Final Knowledge Synthesis Report

Dominant Technological Paradigms: Impacts for Education Systems and Policy

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Summary

New digital technologies are changing the way we work, play and live in wide reaching and increasingly complex ways. With a focus on research knowledge developed within the past 10 years, this knowledge synthesis uses an intersectional framework to explore how new technologies are changing work and society in Canada, and how education can best prepare students for the realities of the perpetually evolving and potentially enigmatic knowledge based economy.

Broadly speaking, technological changes can be understood within one of two paradigms: technology is replacing work through automation and digital taylorism; and technology is changing communication, collaboration and knowledge creation. In this report, the two dominant technological paradigms are explored independently, followed by a discussion of the realized and potential collective impacts for education systems in Canada. Throughout, the social, economic and political contexts that shape and are shaped by the development and implementations of new digital technologies are also surfaced and critically evaluated.

Dominant Technological Paradigm 1

Digital Taylorism: Technology replacing/simplifying work

New digital technologies and increasingly intelligent algorithms are expanding the reach and scope of technological displacement beyond low skilled jobs into employment areas that were previously thought to be immune to automation. A growing number of white collar, middle

class professions, such as in media, education, healthcare, social services, financial management, legal occupations, information and communication technologies, and countless others, are at risk of their jobs being outsourced or of becoming obsolete via digital taylorism (Lewchuck & Lafleche, 2014; Beck, 2000). That diverse individuals within civil society develop an awareness of, and the capacity to, understand and engage with the forms and applications of new technologies as they emerge, will be crucial for identifying and critically evaluating the potential and realized environmental, economic and social impacts of technological progress and expanding labour arbitrage.

Key Ideas:

- Increased automation and digital taylorism highlights the need to develop uniquely human abilities;
- Engaged, informed, critical awareness and reflection of technological progress are essential to overall wellbeing and prosperity.

Dominant Technological Paradigm 2

Information and Communication Technologies are Changing/Expanding Collaboration, Crowdsourcing and Globalization

Digital internet technologies have opened up new avenues for communication and collaboration "with diverse others across globalized transnational spaces, multimodal texts, and distant, heterogeneous, and interactive audiences" (Hull & Stornaiuolo, 2014, p. 16). Individuals are now able to not only consume but produce media, blurring the boundaries between public/private, expert/novice, and objectivity/subjectivity. Further complicating matters,

algorithmic software programs are now writing formulaic, but original content, often indiscernible from and more readily trusted than human authors (Clerwell, 2014). ICT are rapidly becoming better and cheaper, transforming and growing the types of work that can be done remotely for less (Brown et al. 2008; McAfee & Brynjolfsson 2016), while the governments of emerging economies, such as China and India, are proactively investing in advanced ICT and engineering education. Fragmented work arrangements parceled out over vast distances (i.e. crowdsourcing) have become more common and accessible for employers, producing precarious jobs, downloading the responsibility for benefits, training and skills enhancement to individual workers, and challenging the fundamental notion of work as a primarily market driven activity. Undoubtedly, moving forward, digital technologies and collaborative networks will be integral to understanding and addressing social, economic and environmental issues.

Key Ideas:

- Globalization of work is expanding;
- Collaboration in digital platforms is blurring the lines between work and play;
- Innovation will depend on interdisciplinary and an evolving understanding of communication platforms.

Recommendations for Education

An essential first step toward making effective and sustainable improvements to education systems is to surface and evaluate the following underlying ideological assumptions:

1) Meritocracy as the primary effective means to the middle class (Loveday, 2015), which for education means higher skills equals better jobs and a better economy, and that

individuals are, and should, be independently responsibility for their own wellbeing and success (i.e. neoliberalism) (Corman & Luxton, 2007)

2) Progress, including technological progress, is inevitable, thus taking away the responsibility of society to actively engage in making decisions about the future (Hornborg, 2014).

We recommend the follow to improve education systems in Canada:

- Reduce standardized testing and create district-wide digital learning portfolios.
- Place "soft skills" and inter/intrapersonal development at the forefront through student centered approaches that encourage the interests, creativity and agency, in consort with collaborative decision making and democratic engagement.
- Integrate social and emotional learning outcomes into the curriculum and education policy, and develop courses specifically designed to advance innovation, collaboration and social and emotional learning.
- Implement a holistic, threshold concept approach to curriculum development that focuses educational policy and practice on the complexity and transdisciplinary nature of knowledge.

Introduction – Context/Implications

Perpetual and proliferating, the impacts and implications of new digital technologies for lives and livelihoods in the 21st century are far reaching, often remarkable, and primarily irreversible. New digital technologies are replacing both traditional and knowledge based human labour through automation and algorithmic programing, and digital taylorism is allowing companies to more readily compartmentalize and outsource residual knowledge based employment globally. As broad problematic trends in the domestic labour market persist, such as increased part time, contract and precarious work and decreased unionization (Woodman 2012), the dynamic global technoscape further disrupts and dismantles work in Canada as nationally bounded, increasing competition for work and limiting opportunities for even the most highly skilled workers (Brown et al. 2011). Despite the clear trend of technology, particularly digital technology, putting downward pressure on labour, the 20th century education gospel of higher skills equals better jobs equals a better economy remains resolute within education research and practice. This report explores how new technologies and digital taylorism are changing work and society in Canada, and provides recommendations for creating education systems that can best prepare students for the realities of the perpetually evolving and potentially enigmatic knowledge based economy.

Methodology

An intersectional framework was used to explore how new technologies and digital taylorism are changing work and society in Canada, and how education can best prepare students for the realities of the perpetually evolving and potentially enigmatic knowledge based economy. The following questions guided and framed our knowledge synthesis:

- What are the dominant technological paradigms and in what ways have they enabled and constrained the educational landscape as it pertains to the social, political, and economic relationships amongst and across populations and communities?
- In what ways is the digital variable reorienting understandings and blurring the boundaries of what counts as work or play, public or private, local or global?
- What threats and possibilities need to be surfaced so Canadians can better understand what is at stake in the relationship between education, credentialing, and expectations for meaningful employment, as well as individual, community and societal well-being?

A qualitative content analysis approach was employed to systematically review peer reviewed quantitative, qualitative and mixed methods studies, with a primary focus on those based in a Canadian context within the past 10 years. Policy and research documents from public, private and not-for-profit sectors (grey literature) were also collected and analysed, compared and contrasted with extant scholarly sources in education and digital economy discourses.

Peer reviewed economics literature and relevant grey literature discussing the potential and realized impacts of the digital, knowledge based economy on the Canadian labour market, society and culture were gathered. Concurrently, peer reviewed education research and relevant grey literature contextualizing education paradigms in the digital era were also collected. Scholarly literature were searched for and gathered through the university of Prince Edward Island Roberson Library One Search Database, the Education Resources Information Center (ERIC) database, and Google Scholar. Multiple searches were conducted over the duration of the knowledge synthesis, using varied combinations of the following key words: New digital technologies, digital taylorism, algorithms, algorithmic programs, intelligent computers, globalization, Canadian, Canada, labour market, employment, future. Local and national news outlets, as well as popular websites, blogs and online journals that focus on economic and/or new technologies in Canada, were also monitored regularly and searched using the keywords listed above. For both grey and scholarly literature, priority was placed on the most recent publications. Influential sources referenced within these texts were also identified and gathered for inclusion in analysis.

Using a deductive framework methodology (Finfgeld-Connett, 2014), these studies were thematically coded into the following broad areas of analysis: impacts of digital technology on the economy, labour market and society; underlying and identified goals and purposes of education; opportunities and possibilities for local and provincial involvement in shaping education; intersecting inequalities as a mitigating or contributory factor. Throughout the analysis, techniques such as memoing, diagramming and reflection were employed, allowing for sub-themes to be developed, reviewed and adapted and for alterations of the coding framework to materialize iteratively (Finfgeld-Connett, 2014). Findings from both economic and education

literature were juxtaposed in order to identify synchronicity and/or divergence between the current educational paradigms and the digital economy discourse, and to highlight extant gaps in how these studies explore and frame education in the digital age.

