PREMIER'S TECHNOLOGY COUNCIL

A Vision for
21st Century Education

December 2010

FOREWORD

The Premier's Technology Council (PTC) was created in August 2001 to provide advice to the Premier on technology-related issues. The Honourable Gordon Campbell is Chair of the Council, a position shared with the Co-Chair, Greg Peet, formerly Chairman, President and CEO of ALI Technologies (acquired by McKesson Corp in 2002). The Council is fortunate to draw its membership from 20 other leaders of BC's technology industry and from senior levels of the academic sector.

This special report highlights a vision of education in the 21st century. As a result of our research, we believe that our system must transform to properly serve the citizens of a knowledge-based society. The PTC fully understands that the current education system is both large and complex and that engineering the kind of transformation discussed will be a significant challenge. The PTC has not chosen, however, to discuss the specifics of implementation at this time. We have instead chosen to envision what a new system might look like were we able to begin with a blank slate. As there are no implementation steps considered in this special report, it contains no recommendations.

In the development of this vision, the PTC conducted extensive independent research. It also consulted with industry, with academia, with representatives of teachers, school district administrators and with the Ministry of Education. We would like to acknowledge and thank those who participated, in particular the public servants who continue to assist the PTC in its endeavours and who work hard to implement a vision of a knowledge-based society.

We would like to express our thanks to all the members of the Premier's Technology Council who volunteered their time and energy. In particular we would like to recognise the efforts of Mr. Don Safnuk who acts as Chair of the PTC's People Task Force and led the process that created this vision. Finally we would like to thank the Premier for his continued interest and support.

Sincerely,

Eric Jordan,
President
Premier's Technology Council

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EXECUTIVE SUMMARY

The purpose of this paper is to provide a vision for the K-12 education system in the 21st century. This paper does not address implementation issues but instead investigates what a system might look like should it be transformed. In the knowledge-based society of today the sheer volume of accessible information is greater than ever before and is increasing exponentially. There are also increasing expectations for more open government, education, and society. The Premier's Technology Council has long advocated that BC take steps to prepare for this global shift.

The fabric of a knowledge-based society is built around individuals with the ability to use information and continuously adapt to a rapidly changing globe. If BC is going to remain competitive, it must have an education system that ensures everyone, regardless of socio-economic background, is able to participate in such an increasingly demanding, knowledge-based society. Although some steps have been taken in this direction, the province needs to address the issue with greater urgency to create change that is truly transformational.

Needs of the Knowledge-Based Society

Traditional skills like literacy, numeracy, and critical thinking need to be applied in different ways and supplemented with new skills and attributes in order for students to become full participants in a knowledge-based society.

- **Functional Numeracy and Literacy**: Numeracy and literacy are foundational to any meaningful participation in a knowledge-based society. Numeracy is the ability to understand how to apply mathematical concepts to problem solving and to everyday life. Individuals must be functionally literate, in other words they must be able to learn from what they read.
- **Critical Thinking and Problem Solving**: Students need the search skills required to access information, the critical thinking skills needed to analyse and evaluate that information, and the problem solving skills required to effectively use that information. It involves purposeful, reflective judgment, logical analysis, and assessment of factual accuracy, credibility, significance and fairness.
- **Creativity and Innovation**: Creativity and innovation allow one to generate ideas and concepts, to see information in a different way from others, and to approach issues from a different direction.
- **Technological Literacy**: Technology literacy is the ability to use technology to amplify one's learning ability, and improve one's productivity. It means the ability to use technology rather than the ability to construct or maintain technology.

- **Communications and Media Literacy**: Communication is the ability to relate concepts and ideas to others either in person, on the page or through technology. Media literacy includes the ability to interpret and use media to access, assess and analyse information and the ability to use new media forms to communicate information.
- **Collaboration and Teamwork**: The interactive nature of a knowledge-based society mandates the ability to collaborate. Innovation requires multiple people interacting in different ways and this increasingly takes place through interactive technologies.
- **Personal Organization**: Personal organization includes organization of possessions and educational materials as well as time management, such as keeping track of assignments, due dates and deadlines.
- **Motivation, Self-Regulation and Adaptability**: Motivation through self-regulation is the ability to set and accomplish one's own objectives. Knowing how and when to put in effort, how to make responsible personal decisions, and how to prioritize choices and actions enables independence and the transfer of skills to a variety of occupations.
- **Ethics, Civic Responsibility, Cross-Cultural Awareness**: Common ethics about the way we treat others, the way we treat our environment, about civic duty to society and about obeying the law are important to properly function in society. Cross-cultural awareness will also be important because of BC's multiculturalism and because of our increasingly connected global society.

Vision of Education for the 21st Century

The vision of a 21st century K-12 education system is rooted in personalised learning. It focuses on providing students the skills they need to participate in a knowledge-based society, while also allowing them to explore an educational path that is best suited to their interests, their capabilities and their chosen future. Such a vision means the system must be transformed in a number of ways.

- **From Learning Information to Learning to Learn**: The system must place greater emphasis on the learning of skills over the learning of content. The content relevant to a student's interests is constantly changing and growing so students will have to continue learning new things throughout their life. Instruction should more consistently focus on the skills required to find and use relevant content rather than on the delivery of pre-determined content.
- **From Data to Discovery**: Content will have to evolve constantly, not only to remain relevant but so students are ready to deal with how rapidly information changes in a knowledge-based society. Students must play a greater role in discovering their own content so the measurement of success will be related to how they find, use, and develop accurate, relevant content.
- **From One Size Fits All to Tailored Learning**: As students progress they will increasingly access and engage with their own content, at their own pace of learning and take an increasing role in charting a path best suited to those talents, interests and abilities. On a day to day basis this will require a more project-based or problem-based approach and will help to keep the students engaged and interested in learning.
- **From Testing to Assess to Assessing to Learn**: Technology allows educators and students to assess progress more regularly than with traditional classroom assessments and to identify and address each student's challenges as they arise. This

is in contrast to tests and exams that measure what a student learned at the end of an instructional unit by which time it is often too late to address shortcomings.

- **From Classroom Learning to Lifelong Learning**: Lifelong learning can be encouraged by incorporating aspects of a student's life outside of school into their education. The education system must evolve from being the focal point of education to more of a base camp for learning. Students only spend a fraction of their time in schools and there is also a need to continue learning throughout life beyond the period of formal education. This requires a more balanced approach that includes learning partners and increased engagement of parents and the community.

How Would the System Function?

The system's transformation should provide students with more complete access to knowledge of the world around them so they have the flexibility to manage their own learning processes and to drive to deeper understanding of relevant issues. There have been steps toward such a system but greater transformation is required to achieve such a vision.

- **A Flexible Educational Path**: The transformed system would have a flexible curriculum that allows for more in depth study. Early in the student's education the curriculum will remain structured and focus on the foundational skills. As the student progresses and gains more understanding and life experience they will, with the assistance of teachers and parents, take on more responsibility for choosing their educational path. The student would still have to achieve learning outcomes but focused on the student's particular interests. This requires an "integrated", "project-based" or "problem-based" approach to learning which will enable the student to understand how the skills they are learning are integral to their future life.
- **A Blended System**: The system would have a mixture of face-to-face classroom and online learning. It would also incorporate the immense range of learning opportunities outside the classroom. Some students would prefer a heavier emphasis on classroom learning while others may prefer the options of online learning. There has already been a strong uptake of online learning in BC.
- **Access to Learning Objects and Teaching Tools**: Technology allows for better access to learning objects, teaching tools, and information. This is important for students, parents and teachers to collaborate in creating an individualised learning path that incorporates the information they need to know in more customised ways.
- **Open Access to Information Systems**: Students need to be able to access information. Unfettered (but not unguided) access will allow them to learn and to teach themselves as they go forward. Furthermore, access to information will allow students to make informed decisions about their interests and understand the implications of new information for potential career decisions.
- **Constant Feedback and Assessment**: While the system will be more flexible, there is a need for assessment based standards that will be higher in the future than they are today. Technology can provide new options for assessment and improving learning outcomes. In particular it allows for timely assessment so that students, parents and teachers can be informed during, not after, learning and in ways that allow for correction and celebration.

Shifting Roles

This new model will be more collaborative and inclusive, changing the roles of the student, the teacher, and the parent. Some of these shifts have already begun, as the relationship between teachers and students has slowly evolved. However, a more complete transformation of the education system and of the roles within it is required.

- **From Passive Student to Active Learner**: As a student progresses they will begin to take greater responsibility for charting their own path. It is the role of the student to accept and understand this responsibility. This would allow educators to take advantage of the innate learning ability of young people in a more open, exploratory learning environment where they learn by doing, not reading and listening.[1] Most students have known only the digital age, are fully conversant with technology and capable of using it as part of learning. They know that technology provides them with information access, a flexibility of lifestyle, and multiple career choices.
- **From Parent as Supporter to Parent as Participant**: With greater information availability, parents can be more involved with their children's education by guiding decisions, helping to overcome challenges, and supporting learning outcomes. Furthermore, parents have to recognise their educational role outside the classroom. A student's out of school learning is critical.
- **From Teacher as Lecturer to Teacher as Guide**: The role of the teacher switches to that of a learning coach or coordinator and it is no longer a requirement for them to know more information than the student on every topic. Many teachers have already recognised that their role is shifting. However, technology now provides teachers with better tools to guide their students which allows for more significant transformation.

Conclusion

The intent of this paper is to lay out a vision for education in the 21st century. The rate at which our knowledge-base is expanding and the impact this is having on the pace of change demands a system that teaches all students, regardless of background, to thrive in such a world. Such a system is one that individualises learning so students engage in issues important to them while learning the skills critical to participating in a knowledge-based society. While engaging the student in charting their own path it would demand greater involvement of the parents and a shift in the role of the teacher from one of lecturer to one of guide.

