Closing the Gap: How Can the School System Embrace the Age of Acceleration?

Mario Chiasson
Université de Moncton, Faculty of Education, Canada
marioch@nbnet.nb.ca

Viktor Freiman
Université de Moncton, Faculty of Education, Canada
viktor.freiman@umoncton.ca

Abstract: The appearance of ICT in the 80's has transformed industries operations as well as their workspaces to improve productivity and performances (McCain, Jukes, & Crockett, 2010; Lorenz, Rüßmann, Strack, Lasse Lueth, & Bolle, 2015). The evolution of Digital Hardware, Digital Network, Digital Information and Digital Collaboration, which is the new engine of the global economy, companies are continuously upgrading their ICT equipment to maintain or increase performance. This new technological wave demands new skills in the work place, namely, problem solving, team work, communication, critical thinking and creativity which seem to be the top five competencies (Sproat, 2015). Facing increasing demand from the digital industry, the school system has been suffering to prepare student for the digital society. The education system needs to have a complete face lift. Therefore, we have identified Three Educational Forces that could transform the learning culture to prepare students for the digital society.

Context and problem statement

Freidman (2016) indicates that the three largest forces on the planet which are the market place, mother nature and Moore's law are reshaping the world at a fast acceleration rate. Maybe this is the reason why we are living in a period where the school system (K-20) around the world are experiencing enormous turbulence. In fact, specialists in the field are asking themselves a lot of questions for the sake of preparing the next generations for an industry where jobs are still not yet been created or defined. The arrival of this new type of technology called Information and Communication Technology (ICT) during the 1980s, seems to be one of the main reasons (Lorenz, *& al*, 2015 & Zhong et al. 2016). This wave of technological advancement has systemically transformed the operations of industries and consequently created new paradigms of the global economy.

The ICT which is now the nervous system of the industry, have forced businesses to redefine their operations and process workflows to improve productivity and performances of their organization in the interest of competing globally (McCain & al, 2010; NRC, 2011; Lorenz & al, 2015). Moreover, this new technological wave demands new skills that we labelled 21st century skills. Mentioned above, Freidman (2016) indicated that the three largest forces reshaping the planet are the market place, mother nature and Moore's law. From an education system point of view, it is a bit overwhelming on how the school system can relate and adapt to those three forces as well as understanding how complex the challenges are to reach the needs of the industry and most importantly evolve at the same speed. Knowing the industry has invested in ICT to transform their processes and to improve their productivity, which processes of the education system was transformed to improve student performances with the implementation of ICT?

In the world in which ICT plays an important role in carrying out essential daily life tasks, students need to be innovative, creative, critical thinkers and problem solvers in order to develop the essential skills that industry requires in the information age (Miller, Soh, Chiracescu, Ingraham, Shell & Hazley, 2014; Zhong et al. 2016). In the light of these facts, the education system used to be able to prepare students for the work force. So, what really happened during the last few decades in the industry? In what ways did the ICT has significantly transformed industries? What are the essential skills that industry is now requiring? Why has school system has not evolved at the same rate as industry? How can the education system overcome these challenges?

With that being said, the education system can also use three forces in order to level up with the industry. So, let's call them the three Educational Forces. The first force is the learning space where students and teachers can be fully engaged in their learning and teaching experiences. This will feed the second force which is the process of learning. This learning experience needs to shift the students from "What" he needs to learn to "How" he or she needs to learn it. The third force is the skills competencies. While reading, writing and arithmetic are considered to the foundation of basic skills, the learning experience needs to provide the opportunity to students to develop skills

competencies that industries require. Those are the three major forces we should seriously be considering to reshape the learning culture which the education system so desperately needs and deserves. In the paper, we will further explore key aspects of each force and sub sequential changes in a way we teach and learn.

New skills from the industry perspective: The Arrival of the Digital Era

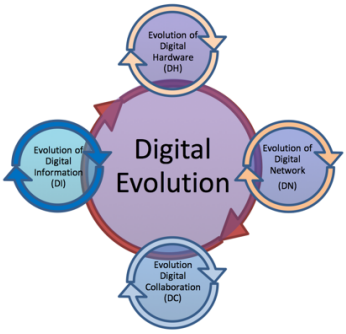
In order to better grasp changes in skills sets from the industrial perspective, it would be important to clarify that the "Digital Industry" can also be defined by the abundance of ICT's. According to the Journal of the Midwest Association for Information System, it is clear that today's labour market relies heavily on information and communication technologies and requires new skills. This "Digital Industry" wave is significantly more important than the others because it is creating a new paradigm of the global economy. McCain *and al*. (2010) explains that since the beginning of the 20th century, four major workforces have significantly changed. These workforces are the agriculture, labour, service and creativity. While it seems that the agriculture, the labour and the service workforces are currently declining, industries favouring creativity are strongly growing, especially since 1980. So, can we assume that creativity in a period of the information age is now an essential competency required for all?