Theoretical Underpinnings

Kuhn (1962) advanced that theory and knowledge acquisition inherently arises from and is situated within paradigms. Exploring theory, including education and economic theory, through a paradigm framework surfaces and provides insight into the ideological underpinnings and implicit assumptions therein. For example, Pikerty's (2014) analysis of the neoliberal paradigm undergirding capitalism highlights the significance and value of a paradigmatic framing of current economic, political and cultural systems, systems that are increasingly gridlocked within traditional prescriptive structures insufficient for envisioning and enacting sustainable positive social change. Social and political will to change economic structures has, and will continue to, impact educational policy. As such, educational change cannot be understood outside the larger political and economic paradigm of preparing a future workforce and future citizens to take up their lives. The difficulty of previous educational reform efforts is that they have typically been envisioned as changes in the classroom with isolated, easily measurable outcomes. This narrow approach makes education a technical endeavour. Should Canada desire to become a world leader in education, a systemic integrated response (i.e. a paradigm shift) is required.

Results/State of Knowledge

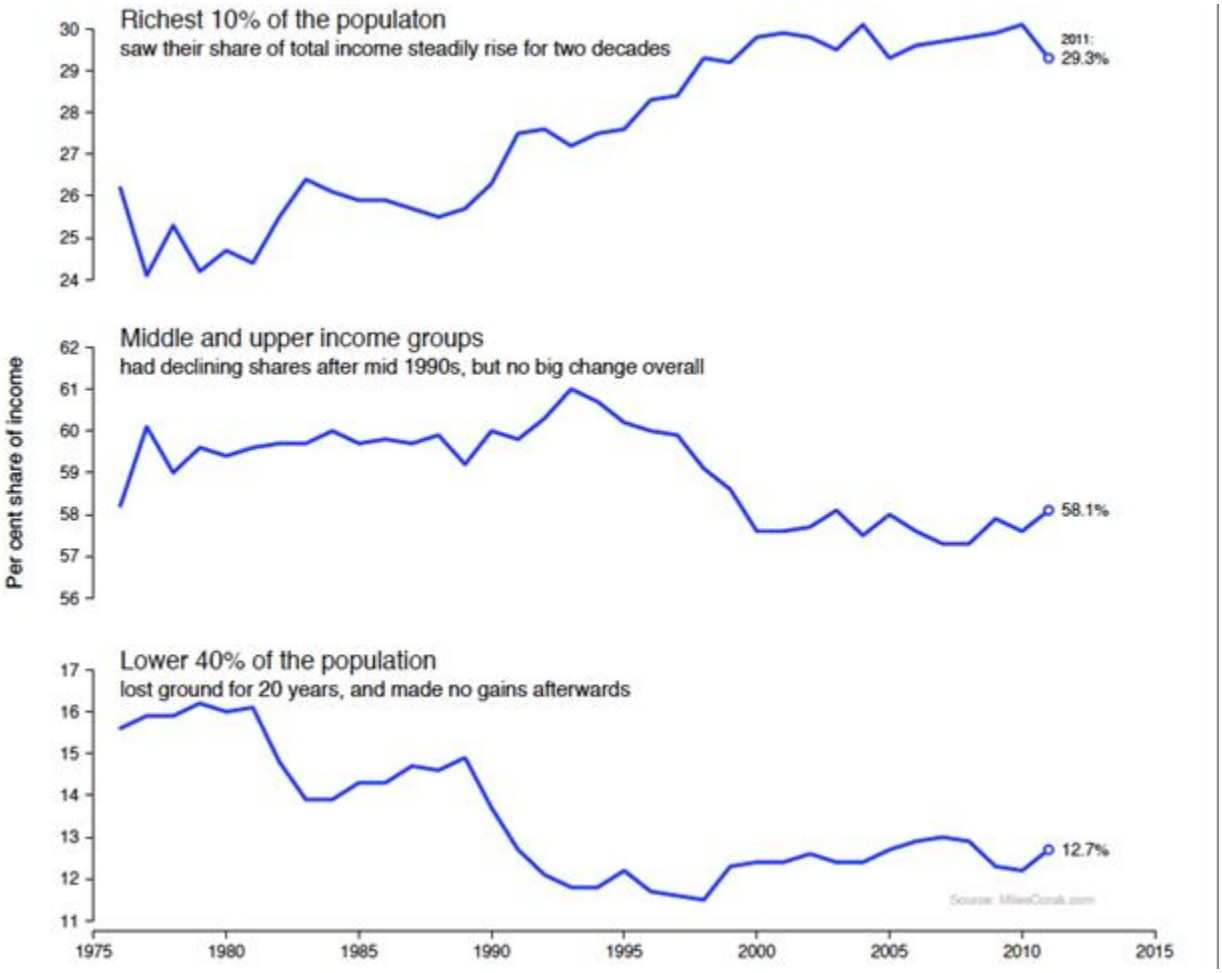
This report surfaces two dominant technological paradigms that are shaping work, play and life in the digital era: one is that technology is replacing work through automation and digital taylorism; and the other is that it is changing communication, collaboration and knowledge creation. The two dominant technological paradigms are explored independently, followed by a discussion of the realized and potential impacts for education systems in Canada.

Dominant Technological Paradigm 1

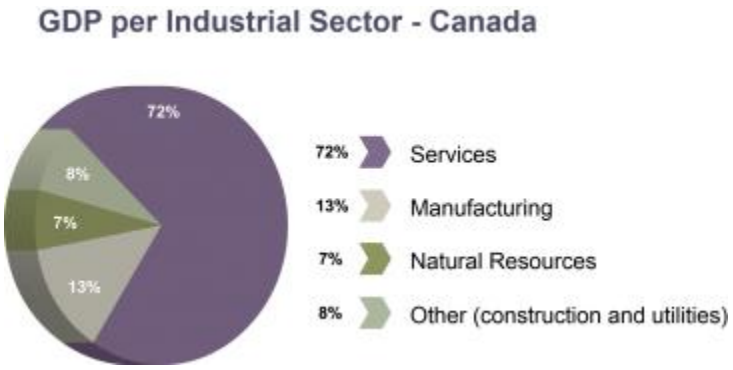
Digital Taylorism: Technology Replacing/Simplifying work

The idea that robots will eventually take over much of human labour has long been a part of our social imaginary, whether it is the Jetson's Rosie doing our household chores or self driving cars simplifying our commute, or Star Trek like tricorders healing our bodies. Remarkably, these realities are either not far off, or are already taking place (see Rumbas, Google cars and the Qualcomm Tricorder project http://tricorder.xprize.org/). But what happens to the nature of work, not only for the significance it has in individual worker's lives, but its implications for society, economically, legally, and politically? Rather than simply accept that replacing human workers with new technologies is part of progress, it is important to interrogate how these transitions are unfolding. For example, until recently, low skilled workers have disproportionately borne the brunt of technological advancement, and generally as a society this

displacement has met minimal resistance. There are a few factors that have permitted and facilitated technological innovations displacing workers to date. As new automated technologies have dismantled and subsumed paid work, residual low skilled labour has been increasingly sent overseas, undermining the breadth and bargaining power of working class labour unions (Atkinson, 2010). While many jobs have been lost in manufacturing and primary sector industries, overwhelming increases in unemployment levels have been largely deflected by a rise in low paid service sector work (Vosko & Clark, 2009).



