at any time or in any given activity. Although Vision I and II have been widely accepted by most in the field of science education to attribute characteristics of a scientifically literate person, a standard definition of a "scientific literate" person is still debated. For complete in-depth reading, please refer to Roberts and Bybee's published piece in 2014 or for a review of their work, please refer to Tan, published in 2016.

In the past decade, scientific literacy has encompassed a STEAM (Science, Technology, Engineering, Arts, and Math) as an attempt to bridge Science and Art disciplines to address

Cartesian divides. In this brief communication, I am presenting a new Vision, one that melds instead of bridging the Science and Art disciplines. Aligning with specific post-humanist theories and Indigenous Hawaiian epistemology, Vision III presents theoretical concepts of relationality with 'others' that include the more-than-human.

Vision III presents attributes of a scientifically literate person who places equal importance to different understandings about science (e.g. Indigenous knowledge, philosophy and art). Vision III is based on theoretical concepts on relationality with/within 'others' by acknowledging that scientific understanding and thinking is a fluid process and recognizing that this process is continual and perpetual. We propose that the convergence of scientific knowledge (Vision I), and scientific application (Vision II) with an understanding about the relations between and within human and non-human entities will eliminate a dualistic and objectified worldview, and thus moving towards a deeper understanding of "science citizenship and global interdependence" (Bybee, 2018, p. 61).

Scientific citizenship is a notion that has been defined and redefined for many centuries. The idea of scientific citizenship implies citizens with scientific knowledge and understanding can make responsible choices for personal well being and for the well-being of others. "Citizenship is both the condition of being a citizen and the reciprocal obligation of duties, rights, and privileges" (Bybee, 2018, p. 57). The idea of citizenship carried through until the Enlightenment period in the late 18th century. The Enlightenment period closely associated with the scientific revolution era where René Descartes philosophy on reasoning was the focus for knowledge creation (Mills & Woods, 1996) and this redefined the meaning of citizenship to move responsibilities from a regional to a national level. As we progress through the 21st century, the idea of citizenship is evolving to include a global perspective. Bybee (2018), acknowledges and insists that scientific citizenship, must now include, a move towards global scientific citizenship where perspectives from other disciplines are considered to realize the "interrelatedness of individuals, environments and communities" (p. 61). The shift in scientific citizenship is further discussed in a concluding argument by Ward and Dubos (1972),

> A strategy for planet Earth, undergirded by a sense of collective responsibility to discover more about man-environment relations, could well move, then, into operation on these three fronts: atmosphere, oceans, and climate. It is no small undertaking, but quite possibly the very minimum required in defense of the future of the human race.
>
> An acceptable strategy for planet Earth must, then explicitly take account of the fact that the natural resource most threatened with pollution, most exposed to degradation, most liable to irreversible damage is not this or that species, not this or that plant or biome or habitat, not even the free airs or the great oceans. *It is man himself.* (p. 217)

Therefore, through my research and this brief communication, I am proposing the three-visions framework (Tan, 2018), illustrated by Figure 1. Through this framework, a science educator approaches her science lessons and her practice from a more purposeful and intentional

place and building and understanding the relation to the subject of study beyond an objective view can potentially bring more meaningful learning for the students.

