Educating with Social Media: Practice and Policy in British Columbia

Two parallel studies examined the use of social media in K-12 and post secondary learning contexts. In the first, focus group interviews of secondary and post secondary students were conducted. In the second, a case study of a school district's development of social media policy and practice with the support of a post-secondary specialist in social media was also studied. Complexity thinking was used as a transdisciplinary perspective that calls the researcher to pay attention to interactions across several levels of complexity – the learner, the classroom, the culture – i.e. policy and practice. Results found that students and teachers were using social media tools in their learning and teaching, but not in ways that were significantly different than face-to-face teaching and learning contexts. A professional development session was found to impact teachers and administrators' attitudes, beliefs, and practices around social media. Recommendations for pedagogical, curricular and policy related decisions by stakeholders in K-12 and post secondary education with regard to social media were offered.

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Introduction

These research efforts aimed to explore the implementation of social media in teaching and learning from the perspective of both practice and policy. Social media are defined as software and web-based technologies that facilitate interactive dialogues and connectivity using the capabilities of Web 2.0 technology that allow for the creation and exchange of user generated content (Kaplan & Haenlein, 2010). Examples include video sharing platforms (e.g., YouTube), image sharing sites (e.g., Flickr), and social networking sites (e.g., Facebook, Twitter). In order to consider the multiple facets, interactive possibilities, and complexities of social media for learning and teaching, the study employed a complexity thinking perspective (Davis & Sumara, 2006) to interpret data collected across a variety of contexts in British Columbia, Canada. The specific objectives of this collaborative research project were to:

1) study students' use of social media for learning across age groups (secondary and post secondary) in the British Columbian context, (hereafter referred to as 'the student study', conducted by R. Moll)

2) examine a case study of the impact of a professional development session on a K-12 district's social media practices and policy development, (hereafter referred to as 'the case study', conducted by J. Hengstler)
3) draw conclusions to inform the use of social media in classrooms, schools, and school districts.

Background: Social Media Practice and Policy

Historically the development of new technologies (language, mass production of books) has facilitated humans to cohere into grander unities with emergent behaviour (i.e., cultural groups). We adopt Bunge's (1999) perspective that technology defines a culture in terms of its methods, theories, and practices, in order to examine 21st century technologies such as social media. The general public's relationship with technology is still young—historically speaking—reaching back around 60 years while publicly funded education in Canada has been around for about 200 years. To put that in perspective, the evolution from mainframe computer to Apple iPad has occurred in a period shorter than the life expectancy of a child born this year in 189 of the 221 countries ranked in the Central Intelligence Agency (CIA) World Factbook (2012). Similarly, public education's relationship with technology is a relatively new phenomenon. It was not until the 1980s that technology began to gain a significant foothold in North American education (Murdock, n.d.). Moreover, the last 10-15 years have seen significant technological changes with the rise of Web 2.0 and the participatory web, and new hardware emerging in the form of web-enabled, user-friendly mobile devices (See Appendix A "Education and Technology: Events, Influences, & Trends"). A recent survey claimed that 35% of Canadians visit a social networking site everyday - a figure that was just 19% a year ago (Ipsos Reid, 2011). Of college students, 95% report using social networking sites, 70% of them on a daily basis (Smith, Salaway, Borreson, & Katz, 2009). Thus, these new technologies have become ubiquitous, connecting learners to each other and information, and may be leading to a major shift in how knowledge is created, stored, and shared.

Schools have found it difficult to keep pace. Educators are uniquely situated to scaffold their students to leverage the interdependencies of society and technology in a way that has yet to be fully explored. Educators are well positioned to guide students—our future citizens—in technology use, skill development, relating to and through technology, and in thinking about

technology in complex, systematic, and socially responsible ways. Currently students are learning about technology from experience, not from education (boyd, 2010). Research has shown that learners rarely take advantage of the collaborative and creative potential of Web 2.0 technologies and that the application of these technologies for learning are strongly influenced by teachers and instructors (Bennett, Maton, & Kervin, 2008).

This paper describes the results of two parallel studies: (a) an exploratory study that used student focus group interviews to collet data about secondary and post secondary students' use of social media for science learning (the student study), and (b) a case study of the impact of a professional development session delivered to a school district on teachers' and administrators' social media policies and practices (the case study). The results of these two studies were interpreted using a complexity thinking perspective, and conclusions and recommendations about how to develop effective practices and policies for using social media for learning are offered. Background literature is provided around how youth and educators currently use social media, and how policy and professional development can impact technology practices in schools.

Youth and Social Media

It has been suggested that a new generation of learners, 'digital natives', those born since 1980 and who have grown up in a digital world, will require a different kind of education system (Prensky, 2001a, 2001b, 2005) to prepare them for a workplace that has also fundamentally changed (Tapscott & Williams, 2006). More recently, Prensky (2009) has put forward the idea of digital wisdom and the notion that today's 'homo sapien digital' differs from today's human in that they are digitally wise in the way they access digital enhancements to complement innate abilities and to facilitate wiser decision making. Schools have responded by incorporating a wide variety of technologies (e.g., Oblinger & Oblinger, 2005) to support learners who are also called 'new millennium learners'. For example, in British Columbia, the Ministry of Education recently released its Education Plan (2011) which "responds to the realities and demands of a world that has already changed dramatically and continues to change" (p. 2) through a focus on personalized learning, flexibility and choice, and learning empowered by technology. However, a recent literature review by Bennett et al. (2008) provided evidence that such claims are empirically and theoretically unfounded, thus opening the 'digital native debate' and establishing a need for further work in the field.

Some empirical evidence has recently been presented by Small and Vorgan (2008) regarding how use of digital technologies can affect neural pathways in the brain but empirical studies to better understand how students engage with digital technologies are needed. To explore the digital debate some large scale studies have been conducted in Australia (Kennedy, Krause, Judd, Churchward, & Gray, 2006), Canada (Bullen, Morgan, Belfer, & Qayyum, 2009), and the UK (Jones, Ramanau, Cross, & Healing, 2010). In the US, large scale studies include those of Ito et al. (2010), the National School Boards Association (2007), and include the work of the Pew Internet and American Life Project (ongoing).

Jones et al. (2010) conducted a survey of first year undergraduate students studying a range of subjects. They found that there were too many significant variations among students to justify the use of terms such as 'digital natives' to describe learners born since 1983. In his book, *The Young and the Digital,* Watkins (2009) used the results of an extensive study of teens' use of social media to paint a picture of how teens use, feel about, and experience technology. Through surveys, interviews, study of online spaces, and by closely following one four-pack of students for six months, Watkins (2009) was able to conclude that young people migrate to the digital world to "maintain and enliven their off-line relationships" (p. 23), not to connect with strangers online. For today's youth, time spent in front of a screen "is rarely, if ever, considered time spent alone" (Watkins, 2009, p. xix). Watkins' (2009) findings support earlier research by Ellison, Steinfield, and Lampe (2007) regarding undergraduate students' use of Facebook. Ellison et al. (2007) found that students reported "significantly more Facebook use involving people with whom they share an offline connection—either an existing friend, a classmate, someone living near them, or someone they met socially…than use involving meeting new people" (Findings, para. 2).

A more recent study by Ito et al. (2010) found that the online social interactions of youth could be framed as either friendship driven, as reported by Watkins (2009) and Ellison et al. (2007), or interest-driven practices. Clark, Logan, Luckin, Mee, and Oliver (2009) conducted a study into the use of Web 2.0 technologies for learning at ages 11-16 in the UK. The study found that 79% of students used social networking and that 78% of students had shared artifacts (photographs, video and/or music). Like Watkins' (2009) findings, Clark et al.'s (2009) results found that the primary motivation for using social networking sites was to interact with their existing social network. The vast majority of students said that they also used the Internet for

study purposes, but the range of sites they used was limited. Few learners reported engaging in collaborative learning using Web 2.0 technologies, besides using instant messaging functions to 'chat' about school work.

These results are dismaying considering Lemke, Coughlin, Garcia, Reifsneider, and Baas's (2009) wide ranging survey of school administrators, superintendents, and technology and curriculum directors which concluded that "there is a growing body of evidence that the collaboration inherent in the participatory nature of Web 2.0 tools can be leveraged to deepen student learning through authentic, real-world learning" (p. 5). For example, Facebook's structure exemplifies "much of what we know to be good models of learning, in that they are collaborative and encourage an active participatory role for users" (Maloney, 2007, p. 26).

A 'Google Generation' study (CIBER, 2008) has shown that research behaviours such as impatience in search and navigation, and zero tolerance for any delay in satisfying their information needs, which were previously associated with younger ages, are now the norm for all age groups – young pupils to professors. However, given the overwhelming amount of information available on the Internet, most users tend to rely on guidance from specific people in their personal networks when searching for particular types of information (Kayahara & Wellman, 2007; Tepper, Hargittai, & Touve, 2007). Finally, another important finding is that for young people "experience with Web 2.0 technologies, particularly active engagement such as creation of blogs and wikis, tagging, meme-ing, reviewing, writing fan fiction, remain minority activities to which many learners are introduced by educators" (Beetham, McGill, & Littlejohn, 2009, p. 15). Similar results have been found for American undergraduate students where ninety eight percent of students owned computers and 90% used social networking sites, but only 28% used them in their courses, and 25% had used wikis as a learning tool (Smith et al., 2009). Interestingly, students also reported only wanting a moderate amount of technology to be integrated into their courses (Smith et al., 2009). However, a study by Bullen et al. (2009) found that undergraduate students were not sophisticated in their use of technology but that they were sensitive to using appropriate technology in context. Student use of technology was driven by "factors such as the student and instructor dynamic within a course or program, the technical requirements of the discipline and the affordances that a tool provided within a given context" (Bullen et al., 2009, p. 10). Thus, research into how students use technology tools such as social media must begin to consider differential influence of discipline specific contexts. The current

study being reported on focused on how students used technology for learning science in both high school and post secondary contexts.

Schools and Social Media

Schools have changed very little in comparison to the rapidly changing culture of technology, social communications, and the workplace (Davidson & Goldberg, 2010). Most of the work in the area of teaching and learning with social media has been conducted by researchers interested in e-learning and online learning (e.g., Franklin & van Harmelen, 2007; US Department of Education, 2010), but effective integration of social media into face-to-face learning contexts, including related policy creation, has been under-researched. Even in the online learning area, few rigorous effectiveness studies of K-12 online learning have been carried out (US Department of Education, 2010). Calls for paying more attention to how people move between online and face-to-face communication have been made (Attwell & Hughes, 2010). A recent report of two and four year colleges in the United States found that 80% of faculty use social media where 52% use them as teaching tools but are just beginning to realize the innovative, interactive, and collaborative possibilities (Bart, 2010). However, there is a growing community of teachers and professors who are integrating social media into their classroom and professional development practices.