How does this new machine work?

As we mentioned previously, ICT is now the 'nervous' system of the digital industry. So, it is plausible to assume that any material capable of receiving, processing and sending digital information can be considered as an ICT tool of which computers, Smart Phones, tablets, gaming platforms are examples. Moreover, we are living in a period where the industries are producing almost anything with a microchip that collects data and can track anything about anything anywhere. So, how does this new machine work? How does it evolve? In what ways it changed the operations of the industries?

In our representation, this digital machine works on the interrelation of four fundamental components which are Digital Hardware (DH), Digital Network (DN), Digital Collaboration (DC) and Digital Information (DI). If one of them evolves, then the others are forced to evolve as well. The fascinating part is that the evolution of the four digital component results in a constant advancement of the ICT revolution and, therefore continuously pushes the innovation of the industry. So, let's examine closely the above mentioned four components to get a basic understanding of each of them.

Figure 1: Model of the Digital Evolution



The Digital Network (DN) is providing connectivity from one device to the other via two types of networking system. The most popular one is called the "Wi-Fi", which we find inside buildings and the second one is the communication towers that are located on the edges of the roads or on the top of the buildings. These two types of networks can be distinguished, among others, by the level of security and accessibility. While the Wi-Fi system can be secured, the communication tower provides an open network but we need to pay (data Plan) to have access to the information. Over the years, due to the evolution of DH, the DN systems had to be upgraded significantly.

Figure 2: Evolution of Digital Network

a) Cellular Network

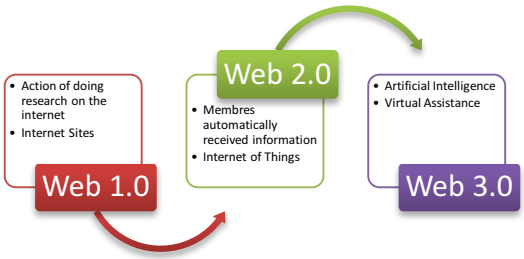
b) Wi-Fi Network

The Digital Hardware (DH) is the foundation of any technology innovation. It is any device containing circuit boards, microchips, wires, and/or sensors to name a few components that are carrying digital information. Thanks to Moore's Law, the form factor has also become smaller over the years. For example, the industries have gradually switched from the desktop to laptops to tablets and now to handheld devices which significantly transformed the operation. Nowadays, wearable technologies are the new trend. Bracelets such as Apple Watch, Fitbit, Fengshi (Internet of things) are some examples. Moreover, digital sensors are now integrated with other types of HD like cups, chairs, glasses, Oculus Rift, HTC Vive, and Microsoft Hololens.

Figure 3: Evolution of Digital Hardware

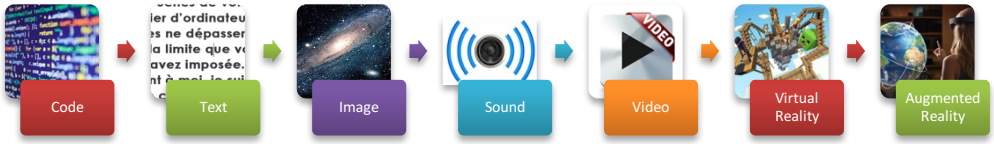
The Digital Collaboration (DC) is the third component and it can be differentiated in three contexts. The first context can be explained by simply searching information on the Internet. This context to find information on the web is called "Web 1.0". The second type of DC, named "Web 2.0" is when the information is automatically transmitted to you. "Web 2.0" is a very powerful marketing tool which industries are taking full advantage of it. Today, businesses must have a Facebook, Instagram and Twitter accounts. Lastly, the "Web 3.0" can be explained by the arrival of digital sensors, Big Data phenomena and "App" development.