BC has discussed similar kinds of changes in the past and has made some steps toward implementation. However, the pace of global change is combining with our shift to more a knowledge-based economy to create greater urgency around the need for change. There is a high level of consensus in this vision amongst education experts and professional administrators as well as agreement that changing such a complex system is a significant challenge. While BC's educational system is evolving and dialogue about these issues is on-going, the PTC believes government should place high priority on accelerating the pace of change to become truly transformational.

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1 John Abbott 21st C Learning Initiative

INTRODUCTION

The world is not just changing, it is becoming increasingly complex as the global pool of information expands and becomes ever more accessible. Students "live in a world that is dramatically more complex than it was just a few years ago. In a remarkably short period of time, the world and its people, economies, and cultures have become inextricably connected, driven largely by the Internet, innovations in mobile computers and devices, and low-cost telecommunications technology."[2]

There are also increasing expectations for more open government, education, and society. Ensuring that everyone remains fully functional in such an increasingly demanding and knowledge-based society will require a constantly rising level of base line skills. The net result is that "there has never been a time in history when education has meant more in terms of human survival and happiness."[3]

BC must have an education system that is structured so all students, regardless of background or community, have the opportunity, not only to reach their own goals but to contribute to our knowledge-based society. Statistics around individual prosperity clarify the importance of education, "an additional year of schooling increases wages … by around 6.5% across European countries … In Canada, it was estimated that each additional year of education raises earnings by approximately 8%."[4]

Education is about more than just individual prosperity, it also serves a public good. "A recent multi-country study found that if the national average educational attainment level is increased by one year, aggregate productivity increases by 5 per cent—the equivalent of adding more than \$60 billion to Canada's GDP."[5] Beyond increasing provincial productivity, the benefit of public education for society comes from increasing the inclination and ability of individuals to be contributing citizens. People who are better educated are more likely to be employed, have higher career satisfaction,[6] live longer with improved health,[7] have reduced participation in crime,[8] participate in voting and volunteering,[9] and are less likely to rely on public tax transfers or benefits.[10]

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2 http://ali.apple.com/acot2/global/files/ACOT2_Background.pdf p6
3 What would Socrates Say? p14
4 http://www.congress.gov.ph/download/cpbd/Noy_Educ.pdf p2
5 How Canada performs – A report card on Canada (2007) p81
6 http://www.utoronto.ca/president/04conference/downloads/Riddell.pdf p1
7 http://www.utoronto.ca/president/04conference/downloads/Riddell.pdf p4
8 http://www.utoronto.ca/president/04conference/downloads/Riddell.pdf p16
9 http://www.collegeboard.com/prod_downloads/press/cost04/EducationPays2004.pdf p6
http://www.utoronto.ca/president/04conference/downloads/Riddell.pdf p17
http://www.chronicle.com/article/College-Education-Young-People/40561
10 http://www.utoronto.ca/president/04conference/downloads/Riddell.pdf p19

INTRODUCTION

The purpose of this paper is to provide a vision for the K-12 education system in the 21st century. The Premier's Technology Council (PTC) is not recommending that the existing system be torn apart but it must transform if it is to prepare students to be successful in our rapidly changing world. The PTC has asked the question, "if there were no pre-existing conditions, what would the changed system look like and how would it be structured?" The PTC is looking to discover how we should transform our system.

BUILDING A KNOWLEDGE-BASED SOCIETY

Education is critical because in a knowledge-based society information is at everyone's fingertips. Users of that information add to its volume and complexity every day by interacting through the burgeoning global network. The net result is that the sheer volume of accessible information is increasing exponentially. For example, Google announced more than two years ago (July 2008) that it had one trillion Web pages indexed for use by its Internet search engine.[11] So two years ago there were 1,000,000,000, while twenty years prior to that there were nearly none. We also have to acknowledge how quickly information is evolving. The children of tomorrow, indeed the students of today, will have to be flexible enough to adapt to an incredible pace of change. In 2001 noted futurist Ray Kurzweil estimated that "we won't experience 100 years of progress in the 21st century — it will be more like 20,000 years of progress (at today's rate)."[12]

The Premier's Technology Council has long advocated that BC acknowledge this global shift and strive to become a knowledge-based society. A knowledge-based economy can help to build "a society that creates, shares and uses knowledge for the prosperity and well-being of its people."[13] Such a society is well educated, and relies on the knowledge of its citizens to drive the innovation, entrepreneurship and dynamism of that society's economy."[14] More specifically, the economy will be "directly based on the production, distribution and use of knowledge and information."[15] It is clear that the fabric of a knowledge-based society is built around skilled personnel. For individuals to fully participate in and contribute to such a society they need to acquire skills that will allow them to use information and continuously adapt to a rapidly changing globe.

If education is so critical, and the demands of the globe are changing so quickly, then what would be the ideal education system to support such a society? By some measures, such as the OECD's Program for International Student Assessment (PISA) rankings, BC has a strong education system and might be considered a leader. It will not remain a leader however, unless it can transform to meet the needs of the changing world. Other leading jurisdictions are also addressing the challenge of a changing world. "China, Singapore, South Korea, and Japan—all named as major competitors—have started education reforms aimed at fostering more creativity and innovative thinking among their citizens."[16]

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11 http://www.google.com/corporate/history.html
12 http://www.kurzweilai.net/the-law-of-accelerating-returns
13 http://www.digitalstrategy.govt.nz/Resources/Glossary-of-Key-Terms/
14 http://www.oas.org/en/topics/knowledge_society.asp
15 http://www.oecd.org/documents/14/0,3343,en_2649_34269_1894478_1_1_1_1,00.html
16 http://www.ascd.org/publications/educational-leadership/may06/vol136/num08/Are-We-Fixing-the-Wrong-Things%CS2%A2.aspx

We also believe that in this new world, students must learn to be creative and how to innovate with the information that is so readily available. Sir Ken Robinson, a thought leader on creativity, has noted both this challenge and that leading jurisdictions are now grappling with how to meet it. He has stated:

> Traditional education's focus on facts, memorization, basic skills, and test taking has not been good for the development of creativity and innovation. This is changing in the 21st century, and education systems from Finland to Singapore are beginning to put creativity and innovation as a high priority in their desired outcomes for student learning.[17]

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17 21st Century Skills p57

NEEDS OF THE KNOWLEDGE-BASED SOCIETY

The PTC believes that a vision for an education system that prepares students to function in a knowledge-based society must first identify what a student needs to learn in order to function in such a society. There are skills and attributes that were important in the past that remain important today. These include literacy, numeracy, and critical thinking. However, the combination of technology and access to information that underpins a knowledge-based society means that these skills need to be applied in different ways and supplemented with new skills in order for students to become full participants in a knowledge-based society.

In addition to acquiring certain skills, the PTC also believes individuals need to acquire particular attributes so they can apply these skills to their best effect. Students must be able to apply their skills both to secure their own future in the knowledge-based society and to take on the responsibility of contributing to our society.

Skills and Attributes for a 21st Century
• Functional Numeracy and Literacy
• Critical Thinking and Problem Solving
• Creativity and Innovation
• Technological Literacy
• Communications and Media Literacy
• Collaboration and Teamwork
• Personal Organisation
• Motivation, Self-Regulation and Adaptability
• Ethics, Civic Responsibility, Cross-Cultural Awareness

FUNCTIONAL NUMERACY AND LITERACY
To operate effectively in such a complex, ever-changing knowledge economy, people will need a variety of skills. The most important are the most basic. Numeracy and literacy are foundational to any meaningful participation in a knowledge-based society. Numeracy is often overlooked but is critically important. Going beyond the mere mechanics of mathematics or arithmetic, numeracy is the ability to understand how to apply mathematical concepts to problem solving and to everyday life. Students must "develop as numerate people in order to cope efficiently with the demands of their everyday lives."[18]

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18 http://www.aamt.edu.au/content/download/1251/25266/file/kemp-hog.pdf

With respect to literacy, if an individual is going to be fully functional in a society driven by information and knowledge then it is critical that they be able to understand what they discover. Just being able to read and write is not enough. Individuals must be functionally literate, in other words they must be able to learn from what they read. The International Adult Literacy Survey (IALS) has identified different levels of literacy and level 3 is likely the most appropriate minimum level for BC. This is defined as "roughly the skill level required for successful secondary school completion and college entry. It requires the ability to integrate several sources of information and solve more complex problems."[19]

CRITICAL THINKING AND PROBLEM SOLVING

If literacy and numeracy skills are core to understanding knowledge, then the second group of skills are core to using it. Ubiquitous access to technology and information makes it important that people know how to use the technology and how to analyse the information that it makes available. They need the search skills required to access information, the critical thinking skills needed to analyse and evaluate that information, and the problem solving skills required to effectively use that information.

Critical thinking is of particular importance to understanding mass market information. It involves purposeful, reflective judgment, logical analysis, assessment of factual accuracy, and assessment of credibility, significance and fairness. Such skills allow users of online information to understand that the biases of authors and the selection of appropriate sources play important roles in the validity of information. Literacy plays a role here as well, as it is required to garner a full understanding of the material. Numeracy is also a component of critical thinking as it allows one to truly assess information that may include data, charts and statistics.

CREATIVITY AND INNOVATION

Another set of skills that will be key to success in a knowledge-based society are creativity and innovation. "Creativity is the ability to think a new idea. (This includes the ability to rethink an old idea for example, to think of a new application for an existing technology)."[20] Creativity and innovation allow one to generate new ideas and concepts, to see information in a different way from others, and to approach issues from a different direction than others. With a world built on information, being able to do something different with the same information will be an important advantage.