Corak, Miles. Statistics Canada data, various surveys.
https://milescorak.com/2015/08/28/who-are-the-middle-class



"The Canadian economy is dominated by the services industry, which makes up 72% of GDP and employs 78% of Canada's workforce…As developed economies have found their value through knowledge creation and innovation activities, 'creative class' workers (e.g., scientists, engineers, media workers, designers) in the services sector have seen their market worth rise, while blue-collar workers and low-skilled service workers have seen little growth in their relative value, even though the latter still dominate the services industry." Policy Horizons Canada: The Government of Canada, 2013. (Chart Adapted from: Statistics Canada, 2011 and 2012). http://www.horizons.gc.ca/eng/content/significant-shifts-key-economic-sectors

While a minority creative class has improved its position in the labour market and economy in recent years, the majority of service sector jobs are part-time, precarious and fall below a living wage. This has contributed to the continued growth of social inequality and increasing number of working poor across Canada. However, the displacement of paid work by new technologies has been permitted to continue unabated because its impacts have been restricted primarily to the working class. There is an underlying understanding within the Canadian social imaginary that the housekeeper replaced by "Rosie", or the taxi driver ousted by the Google car, could be expected to simply "better themselves" by going back to school and getting a middle class job, or more specifically, that they should have done so in the first place. Middle class cultural ideology has been a central driving force within the Canadian social imaginary since the industrial revolution brought a marked distinction between manual labour and skilled 'white collar' professions (Weeks, 2011). The concept of a segmented labour market divided between

primary (i.e. skilled) and secondary (i.e. unskilled) employment (Thompson, 1983) remains salient and continues to shape understandings of what it means to be 'middle class'. The primacy of this middle class ideal was starkly apparent most recently during the 2015 Federal election, exemplified by the Liberal Party's platform geared toward "the middle class and those working hard to join it" (Liberal Party of Canada, 2015). This defining statement demonstrates the neoliberal underpinnings of the middle class narrative; 'good citizens' are those who work for pay in order to purchase goods and services indicative of a middle class lifestyle, independent of state intervention (Thorson, 2007). This lassie-fair lens supports a delineated categorization of the "deserving" and "non-deserving" poor, which has been at the heart of the gradual dismantling of the social safety net in Canada (Pupo & Duffy, 2007), and has been an underlying rationale for systemic labour market deregulation, increasing occurrences of non-standard, flexible work arrangements, precarious jobs, international outsourcing of labour and deunionization disproportionately impacting low-wage workers (Atkinson, 2010; Peck & Theodore, 2012; Vosko & Clark, 2009). The pervasiveness of the middle class individualistic narrative makes it easier to overlook the complex, often interconnected ways that lived experiences, social, cultural and financial capitals, and intersecting inequalities, such as race, gender, sexuality and socio-economic status, create challenges and barriers to attaining and maintaining a "middle class" lifestyle.

Industrialization saw the broad enactment of taylorist work processes that involve breaking down work into simplified, measurable segments requiring repetitive tasks and minimal qualifications, which has contributed to a continual increase in secondary sector employment. The introduction of new digital technologies has further intensified work standardization, surveillance and employee time management in a wide range of employment areas (Parenti,

2001). Notably, standardization and lean management approaches have not been restricted to manufacturing and primary sectors. For example, cutbacks in front line health care and social services have led to the implementation of new organizational methods that strive to break down emotional labour and caring work into measurable cost-effective segments, resulting in job losses and increased worker stress and burnout for those remaining in these sectors (Cumella, 2008). Though jobs in healthcare and social services have represented some of the highest paying, most stable of professions dominated by women, they tend to fall outside the social imaginary of the middle class ideal, and as such, job losses in these areas have been insufficient to challenge the underlying neoliberal narrative. Many of these positions involve characteristics indicative of working class jobs (i.e. physical labour, irregular hours and lower pay than most white collar, middle class professions). Furthermore, though caring work can be fragmented and intensified it can not be replaced completely because it is primarily location specific, and, as such, can not be outsourced overseas (though employing low paid temporary foreign workers adds an additional problematic layer to consider), and also involves skills in empathy and human connectivity that are yet beyond the reach of modern digital technologies, highlighting the need for traits and abilities that are uniquely human within the modern day labour market. However, the tasks that fall under 'uniquely human' are constantly being reevaluated as new technologies challenge assumptions of how and why caring process might be simplified and/or automated. For example, researchers at UPEI are currently testing the effectiveness of a software application that provides addictions treatment (Day, 2015, December). If successful, this online software program could increase access for diverse populations and those who may be more comfortable with a digital counselling format, as well as more easily provide the service in more remote areas. It is not difficult to imagine how this type of program could reduce the number of front

line counselling staff, with only the most extreme cases requiring specialized human interaction and support.

As new digital technologies continue to develop and permeate domains beyond routine tasks (Frey & Osborne, 2013), workers across the employment hierarchy have become increasingly vulnerable to the negative impacts of new organizational methods and technological displacement. Essentially, more and more workers, including those working traditionally middle class positions that seemed largely beyond the reach of taylorism such as those in media, education, healthcare and the knowledge economy, are at risk of their jobs being outsourced or of becoming obsolete (Lewchuck & Lafleche, 2014; Beck, 2000). Parenti (2001) surmised that the development and broad implementation of digital technologies that furthered labour standardization practices and allowed for increased surveillance and time management of workers constituted a form a 'digital taylorism'. Today, the expression of labour arbitrage and new digital taylorist labour practices is via algorithms, and middle class jobs are no longer immune to technological displacement.

One need go no further than the grocery store self-checkout to see how new technologies have and are changing service industries. However, automated service technologies are quickly moving into areas traditionally assumed to be stable, middle class, "skilled" employment. For example, McFeat (2016) interviewed Mike Katchen, the CEO of Wealthsimple, the biggest robo-adviser firm in Canada, and Randy Crass, CEO of Nest Wealth, a Toronto-based robo-adviser firm to discuss the ways software algorithms are being used as "robo-advisers" to work with clients to track investment portfolios. The software algorithms of these so-called robo-advisers are not very complex, and can basically only track the funds. These robo-advisers do not communicate, give advice or actually make stock market trades. As such, they are unlikely to

outperform their human counterparts, a truth to which both Katchen and Crass both concede. “It is at the nexus of *what can be offered for less* and *a reduced consumer expectation for what needs to be offered* that a paradigm shift in this middle class service industry becomes apparent” (Wiebe & Altass, in press). These simplistic algorithms do nothing more than track how the funds are doing and balance the asset mix according to the fairly common questionnaires that a client would fill out to describe her/his investor profile, such as preferred sectors, risk tolerance, and short and long term expectations (McFeat, 2016). Similar to grocery store customers enacting their own labour to scan their purchases, robo-adviser clients provide the necessary information from which the algorithmic software works. As noted above, it is not sophisticated machine learning that is driving this paradigm shift in the financial industry, but a combination of reduced consumer expectation for quality service and increased consumer expectation to pay lower costs (Wiebe & Altass, in press).

To set the background for the middle class employment context, it is important to note that financial management, while not requiring a university degree in business, appears to require the kind of specialized expertise typical of an entry level middle-class job that can be viewed as offering some distinction over the trades. Importantly, this type of white collar job has traditionally been indicative of the middle class ideal of a standard employment relationship (SER) representing full-time, permanent employment of at least 35 regular hours per week (Vosko & Clark, 2009; Bosch 2004). The accoutrements should not go unmentioned as they are important to the social imaginary of a middle class: a young person could wear business dress, work in a financial institution, and receive a starting salary and benefits large enough to be independent. Such a job might be described as the first *real job* after receiving postsecondary training. Furthermore, middle class SER jobs such as this are implicit for merit based social

transfer programs, such as maternity leave and employment insurance, that continue to dominate the social safety net in Canada (Vosko & Clark 2009). Gaining access to these social benefits is essential for supporting young workers as they navigate through life's many stages, experiences and challenges. In addition, the loss of these types of SER jobs is particularly problematic for women who tend to dominate front line service sector employment (Woodman, 2012).