Lemke et al. (2009) found that Web 2.0 technologies such as sharing visual media files, blogging and creating online collaborative projects were widely used in school districts and/or formal curricula. In 2009, edWeb.net, MCH Strategic Data, and MMS Education surveyed 1,284 educators (teachers, principals, and librarians) regarding their use of social networking and content-sharing tools. The researchers found that 61% had joined a social network and that these individuals participated "in more online activities than educators who had not joined a social network" (2009, p. 5). The research found that these educators were also "more positive about the value of this technology for education than those who haven't [joined social networking sites]" (edWeb.net et al., 2009, p. 5). Educators who used social networking did so for the personal desire to connect with family and friends, and for the professional desire to connect with colleagues and to stay current with the technology (edWeb.net et al., 2009). In context, the social media bans uncovered by Lemke et al. (2009) in 70% of US school districts make the lack of social networking use in the classrooms understandable.

EdWeb.net et al. (2009) found that "Social networks dedicated to education…have low penetration thus far, but there is growing awareness." (p.7). In fact, some respondents learned about sites such as Classroom 2.0, and edWeb.net from the survey instrument itself (edWeb.net et al., 2009). In "Final Report: A Survey of K-12 Educators on Social Networking and Content-Sharing Tools", the researchers found that "Although educators are joining social networks, they express a need for guidance, training, and professional development" and have expressed frustration with schools and districts that "often block access to sites" (edWeb.net et al., 2009, p. 8). The report went on to say, "Many educators recognize that they are behind the times in terms of technology, that their students communicate with these tools, and educators need to learn how to integrate social networking and content-sharing tools into teaching" (edWeb.net et al., 2009, p. 9). With regard to social media use by educators, the most heavily used social networking site by far was Facebook, with 85% of respondents reporting membership (edWeb.net et al., 2009). Significant memberships were also reported in MySpace (20%), LinkedIn (14%), and Ning (11%) (edWeb.net et al., 2009). Whether an issue of the survey instrument, or an oversight on the part of the respondents, no connections were made between school policy and social media use by educators in this research.

Currently, the Ministry of Education in British Columbia (Leadbeater, 2008), the Australian National Partnership Agreement on the Digital Education Revolution (Howard & Carceller, 2010), and the Australian Council of Deans of Science (Rice, Thomas, & O'Toole, 2009), have called for education reforms to implement 21st century learning including improved access to educational tools, and personalized learning curricula through the use of communication technology. Social media will play a key role in these education reforms; however, more research is needed in order inform policy and to make recommendations about how education should respond to our increasingly connected culture.

Policy and Social Media

While acceptable use policies (or AUPs) are common fixtures in school districts for students and staff alike, these often do not address the issues inherent in social media. There has been scant research into social media knowledge and policy in North American K-12 education. The 2009 US study, "Leadership for Web 2.0 in Education: Promise and Reality", is one of the few (Lemke et al., 2009). This benchmark study examined US K-12 Web 2.0 (including social

media) policies, practices, and positions from the perspective of district administrators across thousands of school districts in the United States. While Lemke et al. (2009) found that the majority of administrators agreed on the educational potential of Web 2.0 technologies like social media, relevant policies and practices were emergent and reactive. As legal cases continue to emerge, there is increasing pressure to draft school/district policy, identify promising practices, and improve professional development opportunities. While North American examples may be scarce, more mature scaffolding does exist as exemplified by the British policies and practices put in place by the Kent County Council (2012), which can provide some guidance in the Canadian and American contexts. The Kent County Council (KCC) model was presented and discussed at length with participants in the administrative professional development session the case study. The KCC model's maturity is evident in a variety of factors. For example, the wide range of stakeholder involvement – child support workers, police, etc.; training and support documentation for adults working with students and media; consideration of e-safety from a developmentally appropriate perspective K-12; considerations for special needs students; a specific response-flow for responding to incidents of concern that occur with students. It behooves anyone considering policy creation around social media or technology, in general, to visit Kent e-Safety Policies, Information and Guidance (http://www.kenttrustweb.org.uk//Children/safeguards_esafety.cfm).

School district policy plays a significant role in teachers' uptake of technology. Brooks (2011) stated in "Locating Leadership: The Blind Spot in Alberta's Technology Policy Discourse" that

> Education policy documents contribute to, in vary degrees, setting provincial direction, supporting implementation of policy directions within jurisdictions and potentially influencing public discourse. The way thinking about technology is endorsed in and through education policy influences how technology is taken up in schools. (p. 5)

Brooks' (2011) quote highlights the issue inherent in any district's dichotomous relationship to Web 2.0 and social media technologies. While Lemke et al. (2009) found that almost 75% of school administrators in the United States believed that Web 2.0 and social networking had positive applications for education, 70% of the school districts surveyed banned social networking

> while allowing prescribed educational use for most of the other Web 2.0 tools (e.g., blogging, using wikis, sharing music or sound files, sharing visual media, posting messages, participating in virtual worlds, playing interactive games, creating polls or surveys, etc). (p. 9)

Interestingly, Lemke et al.'s 2009 statistic on banning appears to be a significant increase from the National School Boards Association (2007) finding that 52% of United States' school districts specifically prohibited use of any social networking sites (p. 4-5). The policies of banning not only guides teacher classroom and professional practice away from social networking technologies—but officially prohibits it in the school context. As Ahn, Bivola and DiScala (2011) pointed out, "the proliferation of new technologies, media, and services often challenge the established policy and regulatory order" and "introduce new pressures on educational institutions" (Frame analysis in information and education policy research, para. 5). Furthermore, they found that

> The use of social media in public primary and secondary education (K-12) presents schools with numerous obstacles and constraints. Educators might use new media to enrich the classroom, but there are also accounts of grave student misconduct (such as cyber bullying) and legal liabilities for school districts. Education leaders and policy makers face difficult questions of how to promote access and use of technology while safeguarding children. (Ahn et al., 2011, Abstract)

New technology policies like those addressing social media are emerging. Ahn et al. (2011) found that while the majority of US school district acceptable use policies were silent on the issue of social media, 34% permitted use of social media with restrictions; 24% allowed access with teacher or school approval and/or supervision; and 14% banned its use outright. In just two years, these figures stand in stark contrast to the 2009 US figures of Lemke et al. (2009) where 70% of districts were banning social media. Furthermore, Ahn et al. (2011) pointed out that "…very few districts explicitly noted that social media had potential educational value and use in the classroom" (Social media, para. 7).

Ultimately, in the absence of relevant, thoughtful policy, a vacuum forms. The dangers are that educators will either fill that vacuum with unofficial practice by subverting the official policy prohibitions—thereby exposing themselves and their students to personal and professional

consequences—or they will be paralyzed and forego the opportunity to use a powerful, engaging set of tools in the service of learning. To date there has been little—if any—discussion in the literature about the ways in which educators might subvert official policy and practice to use new technologies like Web 2.0 and social media tools in the service of teaching and learning. Educators will find a way to use tools they desire. In one instance, a local middle school educator reported playing a game of 'hide the router' with the IT personnel in the school district in order to provide wireless access for her students (personal communication, Hengstler, 2011). The educator would install and activate the router, the IT staff would find it and disconnect it, and the educator would relocate and reinstall the hardware for her students. In one of her more creative moves, the educator hid the router above a ceiling panel (personal communication, Hengstler, 2011).

Brooks (2011) suggested that reticence from engaging in policy development with regard to new technologies might stem from a variety of factors including a lack of interest, a potential mismatch between technology use and mandated assessments, and an assumption that technology improves learning. Further, Ahn et al. (2011) pointed out that lack of engagement with policy creation—or banning of technology—can stem from concerns regarding "high profile legal battles for school districts" (Introduction, para. 1).

In her review of professional development literature, Desimone (2009) found evidence that suggested "that policy can play a role in influencing who participates in effective professional development" (p. 192). Similarly, Weiss et al. (2005) considered policy support to be a critical workforce input (along with professional development and organizational capacity) to affect outcomes and long term impacts for children and youth. While policy is an important factor in the adoption of technology, Brooks (2011) pointed out that classroom teachers often do not have the opportunity to contribute to setting policy and direction with regard to technology use in schools or the province. Brooks (2011) posited that when teachers become integral to this process they will be able to contribute technology perspectives and ideas that might otherwise be overlooked by other stakeholders with differing agendas. However, to be effective partners in the discourse around technology, and to exploit the full potential of social media for educational aims, educators must be knowledgeable, reflective users of technology themselves; specifically, more fluent in Web 2.0 and social media technologies.

Impacts of Professional Development

In her review of the literature on professional development, Desimone (2009) found that "research increasingly has identified the continuing development and learning of teachers as one of the…critical mediators in the effectiveness of policy for teachers and teaching practice" (p. 181). With regard to technology use by elementary school teachers, O'Dwyer, Russell and Bebell (2004) found that "inadequate professional development…has a negative relationship with technology use for delivering instruction" and that increasing variety in technology-based professional development has "a small positive effect" on technology use (p. 13). O'Dwyer et al. (2004) also found that

> The strongest positive predictor of whether a teacher will use technology to deliver instruction…have their students use technology during class time…and have their students create products using technology…is a teacher's belief about the positive impact of technology for students. (p. 15)

Weiss et al. (2005) created a logic model where professional development was but one of three main elements that can affect short, mid-range, and long term outcomes and ultimately impact learning. The other elements were organizational capacity and policy support. In Weiss et al.'s (2005) logic model regarding professional development outcomes, the short term outcomes were increased knowledge, skill, and competencies; improved organizational supports for staff; and improved policy to sustain the workforce. In the mid-range outcomes professional development was expected to garner improved practice and increased professionalism. In the long term, professional development can influence the quality of experiences for children and youth, and potentially create improved outcomes (Weiss et al., 2005).

While past research has created a foundation of literature with valid empirical results, work has not, so far, been undertaken with a theoretical perspective that offers any recognizable potential to shed light on *why* connectedness facilitated by social media may profoundly change the way people learn. Attending to the connectedness afforded by social media represents an opportunity for investigating the global trends toward increased social media use and its potential for learning in new ways.