TECHNOLOGICAL LITERACY

Use of technology will be critical to future endeavours. "Technology and the digital devices and services that fill a knowledge worker's toolkit—the thinking tools of our time—may be the most potent forces for change in the 21st century."[21] Technology literacy is the ability to use technology to amplify one's ability for learning, and improve one's productivity. It means the ability to use technology rather than the ability to construct or maintain technology. Each individual has to have enough technological literacy to effectively work in the knowledge economy.

COMMUNICATIONS AND MEDIA LITERACY

Related to literacy, communication is the ability to relate concepts and ideas to others either in person, on the page, or through technology. Media literacy is a critical, modern component of communications. "Media change is affecting every aspect of our contemporary experience, and as a consequence, every school discipline needs to take responsibility for helping students to master the skills and knowledge they need to function in a hypermediated environment."[22]

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19 http://www.oecd.org/document/2/0,3343,en_2649_39263294_2670850_1_1_1_1,00.html
20 http://www.cforc.org/newsdata/news.asp?StoryID=73
21 21st Century Skills p57
22 http://www.newmedialiteracies.org/files/working/NMLWhitePaper.pdf p57

To function in such an environment, one must understand how to interpret and use the media as a way of getting, assessing, and analysing in formation. Beyond that, being media literate also includes the ability to use new media forms to communicate information:

> Digital literacy includes, but goes beyond, simple technology skills. Just as traditional literacy goes beyond comprehension to include the more complex skills of composition and analysis, digital literacy includes a deeper understanding of, and ultimately the ability to create a wide range of content with various digital tools.[23]

COLLABORATION AND TEAMWORK

The interactive nature of a knowledge-based society and a knowledge-based economy mandates the ability to collaborate. "Those who have successfully created cultures of innovation and creativity suggest that one key is to ... embrace participation, collaboration, networking ..."[24]

Innovation rarely takes place in just one head. It requires multiple people interacting in different ways and to an increasing extent this takes place through interactive technologies. It has always been important to engage in face to face collaboration, and this skill will remain relevant in the 21st century. However, collaboration is now taking place across the globe. Both industry and advanced education are now recognising the importance of the skills required to collaborate through technology. According to a Cisco study released in March of 2010, "77 percent of IT decision makers surveyed plan to increase their spending on collaboration tools."[25]

PERSONAL ORGANIZATION

Personal organization is an important component of success in school. Personal organization can be as simple as the student learning how to organize their possessions and educational materials. It goes beyond that though. It includes students keeping track of which assignments are due and when, so they can prioritize action. It also involves gauging the amount of effort involved in a task so the student can manage their time appropriately. Such skills will not only translate directly into the workplace but they are viewed as highly desirable by employers. 81% of surveyed BC employers listed time management and planning as a top skill they are looking for.[26]

MOTIVATION, SELF-REGULATION AND ADAPTABILITY

Being organized is important in that it helps the student to prioritize their objectives. Without the motivation to accomplish those objectives however, being organized would be of little use. More importantly this motivation should come from within the student as much as possible. There is significant literature "clearly showing the advantages of being internally motivated to learn, as opposed to learning just for external motivations such as parental approval or performance on tests."[27]

This leads to the concept of self-regulated learning in order to increase motivation. This is where a student thinks about their own learning and self-directs toward specific goals.[28] When striving to achieve such personal goals, students gain a greater understanding of how and when to put in effort, how to make responsible personal decisions, and how to prioritize choices and actions.

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23 http://www.media-awareness.ca/english/corporate/media_kit/digital_literacy_paper_pdf/digitalliteracypaper.pdf p4

24 http://ali.apple.com/acot2/global/files/ACOT2_Background.pdf p26

25 http://newroom.cisco.com/dlls/2010/prod_032310.html

26 http://www.bcbc.com/Documents/REF_SS_2008_CompleteReports.pdf p11

27 21st Century Learning p33

28 Self-regulated (learning) in educational psychology "can be used to describe learning that is guided by metacognition (thinking about one's thinking), strategic action (planning, monitoring, and evaluating personal progress against a standard), and motivation to learn" (source: http://en.wikipedia.org/wiki/Self-regulated_learning)

Such decision making will be important to the student both in pursuing their day to day life and in addressing their long term ambitions and desires. It will also be important when the student enters the workplace. A motivated individual who is aware of how to organize and prioritise will be able to work more independently and will be able to transfer such skills to a variety of occupations. This is why they are attributes that employers are looking for as we evolve into a knowledge-based society.

ETHICS, CIVIC RESPONSIBILITY, CROSS-CULTURAL AWARENESS
Students must also understand they are part of a complex society and that they have a responsibility to that society. Although not everyone shares precisely the same views on all topics, there remain many things that society does agree on. It is important that students in our K-12 system learn what these are. There are common ethics about the way we treat others, the way we treat our environment, and about obeying the law. We share a civic responsibility and students must come to understand the importance of civilized discourse on issues and their role in a democratic society. "One important goal of media education should be to encourage young people to become more reflective about the ethical choices they make as participants and communicators and the impact they have on others."[29]

Finland, a leader in education, places a great importance on voluntary activities and values, noting that they "provide citizenship education and tools for life management and promote social inclusion. The school is an increasingly important element in social inclusion and participation."[30] It is also important for students to become more aware of cultural differences. It has been noted that "advancements in technology bring social interactions between increasingly diverse individuals, groups, business entities, and governments,"[31] and that:

> the success of international business will increasingly depend on our awareness of the social and cultural values of the economies that we work with. It is often our ability to understand and perceive culture-specific, hidden, or implied communication that lead to a successful international business partnership.[32]

Such cultural understanding will be a key to functioning in our multicultural society in BC and to our success in an increasingly connected global society.

These core skills and attributes are identified not only by international experts but by the business sector in British Columbia. The Business Council of British Columbia's Biennial *Attributes and Skills Survey* last completed in 2008 clearly reflected the value of these same skills. "Flexibility/multitasking, Teamwork, and Problem Solving are skills that employers consistently rank in the top three for all occupational groups."[33]

As technology levels the global playing field the work that takes place in a knowledge-based society becomes ever more mobile. It can be done anywhere, by anyone with the appropriate training. In other words the knowledge economy will move with the people who carry that knowledge: "... to have expert knowledge workers, every country needs an education system that produces them; therefore, *education becomes the key to economic survival in the 21st century.*"[34]

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29 http://www.newsmedialiteracies.org/file/working/NML WhitePaper.pdf p17
30 Ministry of Education Finland "Ministry of Education Strategy 2015" p6
31 http://hrd.apec.org/index.php/Cross_Cultural_Awareness_for_21st_Century_Business
33 http://hrd.apec.org/index.php/Cross_Cultural_Awareness_for_21st_Century_Business
33 http://www.bcbc.com/Documents/REF_SS_2008_CompleteReport.pdf p13
34 21st Century Skills p6

Case Study: Finland

"Knowledge, creativity and innovation are the cornerstones of society and its development."
-Finnish Ministry of Education[A]

Finland is noted as an international leader in education as they consistently score top marks in the OECD Programme for International Student Assessment (PISA) tests in math, science, and literacy. Their education system has numerous characteristics that encourage the development of modern, 21st century learning skills. For example, Finnish classrooms have less focus on lecture delivery, and instead:

> Students are generally engaged in independent or group projects, often choosing tasks to work on and setting their own targets with teachers, who serve as Coaches. The cultivation of independence and active learning encourages students to develop problem solving and metacognitive skills.[B]

Finnish students work with their teachers in specific subject areas to help determine weekly targets and choose tasks. The development of this independence and active learning allows students to gain the learning skills to better frame, tackle and solve problems as well as evaluate and improve their own work. The Finnish system already has classroom elements noted in many 21st century learning theories, including the "use of school-based, student-centered, open-ended tasks embedded in the curriculum" and these are also touted as reasons for their current success.[C]

Not content with the excellent performance of their education system and an innovative, high technology economy, Finland continues to push for key 21st century skills. Like other leading jurisdictions, it is recognized by the Finnish Ministry of Education's Strategy 2015 that significant economic value will be generated in creative, high knowledge fields: "Knowledge will be an increasingly important factor of production. Information work, the knowledge economy and content production are growing fields. It is in the knowledge-intensive fields that labour demand will be growing in particular."[D] Furthermore, it notes that, "creativity is a source of development – development optimism and innovativeness" and that developing creativity in their students will be a crucial aspect of maintaining cultural and economic competitiveness in the 21st century.[E]

Finland is also considering additional education reforms including the development of "citizen skills" like thinking, self-expression, personal responsibility, participation, entrepreneurial spirit and leadership.[F] Finland is also planning to focus on intensive early interventions (better support and structure) for those falling behind.[G] In addition, they are discussing the possibilities of allowing greater freedom of choice for student activities and curriculum.[H]

A http://www.minedu.fi/export/sites/default/OPM/Julkaisut/2003/liitteet/opm_155_opm35.pdf?lang=en
B http://www2.ed.gov/programs/racetothetop-assessment/written-input-011810.pdf
C Development of Education A National Report of Finland p6
D http://www.minedu.fi/export/sites/default/OPM/Julkaisut/2003/liitteet/opm_155_opm35.pdf?lang=en
E http://www.minedu.fi/export/sites/default/OPM/Julkaisut/2003/liitteet/opm_155_opm35.pdf?lang=en
F http://www.edu.gov.on.ca/bb4e/finlandEn.pdf
G http://www.edu.gov.on.ca/bb4e/finlandEn.pdf
H http://www.edu.gov.on.ca/bb4e/finlandEn.pdf