Legal professions offer another example of technology subsuming white collar, middle class paid work. Many repetitive, methodical tasks, such as scanning documents or data mining, can be more quickly and easily accomplished by tireless algorithmic programs (Frey & Osborne, 2013). For these types of routine tasks, algorithms not only offer a cost saving alternative to human labour, but are often able to outperform human workers (Turk, 2014, December). Similar to the robo-advisor example above, it has taken very little in terms of actual machine learning to circumvent middle class entry level positions, creating precarious employment conditions for many young people (Wiebe & Altass, in press). More recently, new advances in intelligent algorithmic programs or machine learning algorithms that can "discover unexpected similarities between old and new data" (Frey & Osborne, 2013 p. 16) are allowing computers to independently take on more complicated tasks (Deng & Yu 2013). McAfee & Brynjolfsson (2016) state that presently, "computers have been able to achieve human to super-human levels of performance in a range of tasks: recognizing street signs, parsing human speech, identifying credit fraud, modeling how materials will behave under different conditions, and more" (p.140). In the field of law, increasingly intelligent algorithms have opened the door to the automation of more complex legal tasks, such as e-discovery and predicting the likely success or failure of a perspective lawsuit, which, again, some argue may be even better at completing these tasks than their human counterparts (Katz, Bommarito & Blackman, 2014). Built on IBM's Watson

computer, ROSS is a 24/7 AI lawyer that can simultaneously perform many tasks traditionally delegated to legal (human) associates. The ROSS website states that this AI program "runs in the cloud and can be mastered in minutes—no need to interrupt your workflow with hours of training sessions and lectures just to learn the basics...use ROSS to ensure you deliver the same value to your clients, without writing off thousands of dollars on unbillable research time" (http://www.rossintelligence.com). Though law firms are hiring fewer and fewer legal assistants, paralegals and entry level lawyers, the uniquely human abilities of the most highly qualified lawyers at the top of the legal profession are still and will continue to be needed (Turk 2014, December). However, as the number of skilled, experienced lawyers needed continues to decrease, lower level paid opportunities to gain the experience needed to develop advanced skills in lawyering are being subsumed by digital technologies. While it is clear that law firms today must adopt new technologies to remain competitive, it is important to consider the long term impacts of technological displacement on professions dependant on first hand experience and mentoring opportunities. If the outcomes of technological displacement of work in other professions are any indication (i.e. increased demand for worker flexibility and in precarious work), it is likely that as entry level positions continue to disappear, the ultimate responsibility and cost to update and maintain skills and knowledge will be downloaded to individual workers (Beck, 2000), with only a privileged few able to break into the remaining higher level positions.

Rifken (2016) highlights that "in this expanding digital economy, private enterprises connected to the Internet of Things can use Big Data and analytics to develop algorithms that speed efficiency, increase productivity and dramatically lower the marginal cost of producing and distributing goods and services" (p.9). With so many jobs being streamlined and subsumed by new technologies, it is easy to assume that the most secure path to future employment is

through learning to work with and develop these new technologies. In fact, the Information and Communications Council of Canada assuredly predicts that "under a baseline scenario, cumulative hiring requirements in Canada for ICT talent are expected to be 182,000 by 2019" (Faisal, Asliturk, Bourgi, Savard, Aquilina & Castillo, 2015, p. X), which on the surface seems promising. However, in terms of long term employment prospects, the significance of this number may be misleading. Considering that the Canadian economy lost over 31,000 jobs in July 2016 alone, the majority of which were full time, permanent positions, while youth employment also decreased (Statistics Canada, 2016, July), a possible increase of 182,000 jobs of unknown duration and precariousness over five years seems pretty bleak. That jobs in ICT are overwhelmingly dominated by older men (Faisal et. al 2015 identify that three out of four ICT professionals are men, and only one out of every twenty are below the age of 25) adds an additional problematic layer for many future job seekers. Furthermore, of these 182,000 perspective future jobs, almost 100,000 are attributed to assumed replacement requirements as current ICT professionals retire, a brazen assumption considering that new technologies are regularly simplifying or replacing paid work, including in ICT. For example, software engineers, who can be considered at the top of the ICT employment hierarchy, are at high risk of becoming redundant in their positions simply by the nature of the work itself (i.e. creating software to simplify, automate and in terms of intelligent algorithms, act independently). It stands to reason that if software engineers are not working themselves out of a job, then they are probably not doing their job very well. Once the software infrastructure is in place, any residual maintenance or monitoring work can often be done by a small number of low waged workers if any human workers are required at all.

The problems experienced recently from the Facebook trending algorithm offer an interesting example of ICT professionals working themselves out of a job, while at the same time highlighting some of the current limitations of an intelligent algorithm in real life application. The Facebook trending algorithm was created to identify and post links to the most popular news on the internet at a given time. The algorithm was deemed to be so effective that in late August 2016 the ICT professional team assigned to monitor the trending algorithm were "fired without notice", and the algorithm was left to proceed independent of human intervention and without the influence of software engineers (Thielman, 2016, August). Within days, "the fully automated Facebook trending module pushed out a false story about Fox News host Megyn Kelly, a controversial piece about a comedian's four-letter word attack on right wing pundit Ann Coulter, and links to an article about a video of a man masturbating with a McDonald's chicken sandwich" (Thielman, 2016, August). It is easy to see from this example that some human capabilities and sensibilities are yet beyond the reach of today's artificial intelligence (AI) algorithmic programming. However, to assume an algorithm will never be able to achieve an at least passable proximity to human scanning and editing would be short-sighted. In this case, the algorithmic flub was fairly harmless, but it does highlight the need for caution and critical reflection when implementing AI technologies. During a recent conference presentation, world renowned theoretical physicist, Steven Hawking, presented a sobering perspective on the advent and future implications of AI technologies:

> Governments seem to be engaged in an AI arms race, designing planes and weapons with intelligent technologies. The funding for projects directly beneficial to the human race, such as improved medical screening, seems a somewhat lower priority...I don't think that advances in artificial technology will necessarily be benign. Once machines reach the

> critical stage of being able to evolve themselves, we cannot predict whether their goals will be the same as ours. (Samuels, 2016, June).

As AI technologies continue to expand into areas such as medical diagnoses, warfare and even artificial life (Gortz, 2003), it is imperative for civil society that diverse individuals develop and maintain the capacity to understand and engage with the forms and applications of new technologies as they emerge. The ability to identify and critically evaluate potential and realized environmental, economic and social impacts of new technologies is essential for meaningful participation and informed proactive decision making within 21st century democratic society.

Dominant Technological Paradigm 2

Information and Communication Technologies are Changing/Expanding Collaboration, Crowdsourcing and Globalization

Caruso (2016) defines the knowledge based economy (KBE) as "the production of goods and services based on knowledge intensive activities that contribute to an accelerated pace of technological and scientific advance as well as equally rapid obsolescence" (p. 410). The KBE not only results in the creation and re-invention of new products and services, but has also fundamentally altered the ways and reasons we communicate and interact with each other in both the public and private spheres. As discussed above, work in the KBE is disrupted and dismantled through new digital taylorism and intelligent algorithms, and is further complicated by a second overlapping but distinct paradigm: communication, connection and social interaction in the internet era.

Internet technologies allow for connection and collaboration "with diverse others across globalized transnational spaces, multimodal texts, and distant, heterogeneous, and interactive audiences" (Hull & Stornaiuolo, 2014, p. 16). Pellegrino and Hilton (2012) identify that "the pervasive spread of digital technologies has increased the pace at which individuals communicate and exchange information, requiring competence in processing multiple forms of information to accomplish tasks that may be distributed across contexts that include home, school, workplace, and social networks" (p.3).

