GLOBAL COMPETENCIES IN DEEPER LEARNING ENVIRONMENTS ENABLED BY PERVASIVE DIGITAL TECHNOLOGIES: EVOLVING FRAMEWORK FOR THEORETICAL FOUNDATION AND DEVELOPMENTAL EVALUATION

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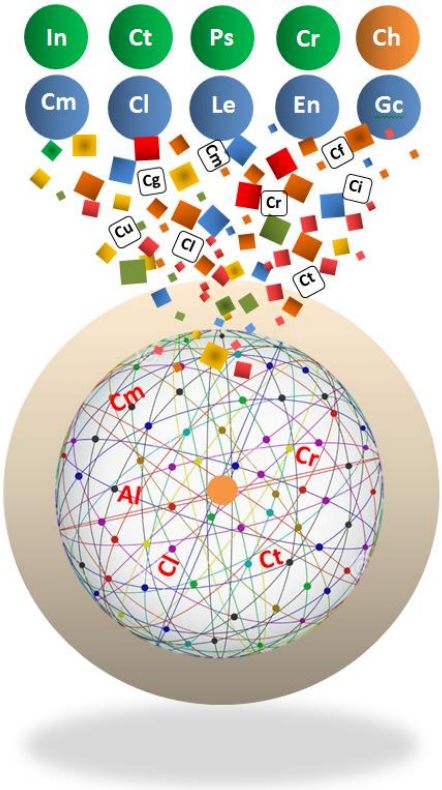

Research & Information Services
Toronto District School Board
March 2018
Report No. 17/18-22

TITLE: Global Competencies in Deeper Learning Environments Enabled by Pervasive Digital Technologies: Evolving Framework for Theoretical Foundation and Developmental Evaluation
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We would like to thank and acknowledge the support and contributions of Thomas G. Ryan, Professor, Faculty of Education, Nipissing University for this study

Cite as:
Sinay, E., & Graikinis, D. (2018). *Global competencies in deeper learning environments enabled by pervasive digital technologies: Evolving framework for theoretical foundation and developmental evaluation*. (Research Report No. 17/18-22). Toronto, Ontario, Canada: Toronto District School Board

Note: As an evolving model most of the content of this manuscript has also been submitted to the "Journal of Research on Technology in Education" on October 24, 2017

R02(STEM\2016-17\Deep Learning and GC Reports\Research Series 10 DLGCDF Framework\DLGCDF Framework)es.1485

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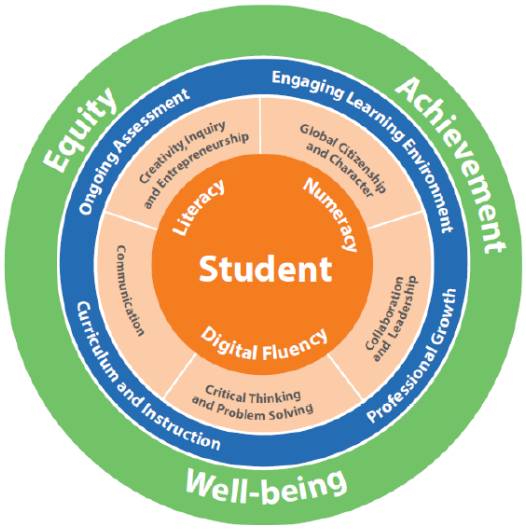
Introduction

The Toronto District School Board (TDSB) has recently introduced *A Vision for Learning in the TDSB*, to "enable all students to reach high levels of achievement and to acquire the knowledge, skills, and values they need to become responsible members of a democratic society" (TDSB, 2017, About Us, Our Students, para. 1). In response to a growing body of evidence regarding the importance of students' digital aptitudes in an information society, this framework embraces digital fluency and has been integrated as a core 21st century outcome, equal in importance to the traditional cores of literacy and numeracy. In the same framework, 10 global competencies support the core 21st century outcomes for graduating TDSB students.

Figure 1: TDSB Vision for Learning



Source: (Malloy, 2016, p. 11)

Importance and Need of Deeper Learning Environments, Global Competencies, and Digital Fluency

In today's changing environments within school settings, increased attention is geared towards effective learning. There is a sense of urgency for innovation in education which arises as part of rapid economic and societal changes. What is the most effective teaching approach for schools to prepare students for success in the future? What kinds of environments create and sustain new competencies students require to learn in order to succeed in a world where the nature of the problems is changing? What is the role of technology in shaping the teaching and learning environments?