Theoretical Perspective: Complexity Thinking

A powerful new theoretical perspective is emerging in educational research, complexity thinking (Davis & Sumara, 2006). Complexity thinking draws upon characteristics of self-organizing complex systems that exhibit intelligent behaviours without a centralized controller (e.g., ant colonies and crowds), to both understand and prompt learning. Social media have increased our awareness of the complex systems that are a part of our everyday lives. For example, the Internet is a decentralized network where many weak links and a few crucial nodes enable the swift searching capabilities of Google (Mitchell, 2009). Wikipedia is an emergent artifact of co-created knowledge where authorship is no longer a relevant concept. Each of these systems has learned (i.e., adapted) as a result of information shared through 'neighbour interactions' between many agents in the network. Psychologist Merlin Donald (2001) used the complexity of technology to infer stages of how human consciousness evolved and to explore implications for learning and teaching. It seems plausible that the ability to connect masses of human minds and store large amounts of digital information could lead to a new stage of consciousness (Davis, Sumara, & Luce-Kapler, 2008). Today's 21st century learners are plugged into this complex network of information through the connections enabled by social media, which may profoundly change the way they can and do learn.

Complexity thinking offers a transdisciplinary perspective that calls the researcher to pay attention to interactions across several levels of complexity – the learner, the classroom, the culture – i.e., policy and practice. Technologies such as social media are key to the structure and dynamics of each of these levels, possibly playing the role of the fibre of the web connecting, interweaving, and facilitating interactions within and between levels. With this perspective, interactions between students and between students and teachers, mediated both with and without technology, and constraints at the administrative and policy level were studied.

Complexity thinking is being drawn upon, in part, to address the lack of theoretical grounding used to approach and interpret studies of social media and learning. Bates (2011) acknowledged that "Web 2.0 tools are so relatively new to education that educators have yet to find new designs for teaching and learning that fully exploit such tools. Most uses to date have been within the framework of a teacher-controlled model of instruction." (p. 26). Bates (2011) suggested that social constructivism theory (e.g., Gould & Brown, 2003) with its learner centered instruction and communication between learners, and connectivism (e.g., Siemens, 2005) with its emphasis on digitally co-constructed knowledge may have much to contribute in designing

pedagogies for developing 21st century skills. In Attwell and Hughes' (2010) literature review of pedagogic approaches to using technology, a wide range of learning theories were summarized, however their application in the area of creating pedagogies for learning with technology were not offered, perhaps because the examples do not yet exist. Finally, Williams, Karousou, and Mackness (2011) wrote a compelling theoretical paper which proposed that

> space needs to be made for substantial, self-motivated, self organized, emergent learning…as a vital part of a learning ecology that includes both emergent and prescriptive learning in a world in which Web 2.0 platforms offer unprecedented affordance for information, interaction, networking and collaboration as well as for unique challenges. (Sec. 5, para.7)

Williams et al. (2011) proposed a framework for defining and managing emergent learning by drawing on complexity theory (Cilliers, 2005), connectivism (Siemens, 2005), and communities of practice (Wenger, 1998). Their framework was applied to gain understandings of empirical data collected in three cases of learning. Williams et al. (2011) drew more heavily on complexity theory than on connectivism and communities of practice because it provided a useful framework for drawing distinctions between emergent and prescriptive learning. Connectivism (Downes, 2009) and communities of practice (Aceto, Dondi, & Marzotto, 2010) have been used to analyze the ways in which learning is enabled by social media. However, in the current student and case studies, complexity thinking (Davis & Sumara, 2006) was used as a transdisiplinary framework that has been applied more generally in the field of education (than connectivism), and which recognizes the social learning that occurs in communities of practice is part of the complex system of learning which also includes learning at other levels (i.e., student, teacher, school, administration, cultural, etc.). Complexity thinking allows us to ask questions about learning such as: How are social media embodied in students' everyday experiences and into their learning experiences? How can social media facilitate the emergence of ideas from collectives of students, and how can teachers promote the kinds of experiences that enable emergence?

Research Questions

There is an established need for empirical work in the area of social media practices and policy that has been approached from a theoretical perspective on learning – especially in the Canadian context. Thus this study explored the following research questions from a complexity thinking perspective:

1) What social media resources do secondary and post-secondary students draw upon as they learn science? How and why? (addressed in the student study; researcher R. Moll)
2) How does consultation between post-secondary researchers and K-12 districts impact the development of social media policy and practice? (addressed in the case study; researcher J. Hengstler)

Research Context

The study of student use of social media and the examination of the outcomes of a professional development session to inform social media policy and practice in a school district were carried out in British Columbia, Canada. While the case study focused on a single public school district in British Columbia, the student study spanned several schools in several school districts and included two post-secondary institutions.

Provincial Context: British Columbia, Canada

In Canada, the responsibility for education rests with the provinces and territories. The education system includes public schools under the direction of the local school boards and the provincial Ministry of Education, as well as independent schools. The province of British Columbia is divided into fifty-seven public school districts with approximately 641,600 students (Ministry of Education, 2012d).

This last year has been a turbulent time for education in British Columbia. There have been challenging contract negotiations between the province and the British Columbia Teachers' Federation that resulted in a long-standing teacher job action. With a lack of progress in negotiations, the job action erupted into a full-blown strike as of March 5, 2012 with the government tabling legislation to force the union back to work. Additionally, over the course of the year, the British Columbia Ministry of Education has been attempting to roll out new educational initiatives based on the concepts of 21st Century Learning and personalized instruction. Some of these plans address standards, policies, and practices with regard to mobile

devices. For example, in the Ministry of Education's (2012a) "2012/2013 Transformation + Technology Update", the province committed to:

- "Establishing a technology forum to exchange information and ideas between the education sector partners." (p. 18)
- "Piloting the Bring Your Own Device (BYOD) model to determine what works in standards, policies, and best practices." (p. 18)
- "Working to create more mobile options for staff, such as participating in a pilot for expanding the range of mobile devices with Shared Services BC." (p. 19)
- "Exploring the BYOD approach in the Ministry through a partnership with the Office of BC's Chief Information Office" (p. 19)

While the "2012/2013 Transformation + Technology Update" makes overt references to mobile devices, there is little consideration given to how educators might pursue harnessing the power of Web 2.0 and social media for education. For instance, in BC the Ministry of Education (2012a) in conjunction with the BC Association of School Business Officials found that while almost 90% of BC schools "have some wireless access and many students had internet-connected devices, but …[there was no] common strategy that would let students use them to enhance learning at school" (p. 12).

Student Study Context

Focus group interviews were held with students sampled from three populations of physics students. Upper year post secondary physics students, first year post secondary physics students, and secondary physics students. Participants (n total = 34) were recruited from a range of physics learning contexts such as both independent and public high schools, and small and large universities in British Columbia (BC), Canada. Demographic information is summarized in Table 1.

Table 1

Demographic Data for Focus Group Participants

Focus Group Type	Number of participants	Number of Focus Groups	Other information
Secondary physics students	24 (12 female, 12 male)	5	Focus groups took place in two schools, one independent and one public school in Vancouver, BC.
First year post secondary physics students	7 (all male)	2	Focus groups took place at a small teaching university in BC.
Upper year post secondary physics students	3 (1 female, 2 male)	2	Focus groups took place at a large research university in BC.
Total	34	9	

Case Study Context: School District 10, Arrow Lakes, British Columbia.

The case study focused exclusively on School District 10 (SD10), Arrow Lakes, British Columbia. SD 10 is a small rural school district located in the mountainous southeastern interior of the province (See Figure 1).

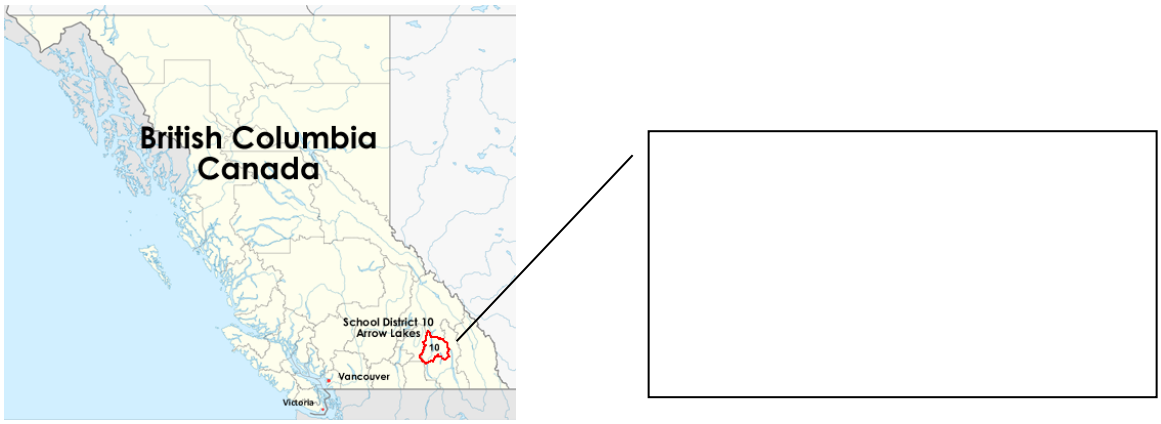

Figure 1. Location of School District 10, British Columbia (Adapted by J. Hengstler from NordNordWest, 2011)

The district is comprised of six schools: three elementary schools, two elementary-secondary schools (including the Distance Education School), and one senior-secondary school (Ministry of Education, 2012c; School District 10, 2012). SD 10 reported 519 students for the 2011/2012 academic year — 285 enrolled in elementary and 234 in secondary schools as follows:

- 503 in "Standard (regular) school" programs (attending face-to-face classes)
- 16 in the "Distributed Learning Program" (attending courses at distance or mediated through technology) (Ministry of Education, 2012c).

The number of educators (teachers and administrators) working in this district was approximately 40 (Ministry of Education, 2012e). At the time of the survey there were approximately six administrators in the district (Maclean, S., 2012, Personal communication). The average years of teaching experience reported for educators in the district was 13.5 years (Ministry of Education, 2012e). The majority of experience was roughly distributed in thirds across the brackets 5-9 years, 10-19 years, and 20 years or more (Ministry of Education, 2012e). For teachers as a sub-group, the average experience was 13.1 years with the bulk of teachers falling into the 5-9 years and 10-19 years experience brackets (Ministry of Education, 2012e). The majority (28) of teachers held "professional certificates"[1] with masked remainders holding "basic" or "standard" certificates (Ministry of Education, 2012e). The age of educators in the district ranged from 25 to 64 with an average age of 48.9 years old (Ministry of Education, 2012e) and approximately 25% of the educators in the district were between 50 and 54 years old (Ministry of Education, 2012e).