VISION OF EDUCATION FOR THE 21ST CENTURY

The vision of a 21st century K-12 education system is rooted in personalised learning. It focuses on providing all students, regardless of their economic, geographic, or ethnic background, the skills they need to participate in a knowledge-based society, while also allowing them to explore an educational path that is best suited to their interests, their capabilities, and their chosen future. Such a vision has been advocated before and steps have been taken towards it. The advancement of technology however, and the move toward a knowledge-based society makes such a vision both more achievable and more important.[35]

Transformation for 21st Century Education
• From Learning Information to Learning to Learn
• From Data to Discovery
• From One Size Fits All to Tailored Learning
• From Testing to Assess to Assessing to Learn
• From Classroom Learning to Lifelong Learning

This means moving away from the traditional education model of the previous century:

> Mass education belongs in the era of massive armies, massive industrial complexes, and massive attempts at social control. We have lost much talent since the 19th century by enforcing stifling education routines in the name of efficiency. Current high school dropout rates clearly indicate that our standardized testing regime and outdated curriculums are wasting the potential of our youth. If we stop thinking of our schools as buildings and start thinking of learning as occurring in many different places, we will free ourselves from the conventional education model that still dominates our thinking.[36]

We have already identified the aspects of a knowledge-based society that impact upon education: the ease of access to content through technology, the pace of change of knowledge and the need for multiple career options. To address these changes, 21st century education must encourage education as a lifelong pursuit and the highly structured nature of the current system cannot achieve that. Sir Ken Robinson has stated that: "Reform is of no use anymore because that is simply improving a broken model."[37]

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35 Because adopting such a vision involves significant transformative change, implementing it should include processes to assess and measure the progress against appropriate benchmarks.
36 What Would Socrates Say p14
37 http://www.ted.com/talks/sir_ken_robinson_bring_on_the_revolution.html

The PTC does not yet subscribe to the view that the current system is broken. What is clear however is that to achieve a vision of education for the 21st century, the system must be transformed in a number of ways.

FROM LEARNING INFORMATION TO LEARNING TO LEARN
The system must put a greater emphasis on the learning of skills over the learning of content. Learning skills are so important because the content relevant to a student's interests is constantly changing and growing. This does not mean that content is irrelevant, but students will need to be flexible because in no field will a student be able to learn all they need to know. Furthermore, most students will have approximately 11 different jobs between the ages 18 and 42[38] and many of the jobs that will sustain our knowledge-based economy in the future do not yet exist. Students will have to continue learning new things throughout their life. "Because ... content (is) virtually infinite, skills that allow one to continue learning and to make judgments about the meaning, adequacy, and accuracy of content are more important than ever."[39]

There is a great deal of evidence that students remain more interested in their education if the content is relevant and current. It ensures they are properly engaged in the learning process. Thus instruction should more consistently focus on how to find and use relevant content rather than on the rote delivery of pre-determined content. This approach will create a community committed to learning. Such a community will be comfortable adapting to the need for multiple career options and the new knowledge bases that go with such options.

FROM DATA TO DISCOVERY
The desire to shift from a content-based system to a skills-based system is rooted in the need to teach the students the skills required for a world of ever changing information. If the education system is to properly prepare students for the future, content will have to evolve constantly, not only to remain relevant but so they are ready to deal with how rapidly information changes in a knowledge-based society. Furthermore, the content must engage the student by being both interesting and relevant.

While the teacher has to take responsibility for helping students to understand why the things they are learning are important, ultimately it is the students who have to learn and if the task is one that interests them the learning will be much faster and more effective. "Children will learn to do what they want to learn to do."[40] If students are to discover their own content instead of having data fed to them, then the system must be flexible enough to accommodate them within the prescribed goals or learning outcomes. The measurement of success will no longer be related to the data they know but how they find, use, and develop accurate, relevant content.

FROM ONE SIZE FITS ALL TO TAILORED LEARNING
Students will be accessing and engaging with their own content at their own pace of learning. In the early years this will be quite structured so the students learn the skills that are foundational to 21st century learning. Even at these early levels however, the learning will need some tailoring. Students enter the system with different backgrounds, different home support systems and different levels of ability. A tailored system will better accommodate the range of different students, from those who need remedial assistance, to those who need greater advancement opportunities in recognition of superior ability in certain subject areas.

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38 http://www.bls.gov/opub/ted/2008/jun/wk5/art01.htm
39 Well Rounded Education for a Flat World p52
40 http://www.ted.com/talks/sugata_mitra_the_child_driven_education.html

As the student progresses the system needs to allow flexibility that not only accommodates the student's abilities but also engages them by catering to their interests. The student will take a larger and larger role in charting a path best suited to those talents, interests, and abilities. "Learning sciences research suggests that more effective learning will occur if each learner receives a customized learning experience.[...] students learn best when they are placed in a learning environment that is sensitive to their pre-existing [cognitive] structures and that is flexible enough to adapt teaching strategies to individual needs."[41] On a day to day basis this will require a more project-based or problem-based approach, where the learning is related to a specific task that integrates a number of traditional subject areas. While on a broader time scale, parents and students must take a more active role in guiding their own education. This will help to keep the students engaged and interested in learning.

FROM TESTING TO ASSESS TO ASSESSING TO LEARN
While students are encouraged to follow their own path, they must not be completely independent. They should collaborate with the educators who are assessing and diagnosing their progress. Today's technology can provide instant feedback to students on their progress and students can use that feedback to adapt and improve outcomes.[42]

Technology allows educators to assess a student's progress far more regularly than is possible with traditional classroom assessments and to identify and address each student's challenges as they arise. This is in contrast to a system where assessment through tests and exams measures what a student learned at the end of an instructional unit, by which time it is often too late to address shortcomings.

Having said that, measurement and assessment must not only be a tool to help the student learn but also to measure achievement for those outside the system, be it post-secondary education institutions or potential employers. However, what gets measured will impact upon both teaching and learning. Some of the skills discussed earlier are difficult to measure so it is important that a balance be struck that ensures a student's progress is properly measured and yet does not stifle, or discourage some of the creativity and courage we are trying to engender in our students.[43]

FROM CLASSROOM LEARNING TO LIFELONG LEARNING
Lifelong learning can be encouraged by incorporating aspects of a student's life outside of school into their education. "Learning is not confined to places dedicated to it like schools and universities. A vast range of inputs and influences affect the process of learning."[44]

In other words, the education system must evolve from being the focal point of education to more of a base camp for learning. This requires a more balanced approach that includes learning partners and increased engagement of parents and the community. Engaging in life learning outside of school will better prepare students for the future. They must accept that learning does not simply end with formal schooling. People must be able to continue learning in order to remain engaged in society.

The vision of a 21st century education system is one that focuses on learning skills, and depending upon the freedom allowed to any particular grade level, will allow students to work in concert with instructors to design and pursue their own personal learning tracks according to their own capabilities and interests. As well, it is one that uses technology to collaborate and provide ready access to ever changing content as opposed to providing fixed data. It is one that acknowledges that with today's enabling

41 http://www.oecd.org/dataoecd/39/8/40554299.pdf p9
42 http://ali.apple.com/acot2/global/files/ACOT2_Background.pdf
43 For a discussion of possible measurements see Appendix A.
44 http://www.cisco.com/web/about/citizenship/socio-economic/docs/LearningSociety_WhitePaper.pdf p14

technology all members of society increasingly expect to be given options and flexibility to customize experiences and to follow their passions. Our education systems should acknowledge this, not only by using the technology available to allow students to follow their passions but by giving them the skills they need to do so.

Case Study: Singapore

Singapore's development is a remarkable success story in education. Since gaining independence in 1965, Singapore has developed from a nation where half the population was illiterate and 2/3rds of students dropped out of school before the end of 10th grade, to becoming one of the top performing nations in math, science, and literacy achievement.[A] Overcoming a lack of development and infrastructure while struggling with political and ethnic tensions, Singapore has become a modernized economy with a well-educated population. In recent years, they have achieved top OECD PISA scores in math and science. They have also made significant improvements in reading performance as Singapore has "emerged 4th among 45 education systems which participated in the Progress in International Reading Literacy Study (PIRLS) 2006, an improvement from rank 15th in PIRLS 2001."[B]

Despite these remarkable achievements, Singapore believes there is still room for improvement. "Employers were critical of the school system's ability to nurture creativity and innovation" and as one research leader remarked: "We produce good imitators and efficient managers, but not creative entrepreneurs."[C] Singapore's Ministry of Education has acknowledged the need for a 21st century style education and has plans to "enhance [student's] creative and expressive capacities," noting that they "need to possess life-ready competencies like creativity [and] innovation."[D]

There are also efforts to broaden the curriculum to include additional competencies such as knowledge application skills and self-management skills.[E] The goal is to develop self-directed learners and innovative critical thinkers, while improving information and communication skills.[F] Also, they hope to develop student skills in areas such as "finding, analyzing, and categorizing information; and learning how to learn" as part of continuing to develop a modern, competitive national economy.[G]

A Lessons Learned: How Good Policies Produce Better Schools P24-25
B http://www.moe.gov.sg/media/press/2007/pr20071129.htm
C Lessons Learned: How Good Policies Produce Better Schools p25
D http://www.moe.gov.sg/media/press/2010/03/moe-to-enhance-learning-of-21s.php
E ftp://download.intel.com/education/wsis/ICT_Education_Reform_Economic_Growth.pdf p6
F http://www.moe.gov.sg/media/press/2010/03/moe-to-enhance-learning-of-21s.php
G http://www.gse.uci.edu/person/warschauer_m/docs/singapore.pdf p307

How Would the System Function?