Table 358-0154 Statistics Canada- Canadian Internet use survey- 4432

Internet use by age group for Canada, occasional (percent)

Age group	2010	2012
Total, individuals aged 16 years and over	80.3	83.4
Individuals aged 16 to 24 years	97.5	98.6
Individuals aged 25 to 44 years	93	95.5
Individuals aged 45 to 64 years	80.1	83.8
Individuals aged 65 years and over	40.2	47.5

**Internet users are individuals who answered that they used the Internet for personal nonbusiness use from any location in the past twelve months.*
http://www5.statcan.gc.ca/cansim/a47

Today's youth have grown up with the internet and spend more time online than any other age group (Leu, McVerry, O'Byrne, Kiili, Zawilinski, Everett-Cacopardo, Kennedy, & Forzani, 2011). However, many fail to identify the need for, and lack the ability to critically evaluate information and sources online (Devoss, Eidman-Aadahl & Hicks 2010; Evering & Moorman, 2012; Harouni, 2009; Hubert & Lewis, 2014; Wesch, 2013). For example, many are not aware that while Wikipedia and similar sites often contain accurate and useful information, user generated content formats may also be unreliable, inaccurate and/or biased (Ayers, 2010;

Bowker & Star, 2009; Harouni, 2009; Wesch, 2013). Furthermore, issues of data ownership and plagiarism in digital media can also be complex and perplexing for students today (Evering & Moorman, 2012).

Internet technologies have also changed and are changing work; the way we work, the types of work one can engage in, and from where. Media production, publication and distribution has been thoroughly disrupted and reimagined by digital technologies and social media. With the growing availability, affordability and accessibility of personal computers and smartphone technologies, established media sources, such as newspapers, books, radio and TV, no longer hold a monopoly on the public distribution, or even production of information. Today, the overwhelming majority of Canadians not only consume but create media regularly via social media, blogs, mainstream and alternative news sites, online libraries and resources, and other avenues accessible in the digital realm (Altass and Wiebe, in press). Shirky (2010) highlights,

> Publishing used to be something we had to ask permission to do; the people whose permission we had to ask were publishers. Not anymore. Publishers still perform other functions in selecting, editing, and marketing work (dozens of people besides me have worked to improve this book for example), but they no longer form the barrier between private and public writing. (p. 46)

Further complicating matters, in 2011 McEneaney predicted that in the future, software will effectively "automate what we do as readers and writers, creating a new kind of 'who' in reading and literacy - that is, machines that read" (p. 378). The Facebook trending algorithm case discussed in the previous section is only one example of how McEneaney's prediction has quickly become a reality. Software programs that can write original news articles based on

current events are already being used by mainstream media. For example, an algorithm used by the Los Angeles times dubbed “Quakebot” independently authored the first news report just 3 minutes after an earthquake in March of 2014 (Podolny, 2015, March). Quakebot is just one of the many algorithmic programs currently being used by media outlets to monitor and produce content on everything from sports, weather and economic market trends. In fact, though newspaper articles written by algorithms are primarily descriptive and formulaic, Clerwell (2014) found that these articles are often indiscernible from human generated content. Furthermore, many readers today consider computer generated content to be more credible and objective than that produced by human authors (Clerwell, 2014). Pursuant to Clerwell’s findings, only a few months before the Facebook “McChicken debockle”, Facebook was overtly criticized for allowing human workers to interfere with the trending algorithm at all, facing allegations of suppressing conservative news and biasing results (Nunez, 2016, May); a criticism that likely had a great impact on the decision to allow the algorithm to run without human intervention in the first place. In the case of the “Quakebot”, the computer generated article was briefly reviewed and approved by a human journalist before distributing to the public. However, it is easy to see how this scanning and editing role significantly simplifies the work. Collins (2013) identifies that “although Information Technology (IT) generates new activities, it does not generate paying jobs at the same rate that it eliminates them. The proliferation of opinion blogs does not make up for the elimination of paid occupations in journalism” (p. 41). The collective impact of the unprecedented internet access to information sources (of varying quality and reliability), citizen lead social media, and algorithm writing-bots on the media industry has been substantial, as more and more local news outlets and TV stations continue to be downsized or

closed down completely, resulting in unprecedented job losses and limiting paid opportunities for future workers (Lareau, 2010).

Globalization of work has also been expanded and intensified by internet technologies. Of course, globalization of work has been occurring for decades, as manual labour and front line service work (such as call centers) have been regularly offshored to countries where workers are paid less under lenient labour laws. Companies that have been able to mass-produce and have a global supply chain to keep labor costs down and profits up have thrived within this globalized labour market. Concurrently, conditions for Canadian workers in these fields have deteriorated, resulting in increases in work intensification, downloading of responsibility to obtain and update training, and reduced benefits, such as minimum wage, minimum hours, bargaining power, and limited opportunities for full-time permanent employment. Today, globalization of work continues to grow, and is now expanding into middle class jobs, including ICT jobs themselves (Collins, 2013). The current technology driven dynamic expansion in globalized work is primarily facilitated by two factors: ICT technologies, such as bandwidth, processing, storage and cloud computing, are rapidly becoming better and cheaper, transforming and growing the types of work that can be done remotely for less (Brown et al. 2008; McAfee & Brynjolfsson 2016); concurrently, the governments of emerging economies, such as China and India, are proactively investing in advanced ICT and engineering education "to leapfrog decades of industrial development to create a high-skill, low-wage workforce capable of competing successfully for hi-tech, high-value employment" (Brown et. al 2011, p. 3). Brown et al (2008) give the example that "employing a chip design engineer in the United States is over four times more than a designer in Korea and 10 times or over the costs associated with the same workers in India and China" (p. 135). Surprisingly, the Information and Communications Sector Council of

Canada predicts that training new workers in ICT to increase the "availability of Canadian solutions will ensure that outsourcing and offshoring do not increase" (Faisal et. al 2015, p. II). Given the growing availability of highly qualified ICT professionals globally, the increasing ability of ICT technologies to facilitate outsourcing ICT work, and an established pattern of businesses offshoring work for financial gain whenever possible, this claim seems unsubstantiated at best. Situating new digital taylorism within the broader historical context of capital and the globalization of work, it seems likely that within the existing capitalist market structure, labour market trajectories for ICT workers will follow that of other sectors open to global competition. While a few ICT based companies may utilize locally sourced workers to meet a niche consumer market, the majority of companies can be expected to seek out the lowest cost option globally and outsource work, whenever possible.

Existing and emerging digital tools and hybrid genres are sites of open and interactive knowledge creation and collaboration, occurring across globally networked and interconnected systems (Williamson, 2013). These technological advances have expanded the range of possibilities for fragmented work arrangements parceled out over vast distances. Internet enabled labour exchanges, such as crowdsourcing, where a large group of independent workers each take on small parts of a project that in the past would have been completed by a single contractor, are becoming more common and accessible for both workers and employers (Barnes, Green and Hoyos, 2015). Together with enhanced and expanded instances of automation via new technologies, compartmentalizing and outsourcing residual work through crowdsourcing venues further enhances the scope and disruptive impacts of digital taylorism for middle class workers. Barnes et, al. (2015) highlight that while crowdsourcing platforms and websites rarely share detailed employment statistics, recent estimates suggest there are over two million workers

engaged in crowdsourcing employment worldwide, and that this number is growing. While additional research is needed to explore the far reaching impacts and diverse experiences of crowdsourcing work on local, national and international economies, many of the underlying impacts of traditional taylorism remain salient within this new digital genre: increases in required worker flexibility and precariousness of work, decreases in remuneration for work and cost savings for employers, and downloading of responsibility for training and skill enhancement to individual workers (Barnes et al. 2015). Furthermore, some crowdsourced projects make use of voluntarily shared, user generated contributions and/or data, for which no remuneration is required. However, crowdsourcing also provides some interesting and unique implications for work processes and outputs, challenging the fundamental notion of work as a primarily market driven activity. For example, online communities of computer programmers from across the globe regularly collaborate, without remuneration, on open source projects like Apache and Linux (Shirky, 2010). These types of voluntary collaborations for a greater good offer new possibilities for expanding the space between work and play, representing a decreased focus on individual gain.

Rifken (2011) anticipates an imminent and promising connection between new communication technologies and energy infrastructure, which he argues will lead to a Third Industrial Revolution in which green energy will be produced in individual locations, such as homes, offices, and factories, and networked and shared collaboratively through a new digital infrastructure.