Figure 4: Evolution of Digital Collaboration (Nation, 2017)



The last component is the Digital Information (DI). At the age of 15, the parents of one of the author bought him a computer called TRS-80 Tandy Color Computer 3. That's when he was introduced to the information age and learned how to code with Fortran, Objective C, Pascal and Basic. It was gratifying to see in action a frog crossing a road after writing lines and lines of codes. Moreover, it was even more stimulating when it wasn't working. You had to find the problem and solve it through tinkering and debugging the codes. With the evolution of DI, coding is rarely used because we have now access to operating systems like Windows 10, Linux, Unix and OS X enabled people to use text, insert tables, images, soundtracks, videos and 3D animations through applications. Nowadays, because of Apple innovation and its App creation in 2000, companies have focused on having their own application "App" giving access to their products or services. That is why the industry demands employees that have coding and problem solving skills. Those skills are now considered essential competencies (Wing, 2006; Bundy, 2007; Djambong & Freiman, 2015; Sproat, 2015 & Freiman, Chiasson, Godin, Larose, Leger, Volkanova, & Goulet, 2017).

Figure 5: Evolution of Digital Information



The School System – What happen?

It is difficult to understand why the school system has not been able to keep the pace with the digital industry (Barker & Erickson, 2005; McCain, Jukes, & Crockett, 2010; Cobo, 2013, Lorenz & al, 2015). Since 2004, one of the authors has been involved in many provincial projects as Technology Mentor, Technology & Skills Trades Supervisor and Technology Subject Coordinator in New Brunswick, Canada. The Ministry of Education has certainly implemented ICT projects to prepare future generations for this so-called digital industry. First, during the years 1995 to 2000, the province invested in school libraries to give them access to digital information. The year 2004 brought a historic change in New Brunswick as the government gave a laptop to all teachers and 3,200 laptops to students. In 2006, Early Education Childhood Department (EECD) initiated a project called "Model Schools" where six secondary schools have received digital resources to use in the classrooms to support project-based learning environment. Subsequently, the government initiated a project called $NB^3 21^C$ in 2008. NB^3 acronyms meant literacy, numeracy and science and 21^C represented the skills of the 21st century. In 2010, the government launched a project called Demonstration Schools, enabling students in forty schools to have a "1 to 1" laptop. Finally, the province last initiative was launched in 2013: the Bring Your Digital Device (BYOD) program was implemented in twenty-two schools where students could bring and use their mobile devices at school. After all these techno-pedagogical initiatives, the school system still faces enormous challenges related to prepare future generations. So why, after several initiatives, has the school system not yet succeeded? Do the learning outcomes reflect the needs of the digital industry? What skills do students need to master today in order to meet the demands of the industry? What are the fundamental objectives of education?

Fluke et al. (2016) argue that the integration of ICT into the K-12 curriculum is essential to support all economic sectors. Lorenz et al. (2015) share that the school system should seek to develop competence skills instead of knowledge in order to meet the needs of the industry. Sproat (2015) indicates that amongst all the 21st Century competencies, the top five needed in the workplace are problem solving, team work, communication, critical thinking and creativity. Knowing the education system is focusing on literacy, numeracy and sciences (according to data from the evaluations of the International Program for the Monitoring of Student Achievement (PISA) and The Pan-Candadian Assessment Program (OCAP)), this seems to be one of the reasons why the school system is disconnected with the industry. In fact, Cobo (2013), referring to the Organization for Economic Co-operation and Development report published by Toner (2011), calls this the mismatch between formal education and challenges of an innovation society. He continued to explain the importance of the expert thinking profile which represents a person capable of working in a changing environment using skills such as creativity, communication, collaboration et problem solving. However, this mismatch between school and industry needs is not a new phenomenon. A paper that can be considered a "classic" is this respect is the report called "A Nation at Risk: The Imperative for Education Reform" published by Gardner (1983). The report highlights the importance of stimulating skills such as comprehension, interpretation, evaluation, understands the computer as an ICT device and computational and problem solving skills.

The Three Educational Forces – Let's Close the Gap

The lack of ICT knowledge and vision by the education leaders has certainly created a mismatch between education and challenges of an innovation society (Chiasson, 2004 & Toner, 2011). Therefore, the education system faces a very complex problem to overcome the current challenges of the digital industry. Elliot Eisner mentioned that the educator's job is not to prepare kids to do well in class, but to do well in life. How can we prepare our students to perform and do well in life? How can we assure that reading, writing, arithmetic which are the basic skills can be maintain and infuse the 21st Century skills? What policies do we need to change?

There are lots of other factors that we have not mentioned yet that affects the student performances. However, we have identified the top three that have arisen of all of them and we have called them the Three Educational Forces that will change the learning culture. They are the learning space, the learning process and the learning competencies.

The following lines will describe the Three Educational Forces and explain the importance why we need to consider them to better prepare the students.

Educational Force 1: Learning Space – Change the Space, Change the Behavior!