When discussing a systemic change as transformative as the one being considered here, it is important to ensure there is some understanding of how it would function. Although some components of the vision are already present, we have really only just begun the kind of transformation envisioned.
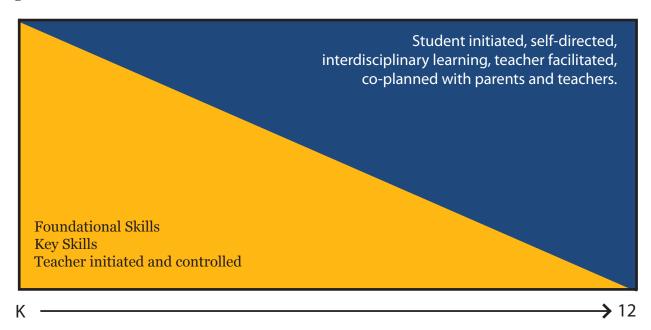
Components of a 21st Century System
• A flexible educational path with project-based or integrated learning.
• A blended system that uses classrooms and technology
• Technology to access learning objects and teaching tools.
• Open access to information systems for content and decision making
• Constant feedback and assessment to allow students, parents and teachers to adjust to meet challenges or accommodate progress.

A FLEXIBLE EDUCATIONAL PATH

One key component of a transformed system would be a flexible curriculum that allows for more in depth study. This will require new instructional approaches that promote deep understanding over mere 'knowing'. However, although the path should flexible enough to maximize benefit by focusing on a student's interests, the student should not be completely independent. Firstly, students are young and will still need the kind of guidance that can only be provided by an adult. Furthermore, there are required areas of learning, certain content a student must know and skills a student must have regardless of whether they fall within the student's personal interests.

Early in the student's education the curriculum will remain structured and focus on the foundational skills. As the student progresses and gains more understanding and life experience they will, with the assistance of teachers and parents, take on more responsibility for choosing their educational path. This will create greater engagement by focussing on the student's interests. Currently, curriculum is structured by compressing a number of learning outcomes into a single course. In a flexible system a student would still have to achieve learning outcomes but those would be more blended to focus on the student's particular interests (Figure A). BC, unlike most other jurisdictions, has already taken a significant step in this direction by constructing curriculae out of sensible, identifiable, learning outcomes. This would ease the shift to greater flexibility.

Figure A. Flexible Path to Education

Student initiated, self-directed, interdisciplinary learning, teacher facilitated, co-planned with parents and teachers.

Foundational Skills
Key Skills
Teacher initiated and controlled

K ⟶ 12

This requires an "integrated", "project-based" or "problem-based" approach to learning. This will both depend upon and promote the critical thinking skills we have already identified as crucial: "... a model of a 21st century approach to instruction using inquiry, design, and collaborative learning projects. A learning model based on a blend of these learning methods with more direct forms of instruction is what is now needed to build knowledge, understanding, creativity, and other 21st century skills."[45] At a broader level it will also require the system to reduce the required elements in the curriculum. This would allow students to focus more time on those elements most integral to their interests.

Along the way they will begin to understand how integral the skills they are learning are to their future life. This is something often seen as lacking within the current systems of education. It is noted that "...many [educators] feel very strongly that just to teach those skills in isolation doesn't actually appeal very much to the young mind that doesn't see the logic in seeing those skills in isolation from everything else."[46]

A BLENDED SYSTEM
At its broadest, this education system would likely have a mixture of face-to-face classroom and online learning. It would also incorporate the immense range of learning opportunities outside the classroom. Virginia school districts have found value in utilizing this combination: "blended or hybrid learning, is proving to be effective because it plays to student's strengths and weaknesses" as it provides flexibility in learning styles and time management.[47] Some students would likely prefer a heavier emphasis on classroom learning while others may prefer the options of online learning, especially if they find their scheduling difficult, and it would be beneficial to allow choices to best fit the individual.

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45 21st Century Skills p135
46 http://www.21learn.org/site/archive/relearning-learning-an-interview-with-john-abbott/2/
47 EducationWeek E-Learning 2010 Special Report p s3

Evidence that students have the desire to shift to a more blended model of learning can be found here in British Columbia. When the BC government made it easier to participate in online learning through the creation of LearnNowBC in 2006, the number of participants increased exponentially. In 2006, there were only 17,000 users of the online learning in BC. By the end of the 2009-2010 school year more than 71,000 students were using the system (Figure B).[48] The latest indicators are that one of every three BC students now takes at least one course online prior to graduation.[49]
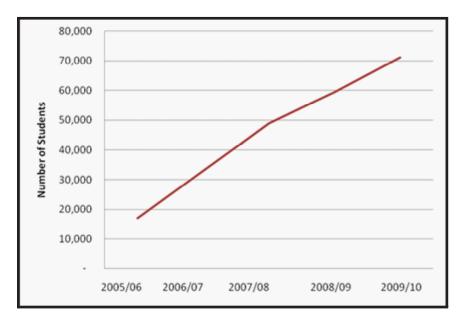
Figure B. Students Using Online Learning in BC

ACCESS TO LEARNING OBJECTS AND TEACHING TOOLS

One of the most promising aspects of education in the 21st century is the possibility of using technology for better access to learning objects, teaching tools, and information. It is this access in particular that allows students, parents, and teachers to collaborate in creating an individualised learning path that incorporates the information they need to know in more customised ways. The new use of technology has the potential of:

> boosting basic skills such as the recall of math principles and procedures, vocabulary development in language, and internalization of science terms and principles. Learning technologies are also freeing up time to focus on the 21st century skills that require more interaction among learners while providing tools to further their skill-building online— collaboration, communication, leadership, and social and cross-cultural skills.[50]

OPEN ACCESS TO INFORMATION SYSTEMS

At the level of the student there are a handful of components that are critical to the success of this more self-directed kind of learning. The first is that students must be able to access information. Unfettered (but not unguided) access will allow them to find the information they need to learn and to teach

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48 Data from LearnNowBC.
49 Data from BC Ministry of Education.
50 21st Century Skills p40

themselves as they go forward: "Groups of children can navigate the internet to achieve educational objectives on their own."[51]

Access to information will also allow students to make informed decisions about their interests. They must understand the implications of new information for potential career decisions. Furthermore, the nature of a knowledge-based society is such that, one way or another, all of their future interests will be affected by information gathering. So in order for students to make the right choices, education should not take place in a hermetically sealed environment. They need technological and physical connectivity to the world outside of school as well as the permission and encouragement to use it.

A critical component of adding connectivity to the system is equity of access. Currently, schools and communities have different levels of access based on geographic and economic factors. Learning takes place both inside and outside of schools and a lack of connectivity in the school, in the home and in the larger community would be represent a barrier to the success of such an education vision.

CONSTANT FEEDBACK AND ASSESSMENT

Finally, while it is important to allow for personalised learning, it must be noted that there is still a need for measurements and standards for assessment. Flexibility, self-assessment, and integration do not mean a lack of rigour. We must be very clear that standards our students must meet have to be higher in the future than they are today.

Attainment of these standards should occur at each student's pace. Technology can provide new options for assessment and data analysis for improved learning outcomes. There are two crucial components for such improved assessment. Feedback during learning (not after the term) is critical and we should improve the role of assessment beyond finals and midterms. Furthermore, assessment must be timely and appropriate so that students, parents and teachers can be informed during, not after, learning and in ways that allow for correction and celebration.

More frequent assessment and the ability to recognize trends in real time (providing data to the student, teachers, and parents) would allow for better adjustments and if necessary, interventions, for the individual learning path. Immediate feedback and assessment can allow students to advance very quickly in the areas where they are strong so they are less likely to become bored. At the same time frequent assessment allows for rapid correction of issues before students fall so far behind that they become frustrated and disconnected from learning.

> We need to understand assessment as a powerful form of teaching and learning that signals to students what knowledge and skills they need to master and what standards they need to achieve. Ultimately, we want students not to please us or to simply get good grades, but rather to please themselves by achieving worthwhile goals and reaching standards of excellence, thus becoming long-term learners.[52]

With more complete access to knowledge of the world around them and a drive to deeper understanding of relevant issues students will be better able to manage their own learning processes. This will allow them to be more creative and inventive in a later work environment. They will also become more engaged in the process and better able to understand and use the forms of self-assessment that will be available to them.

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51 http://www.ted.com/talks/lang/eng/sugata_mitra_the_child_driven_education.html
52 Well Rounded Education for a Flat World p53

Case Study: China

In China there has been a movement to reform the education system to develop new skill sets and thinking for a modern, innovative economy. Notably, the Chinese education system is moving away from the memorization of content to methods of inquiry, discussion, application of knowledge and use of technology.[A] Chinese leaders have noted that while their system has produced strong results in the basic concepts of math and science, the competitive global economies of the 21st century will also require citizens who can think independently and apply knowledge to new situations.[B]

There are significant concerns at the national level and they are implementing reforms both to decentralize the rigid education system and to emphasize "a "quality-oriented" system, with an emphasis on learner-centered methods."[C] This reform movement (often referred to as 'quality education)' places less emphasis on the Chinese system's historical strength in testing and signals a move towards learner-centered approaches to help generate new ideas and thinking. In the words of a researcher at the Institute of Econometrics of the Chinese Academy of Sciences, "The essential difference between education for examinations and education for quality is the capacity to cultivate in people the ability to innovate; such cultivation is the soul of quality education."[D]

It is hoped that engaging students in more active learning by encouraging participation, role-playing, and discussion, will develop flexibility and problem solving skills. The Chinese government is making significant efforts to improve their education system as it is believed that "China must foster creativity and innovation to compete in the global economy".[E]

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A http://asiasociety.org/files/ChinaDelegationReport120105b.pdf p6
B http://asiasociety.org/files/ChinaDelegationReport120105b.pdf p13
C http://www.pdkintl.org/kappan/k_v89/k0710pre.htm
D The Basic Characteristics and Tasks of Twenty-first-Century Education p38
E http://www.pdkintl.org/kappan/k_v89/k0710pre.htm