Methodology

Data were collected in two parallel studies that explored how social media was being used by students and integrated into schools and post secondary institutions in British Columbia: (a) a focus group study on student use of social media and science learning (the student study), and (b) a case study of the impact of a professional development session (the case study).

[1] Professional certification means that the teacher "has met *all* of BC's standards for teacher certification" (Ministry of Education, 2012b).

Student Focus Group Study Methodology

The first study was designed as an exploratory, interpretive multiple case study (Schwandt, 1998; Stake, 1995) aimed at gathering data about how science students use social media for science learning from science students in several contexts. Data were gathered through focus group interviews with three populations or cases: secondary (grade 11 and 12) physics students (n=24), post secondary introductory (first year) physics students (n=7), and upper year post secondary physics students (n=3). Demographics of participants are described in Table 1. Data from each case were compared and similarities and differences were identified.

The focus group interviews were a preliminary study of an international collaboration in science education focusing on social media and science teaching and learning, thus they were conducted with physics learners. The aim of the focus groups was exploratory, to determine what kinds of social media tools students used when learning science and how they used them in order to inform the development of a survey for the second stage of the project. The survey will be administered to science learners, including secondary and post secondary students, and pre-service science teachers in several local and international contexts. A range of populations were sought because one of the aims of the international collaboration is to examine changes in how students use social media for learning depending on their level of scientific study.

Focus group interviews (n=9) were run by one of the researchers (Moll). Interviews were typically about half an hour long, and occurred at the school or university the participants attended. Following a semi-structured interview protocol, exploratory data were collected about how the participants used social media both within and outside school contexts to support learning. Students were asked to list which social media sites they used, to describe how they used social media and online resources when they were stuck on a physics problem, and about how their teachers used social media in their classes. Focus groups were video taped and transcribed verbatim for coding, theme searching, and interpretation. The coding, identification of emergent themes and interpretation process were guided by qualitative data analysis software, *Atlas Ti*, and a complexity thinking perspective on learning (Davis & Sumara, 2006). Emergent themes will be reported on in this paper and were used to develop a survey, the Social Media and Science Learning (SMSL) survey – a survey that will be administered more widely in subsequent research to study social media and science learning from a student perspective.

Case Study Methodology: SD 10, Arrow Lakes

Since 2007, one of the researchers, Julia Hengstler, has been presenting in British Columbia on digital professionalism for teachers with a focus on social media and Web 2.0 technologies. During August 2011, the researcher was invited by School District 10, Arrow Lakes, British Columbia, to provide professional development sessions to support policy and best practices development in the area of Web 2.0 and social media: one for district administrators, and another for the full district faculty. In the British Columbia public education system, educators have allocated days and time for professional development: some professional development activities are self-selected by educators, and other activities are specified by the educators' school or district. The professional development sessions provided by the researcher fell under 'district professional development' days as opposed to self-directed days. All district staff were expected to attend one of the two sessions depending on their role in the district.

The researcher provided separate training sessions for teachers and administrators based on a framework of digital professionalism developed by the researcher (Hengstler, 2011, Kuehn, 2010). Sessions addressed the use of all digital technologies by educators with specific discussion of social media and Web 2.0 tools in the context of creating and managing digital footprints - traces or records of a person's online activities (Hengstler, 2011). The professional development sessions were provided in the following format:

- one day of professional development with school district administrators delivered at the school board office in Nakusp, BC; (n=approximately 40)
- one day of professional development with school staff delivered at Nakusp Elementary School; (n=approximately 40)

While qualitatively similar in that both sessions addressed the issues of digital professionalism in a Web 2.0 world and the researcher's suggested theoretical scaffolding for developmentally appropriate student access to technology tools, the presentation for administrators focused more intently on policy and practice issues, how policy and practice might be scaffolded (including Canadian, American and British exemplars selected by the researcher as "best practices"), and suggested policy considerations for Web 2.0, social media, and emerging technologies. In contrast, the teacher session focused more on professionalism in personal and professional use of technology, with some suggestions regarding responsible

practices for social media use in the classroom (e.g., use of Web 2.0 permission slips, consultation with school administrators in the absence of policy, etc.).

The impact of the specialist's work with the district was assessed using a survey based on D. Kirkpatrick and J. Kirkpatrick's (2006) Four Level Model for evaluating training programs. This assessment approach addressed four levels: degree of participants' favourable reaction to the on-site work of the specialist; degree to which participants acquired the intended knowledge and skills; degree to which participants' behavior was affected; and degree to which the organization or environment was affected by the participants' training (e.g., drafts of social media policy and practice guidelines were produced; participants actively managed their digital footprints) occurred as a result of the specialist's on-site sessions and subsequent support. The survey was deployed approximately six months after the professional development training was delivered. The survey was divided into four main sections:

- Section 1-demographic data: items regarding respondent role in the district (teacher or administrator) and professional development session attended;
- Section 2-respondent's reaction: items regarding the respondent's reactions to the training session and trainer;
- Section 3- respondent's learning in 2 sub-sections "Learning as a Result of On-Site Professional Development" (addressing prior knowledge, changes in awareness, beliefs and feelings) and "Behaviour as a Result of Session" (addressing changes in respondent behavior) within specific contexts: personal, professional, classroom, school, and district.
- Section 4-value of similar training for others: items regarding the respondent's perception of the value of similar training for other specified groups (in-service teachers, pre-service teachers, school administrators, students, and parents/guardians).

The purpose of the demographic data was to determine if there were differences in the results from the two separate professional development sessions. The respondents' reaction section was structured based on Kirkpatrick and Kirkpatrick's (2006) Four Level Model for evaluating employee training sessions. In this model, favourable reactions to the professional development trainer and session were assumed to increase the likelihood of the session affecting attendees' knowledge, skills, and/or attitudes, and therefore increase the likelihood that attendees will incorporate the content from the session into their personal and/or professional practice. The

third section was designed to determine potential ways attendees might have changed their behaviours as a result of the professional development sessions. This was considered to be evidence of learning as a direct result of the professional development sessions. The fourth section of the survey was designed to determine the value of this type of professional development for in-service teachers, pre-service teachers, school administrators, students, and/or parents and guardians. This section was structured to inform the researcher's practice as the researcher currently delivers similar training to post secondary pre-service teachers, K-12 students, schools/districts, and professional teaching associations. The survey was also designed as a retrospective pretest. A retrospective pretest is defined by Preskill and Russ-Eft (2005) as when "the evaluator collects data at one time but asks for recall of behavior or conditions prior to, as well as after, the intervention or program" (p. 104). Reliance on recall over time can be somewhat problematic as the time gap between training in and assessment can obscure respondents' memories of their experiences of the professional development event.

SD 10 was distant from the researcher's location. Consequently, the researcher depended on emails forwarded by administration to recruit the majority of respondents. By the time the survey was deployed, approximately six months after the training session, a provincial job action was in effect. As a result of this job action, teachers were not reading or responding to emails from administration; thus, with union input, the researcher reached out to the local association president to forward the researcher's emails soliciting respondents.

Results

Results from two parallel studies are presented. Results from the student focus group study are presented first. The results from the case study of the impact of a professional development session are presented second.

Student Focus Group Study Results

Three types of focus group interviews of physics students were conducted: secondary students, first year post secondary students, and upper year post secondary students. In each focus group, students were asked some demographic information such as why they were taking physics and the types of technologies that they had access to.

The secondary students (n=24) were recruited from two different contexts. Two male Grade 12 Physics students were interviewed at an independent high school in Vancouver, BC. The remainder of the sample were students who were taking Grade 11 Physics at a public high school in an affluent area in Vancouver, BC. The Grade 12 students who were interviewed were taking physics because of their goals of pursuing engineering or business programs at university. Grade 11 students' reasons for taking physics were more varied: some took it to keep their options open; some because it was expected in their peer group or by their parents; and some had science and/or math related interests or career goals. More students found physics difficult (n=13) than easy (n=8) (not all students answered the question), but most had neutral or moderately positive attitudes towards physics. Focus group interviews were held in October when most of the participants were just two months into their first dedicated physics course (Physics 11). Thus strong student perspectives and attitudes towards physics had not had much time to develop. All of the secondary students who participated in focus group interviews owned their own computer, almost half (n=11) owned a smartphone and some (n=5) used an iPod touch or tablet to access the Internet. Most students (n=18) said that they were members of Facebook and had been since middle school (Grade 7 or 8).

Ten post secondary students participated in four different focus group interviews. The post secondary physics students fell into two sub groups: upper year students and first year students. In the upper year sub group there were three students who were finishing honours physics degrees at a large research intensive university in Vancouver, BC. All three of these students owned their own computer and were members of Facebook. Two students had a smart phone device that they used to access the Internet. Seven first year students were also interviewed. All the first year students were male and were recruited from introductory physics courses at a small teaching university on Vancouver Island. Most of these students were science majors, but only one might major in physics. The others said that they might major in computer studies, engineering, or biology. When asked if they found physics easy or difficult, most first year students said that it depended on the context. While most first year students were taking physics as a required course in their science degree, some said that they were interested in physics and enjoyed it. Thus, this group of physics learners, who volunteered to participate in the study, had generally positive attitudes towards physics so far. Similar to the high school students, interviews with first year university students were conducted in September thus students were

only just starting their first university level physics course. All seven of the first year students owned their own computer, some (n=3) owned a smartphone and most (n=6) were members of Facebook. Thus, of all the students interviewed, the demographics were surprisingly similar: all students owned their own computers; most, but not all, were members of Facebook; and about half owned smartphones. These findings were consistent with large scale surveys of students in these age groups (e.g., Clark et al., 2008; Watkins, 2009) – Facebook use was prevalent, but not all students had access to mobile technologies.

Besides demographic information about the kind of physics learner and technology user they were, students were asked to describe how they used technology for physics learning purposes. Themes emerged within three broad areas: (a) use of social media tools, (b) personalized physics learning, and (c) teachers and social media use. Some specific themes from each area will be presented.