> "The Third Industrial Revolution is the last of the great Industrial Revolutions and will lay the foundational infrastructure for an emerging collaborative age. The forty-year build

> out of the TIR infrastructure will create hundreds of thousands of new businesses and hundreds of millions of new jobs. Its completion will signal the end of a two-hundred-year commercial age characterized by industrious thinking, entrepreneurial markets, and mass labor workforces, and the beginning of a new era marked by collaborative behaviour, social networks, and boutique professional and technical workforces." (Rifken 2011, p. 5).

Though the real potential for and outcomes of a Third Industrial Revolution are yet to be realized, Rifken is currently working closely with the European Union on a plan called "Digital Europe" with the hopes of making this vision a reality, and officials from other developing nations, such as China, have displayed a commitment to this vision as well (see Rifken 2016). Collins (2013) surmises that "a host of processes and problems will complicate the future: aging populations, explosion of medical costs, ethnic and religious conflict, ecological crisis, huge international migrations, perhaps wars of varying scope" (p. 61). The increasing breadth of technological displacement and globalization of paid employment are already bringing to the forefront the limitations of extant market based capitalism and resulting impacts on the labour market in the digital era (see Ontario Basic Income Pilot Project or the recently expanded Jobs for Youth programs in PEI). Undoubtedly, moving forward, digital technologies and collaborative networks will be integral to being able to effectively understand and address social, economic and environmental issues.

Education in the Digital Era

Given the impact of digital technologies, there is an urgent need for upgrades in education in Canada. The ability to effectively communicate, collaborate and create with and within digital media, while exercising autonomy and flexibility (Pegrum, 2009), will be broadly essential for success, health and wellbeing at individual, community and societal levels. Communication technologies and platforms continue to permeate more and more areas of our lives and livelihoods. Integral to future education plans will be providing students with opportunities to work with new technologies, to use them to engage with others, to explore and contribute to solving relevant real life problems (Dietrich & Balli, 2014), and to understand and critically evaluate their applications, implications and outcomes.

Fullan 2013 argues, students, along with educators, must learn "how to work *with* machines, not *against* them, and not in ignorance of them" (p. 12). Traditionally, incorporating digital technologies into the classroom has situated students primarily as passive consumers of technology, rather than creators, collaborators and innovators. For example, some schools have installed expensive digital whiteboards in every classroom. Even with professional development training, these boards are mainly used as content projectors and fall short of students being creators, collaborators and innovators. Similarly, recent interest in teaching coding, which does start to move students beyond the limited role of technological consumer, is still justified in a literacies paradigm, trying to match skills to jobs. While teaching basic coding in high school will no doubt be an important gateway for the few students who will become highly skilled

computer science professionals, not everyone will be suited for this type of work, and ICT professions are not immune to technological displacement and digital taylorism. As noted above, technical input-styled jobs will continue to be disrupted, and coding jobs are not an exception to that trend. Brown et al. (2011, p. 584) refer to matching skills to jobs as "the opportunity bargain, where the role of the state is limited to making opportunities for people through education." To move beyond an industrial revolution based education paradigm of narrowly matching skills to anticipated future employment, the nature of the emerging economy calls for systems level change and a reimagining of the forms and purposes of education in the digital era.

An essential first step toward making effective and sustainable improvements to education systems is to surface and evaluate underlying ideological assumptions that have guided and shaped policy to date. Strongly coupled to educational policy are the following prevailing political and cultural narratives: one, meritocracy as the primary effective means to the middle class (Loveday, 2015), which for education means higher skills equals better jobs and a better economy, and that individuals are, and should, be independently responsibility for their own wellbeing and success (i.e. neoliberalism) (Corman & Luxton, 2007); and two, progress, including technological progress, is inevitable, thus taking away the responsibility of society to actively engage in making decisions about the future (Hornborg, 2014). Paradoxically, though these underlying ideologies guide and shape public policy and the social imaginary in complex and interconnected ways, they are generally only vaguely defined and rarely discussed outside of the critical literature. For example, that most policy makers would not identify themselves or their actions as neoliberal, makes it difficult to identify and directly challenge neoliberal ideologies in the practical application of educational policies (Thorsen, 2010).

The widespread and heavily invested practice of standardized testing merited by the underlying narrative of individual responsibility, is a consummate example of how ideology influences educational policy. The downside of standardized testing is that it encourages surface learning approaches focused on reproducing material rather than deep learning for the purpose of understanding (Schlechty, 2011). Through a trickle down effect (Eisner, 2000) such testing leads to curriculum that largely fails to support students' development of creative, collaborative, and entrepreneurial capacities beyond a standard of what computers will soon be capable of. There is broad consensus that current assessment methods do not effectively incorporate digital literacy, multiliteracies and/or soft skills which are most desired within the current employment landscape (Botelho, Kerekes, Jang & Peterson 2014; Devoss et al. 2010; Peterson et al. 2012; Wosley & Grisham, 2007). We recommend reducing standardized testing and creating instead district-wide digital learning portfolios. Digital learning portfolios offer a more holistic, multifaceted and pragmatic approach to assessing not only measurable progress, but process and personal growth, while also providing space for creativity, collaboration and critical thinking (Abrami, Venkatesh, Meyer, & Wade, 2013; Beach, 2012; Chang, Liang, & Chen, 2013; Hubert & Lewis, 2014). The digital nature of e-portfolios allows for web-based interactions such as peer and self assessment, sharing products and collaborating with audiences outside of the school, cumulative creation of meaningful and diverse work in multiple genres, as well as supporting teachers to monitor performance and provide ongoing feedback (Afflerbach et al. 2010; Beach et al. 2009; Chang & Wu 2012; Clark, 2010; Oskay, Schallies & Morgil, 2008).

To effectively prepare students for life in the KBE it is important to consider that though machine learning algorithms are now able to take on more complex tasks, "machines do not bring about anything by themselves, any more than a given quantity of information (such as that