SHIFTING ROLES

The net result of this new model of education is that it will be more collaborative and inclusive, changing the roles of the student, the teacher, and the parent. Some of this shift has already taken place, as the relationship between teachers and students has slowly evolved. However, the PTC believes a more complete transformation of the education system is required and within that context it is important to clearly illustrate what the new roles should be.
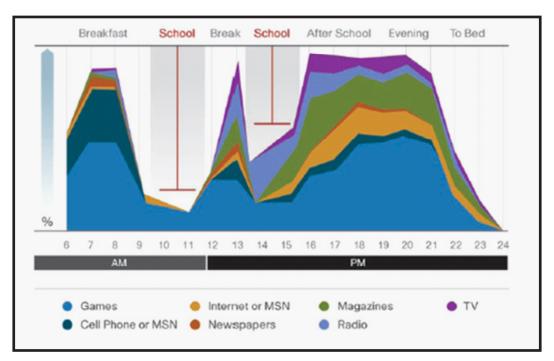
Shifting Roles in the 21st Century System
• From Passive Student to Active Learner • From Parent as Supporter to Parent as Participant • From Teacher as Lecturer to Teacher as Guide

FROM PASSIVE STUDENT TO ACTIVE LEARNER

As a student ages they will begin to take greater and greater responsibility for charting their own path. It is the role of the student to accept and understand this responsibility. "In a world of continuous change, the ability of individuals to plan and implement their own learning without external direction is the key to success."[53] Students would be empowered – and ideally inspired – to "pursue learning both in school (formal learning) and outside of school (informal learning)."[54] This would allow educators to take advantage of the innate learning ability of young people in a more open, exploratory learning environment where they learn by doing, not reading and listening.[55]

The students are ahead of the system in this regard. Most are "digital natives," or students who have known only the digital age. The majority are already familiar with the technologies. Cisco pointed this out in 2007 when they tracked the use of technology by high school students. It became clear that, except for when sleeping, school is nearly the only time when they do not use technology. This pattern of technology use (Figure C) clearly shows they are conversant with technology and are likely not only capable but eager to use it as part of their learning. And even those students who are not familiar with the technology will need to learn to be in order to fully participate in a knowledge-based society.

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53 http://www.21learn.org/site/archive/the-search-for-expertise/
54 http://ali.apple.com/acot2/global/files/ACOT2_Background.pdf p8
55 John Abbott 21st C Learning Initiative

Figure C. Media Consumption by Percent[56]

Today's students are fully aware that technology provides them with information access, a flexibility of lifestyle, and multiple career choices. They are used to instant feedback through media usage in a variety of ways. They also fully expect an education system to cater to the demands of the changing world:

> … expectations present new sets of demands on our education systems—demands that are coming from education's clients and customers—the growing ranks of net generation students. A one-size-fits-all factory model and one-way broadcast approach to learning does not work well for these students. New ways to make learning interactive, personalized, collaborative, creative, and innovative are needed to engage and keep net geners actively learning in schools everywhere.[57]

FROM PARENT AS SUPPORTER TO PARENT AS PARTICIPANT
The increased role of the parent also has to be acknowledged. With greater information availability, parents can be more involved with their children's education progress, overcoming challenges, and supporting learning outcomes. They can learn more quickly and more intimately what their child is doing at school. They can help guide decisions and more rapidly respond to challenges.

Technology allows far more access to the student's progress than the periodic report cards and parent teacher interviews of today. Parents are already beginning to expect greater feedback than in the past.

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56 http://www.cisco.com/web/about/citizenship/socio-economic/docs/GlobalEdWP.pdf p.5
57 21st Century Skills p30

Furthermore, parents have to recognise their educational role outside the classroom. A student's out of school learning is critical. "Students only spend 14% of their time at school. Indeed, learning is an inherent part of everyday life: each new experience, at home, at work, or during leisure time, may throw up a challenge, a problem to be solved, or a possibility of an improved future state."[58]

While we envision a stronger role for parents, we are aware that not all students have the family support structures that will allow such involvement. BC needs all of its students to have the best possible opportunity and any implementation of this vision should take such issues into consideration. The system must be structured in such a way that those who face societal barriers such as being single parents or immigrant parents are able to participate to the degree they are able while the system incorporates the support structures necessary to ensure the students get the support they need.

FROM TEACHER AS LECTURER TO TEACHER AS GUIDE
Teachers are the core of any education system and their role undergoes just as great a transformation as that of the student and the parent. Many teachers have already recognised that their role is shifting and although there have been directives to begin moving in the direction laid out in this vision, the significance of such a transformation has not been recognised from an operational perspective. The net result is that the operational inertia within the system hinders the ability to change.

The technological capability needed to implement such a transformation however is becoming ever more advanced. As a result, teachers have much better tools at their disposal to bring information to their students and equally importantly, to guide their progress in a new model: "... as more data becomes available to teachers, they are now better able to diagnose individual students' needs and make better decisions about what will help individual students learn. This ability opens up a whole new range of possibilities for personalizing teaching to meet the abilities of each learner."[59]

The result is that it is no longer a requirement for the teacher to know more information than the student on every topic. "In this interactive environment, the role of the teacher is transformed from the expert telling people the answer to an enabler of learning."[60] As a learning coach or coordinator the teacher can, "move from being the primary source of information and direction to acting as a coordinator of purposeful activity that matches student learning needs with available resources, thereby promoting self-directed learning behaviour."[61] For the teacher this will require a focus on participation and negotiation rather than direction and instruction.[62]

58 http://www.cisco.com/web/about/citizenship/socio-economic/docs/LearningSociety_WhitePaper.pdf p14
59 http://ali.apple.com/acot2/global/files/ACOT2_Background.pdf p21

60 http://www.metropolismag.com/story/20090218/ideos-ten-tips-for-creating-a-21st-century-classroom-experience
61 http://ali.apple.com/acot2/global/files/ACOT2_Background.pdf p21
62 http://www.cisco.com/web/about/citizenship/socio-economic/docs/LearningSociety_WhitePaper.pdf

CONCLUSION

The intent of this paper has been to lay out a vision for education in the 21st century. The rate at which our knowledge-base is expanding and the impact this is having on the pace of change within our world demands a system that teaches students to thrive in such a world. Such a system is one that individualises learning so students engage in issues important to them while learning the skills critical to participating in a knowledge-based society. While engaging the student in charting their own path, it would demand greater involvement of the parents and a shift in the role of the teacher from one of lecturer to one of guide.

It is also important to note that this paper was structured to address ideal conditions. Any implementation of such a vision needs to account for parents and students who face societal barriers. The PTC would also like to emphasise that this paper is not predicated on deconstructing the current system but is intended instead to promote discussion about how our K-12 system needs to transform itself to address the needs of the 21st century. There are a number of players involved in the delivery of education in BC and delivering such a vision will require a collaborative effort.

Recognised world leaders in education such as Finland and Singapore have acknowledged the challenges of the rapidly changing knowledge-based world. In spite of their current leading status they are in the process of fundamentally re-examining their education systems. BC needs to do the same if it wants to retain its own status as a leader and to approach the rapidly changing world with confidence.

BC has discussed similar kinds of changes in the past and has made some smaller steps toward implementation. However, the pace of world change is combining with our shift to a more knowledge-based economy to create greater urgency around the need for change. The PTC believes the 21st century transformation of BC's education system is a critical social issue that is upon us now. The concepts articulated in this paper are well known by education experts and professional administrators alike. There is a high level of consensus on this vision as well as agreement that changing such a complex system is a significant challenge. While BC's education system is evolving and dialogue about these issues is on-going, the PTC believes government should place high priority on accelerating the pace of change to become truly transformational.

Appendix A. Measuring 21st Century Skills

In the process of researching 21st century skills the PTC also investigated potential measures that would help assess a student's progress in these skills. Our research in this area was not exhaustive but the PTC has identified a variety of measures that are used around the world to assess some of the different skill sets identified in the paper. Some of this research is summarised in this appendix. Included in this summary are recognized measures for:

- Numeracy and Mathematics
- Reading Literacy
- Creativity
- ITC/Technological Literacy
- Digital Literacy

Numeracy and Mathematics

Importance of Numeracy

There are many definitions and interpretations of the term numeracy. Its definition is complicated by related terms including mathematical literacy, quantitative literacy, mathematical skills, critical numeracy, statistical literacy and critical mathematics.[63] Generally speaking, it is understood to be the ability to reason with numbers and other mathematical concepts such as orders of magnitude, geometry, algebra, probability and statistics. Many definitions put a focus on using appropriate math knowledge and understanding in everyday life.[64] Numeracy is not a synonym for school mathematics but the concepts are interrelated as math learning underpins numeracy.[65] It is important for all citizens to have numeracy skills to assist them through their everyday lives in a variety of situations like shopping, paying bills, budgeting, planning, and understanding economic indicators. Furthermore, there is the benefit of having the ability to sift through, understand, and question information to avoid being misled by quantitative data.

Technology can assist those who lack basic mathematical computation skills, but there is still a need for knowledge beyond that, to view data and information in a critical manner (especially with increasing access to information online). Unfortunately, innumeracy is widespread among all educational levels, which has economic and social implications.