Use of social media tools. When students were asked to describe the types of social media resources they used for learning physics a wide variety of tools were named. A tally of the most frequently discussed resources during the course of the focus group interviews is presented in Table 2. Note that not all the resources in Table 2 are social media tools (i.e., bookmarking), but can be used in social media kinds of ways (i.e., Delicious for social bookmarking).

Table 2

Frequency of codes for social media tools that students mentioned in focus group interviews.

Technology	Code frequency	Technology	Code frequency
Facebook	54	Course Management Systems	9
Videos (i.e., YouTube)	38	Bookmarking	7
Online forums (i.e., Yahoo Answers)	34	Skype	6
Google	27	Wolfram Alfa	5
Twitter*	17	Cloud Computing	4
Wikipedia	15	Reddit	4

*Findings indicated that students do not use Twitter much (socially or academically) but Twitter was discussed in each focus group because the researcher asked about it.

Student use of Facebook, videos, online forums and Google were high, thus some trends within each of these categories were discussed in more detail below.

According to the students, Facebook was the primary communication tool. It was preferred over email and in fact, some of the secondary students said that they did not even know their close friends' email addresses. A post secondary student attempts to explain the phenomenon:

> I find that I send like an email to people and sometimes they don't respond. And sometimes it takes two or three days for them to respond. But if I send them a message on Facebook, they will respond immediately. When I get a message on Facebook…I feel like I have a responsibility…a social responsibility to [respond]. It's almost like when I'm talking to a person at a party. [upper year post secondary student]

Secondary students said "Yeah, I don't check it [my email] like every day. Like if you want an instant response, you would Facebook message someone" and "I still have to check it [my email] sometimes because teachers like using it."

Given that Facebook is a major communication tool, students often used it to chat online about their homework and assignments. When students were asked what they did when they were stuck on a physics homework question 71% said that one of the first things they would try was chatting online with a friend. Facebook was the most frequent chat client that they named but other tools were sometimes used such as MSN and Skype. Students acknowledged that chatting online about physics homework was challenging, particularly when equations and symbols were needed, but it was still one of the dominant coping strategies that students used while they were working on their physics homework.

Students also talked about Facebook most frequently when they were asked for suggestions about how their teachers or instructors could use social media in their teaching. Some students could describe instances that they had heard about where teachers had used Facebook as a way to communicate with their students, usually through a Facebook group. Some students suggested that teachers develop a presence on Facebook, usually so that they could be more accessible for students' questions:

> I think it would be cool if they had like a Facebook because they only have a certain amount of office hours. But if you were on Facebook, you could just talk to them anytime

> you want kind of thing. And it's a lot quicker than email. And you wouldn't have to wait for them. [first year post secondary student]

But other students did not like the idea of mixing school with their social life:

> I know that they have email, but I wouldn't want to add them [teachers] on Facebook as a 'friend' because that's just really weird. I don't think that I really want them in my social life except for part of my education part of my life. [secondary student].

Secondary and post secondary students talked about Facebook in the same ways and with similar frequency and emphasis. For all of the groups interviewed, Facebook played an important role in the ways their social network supported their academic work.

Videos were a heavily accessed social media resource. Students in each focus group agreed that they sometimes used videos to learn physics and a little more than half (n=13) of the secondary students specifically cited online videos as a resource that they consulted when they were stuck on a physics problem. Some students used video to clarify a concept:

> People post video lectures online on YouTube. They are also sometimes helpful as a supplement to what you are learning. MIT has a bunch of lectures they put up. I usually [watch] when it's really confusing….not only are they good for Physics but I also find they have put like a bunch of other ones as well. [upper year post secondary student]

Videos were used to review a concept:

> I think most of my learning that I get done is in the classroom setting but these videos seem to be like refreshing, like just to remember what you've done before. [first year post secondary student]

Or to learn more about a concept:

> It's mostly for my own entertainment too. I'm not always convinced that I'll have a better understanding maybe because of it but, I'll find somebody and think "Oh, yeah! This is really neat!" and, I'll try to find another one [video] that explains it even better at that point. [upper year post secondary student]

However, secondary students were more likely to use videos to find the answer to a physics problem:

> Researcher: If you are stuck on a physics problem, what is the first thing you will do?
> Student 1: I'll YouTube it. I look at the chapter, the questions in it and usually there's a video. Like a math tutor.

Both secondary and post secondary students used videos that they had found online to support their learning. They gave similar reasons for using video:

> I think the big thing about having media to do that is, you know that you could access it anytime you want…Like I can't tell a prof, "You want to stop now?"…with videos I could. [first year post secondary student]

> Student 1: [Videos help me learn] because like when we're in class we have to like listen to the teacher but we have the choice not to because like we don't really want to. And then when we're self-studying, like when we're on the computer, we're like focused on one point. So I guess we're like concentrating on that video or like information.
> Student 2: The video gives much more information.
> Student 3: You can't exactly press pause on the teacher and go back and… [secondary students]

Some students appreciated the visual capabilities of video, however in the physics learning context, simulations and animations were rarely used and most of the videos students

viewed were 'chalk and talk' style lectures. Students said that you could find a video lecture on almost anything online, but recognized that resources "need to be compiled better" and that "a professor knows if a video is actually true". Several secondary students talked about online tutoring sites such as the Khan Academy, which have videos and worksheets, and found them very helpful for independent learning. "He has notes and stuff as well so that while you're watching the videos you can look at his notes and stuff". Some also clearly prefer the visual learning style of watching videos:

> For me overall to watch something in a video, I learn a lot from that instead of just listening. It's the same thing if the teacher does an experiment, it's easier to understand and to learn. So if I watch a video on YouTube, I learned it a lot easier [secondary student]

In the process of learning physics students clearly spend time looking for and watching videos online. Some suggestions students had for incorporating these activities into their more formal schooling was for teachers and professors to recommend videos, and also for teachers to create videos of their classes and lectures that students could access. Students, however, did not advocate for the replacement of classes with videos. Students valued coming to school, in part for social reasons, and having a teacher to consult with. "The fact that the teacher is there and we're interacting with him and we can ask, we can ask him questions that can be answered that can't be answered online." One student said that they thought personal interaction was better and that teachers were there to answer questions. A secondary student said "I like learning from a teacher. Like having them verbally teach it to you rather than reading it from a textbook. And it's fun learning together in a group."

While students in both secondary and post secondary education tended to use Facebook and online videos in similar ways, student use of online discussion forums was markedly different between these two groups. Thirteen or 54% of secondary students said that they used online forums or question and answer sites such as Yahoo answers or Answers.com, whereas only 3/10 or 30% of post secondary students said that these kinds of sites were helpful, and these were all first year students. None of the upper year physics students mentioned these sites. Secondary students also relied more heavily on Google (75%) than post secondary students

(57%). One first year student said that they liked learning online because "You can type in exactly what you want to know and you can find it out." Secondary students described their strategies:

> I just Google like a really stupid sentence, question like, "How do you do this Physics question?" And then, see if it's on Yahoo answers.
>
> Student 1: I'll type something in [to Yahoo Answers] and usually like someone's asked that question.
> Student 2: There's also like, if you ask a question and wait for someone to answer…for if you want some more answers.

Secondary students recognized that it was difficult to Google the answers to physics questions:

> The equations ones, there's like really hard to find some of the answers. It's like, "Oh, my God! I don't understand what I'm doing!".
>
> If it's stuff like that where I can't really Google it then, I just ask my online friends.
>
> Researcher: Do you find the right answers, or the solutions that you're looking for?
> Student 1: Sometimes. For physics, it's kind of hard.
> Students 2-4: Yeah.
> Student 1: I tried yesterday and it didn't really work.
> Student 2: Sometimes if you put too many words in or, like you're not specific enough, they give you too broad…
> Student 1: And also because we're in Physics 11, whereas like the…and a lot of the Physics is like really advanced. So it doesn't help me understand it.

Results from focus group interviews support claims from the literature (e.g., CIBER, 2008; Clark et al., 2008) that today's students increasingly need immediate, easy to find, and

surface level solutions. Though many students recognized that Googling for physics answers does not work very well, the majority still said that it was a strategy that they frequently used. However, students were twice as likely to say that they would ask a friend (in person or virtually) before asking Google or posting the question online. In addition, it seemed that secondary students used the Internet in a mostly Web 1.0 way, to find information that is stored there and use it to help them with their homework. They much more frequently searched for and read sites like Answers.com than they contributed to the community. However they appeared to recognize and value knowledge created by mass collaborations and were more likely to trust sites that were popular and frequently contributed to such as Yahoo Answers and Wikipedia, rather than an unrecognized source. A secondary student said, "on the Internet, if you go into Wikipedia, since so many people have contributed to it, you actually get the full thing. Instead of just kind of part of it. And it makes sense more." Post secondary students, on the other hand, particularly the upper level physics students, were more likely to use social media and online resources to gain a deeper understanding of a concept and were less likely to be 'looking for the right answer'. For example, one first year post secondary student described the difference between learning using technology in high school and in university:

> In high school, the teacher gave you a lesson and you just kept that and you just stay there. You don't go beyond that. Here [at university], you have to go…for me, I don't know, I have to go beyond that. So I have to look for other sources to get more information and support my knowledge. It helps us to know like more about it even if it's not relevant to answering the questions. So you're not just parroting things back.

Personalized physics learning. Without calling it 'personalized learning', students talked about being able to have the flexibility to tailor their learning programs. A secondary student said: "I think that on the Internet, a lot of times, it's, especially if you are asking questions, it's specifically tuned to what you want instead of the teacher who just teaches the general topic". They talked about the frustrations of learning physics in a classroom environment:

> sometimes they [the teacher] are moving too fast. And sometimes it feels like they're not moving at all. And yeah, so sometimes you're in class and doing the same thing over and over again. I think it's because it's like everyone has their own pace in their learning and their own like how they want to learn and methods and stuff so, it's like a teacher can't adjust to like every single one of the students. Which is like really hard. [secondary student]

One secondary student described how she learned specific singing skills from YouTube because "the [choir] teacher cannot focus on specific people, so it's better to watch the video."

Upper year post secondary physics students discussed how they pull together resources to become self-directed learners since they rarely found their on-campus lectures helpful. Some secondary students enjoyed taking online courses because "you could work at your own pace and do like whatever you want. If you wanted, you could get like English done in a week.", while other students recognized that they needed the structure of class meeting times. An upper year post secondary student said: "The Internet, for learning, it isn't structured at all and like, you can do whatever you want and you can find whatever you want. But sometimes you'll go off on a completely wrong course and learn something that doesn't really help you."