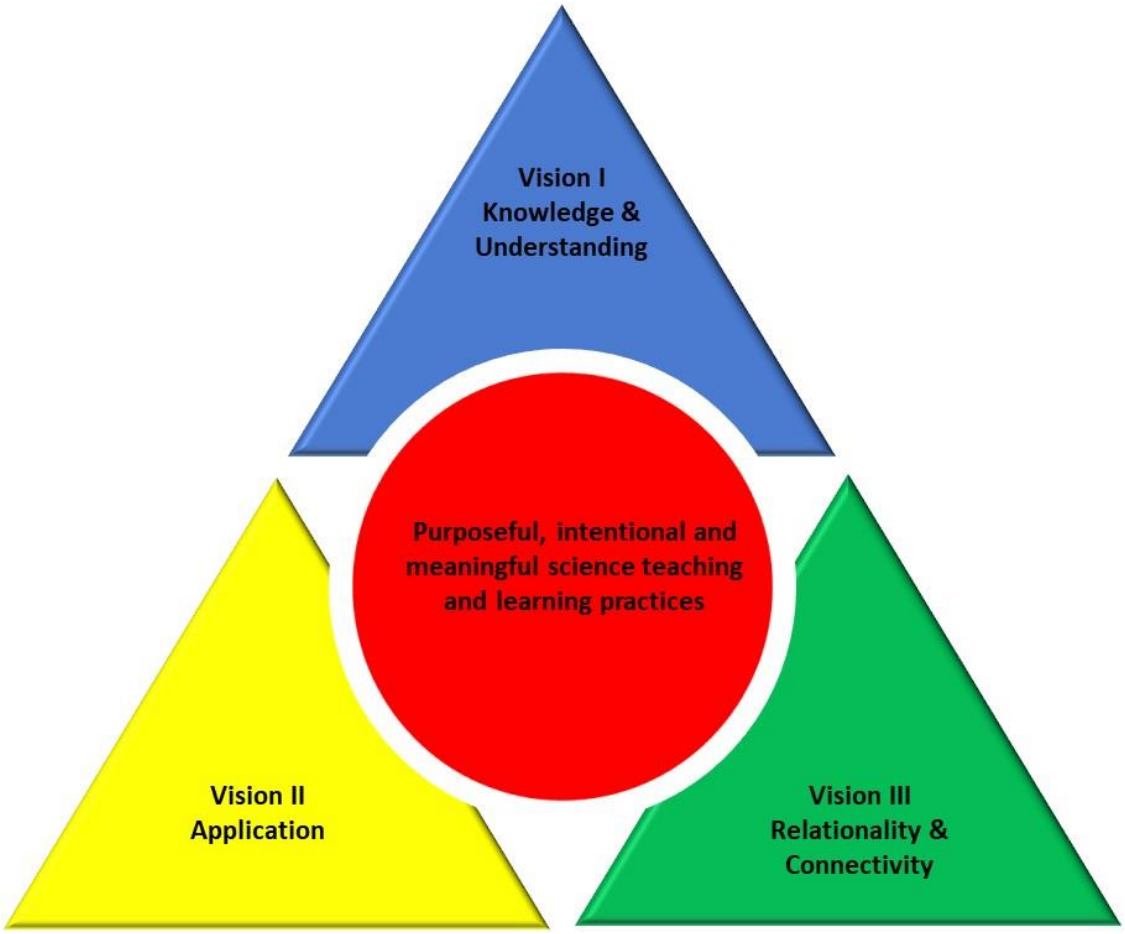

Figure 1 Three visions framework built upon accepted definitions of scientific and science literacy to include relationality and connectivity through different approaches of teaching science.

References

Anderson, C. (2007). Perspectives in science learning. In S. K. Abell, & N. G. Lederman, *Handbook of Research on Science Education* (pp. 3-30). New York: Routledge.

Bybee, R. W. (2018). *STEM education more than ever.* Arlington, Virginia: National Science Teachers Association Press.

Fischer, C. N. (2011). Changing the science education paradigm: From teaching facts to engaging the intellect: Science education colloquia series. *The Yale Journal of Biology and Medicine*, 247-251.

Mills, R. K., & Woods, J. C. (1996). Teaching about the influence of the scientific revolution and the Enlightenment on early American history. *The Social Studies, 87*(4), 152-155. doi:https://doi-org.proxy.lib.sfu.ca/10.1080/00377996.1996.9958430

Roberts, D. A. (2007). Scientific Literacy/Science Literacy. In S. K. Abell, & N. G. Lederman, *Handbook of Research on Science Education* (pp. 729-781). New York, NY: Routledge.

Roberts, D., & Bybee, R. (2014). Scientific Literacy, Science Literacy and Science Education. In N. G. Lederman, & S. K. Abell, *Handbook of Research on Science Education* (pp. 545-558). New York: Routledge.

Tan, P. (2016). Science education: Defining the scientific literate person. *Simon Fraser University Educational Review, 9.*

Ward, B., & Dubos, R. (1972). *Only one Earth.* New York, New York: W. W. Norton and Company.

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