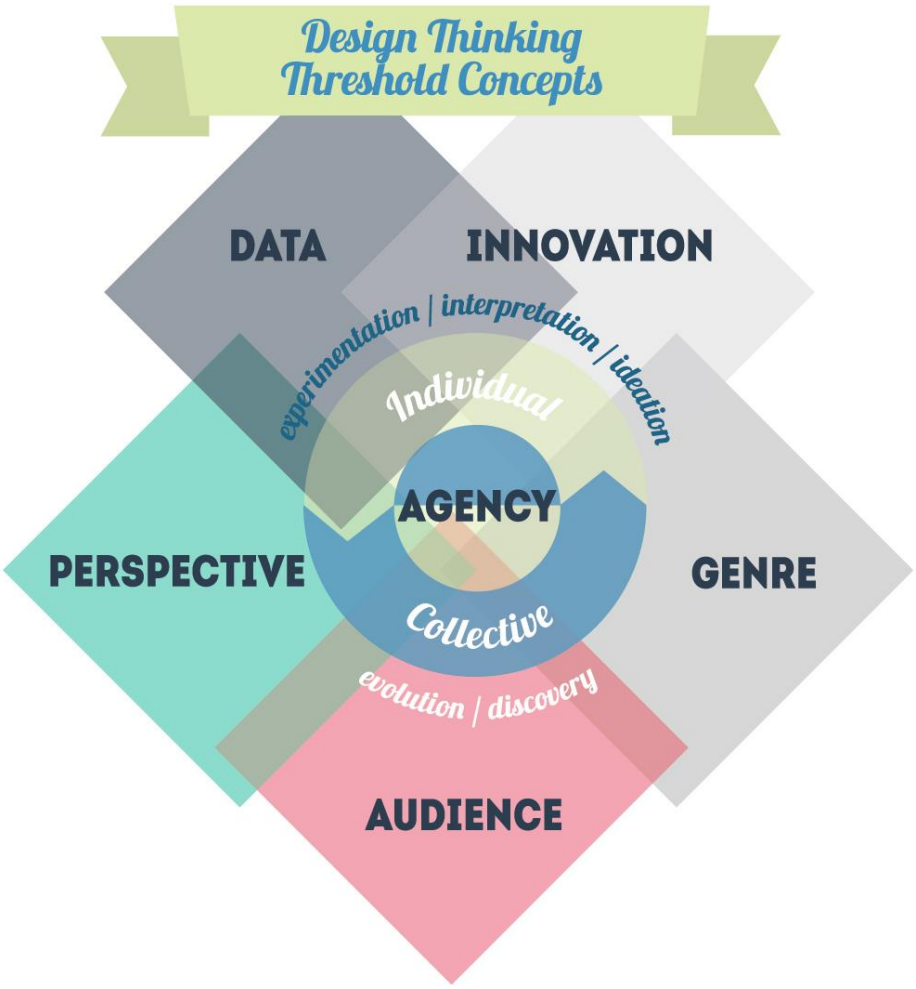
purchased in a database) produces knowledge. Without human skills to set the equipment in motion, technology itself produces nothing by way of development or growth." (Boutang, 2011 p. 42). In today's digital world, innovation, collaboration and social and emotional skills are readily identified as highly desired for work and life within the KBE (Jackson, 2006; Levin, 2012) as well as for maintaining a competitive labour force in the increasingly competitive global labour market. The good news is that these intrapersonal, and interpersonal competencies are malleable and can be learned and developed through education and life experience (Pellegrino & Hilton, 2012). However, the prevailing organization of curriculum around teaching isolated, measurable skills inherently fails to place sufficient time and resources on attainment of these "soft skills". Furthermore, some of the most significant, yet rarely identified, challenges presented by digital taylorism and globalization of work are that standardized, precarious labour conditions are a direct deterrent to innovation, collective action, and critical thinking (Brown et al. 2011), making the role of public education as a safe and unique space for experiencing and developing these "soft skills" even more significant. Student centered approaches that encourage the interests, creativity and independence of students (Baeten, Kyndt, Struyven & Dochy, 2010) implemented within learning environments that support "autonomy, competence and relatedness" (Appleton et al. 2008, p. 370), collaborative decision making and democratic engagement (Beane, 2005) more effectively nurture inter/intra personal skill development. Both in and outside of the classroom, students should be encouraged to ask questions, engage uncertainty, act creatively, take risks, think critically and contribute to discussions that are important to the students' lives and communities (Ayers, 2010; Beane, 2005; Carrington, 2005; Claxton, 2007; Dunleavy, Milton & Willms, 2012; Harouni, 2009; Schlechty, 2011). At the same time, commitment to social and emotional learning in the classroom, as well as at the curriculum

and policy level, will improve academic performance, enhance positive school atmosphere and teacher-student relationships (Durlack, Weissberg, Dymnicki, Taylor & Schellinger, 2011; Schonfeld, Adams, Fredstrom, Weissberg, Gilman, Voyce, Tomlin & Speese-Linehan, 2014), support the development of inter/intrapersonal skills that are highly valued in the labour market (Levin 2012), and encourage lifelong learning, personal development and emotional well-being. (Sheard, Ross & Cheung, 2013). While curriculum departments might argue that such skills are already addressed in the current offering of courses, there is strong evidence to suggest that the long history of schools focusing on individual content knowledge overshadows inter/intra personal skill development, collaboration, taking risks, and engaging uncertainty (Dodge & Powers-Silverberg, 2015). Schools are hardly places where students are encouraged to fail as part of the learning process (Wagner, 2012). We recommend the development of courses specifically designed to advance innovation, collaboration and social and emotional skills in holistic ways and in collaborative environments.

Pegrum (2009) highlights that "effectively our whole culture has moved to perpetual beta, where changes happen so quickly, and are contributed to by so many diverse people and groups, that everything becomes provisional" (p. 20). Tomorrow's workers will need to adapt, collaborate and innovate using new technologies, often while identifying and actualizing opportunities interdisciplinarily. As such, curriculum integration and holistic assessment must increase accordingly. In a transdisciplinary employment context, separate disciplinary courses such as English, Biology, Technology, or Physics make less and less sense, neither does assessing measurable isolated skills (many of which are now or will be performed in some measure by machines/algorithms) to generate data for educational planning. Instead, effective education for 21st century learning calls for a more holistic or threshold concept approach that

focuses educational policy and practice based on the complexity and transdisciplinary nature of knowledge that exposes new ways of "understanding, or interpreting, or viewing something without which the learner cannot progress" (Meyer & Land 2006, p. xv). Threshold concepts also highlight opportunities for integration of concepts between disciplines (Barradell, 2013), supporting students to readily see connections, overlaps and to innovate in multiple fields. Being able to adapt to changes and contribute to and be a part of innovative change requires skills such as creativity, initiative, and critical thinking (Studdard, Dawson & Jackson, 2013). "Long standing cultural narratives tend to depict innovation as nothing more than a happy accident, predicating the illusion that innovation is based more on luck or innate ability, rather than a skill that can be nurtured and developed" (Altass and Wiebe, in press). Students must be encouraged to embrace complexity and to expect and invite feelings of "discomfort and uncertainty" as an integral part of the learning process (Cousin 2008, p. 263), as work in the KBE will require openness to learn new skills, be creative and adapt, both in work and in the labour market overall. For example, English Language Arts (ELA) curriculum in most provinces is constructed based on the disciplinary organizers, reading/writing, speaking/listening, viewing/representing, which were developed during a time when film and television had become the dominant sources of information and entertainment (Altass & Wiebe, in press). These disciplinary organizers represent a complexity reduction that has helped to facilitate dependence on measurable tasks and isolated skills in ELA. However, this outdated approach has limited applicability with the multimodal, participatory contexts prevalent in the digital age. A design thinking threshold concept approach enumerated as *data, genre, audience, perspective, innovation, and (individual and collective) agency*, "and the points of relation between each of the threshold concepts, provide a clear, yet complex map of what's involved, what to be aware of and how to read/write,

speak/listen and view/represent creatively and effectively." (Wiebe, Altass, MacDonald & McAuley in press). Threshold concept understandings emphasize the transdisciplinary possibilities of knowledge, the iterative approach to innovation, and the design-creativity critical to new economies.



A threshold concept approach supports curriculum innovations that encourage students to develop "proactive knowledge (that) goes beyond understanding to prepare the learner for the alert and lively use of knowledge" (Perkins 2008, p.3) that can be creatively, attentively, and critically applied in many different ways and contexts, both inside and outside of the classroom. Across the disciplines, identification and guided exploration of threshold concepts lays the

foundation for lifelong learning, as new questions, ideas and challenges emerge through knowledge acquisition as well as individual and collaborative development (Williamson, 2013).