According to Branigan-Pipe (2016), teaching and learning strategies have changed, yet school buildings, physical structures, classroom organization and classroom design remain the same. She goes on to say that current classroom environments limit student learning and the practice of new learning strategies. Project Base Learning (PBL), Inquiry Based Learning (IBL), Challenge Based Learning (CBL), Flipped Classroom (FC) and Universal Design Learning (UDL) are some examples. Janjiwsja & Atley (2008); Lye & Koh (2014) and Webster (2015) share that learning space is one of the systemic components that the school system must seriously consider. Until recently, there has not been much research or theories explaining the nature of the relationship between space and learning (Zufferey & King, 2016, Cox & Keating 2012). The French sociologist Lefebvre (1991) was the first to examine the notions of the passive learner and the use of space. So, in light of these facts, have the classrooms (learning spaces) changed since the appearance of ICT, like the industries did? Knowing that industries have transformed their workspaces and processes, what would be the characteristics of learning spaces that will unleash the ability to innovate, create, collaborate, work in a team, demonstrate critical thinking, solve complex problems? Do we still need classes? As a very preliminary claim, we argue that LS must provide students with a real authentic environment to develop their knowledge, skills, abilities, and receive instant feedback from their learning community to gain confidence in their work ethics (Zufferey & King, 2016). Finally, projecting these observations onto a lifelong continuum, this new educational ecosystem will create an opportunity to redefine the learning process which we will explain in the following section.

Educational Force 2: Learning Process – From What to How

On a daily basis, industries look at their data and tries to improve processes by identifying areas that can be enhanced or find solutions to problems presented. Over the years, the education system has tried to embrace new teaching strategies to simulate the same practices as the industry. Freiman & al, (2017) indicate the education system (K-20) need to go through a similar process where he or she can prove his or her learning by actively acquiring knowledge, test knowledge by experiences, convey his or her finding with peers, collaborate within the community to share their learning and finally reflect by internalizing the knowledge which could result in a successful interaction of digital literacy and soft skills, among other components of digital competences. Finally, this learning experience shifts the students learning processes from "What" he needs to learn to "How" he or she needs to learn (JISC, 2006; Cobo, 2013; Miller & al, 2014). Hence, there is a clear need to design a learning process where students will go through a learning experience where he or she will be in charge of their own learning.

Educational Force 3: Learning Competencies

The 21st century competencies are not a new thing and we have seen many versions of it since the early 2000. As we have highlighted some of them through the document, Sproat (2015) indicates that amongst all the 21st Century competencies, the top five needed in the work places are problem solving (51%), team work (33%), communication (26%), critical thinking (21%) and creativity (18%). Based on what we have learned on how the industry operates in the information age, it is not a surprise to understand that the above competencies are essential. Many research also shares the importance of the development of the computational thinking skills (Wing, 2006; Djambong & Freiman, 2015 & Freiman, Chiasson, Godin, Larose, Leger, Volkanova, & Goulet, 2017). Bundy (2007) explains that through the process of problem-solving activities and algorithmic problems, students develop their computational thinking skills. In addition, he also mentions that it is an essential skill to the understanding of new concepts created and designed in each area of the digital industry.

From an education system perspective, it is a bit overwhelming on how the school system can relate and integrate those skills we have mentioned above when literacy, numeracy and science are still the main components the education system is measuring. Even though we are starting to see some movement in integrating skills competencies assessments, the complexity of assessing skills remains a huge challenge and most importantly measuring the ones the industry really needs. While we maintain those basic skills, students would develop the skills competencies such as problem solving, computational thinking skills, etc. throw the researching, producing, publishing and reflecting steps explained in the learning space section.

Conclusion – Reshaping the Learning Culture

The appearance of ICT in the 80's has forced businesses to transform their operations as well as their workspaces to improve productivity and performances to competing globally (McCain & al, 2010; Lorenz & al, 2015). We have also learned that due to the evolution of Digital Hardware, Digital Network, Digital Information and Digital Collaboration, which in is the new engine of the global economy, companies are continuously upgrading their ICT equipment to maintain or increase performance. This new technological wave demands new skills in the work place and problem solving, team work, communication, critical thinking and creativity seems to be the top five competencies (Sproat, 2015). Over the years, the ICT has also contributed to the transformation of the working spaces to increase the efficiency and productivity of the organizations. In addition, looking at creating a new culture conducive to collaborate providing the ability to work and learn in teams while also being complex communicators, the education system needs to have a complete face lift while taking the risk to create a paradigm shift in order to prepare students in the digital society.

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