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63 Planning for an emphasis on numeracy in the curriculum p5
64 Numeracy=Everyone's Business p13
65 Numeracy=Everyone's Business p11

Improving numeracy outcomes is particularly important to improve the circumstances of those who are economically and educationally disadvantaged.[66] "Poor numeracy skills make it difficult to function effectively in all areas of modern life, particularly for women."[67] Despite the growing importance that employers place on numeracy, it is believed to be undervalued: "There remains an inherent assumption among adults that being able to deal with numbers and graphics is not as important as being able to read and write competently."[68]

It should be noted that numeracy poses particular problems for employability because if numeracy skills are not used in the workplace, they are likely to decline. This is less applicable to literacy as there is more frequent exposure to written communications: "It is not surprising therefore that re-analysis of the International Adult Literacy Survey (IALS) data showed a decline in numeracy with age."[69] In some jurisdictions, numeracy discussions have previously focused on computational skills, but it is increasingly believed that if numeracy is to improve student's use of mathematics in life, numeracy education cannot be restricted to math classes but should be implemented across the overall curriculum.

NCTM Standards

The NCTM (National Council of Teachers of Mathematics), a global leader in math education, developed a system of math standards to provide learning objectives for curriculum planning. Many US states have modeled their standards with NCTM elements, including progressive math reforms, and this has occasionally led to backlash from some parents and educators. While there are mixed opinions on the matter, it is worth examining when investigating education standards.

The NCTM Standards has a goal to put forth a "comprehensive and coherent set of learning goals for mathematics for all students from prekindergarten through grade 12." This includes the following:

- *Serve as a resource for teachers, education leaders, and policymakers to use in examining and improving the quality of mathematics instructional programs.*
- *Guide the development of curriculum frameworks, assessments, and instructional materials.*
- *Stimulate ideas and ongoing conversations.[70]*

There are broad categories of mathematics instruction including: Number & Operations, Algebra, Geometry, Measurement, Data Analysis & Probability, Process Standards, Problem Solving, Reasoning and Proof, Communication, Connections, Representation. The standards include an instructional grade guide for expected outcomes, for example, between grades 6 and 8 students would be expected to learn the following numbers and operations concepts:

- *work flexibly with fractions, decimals, and percents to solve problems;*
- *compare and order fractions, decimals, and percents efficiently and find their approximate locations on a number line;*

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66 Planning for an emphasis on numeracy in the curriculum p9
67 Does Numeracy Matter More? p7
68 Does Numeracy Matter More? p8
69 Does Numeracy Matter More? p35
70 http://www.nctm.org/uploadedFiles/Math_Standards/12752_exec_pssm.pdf

- *understand and use ratios and proportions to represent quantitative relationships;*
- *develop an understanding of large numbers and recognize and appropriately use exponential, scientific, and calculator notation;*
- *use factors, multiples, prime factorization, and relatively prime numbers to solve problems;*
- *develop meaning for integers and represent and compare quantities with them.*[71]

NCTM also provides "Curriculum Focal Points." These focal points highlight important math topics by grade level from preK-8. These emphasized instructional areas can provide organizing structures for curriculum design and instruction. The goal is to teach topics that are central to mathematics to "convey knowledge and skills that are essential to educated citizens, and they provide the foundations for further mathematical learning."[72]

Reading Literacy

There is a variety of international literacy assessments, as various jurisdictions maintain different reading literacy standards.

Literacy BC

Literacy BC is the province's membership-based not-for-profit organization for promoting and supporting literacy. They provide resources and support for literacy achievement in BC. Some highlights:

- "nine in 10 (90%) Canadians believe that improving literacy levels in Canada is key to improving the country's economy."[73]
- "Approximately 95% of Canadians agree that literacy training is critical to improving job prospects for Canadians."[74]
- "94% 'agree that Canadians' literacy skills are critical to quality of life' and 93% also 'agree that governments need to support improving the literacy levels of Canadians.'"[75]
- "BC's literacy profile is stronger than the Canadian average, but scores among the youngest adults, aged 16 to 25, are lower than the Canadian average. 12% of this cohort have difficulty with even the most basic written materials."[76]
- 80% of BC adults with the strongest literacy skills are employed, compared to 47% employment of those with the weakest literacy skills (who also have less secure jobs).[77]
- "The difference in average household income of working age Canadians between those at the lowest and those at the highest literacy levels exceeds $30,000 annually."[78]
- There are also societal implications as those with high literacy are more likely to vote and participate in community groups.

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71 http://standards.nctm.org/document/appendix/numb.htm

72 http://www.nctm.org/standards/content.aspx?id=264

73 http://abclifeliteracy.ca/en/ipsos-reid-national-literacy-results-revealed

74 http://abclifeliteracy.ca/en/ipsos-reid-national-literacy-results-revealed

75 http://abclifeliteracy.ca/en/ipsos-reid-national-literacy-results-revealed

76 http://www.literacybc.ca/Info/literacyinbc.pdf

77 http://www.literacybc.ca/Info/literacyinbc.pdf

78 http://www.literacybc.ca/Info/literacyinbc.pdf

IALS

The International Adult Literacy Survey (IALS) was a seven-country initiative to create comparable literacy profiles across national, linguistic, and cultural boundaries.[79] First conducted in 1994, the survey also offers the only international source of comparative data on participation in adult education and training. Further data was collected in 1996 and 1998 following the publishing of the report "Literacy, economy and society: Results of the first International Adult Literacy Survey" (OECD and Statistics Canada, 1995). IALS literacy data now includes information from 23 countries or regions.

The IALS examined skills in the following areas:

- ***Prose literacy*** *– understanding and using information from texts, including news, brochures and instruction manuals.*
- ***Document literacy*** *– locating and using information contained in formats such as job applications, payroll forms, schedules, maps and charts.*
- ***Numeracy*** *– applying arithmetic operations to numbers embedded in printed materials, in tasks such as balancing accounts, figuring out tips, and completing order forms.*
- ***Problem-solving*** *– goal-directed understanding of problem situations and their step-by-step transformation, based on planning and reasoning.[80]*

Scores were grouped into five levels:

- ***Level 1****- difficulty reading and have few basic skills or strategies for decoding and working with text. Generally, they are aware that they have a literacy problem.*
- ***Level 2*** *- limited skills and can deal well only with material that is simple and clearly laid-out. They often do not recognise their limitations.*
- ***Level 3*** *– ability to read well, though they may have problems with more complex tasks.*
- ***Levels 4 & 5****-strong literacy skills and many strategies for dealing with complex materials.[81]*

Level 3 has been validated as the level "needed to fully participate and succeed in the modern, knowledge-based society."[82] There were several themes concluded from the study including:

- "Important differences in literacy skill exist, both within and among countries. These differences, which are much larger than those observed in studies of school literacy such as the IEA Reading Literacy Survey (Elley, 1994) substantiate the basic hypothesis of IALS, that is skill differences exist that are large enough to matter both socially and economically."[83]

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79 http://www.statcan.gc.ca/dli-ild/data-donnees/ftp/ials-eiaa-eng.htm
80 http://www.literacybc.ca/Info/literacyinbc.pdf
81 http://www.literacybc.ca/Info/literacyinbc.pdf
82 http://www.literacybc.ca/Info/literacyinbc.pdf
83 http://www.statcan.gc.ca/pub/89-588-x/4152886-eng.htm

- "Literacy is strongly associated with economic life chances and well-being. It affects, inter alia, employment stability, the incidence of unemployment and income."[84]
- "In North America and several European countries, scores on the quantitative scale show the strongest correlation with income. There is a large 'wage premium' in Canada."[85]

PIRLS

PIRLS (The Progress in International Reading Literacy Study) is one of the largest international comparative studies of the reading literacy of young students. It is coordinated by the IEA (International Association for the Evaluation of Educational Achievement) and was administered to students in 45 education systems, including both countries and sub-national systems, such as the provincial or state level.[86] It was first implemented in 2001.

This study measures the reading achievement and reading behaviours and attitudes of fourth-grade students in the US as well as participating countries. The study consists of a main survey testing reading comprehension and a background questionnaire. The assessment focuses on several areas of literacy including: comprehension, purposes for reading, and reading behaviours and attitudes.

OECD PISA

The OECD provides international testing of educational achievement through the PISA (Programme for International Student Assessment). Over 60 countries have taken part in PISA to date. The surveys that occur every three years, allow participants to track their progress in educational goals and to provide an international comparison. The OECD PISA is notable for measuring the knowledge and skills of 15-year-olds, who are often approaching the end of compulsory schooling at this age.[87] By focusing on literacy rather than factual knowledge, PISA "emphasizes the mastery of processes, understanding of concepts, and application of knowledge and functioning in various situations within domains."[88] In addition to language literacy, PISA also provides surveys for evaluation of math and science literacy.

Creativity

The Torrance Tests of Creative Thinking (TTCT), developed in 1966, is the leading test for the measurement of creative thinking. It has been reformed four times since its creation and is translated into 35 different languages for both education and corporate usage.[89] It takes approximately one hour 45 minutes and consists of three sections:

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84 http://www.statcan.gc.ca/pub/89-588-x/4152886-eng.htm
85 http://www.statcan.gc.ca/pub/89-588-x/4152886-eng.htm
86 http://nces.ed.gov/surveys/pirls/
87 http://www.pisa.oecd.org/document/53/0,3343,en_32252351_32235731_38262901_1_1_1_1,00.html
88 http://nces.ed.gov/surveys/pisa/pdf/comppaper12082004.pdf
89 The Latent Structure and Measurement Invariance of Scores on the Torrance Tests of Creative Thinking-Figural p460

1) Thinking creativity with pictures: measures creative thinking using picture based exercises to assess the following mental characteristics: fluency, originality, elaboration, abstractness of titles, and resistance to closure).[90]

2) Figural test: asks the participant to state what an abstract picture might be.[91] There are three subtests – Picture Construction (from a marked cue), Picture Completion (again with cues), and Parallel Lines.[92]

3) The verbal section has the following subtests: Asking, Guessing Causes, Guessing Consequences, Product Improvement, Unusual Uses, Unusual Questions, and Just Suppose.