A first year post secondary student talked about how much he valued being able to get a second opinion and view different perspectives on a topic, and how having access to the Internet had impacted his learning:

> It [the Internet] makes the topic more interesting. Like if I were to just be going off of the Physics that I have learned from high school, I probably wouldn't even do Physics at all. But like university stuff or sometimes you know the Internet is much more interesting. So I probably wouldn't even be pursuing this if I hadn't known about that.

Students were asked what steps they took when they were stuck on a physics problem. While some clear trends emerged that have already been described, another result was the diversity of strategies students used and that the order in which students accessed them varied widely. Only four students total talked about using the textbook if they got stuck. A secondary student said: "I don't like the text book. I don't know. It's like long and they use big words and

they use big paragraphs. I think that if they shortened it where they just gave us really important notes and a lot of pictures that would make more sense." Only one student mentioned asking the teacher. Therefore, using an array of social media and other learning and communication tools, students develop their own personalized learning support system that is likely tailored to fit the needs of the discipline they are learning and the context in which they are learning (secondary or post secondary).

Teachers and social media use. Secondary and post secondary students were asked about whether their teachers used social media in their courses and how they would like their teachers to use it. Students in all age groups agreed that their teachers did not frequently use social media as teaching tools. The only example of social media use from the post secondary students was the use of YouTube videos in lectures and posting of assignments and information on course management systems. One upper year post secondary student described how some mathematics professors used Twitter: "They would talk about, you know, the problems that they would encounter in their work, and it's just a conversation group between a few people [upper level and graduate students]". Some of the post secondary students said that it would be nice if they could talk to their professors online, as opposed to office hours. One said, "Chat might be more of a good thing. It might increase like, not coming physically to visit them, but to ask questions in the same way".

The secondary students who were interviewed had more examples of how social media had been incorporated into a variety of their courses at school. Most of the students who were interviewed attended the same school, so the results represented a narrow perspective on what teachers may be doing with social media at the high school level. Students said that they had contributed to wikis as part of an assignment and had teachers who maintained blogs. The Grade 12 students attending the private high school said that one of their teachers was willing to meet students via Skype to provide extra assistance during an extended period of absence from regular classes. The teachers who had blogs used them to disseminate coursework and information, not in interactive ways (i.e., to hold discussions or allow student contribution and commenting). Students talked about doing online mathematics problem sets: "In Math, they give us like a problem set to do online, but they say "Go to this link." But it's hard to do because the link is actually in the text book and we're not allowed to take the textbook home." In one case, students described a science teacher who posted a presentation online after class. They said: "It's better, if

the teacher is going too fast in class, and she is video-taping it then, you can pause it and figure out what is actually going on in the question and break it down." Students also said that when YouTube videos were used in class and the links were made available that they would go and re-watch the videos when they were studying.

Case Study Results

Of the approximately 40 educators (teachers and administrators) in SD 10, 11 respondents completed the survey for a response rate of approximately 27% of district staff (teachers and administrators). Based on the number of responses (n=11) it was difficult to delineate general results between the two professional development sessions or by demographic subgroup of teacher (n=9) or administrator (n=2).

With regard to Section 2 items (n=6) which addressed the respondents' reactions to the training session and trainer, the feedback was overwhelmingly positive. The items asked respondents to rate statements on a five point Likert scale which ranged from strongly agree to strongly disagree. Each item was framed in positive language and asked about aspects of the training session. For example: (a) "I liked the Managing Digital Footprints session provided"; (b) "The presenter was good at delivering the session"; (c) "The presentation was engaging"; and (d) "The session topics were interesting and relevant and/or on point". In all cases, the positive response rates (collapsing agree and strongly agree) ranged from 82% to 90%. Thus, it was clear that participants had positive reactions to all aspects of the training session that were queried.

Given this favourable reaction, the Kirkpatrick and Kirkpatrick (2006) Four Level Model predicts that respondents should evidence some changes in behavior as a result of the professional development session received. Section 3 of the survey was designed to determine participants' knowledge and attitudes towards social media before the sessions and the impact of the sessions on awareness, beliefs, feelings, and behaviours. Section 3 was divided into two sections: (a) Section 3A "Learning as a Result of On-Site Professional development", and (b) Section 3B "Behaviour as a Result of the Session". An item that was designed to elicit an indication of prior knowledge respondents might have had about the professional development topic before the researcher's sessions had one of the lowest (45%) positive responses. Thus, the likelihood of change in knowledge, attitudes and behaviours was high. The responses to all items in Section 3 regarding learning directly resulting from the onsite professional development

demonstrated that the professional development sessions affected changes in respondents' knowledge, attitudes, or behaviours within all the specific contexts (personal, professional, classroom, school, and district) addressed by the survey. Responses ranged from a low of 55% (agree or strongly agree) to a high of 100%. The higher percentages of positive responses ranged from 72% to 100%. Most significantly, the highest positive response (100%) was to Item 8 in Section 3A: "I believe more that students need support and scaffolding in use of social media." Additionally, 91% of respondents indicated positive responses to:

- "This session raised my awareness that there was a lot I didn't know about digital footprints, social media & Web 2.0" [Section 3A, Item 2].
- "I know of the professional issues that can arise in using social media" [Section 3A, Item 4].

Though remaining items from Section 3A: "Learning as a Result of On-Site Professional Development" received a lower (82% to 72%) positive response, they still indicated positive impacts of the professional development:

- "I know more about managing digital footprints in social media than I did before" (82%) [Item 3].
- "I know more about the issues that can arise for schools in using social media" (82%) [Item 6].
- "I know more about the issues that can arise for students in using social media" (81%) [Item 5].
- "I believe that the practices of the teacher in and out of the classroom can form student behavior with social media" (72%) [Item 9].
- "I believe that my school needs to directly address social media in our policies and procedures" (72%) [Item 10].
- "I believe that my district needs to directly address social media in our policies and procedures" (72%) [Item 11].

The results in Section 3 of the survey also indicated that though there were a variety of aspects for which the professional development was less effective; two items garnered the lowest (18%) positive response: "I felt more confident about using or trying to use social media" (Section 3A, Item 13) and "This session influenced me to develop classroom practices and

policies for social media use (e.g., permission slips, and guidelines)" (Section 3B, Item 11). Also, "This session influenced me to develop district practices and policies for social media use (e.g., permission slips, and guidelines)" (Section 3B, Item 7) had a low positive response of 27%. The remaining items in Section 3B "Behaviour as a Result of the Session" with a relatively low positive response were related to changes in behaviours. In order from lower to higher percentage response, they addressed professional use of social media, feeling more likely to use social media, personal use of social media, developing school-wide practices and policies for social media, creating a positive digital footprint, and raising awareness of social media issues at the district level.

Responses to Section 4, which assessed whether respondents thought similar training would be valuable for others—specifically in-service teachers, pre-service teachers, school administrators, students, and parents/guardians—received the most consistently high percentages of positive responses ranging from 73% to 100%. Participants gave a 100% positive response to two items:

- "Developmentally appropriate sessions similar to the one(s) I attended should be provided for students" [Item 4].
- "Sessions similar to the one(s) I attended should be provided for parents and guardians" [Item 5].

The next highest positive percentage response (91%) was to "Sessions similar to the one(s) I attended should be provided for pre-service teachers" (Item 2). There were two remaining items in this section which also received positive responses but to a lesser degree:

- "Sessions similar to the one(s) I attended should be provided for in-service teachers" (82%) [Item 1].
- "Sessions similar to the one(s) I attended should be provided for school administrators" (73%) [Item 3].

Moreover, though there were no open ended items with regard to value of this type of professional development for other stakeholders, one respondent used an "Other comments?" box at the end of the survey to suggest, "Similar sessions for educational assistants, community workers (mental health, social work, etc.) school boards and other stakeholders. Where appropriate, adapted sessions for students with developmental disabilities and mental health challenges." Therefore, respondents valued the content of the professional development sessions

highly enough to recommend them to their colleagues and other stakeholders in school communities.

Within the scope of the survey, respondents had several opportunities for open ended responses. One of the items was, "In your view, what were two important strengths of the training?" (Item 5, Reactions to Training Sessions & Trainer). All but one of the respondents (n=10) to the survey answered this item. Responses indicated that key strengths of the training were the timeliness of the professional development with regard to what is occurring in the larger social/technological context—especially with regard to children; as well as the training emphases on the need to stay current with technology, and raising attendees' awareness about digital footprints. The knowledge, expertise, and delivery of the presenter were also cited as strengths. One respondent noted,

> Provision of sample policy, background research, source material, and other supporting docs is invaluable. Depth and breadth and support in presentations makes it likely that change will occur as a result. We know where to go next, and trust the process.

Another respondent said that a strength of the training was learning "Caution when using social media. All students need to be given instruction on social media behaviour, life-long implications, responsibility associated with using this form of communication."

Responses to open ended items soliciting weaknesses of the training sessions were slightly lower in number (n=8); 50% of those who responded took the opportunity to cite issues with technological access or infrastructure in the district. Respondents also cited a desire for more hands-on, interactive activities, "Practical applications. It would be nice to go through accounts and create or manage them with the presenter."

Where respondents had the opportunity to share actions they have taken as a result of the professional development, responses were lower and ranged from n=4-5. Some reported changes in individual and instructional behavior reported were:

- Being more 'cautious' or 'careful' with regard to social media and Web 2.0 use and sharing this perspective with students using social media
- Expanding upon what respondents were previously sharing with students regarding social media use

- Checking and controlling what's online with regard to respondent's identity, including photos
- Using pseudonyms to protect identities
- Better personal branding when using social media/Web 2.0
- Trying a Moodle forum for students
- Increased Twitter use

Discussion

Student Study Discussion

The results of a focus group study of students' perspectives on social media and science learning demonstrated that student use of social media tools were wide ranging and ubiquitous, but that the tools were not being used in creative and collaborative ways to support their science learning. For example, it was somewhat surprising that only one student, a post secondary student, talked about having a course related Facebook group, where students could meet, chat, and share ideas and content in a centralized place. Such a group could be an emergent artifact of students connecting online for their learning and could be a generative learning tool for them to use both within and outside the scope of their regular assignments. However, most had not created or participated in such a space. Interpreted from a complexity thinking perspective on learning, it was concluded that students were, in most cases, not describing uses for social media tools that optimized the tools' possibilities for co-constructing knowledge and emergent learning opportunities. Students at the post secondary level were more likely to recognize and partake in these opportunities. They were more likely to say that they used tools such as online videos and discussion forums to get a better understanding of a complex concept or idea. One notable instance was a first year student who said that he used Internet sources to get a diverse array of perspectives on what he was learning and that having access to supplementary physics resources had made a significant difference to his interest level and engagement in the subject matter. Secondary students, on the other hand were more likely to use social media tools to find the answer to a question either through asking a friend or Googling it to find an answer that had been previously posed on an online question and answer forum such as Answers.com.