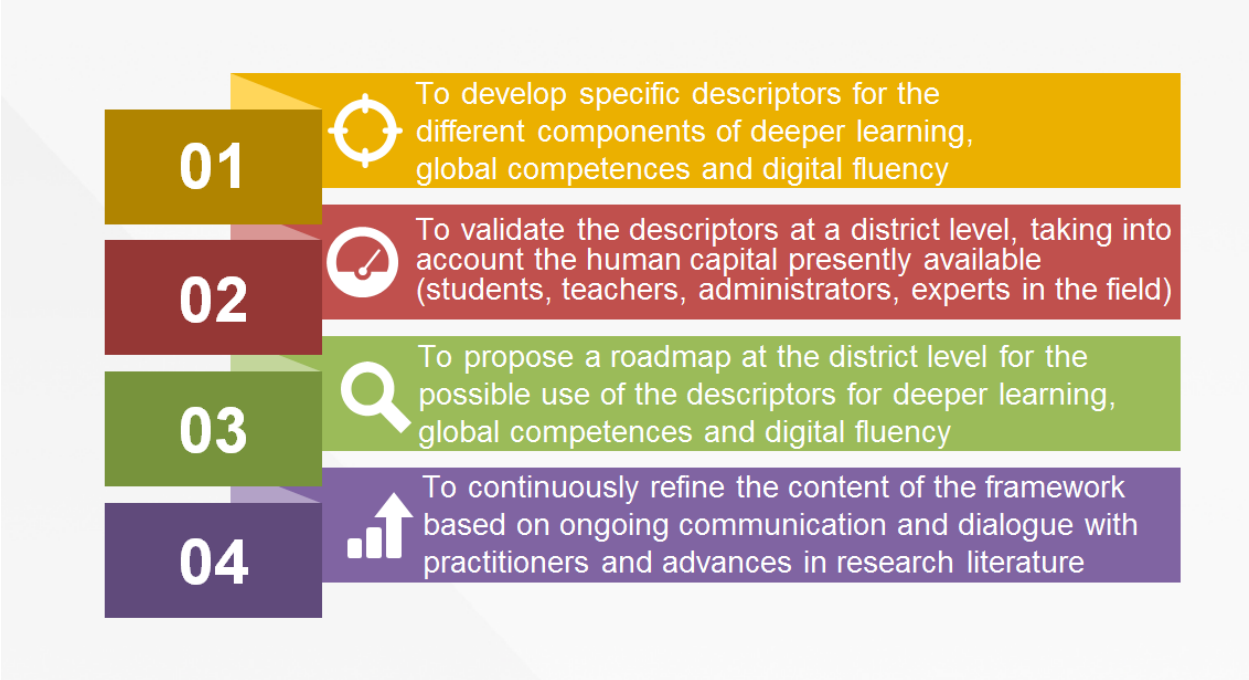
There is an abundance of evidence within the literature which suggests that effective teaching approaches, like deep learning, will help students today, while supporting competencies gained in the learning process, which includes digital technologies in the teaching and learning process.

The purpose of this report is

- To briefly review the research literature on the the relationship between deeper learning, global competencies, and digital fluency, all of which change the learning process of our students. We argue that learning environments where global competencies are refined by deeper learning and supported by pervasive digital technologies enable TDSB students to achieve high levels of literacy, numeracy, and

digital fluency. This work provides clarification of the basic features of the three areas researched including, the interrelationships and forms the basis for the development of deeper learning, global competencies and digital fluency in subsequent steps.

Figure 2: Next Steps



This work builds on previous work completed by the Research and Information Services Department and it is informed by the preliminary results of those studies[1].

[1] Please see the reports on Technology and Innovation in Education in: http://www.tdsb.on.ca/research/Research/Publications/TechnologyandInnovationinEducation.aspx

Deeper Learning Environments: Production of Transferable Knowledge

At the Toronto District School Board (TDSB), we view deeper learning situations as the environments where a set of instructional approaches are aligned with three core learning foundations across academic subjects. These core learning foundations suggest student learning takes place when students are:

a. **Meaningfully engaged**;
b. Presented with **factual knowledge organized** around a conceptual framework; and
c. Taught in their learning environment using **metacognitive practices** (Donovan & Bransford, 2005; Bransford, 2000 - as cited in Dede & Frumin, 2016; Organization for Economic Co-operation and Development, 2010).