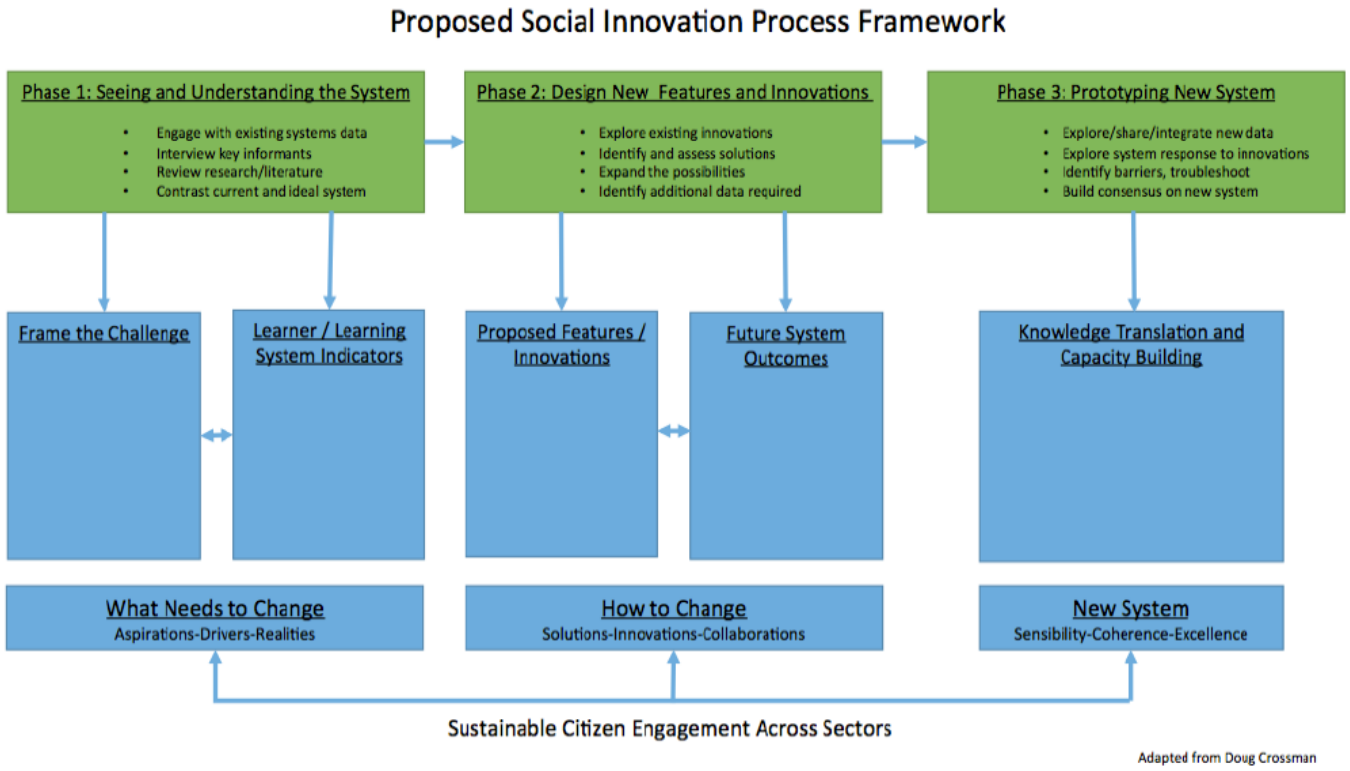
"Everything from individual tasks to entire industries is being disrupted, so it's foolish to try to lock in place select elements of the existing order" (McAfee and Brynjolfsson, 2016, p. 141). However, while we can identify and predict that many jobs are or will soon be undertaken by computers, predicting what work, if any, might replace these jobs, or even how work will be understood and defined in the future is far more challenging. Leopold, Ratcheva & Zahidi (2016) highlight that popular estimates have suggested up to 65% of children entering primary school today will end up working in jobs that don't exist yet (see https://shifthappens.wikispaces.com/). If education is to effectively meet the needs of future generations within the enigmatic knowledge based economy, students will need to be prepared not only for the world of paid employment, but to actively engage in creating what the world of the future will look like, economically, environmentally and socially.

Knowledge Mobilization

The province of Prince Edward Island has recently undergone a complete re-imagining of its English Language Public education system, providing a unique opportunity to mobilize knowledge and facilitate dialogue between academic researchers, cross-sectoral stakeholders and policy-makers in government. In September 2016, the responsibilities and function of the PEI English Language School Board were integrated into the Department of Education, Early Learning and Culture. This new model for education and learning included the creation of a Learning Partners Advisory Council (LPAC) comprised of ten education partners and ten community partners from across PEI. The LPAC, co-chaired by the PEI Premier Wade MacLauchlan and Dr. Bill Whelan, is mandated to support a broader view of learning as spanning from the early years through to the workforce, by advising the provincial government on policies, programs and strategies to lead PEI‘s education and learning systems. (http://www.gov.pe.ca/engagepei/index.php?number=1054320&lang=E).

Dr. Bill Whelan (LPAC co-chair and Chair of the department of Physics at UPEI) and Dr. Ron Macdonald (LPAC member and Dean of the Faculty of Education at UPEI) have contributed to this report and provided guidance regarding the potential role and implications of this knowledge synthesis for the LPAC. At the end of October 2016, the report will be shared with the LPAC and an overview of the report findings will be presented, initiating a collaborative discussion of the ensuing possibilities and challenges for education policy and practice in PEI.

As a newly formed group, the LPAC is in the process of defining how it will work together and engage with others in the PEI community to develop a "high performing learning ecosystem for the province" (LPAC 2016, April). Based on a Social Innovation Lab model created by researchers at the University of Waterloo Institute for Social Innovation and Resilience (Westley, Laban, Rose, McGowan, Robinson, Tjombo & Tovey, 2014), the LPAC has proposed a draft social innovation framework, that will be modified and further developing as the group continues to establish its processes, structures and working groups.



This knowledge synthesis provides the foundation for initiating phase 1 of the proposed social innovation lab model, providing a review of research and literature and comparing and contrasting current and ideal education systems within the knowledge based economy. Framing the realities, impacts and possibilities of new and evolving digital technologies within two dominant technological paradigms simplifies and clarifies the extant complex technological

narrative and provides a foundation from which to understand future digital innovations. This report will help facilitate meaningful discussion by surfacing the overriding themes that must be considered when developing effective education policy.

Conclusion

As new technologies continue to evolve and expand in reach, scope and capabilities within today's knowledge based economy, the segmented labour market is becoming increasingly polarized with a shrinking number of middle class jobs for which to strive (Frey & Osborne, 2013). Inevitably, paid employment opportunities will continue to be shaped and/or engulfed by digital technologies, disrupting the work lives and earning potential for an increasing number of diverse workers from across the employment hierarchy. New digital technologies are replacing both traditional and knowledge based human labour through automation and algorithmic programing, and digital taylorism is allowing companies to more readily compartmentalize and outsource residual knowledge based employment globally. Increased part-time and contract work and decreased unionization, as well as automation tools and techniques, and redistribution of work across the globe are limiting opportunities for even the most highly skilled Canadian workers. The long term broad and global impacts of technological displacement of work and the changing landscape of work within the digital era on capitalist economic systems are yet to be realized and widely debated. Most importantly, the cumulative trajectories of the dominant technological paradigms (ie. digital taylorism replacing work and new communication technologies changing work and play) are fundamentally shifting the knowledge based economy to a creativity based economy, where global economic success is increasingly being driven by ideas (creative economy) rather than the creation, distribution, and use of information

(knowledge economy). This fundamental shift brings to the forefront the worldwide studies that link weak creativity development at work and school to unhealthy economic and societal well-being (see European Commission, 2009; Howkins, 2007; Lichtenberg, Woock, & Wright, 2008; Vesela & Klimova, 2013; Yanning, 2012a/b; White, 2010). Web-based technologies, the enablers of frontier discovery, have been instrumental in the changing nature of how people connect, learn, use, and create knowledge (Thompson, 2010). Yet contrary to popular notions that the "digital age" offers creativity building to all, the dilemma is that digital tools have primarily been used to *consume* not *create* digital content (Wiebe, Gabriel, Campbell, MacDonald & McAuley, 2010). While more and more people are using digital media to produce content in various ways (e.g. facebook, comment threads, vines, twitter, snapchat, etc.), these contributions are often superficial and formulaic. In addition, user generated content involves issues of ownership and economic trade-off that are rarely considered or understood in practical application. Providing opportunities for students to practice meaningful engagement, creative expression and critical thinking must be central for effective participation and success within the emerging creative economy. Through digital and internet technologies students can be part of innovative and critical learning (Harouni, 2009; LaMonde & Rogers, 2007), engage in online discussions with diverse and multiple audiences and in knowledge co-construction across disciplines (Beach, 2012; Beach et al. 2009; Kiili et al. 2012; Sutherland-Smith, 2002).

As the realities of this creative economy continue to surface and challenge underlying assumptions and understandings about what work is, how we go about it and what work is of value, the limitations of neoliberally informed public policies will become impossible to ignore. A proactive approach to education in the 21st century will acknowledge and move beyond the deficient individualistic narrative to engage with the complexities and possibilities of a world

within which the dominant technological paradigms (that technology replaces work through automation and digital taylorism, and that technology changes communication, collaboration and knowledge) are fundamentally changing how we work, play and live together locally, nationally and globally.

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