The tests are game-like as they are designed for child testing.[93] They are marked by hand, by someone with experience administrating tests (e.g., teacher, counsellor, school staff, accredited school, college, governmental agency, or researcher, such as a graduate student working under supervision).[94] It is preferable to have the testing administered by a psychologist.[95]

The TTCT is known to be surprisingly effective at predicting future creative accomplishment in adults, and those who scored higher later became entrepreneurs, inventors, college presidents, authors, and software developers (lifetime creative accomplishments correlation was more than three times stronger than childhood IQ scores).[96] It should be noted that while IQ scores rise approximately 10 points with each generation due to enriched environments, there is an opposite trend for creativity scores in American children.[97] The most serious decline in scores is in the younger children from kindergarten to grade six. There are currently pilot programs in Europe for using the Torrance test to assess progress in this area.

ICT/Technological Literacy

It should be noted that there is some debate over what is considered technological literacy, as it is not strictly comparable to traditional literacy or numeracy. While some believe that it should be a measurement of the use of technology in a productivity/research context, others have argued that technological literacy should also include a broader scope such as online community usage, Internet safety, cyberbullying, IP usage and other concepts.[98] While educators agree that tech literacy is important, there is confusion over the competing meanings of the phrase and the diverse ways to measure it; as a result, some US states and school districts are working on developing standards and assessments.

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90 http://www.indiana.edu/~bobweb/Handout/d3.ttct.htm
91 http://www.indiana.edu/~bobweb/Handout/d3.ttct.htm
92 http://psycentre.apps01.yorku.ca/drpl/?q=node/16307
93 http://psycentre.apps01.yorku.ca/drpl/?q=node/16307
94 http://www.indiana.edu/~bobweb/Handout/d3.ttct.htm
95 http://www.newsweek.com/2010/07/10/the-creativity-crisis.html
96 http://www.newsweek.com/2010/07/10/the-creativity-crisis.html
97 http://www.newsweek.com/2010/07/10/the-creativity-crisis.html
98 http://www.edweek.org/dd/articles/2009/01/21/03techlit.h02.html

These efforts generally rely heavily on existing work such as that of the ISTE (International Society for Technology in Education), the ITEA (International Technology and Engineering Educators Association) or curriculum frameworks released by the Partnership for 21st Century Skills. There is a lack of firm benchmarks of ICT literacy available today to provide comparative measures, particularly across jurisdictions.[99] In 2006, an American review of technology tests and surveys found that many tests were based on attitudes towards technology and that there was a need for new or improved tests to better measure technological literacy.[100]

> 1) The ITEA is one of the leaders in this area, and defines technological literacy as the ability to manage, assess, and understand technology.[101] The IETA has also developed the Standards for Technological Literacy (STL).
>
> The STL does not provide an assessment process, but instead provides criteria for assessment.[102] The themes covered under these standards include: nature of technology, technology and society, design, abilities of a technological world, and the designed world. It provides a breakdown (by grade) for desired learning outcomes, like a curriculum guide. For example:
>
>> In order to recognize the core concepts of technology, students in Grade 6-8 should learn that: Technological systems include input, processes, output, and, at times, feed back … Systems thinking involves considering how every part relates to others …[103]
>
> 2) The Educational Testing Service (ETS) –the world's largest non-profit educational testing and assessment organization[104]– put forward a testing system that focuses on ICT literacy/usage in 2003. It was designed for college students but is also used for high school seniors. They responded to demands from colleges to provide a way to measure ICT competency/usage amongst students and released a computer-based exam that measures skills and understanding, such as the ability to judge the objectivity of a website (a pilot study of the test determined that only have of high school seniors could judge this correctly!).[105] A researcher involved in the study stated, "Kids tend to go to Google and cut and paste a research report together … We kind of assumed this generation was so comfortable with technology that they know how to use it for research and deeper thinking … But if they're not taught these skills, they don't necessarily pick them up."[106]

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99 Benchmarking ICT Literacy in Tertiary Learning Settings p6

100 http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=11691

101 http://www.cust.educ.ubc.ca/wcourses/educ500/Resources/petrina&guo.pdf

102 http://www.iteaconnect.org/TAA/PDFs/xstnd.pdf p13

103 http://www.iteaconnect.org/TAA/PDFs/xstnd.pdf p38-39

104 They are also responsible for other leading international standardized tests such as the TOEFL and the GRE

105 http://www.time.com/time/magazine/article/0,9171,1568480-5,00.html

106 http://www.time.com/time/magazine/article/0,9171,1568480-5,00.html

The focus of this testing is on real-world usage such as using databases, Internet browsers, ICT-based presentations, spreadsheets, and email usage. The test itself is 75 minutes long, consisting of 13-15 tasks covering the following themes:

Proficiency	*Definition*
Define	*Using digital tools to identify and represent an information need*
Access	*Collecting and/or retrieving information in digital environments*
Manage	*Using digital tools to apply an existing organizational or classification scheme for information*
Integrate	*Interpreting and representing information, such as by using digital tools to synthesize, summarize, compare, and contrast information from multiple sources*
Evaluate	*Judging the degree to which digital information satisfies the needs of an information problem, including determining authority, bias, and timeliness of materials*
Create	*Adapting, applying, designing, or constructing information in digital environments*
Communicate	*Disseminating information relevant to a particular audience in an effective digital format[107]*

Interestingly, it should be noted that a study has shown low correlation between ICT literacy scores and frequency of ICT activities; many students believe they have high levels of literacy due to frequency of ICT interactions but this is not reflected in scores.[108] It is believed that the "confluence of information and technology directly reflects the 'new illiteracy' concerns of educators: students quickly adopt new technology, but do not similarly acquire skills for being critical consumers and ethical producers of information."[109]

Digital Literacy

As pointed out earlier, there are issues with defining technologically-based literacy measures; it is difficult to come to consensus as to what skills and understanding should be taught. There is significant overlap between ICT and digital literacy terminology and expectations should be defined.

Generally speaking, international definitions of digital literacy include the following principles:"the skills and knowledge to use a variety of digital media software applications and hardware devices, such as a computer, a mobile phone, and Internet technology; the ability to critically understand digital media content and applications; and the knowledge and capacity to create with digital technology."[110]

A Canadian paper on digital literacy recommended the development of national standards; it stated that we could use the International Society for Technology in Education (ISTE) standards and performance indicators as a starting point for determining desired outcomes for Canadians.[111]

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107 http://www.iiisci.org/journal/CV$/sci/pdfs/P890541.pdf p51
108 http://www.iiisci.org/journal/CV$/sci/pdfs/P890541.pdf p53
109 http://library.ias.edu/hs/ssstheme/20081218_ICT%20.pdf p4
110 http://www.media-awareness.ca/english/corporate/media_kit/digital_literacy_paper_pdf/digitalliteracypaper.pdf p4
111 http://www.media-awareness.ca/english/corporate/media_kit/digital_literacy_paper_pdf/digitalliteracypaper.pdf p6

Digital literacy has been emphasised for the following benefits:

> *1) A digitally literate population is more innovative and creative.*
> *2) Digital literacy increases ICT infrastructure development and use.*
> *3) Digital literacy promotes smart ICT adoption and increased productivity.*
> *4) A digitally literate population makes good organizational sense.*
> *5) Digital literacy enables public participation.*
> *6) Digital literacy promotes economic and social inclusion.*
> *7) Digital literacy supports and promotes empowerment and engagement.*
> *8) Digital literacy helps children and youth mitigate online risk.*[112]

The ISTE focuses on thematic guidelines for technological standards; similarly to the ITEA standards for ICT literacy, it uses learning/teaching outcomes rather than providing a method of assessment or scoring system, providing flexibility for use in different circumstances. It should be noted that the ISTE NETS 2007 system has three separate guides for students, teachers, and administrators to better match outcomes and responsibilities.

For students there are the following themes that should be covered in the education curriculum:

1. Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students:

> *a. apply existing knowledge to generate new ideas, products, or processes.*
> *b. create original works as a means of personal or group expression.*
> *c. use models and simulations to explore complex systems and issues.*
> *d. identify trends and forecast possibilities.*

2. Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students:

> *a. interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.*
> *b. communicate information and ideas effectively to multiple audiences using a variety of media and formats.*
> *c. develop cultural understanding and global awareness by engaging with learn ers of other cultures.*
> *d. contribute to project teams to produce original works or solve problems.*

3. Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students:

> *a. plan strategies to guide inquiry.*

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112 http://www.media-awareness.ca/english/corporate/media_kit/digital_literacy_paper_pdf/digitalliteracypaper.pdf

b. locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media
c. evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
d. process data and report results.

4. Critical Thinking, Problem Solving, and Decision Making

Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students:

a. identify and define authentic problems and significant questions for investigation.
b. plan and manage activities to develop a solution or complete a project.
c. collect and analyze data to identify solutions and/or make informed decisions.
d. use multiple processes and diverse perspectives to explore alternative solutions.

5. Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students:

a. advocate and practice safe, legal, and responsible use of information and technology.
b. exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. demonstrate personal responsibility for lifelong learning.
d. exhibit leadership for digital citizenship.

6. Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students:
a. understand and use technology systems.
b. select and use applications effectively and productively.
c. troubleshoot systems and applications.
d. transfer current knowledge to learning of new technologies.[113]

Teacher and administrator technology education standards/performance indicators are available at http://www.iste.org/standards/nets-for-teachers.aspx and http://www.iste.org/standards/nets-for-administrators.aspx, respectively.

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113 heep://www.iste.org/standards/nets-for-students/nets-student-standards-2007-.aspx

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