The implications for these results are that teachers need to be aware of the level of sophistication with which students are engaging with social media tools. Simply knowing that they are using them is not sufficient to be able to design pedagogies that will build on students' experiences. It is necessary to determine in what ways students are using social media for particular types of tasks. The current study examined primarily how students use social media when working on physics homework problems. Students may use social media in a wider variety of ways in different disciplinary contexts, but for physics learning they have yet to develop strategies to adapt their studying and learning practices to include some of the possibilities that connecting with others with social media could provide.

Students were, of course, constrained by the existing structures of traditional schooling, where most physics homework problems are assigned out of textbooks and most work is assessed individually. Student reticence to engage in, or perhaps talk about engaging in, collaborative efforts online to support their learning may have stemmed from a concern that they would be judged as having cheated. For example, in 2008, a first year student was charged for cheating for running a Facebook group (CBC News, 2008). While the researcher was not the students' teacher, most of the secondary students who were interviewed were high achieving students from an affluent community who would likely not want to risk their academic success by disclosing their online behaviours in a research interview. However, the results of the focus group interviews do support previous research in the field that established that while students spend a lot of time on social networking sites and know how to navigate online spaces, only a small percentage actually fully participate by creating content for blogs, commenting in discussions and designing personal learning spaces (Beetham, McGill, & Littlejohn, 2009). Follow up research in this area will be conducted in the form of an anonymous survey which may yield different results about how much students collaborate and share their ideas online.

A key result from focus group interviews was that students used social media tools in different ways, but most enjoyed the ability to be able to learn the way they want to, in their own independent and personalized way. Social media and Web 2.0 technologies provide many possibilities for designing personalized learning spaces or plans. However, students need to be supported in this effort, as they do not have the skills and expertise to design effective learning spaces, particularly in managing the connective and collaborative powers of Web 2.0 technologies. Williams et al. (2011) drew on complexity thinking to propose some strategies for

managing emergent learning with social media such as developing negative constraints (i.e., specifying what is not allowed to happen), rather than what is allowed to happen. Davis and Sumara (2006) called this practice creating enabling constraints. A mechanism for being able to make mistakes and to learn from them is another strategy that Williams et al. (2011) described, which is also similar to the positive feedback loops that Davis and Sumara (2006) say drive a complex system closer to the state of instability where emergence, or learning, can occur. Thus by applying principles of complexity thinking recommendations for implementing pedagogies for learning with social media in classrooms can be made. In British Columbia, personalized learning is the central idea in the Ministry of Education's current Education Plan (2011) and thus in the local and provincial context of these studies, ways to enable personalized learning to occur are being prioritized.

Similar to previous research (e.g., Watkins, 2009), social media and Web 2.0 resources were being used by students to connect with people in their existing face-to-face social networks. Particularly when they needed support with their learning, they used online tools to interact in ways similar to how they would interact with their peers in person at school. It is important to note that students communicated frequently with each other and that they expected communication to be fast and convenient. While email may appear to be a form of instant digital communication, to secondary and post secondary students it is not their primary form of communication. Teachers and instructors need to be aware that their emails may go unread or unnoticed for days, while Facebook notifications are usually quickly acknowledged. The results of the focus group student study help teachers and other stakeholders in the education system become aware of how students are communicating and what their preferred communication tools are. Teachers are often trying to find effective ways to ensure that communication is clear and effective between students, parents, and teachers. Social networking tools could be used to facilitate clear and open communication between students, parents, and teachers and to build a sense of community.

Focus group interview results also provided insight into how some teachers are using social media resources. Post secondary students believed that their physics courses in particular lagged behind in terms of the incorporation of new technologies compared to their experiences in other subject areas (such as Biology and Math). Physics courses were less likely to have any kind of assignment submission online and had very low participation in online discussion forums

on classroom management systems. Secondary students were able to provide examples of teachers who had used social media tools such as blogs and wikis as communication and assessment tools, but they were not used in collaborative ways. Information was disseminated on blogs, not constructed with students' comments and perspectives; wikis were used as individual assessment tools, not a space for students to collaborate and create. Similar to students, teachers were constrained by traditional school curriculum and pedagogical structures, although in the student focus group study no data was collected on schools' policies and procedures regarding social media. Complexity thinking troubles the theoretical foundations of traditional schooling structures such as imperialism and behaviourism, and views knowledge as dynamic, learning as a process of adaptations to fit appropriate context, and teaching as opening the space of possibilities (Davis, Sumara, & Luce-Kapler, 2008). A complexity thinking perspective has much to contribute to the design of generative, meaningful online learning spaces that work in concert with more traditional, prescriptive learning spaces that exist in current schooling structures. Although research has yet to demonstrate its effectiveness, it is the researcher's (Moll's) belief that supporting teachers in the development of more of a complexity thinking perspective on knowing, learning, and teaching and expertise in working social media and Web 2.0 technologies would allow teachers to optimize new technologies for their capabilities to create generative learning spaces that meet the needs of 21st century learners and curriculum.

Case Study Discussion

Overall, the district case study results indicated that the professional development sessions provided by the researcher (Hengstler) on managing digital footprints, addressing professionalism, social media and Web 2.0, positively influenced professional awareness, and knowledge about social media and Web 2.0. The results also indicated, to a lesser extent, that the professional development training influenced changes in behavior, practice, and policies at the personal/professional, school, and district levels.

A large majority (91%) stated that the sessions raised their awareness that there was "a lot" they did not know about digital footprints. Considering that 45% of respondents reported prior knowledge on the topic, this indicated that the training increased knowledge among entry level learners as well as those who had prior knowledge. The greatest impacts reported as a result of the training sessions were:

- Respondents believing that students need more support and scaffolding around social media (100%);
- Respondents perceiving value in similar, developmentally appropriate sessions for students (100%), parents and guardians (100%), and pre-service teachers (91%).

These results affirmed the value of the researcher's (Hengstler's) previous work with K-12 sector students, and her concept for developing training materials appropriate to parents and guardians with regard to digital footprints, social media, and Web 2.0. The results also affirmed the researcher's (Hengstler's) ongoing work with pre-service and in-service teachers in this area and indicated that the respondents valued the contents of the professional development training sessions highly enough to recommend them to their colleagues and other stakeholders. In fact, one respondent indicated a desire for

> Similar sessions for educational assistants, community workers (mental health, social work, etc.) school boards and other stakeholders. Where appropriate, adapted sessions for student with developmental disabilities and mental health challenges.

This comment provided potential directions for developing additional professional development training on the topic of digital footprints, social media, and Web 2.0.

Interestingly, the positive response to the value of similar training for pre-service teachers (91%) was higher than the value attributed to training for in-service teachers (82%). That difference may be attributed to in-service educators perceptions that faculties of education and teacher training programs should focus on emergent issues or that in-service educators have other, more relevant 'practical' topics for professional development. More research is needed to determine why this difference emerged. Responses may also be due to 'newness' of the technology, or the fact that managing social media and Web 2.0 behaviour for educators and students is still an emergent area. This gap could also be related to the age demographics of the district. As an emergent area, training is not readily or widely available because expertise in these areas is still confined to a small group in the educational community—British Columbia and elsewhere. Moreover, perceived need for training across a variety of stakeholder groups may be because the topics of digital footprints, social media, and Web 2.0 have not yet been embedded in provincial curricula. To date, no specific body has stepped forward to coordinate training or supply information in this area—as has been done with anti-drinking and driving campaigns, recycling efforts, etc. Currently, the most consistent organizational response to this

topic has been the application and/or updating of acceptable use policies and/or prohibitions—generally at the school level.

It was also notable that the majority of respondents (91%) reported that the professional development sessions raised their awareness about how much they didn't know about digital footprints, social media, and Web 2.0; and increased their knowledge of the professional issues that can arise in using social media. Kutner et al.'s (1997) review of professional development literature indicated that "one-shot" professional development activities such as the one provided in the case study were unlikely to affect behavior. In the Four Level Model (Kirkpatrick & Kirkpatrick, 2006), the ability of the training to affect participant behavior moves training to the third level. In the case study, while the perceived need for school and district policy received a 72% positive response, at the time of the survey (six months post-training), 55% of respondents also reported being influenced by the training to develop school-wide practice and polices for social media use (e.g., permission slips, and guidelines). The literature in the field has yet to determine the critical mass required for affecting change in technological policy and practice in a school district; however, if over half (55%) of a sample of the district was moved to take some type of action at the school level, that represented a significant movement as a result of the professional development training for a school, and by extension, the district. One respondent commented that as a result of the professional development "Several teachers in one of my schools have been teaching social media/dig[ital] footprint in their Planning/HCE classes—this was a school wide decision by our staff".

This influence on school-related practice and policy may have been affected by several factors. Firstly, the separate training provided to the school district administrators (of which faculty were made aware), the commitment of district resources allotted for the training, the commitment of the "district day" training to the topic; and the fact that all district administrators and faculty were expected to attend a training session may have signaled to all educators in the district an 'upper level' significance or priority for the topic. Perhaps the district-wide scale of the training might have been the most significant factor as it also meant that a professional-interest group could coalesce at the school level—and in each school in the district—around a shared knowledge base and similarly heightened awareness of issues. The relatively small size of the district lent itself to this type of full-scale training. It is unclear at this point in time whether similar district-wide training in a substantially larger district would have a similar effect.

The positive response regarding the influence of the professional training on the development of district practices and policies was roughly half of that found at the school level (27%). The higher positive response for school versus district influence to act could have resulted from a variety of factors. Some of these might be faculty perception that their sphere of concern/influence is located more at the level of the school than at the district; teachers' perceptions that the business of district-wide policy and practice is more relevant to administrative roles and takes place in the school board office; or that a larger number of teachers do not have sufficient time to influence district practices and policy. The level of positive response was even higher (60%) for being influenced in the more individualistic behavior of creating a positive digital footprint for their professional identity. That said, regarding district-wide influence of the training, two respondents reported "A district committee has been struck" and another stated that s/he had presented to the board to help "form [a] committee to develop policy." From a complexity thinking perspective these results can be interpreted in terms of the multiple levels of complex systems that teachers regularly participate in. In some systems (their own personal behaviour and at the school level) they feel more control than at the district level.

In future research, potential factors affecting faculty perceived spheres of participation should be considered alongside the provision of professional development training regarding the development of social media and Web 2.0 practices and policies. Further, since the case study district had relatively few schools, administrators, staff and potential stakeholder inputs, future research should consider whether smaller districts might be more nimble and responsive in the design and development of district-wide practices and policies such as those relating to social media and Web 2.0.

Due to the structure of the professional development sessions—'one-shot' presentations rather than workshops, or presentations with follow-up sessions—it was not surprising that evidence of impact on behaviours was not as strong as the influences on knowledge, beliefs, and attitudes, or that responses to open ended questions asked for more "hands-on" time to practice what was presented in the training sessions. These responses will inform future professional development design by the researcher (Hengstler) in this area. Additional follow-up sessions might be designed to complement the 'one-shot' presentation content focusing on the areas with lower positive responses (45-60%): professional uses of social media, personal uses of social

media, and creating a positive professional digital footprint. This was a limitation of the professional development design that could be addressed by providing additional sessions in the case study district.

As the school district in the case study was rural and remote, access to professional development appeared to be an ongoing theme. Additional partnerships between post-secondary faculties of education and rural districts such as the one in this case study may help provide opportunities for further professional development. While not an intended focus of this research, an outcome was that a partnership between post-secondary faculty with the knowledge and skills in this area and British Columbia's K-12 schools might provide a model to address this specific professional development gap while fostering relationships with the potential to encourage symbiotic learning partnerships, reduce duplicate efforts, and share knowledge and experience provincially, nationally, and internationally.

Conclusions

The main conclusions of the student focus group study were that secondary and post secondary students, and their teachers were using social media, but not in ways that would significantly improve the in school or out of school learning environment. Both students and teachers need support to enhance the ways that social media are used for science learning and for teaching in general. Applying complexity thinking to understand the ways in which social media tools can allow for emergent learning may help teachers to use social media tools to support students in designing personalized learning spaces for themselves. These spaces should be tailored for specific disciplinary learning contexts.

The results of the case study found that a professional development session focused on developing social media practices and policies in the teaching profession had a positive impact on teachers' attitudes, beliefs, and behaviours. The case study results provided insight into a potentially effective professional development model for enhancing teachers' confidence in developing social media policy, changing classroom practice and their own professional social media practices. Case study findings highlighted benefits of additional cooperation between faculties of education and the K-12 and post secondary fields—connecting educational research and practice with the goal of increasing pedagogical skill and efficacy. The findings will be of increasing importance as districts and ministries of education strive to meet calls for 21st century learning in schools.

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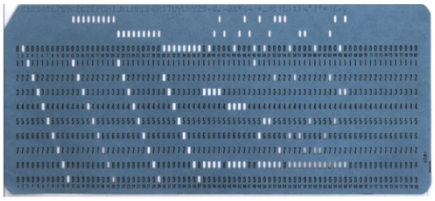
Appendix A: Education and Technology: Events, Influences, & Trends (J. Hengstler, 2012)

While schools made use of television in the early 1950s, technology as defined by the emergence of the computer did not gain prevalence in North American schools until the 1980s (Murdock, n.d.). Many older educators in North American systems have lived through the emergence and proliferation of the personal computer within their professional and possibly middle school/high school student lives. Many educators have lived through the emergence and proliferation of the Internet as a teacher, but likely also as a middle or high school student. Few educators in the profession today have experience of Web 2.0 and mobile technologies—the Internet dominated by Amazon, Google, blogs, wikis, YouTube and the like, mobile devices—prior to their professional or post secondary career. Below is a timeline of events, influences, and trends affecting the use of technology in education.

- Early 1950s: first commercial mainframes sold to University of Manchester and University of Toronto; first mass produced computers (Wikipedia, March 14, 2012)

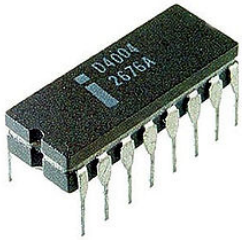
Example of a mainframe (Seaver, 2005)

- Mid 1950s to Early 1960s: IBM developed smaller more affordable commercial computer; transistors replaced vacuum tubes in computers significantly reducing size, purchase prices and maintenance costs; emergence of peripherals devices (Wikipedia, March 14, 2012)
- Mid 1960s: some schools received mainframe and mini computers—computers that were using punch-cards for inputting data and outputting via line printers; where available most schools used computers "for administration of for school counseling (databases for information about and for students)" (Murdock, n.d.)



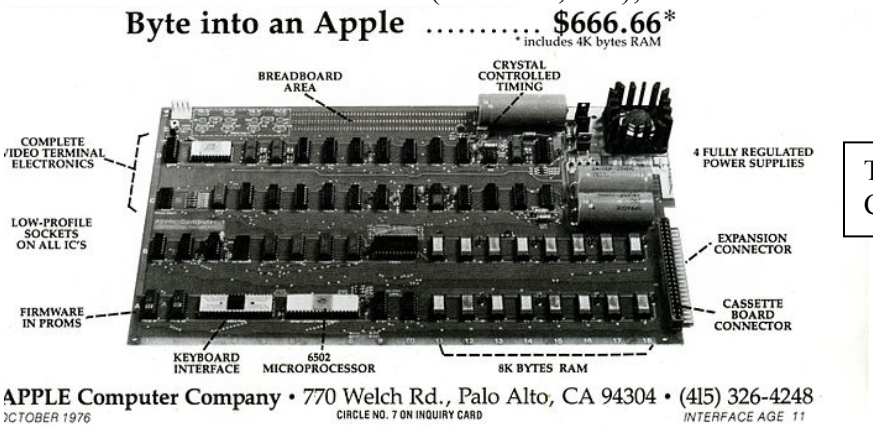
Example of a punch card (Gwern, 2006)

- Early 1970s: "mainframes and minicomputers in some schools, but very little use in the delivery of instruction" primarily because they were not compatible with the "teacher/manager model of learning" in a single classroom; computers were widely used in business; microprocessor developed; early instructional programs for mainframe and microcomputers developed (Murdock, n.d.);



First commercial microprocessor, Intel 4004 (LucaDetomi, 2005)

- Mid 1970s: Apple sold first Apple computer, Apple I (Wikipedia, March 14, 2012); Apple began to donate first personal computers to schools; some schools stuck to the mainframe/microcomputer infrastructure in which they had invested time and effort rather than transition to the new PCs (Murdock, n.d.);



The Apple I (Apple Computer Company, 1976)

- 1979: estimated 15 million PCs in use in the United States (ISTE, n.d.)
- Early 1980s: mainframe manufacturers develop PCs; computer assisted instruction "gains acceptance in schools"; early educational drill and practice programs developed for PCs; early simple simulations programs developed for PCs (Murdock, n.d.); first presentation software released (Wikipedia, May 2011).

T180- Z80-microcomputer by Digital Equipment Corp. (Berberich, 2000)

- Mid 1980s: Apple Macintosh introduced; commercial software manufacturers began developing computer-based tutorials and educational games; 25% of American secondary

schools used PCs for "college career guidance; K-8 schools buying mostly Apple II and Macintosh computers, high schools buying mostly DOS-based clones" (Murdock, n.d.);

Apple II (Rama & Musée Bolo, 2000)

- Late 1980s: "60% of all workers in the US use computers"; emergence of laptop computers (Murdock, n.d.);

Toshiba T3200 Laptop (Liftarn, 2007)

- Early 1990s: multimedia PCs developed; schools used videodiscs; simulations, educational databases, and other computer assisted instruction delivered on CD-ROM, many incorporated animation and sound; early access to online information through Gopher servers (Murdock, n.d.); first search engine "Archie" from McGill University (Computer Hope, n.d.)

CD ROM Drive (Wikimedia Commons, 2007)

- Mid 1990s: digital video, virtual reality, 3-d technologies emerged; business PCs more prevalent than multimedia PCs; object-oriented authoring systems; "most US classrooms now have at least one PC available for instructional delivery, but not all teachers have access to a computer for instructional preparation" (Murdock, n.d.);

IBM PC running Windows 95 c. 1995 (Lemos, 2007 & adapted by Hengstler, 2012)

- 1995: Internet and world wide web grew in popularity; businesses, schools, and individuals began creating web pages; computer assisted instruction was growing in popularity and was CD-ROM based (Murdock, n.d.); Amazon went online (company started in 1994) (Wikipedia, March 6, 2012)

- Mid to Late 1990s: Internet continued to grow in popularity; businesses, schools, and individuals began creating web pages; computer assisted instruction was growing in popularity and was CD-ROM based; businesses used Internet for advertising and product/service delivery; new graphics and multimedia tools "for the delivery of information and instruction using the Internet; many schools are requiring for Internet access; a few schools install web servers and provide faculty with a way to create instructional web pages." (Murdock, n.d.); early smart phones sold (Wikipedia, March 7, 2012); Google launched (Wikipedia, wikis emerge (Wikipedia, Februrary 20, 2012); blogs emerge (Wikipedia, March 5, 2012); social bookmarking emerges and tagging systems developed (Wikipedia, February 19, 2012); photo and video sharing sites emerged

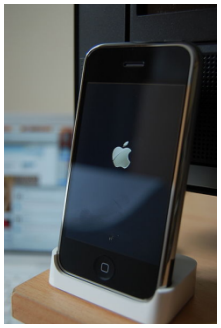
Google

Google logo (Google, Inc. 2011)

- 2000-2005: Wikipedia launched; proliferation of social media like Facebook, Twitter, YouTube, Flickr; emergence of tablet PCs for consumers (Evans, 2011)

Compaq TC1000 c. 2003 (Lozére, 2005)

- 2006-2010: Apple launched first iPhone (Wikipedia, March 7, 2012), iPod Touch (iPod History, 2010), and Android operating system released (Wikipedia, March 7, 2012); Amazon Kindle released; Apple iPad released (Evans, 2011)



Original iPhone (Andrew, 2008)