Deeper learning is a **complex, intricate, and multifaceted** instructional approach; it **is constructivist in nature** addressing the subjective (internal) nature of learning; it refers to the learners experiences directed to the student using **active techniques** (authentic, real-world problem solving) (Rillero, 2016). Putting the **student in the center of the learning process** reflects "a profound respect for who students are and what they can do" (Mehta & Fine, 2015, p. 33). Deeper learning is characterized by **learning that sticks** (Fullan, 2017), because it changes the teacher-student relationship and the pedagogy used in the classroom. Similarly, for Mehta and Fine (2015), deeper learning emerges at the crossroads of mastery of the content, intrinsic motivation (identity), and action or making something new within the field (creativity). Deeper learning is associated with "**the ability to *transfer* knowledge**" (p. 4).

Applying learned knowledge in new situations (transferable knowledge) and the development of new competencies are the main components in definitions of deep learning.

Deeper learning takes place when students are immersed in learning environments rich in opportunities for **critical thinking, collaboration, creativity, communication, and autonomous learning.**

The importance of the metacognitive component of deeper learning is emphasized above all other factors in a wide range of studies. It appears that students who self-regulate need to be engaged in metacognition, that is, thinking about one's own cognition (Metcalfe, 2000; Norman & Furnes, 2016). Metacognitive processes are cultivated by engaging students in problem-based learning and peer collaborative environments where they have the opportunities to reflect on new concepts. Only under these conditions are they able to graft new knowledge to their

existing cognitive framework. “Once new learning is integrated into existing ‘ways of knowing’, this in turn nurtures creativity and originality and establishes new cognitive habits. Critical thinking skills are also enhanced” (Lai, 2011a, as it is cited in UNESCO, 2015, p. 3). Engaging students in metacognitive processes appears to enhance transferable knowledge, (i.e., applying knowledge acquired in new situations and contexts).

Pedagogies, Principles, and Strategies of Deeper Learning

There is agreement among experts in the field for the effectiveness of deeper learning as an instructional approach and for its key pedagogies, principles, and strategies (American Institute for Research, 2017; Dede & Frumin, 2016; Fullan & Langworthy, 2013; Hewlett Foundation, n.d.; Mehta & Fine, 2015; National Research Council [NRC], 2012; OECD, 2010; OECD, 2017a).

The backbone of deeper learning is the formation of new partnerships between and among students and the teacher, which leads to a **student-centered** instructional approach (the “**new pedagogies**” in praxis, according to Fullan & Donnelly, 2013; UNESCO, 2015). In student-centric learning environments, students take greater control of their learning and teachers are called to apply **pedagogical competency** by acting as “aggregators, amplifiers, and facilitators of knowledge, and [by] focusing on the cultivation of connectivity and inter-sections between different nodes of information or knowledge which extend beyond the classroom environment” (Sinay, 2014, p. 14; Apelgren & Giertz, 2010).

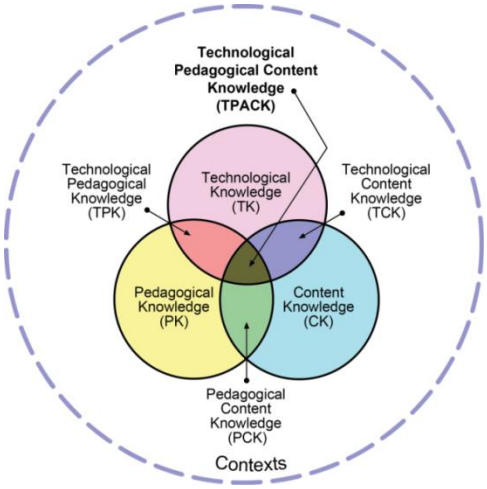
In a seminal paper prepared for UNESCO (2015), the author argues that the new competencies required by today’s students can’t be taught by the traditional “transmission” or “lecture model”. UNESCO advocates for new effective pedagogies which need to be adopted for student learning and which engage students in the learning processes that support new competencies linked to the cognitive domain. **Pedagogy 2.0** redefines the teaching and learning process at both ends: teachers assume new roles and act as facilitators of knowledge; whereas, students contribute to course content by idea production and active performance.

Technology, Deeper Learning Pedagogy, and Content

OECD’s (2017b) pedagogical core includes the dynamic interplay between teachers, learners, resources, and content. Subject-specific knowledge and deeper learning pedagogical knowledge are the main teacher-related determinants for effective teaching (OECD, 2016a). At the TDSB we adopted the Technological Pedagogical Content Knowledge (TPACK) model which integrates subject-specific knowledge, pedagogical knowledge together with technological knowledge, as the pedagogical framework to be used in deeper learning environments (Mishra & Koehler, 2006; Schmidt et al., 2009). Subject-specific knowledge and technological knowledge are easily defined but cultural differences infusing perspectives on the role of teachers and

schooling "should be taken into account while defining the concept of pedagogical knowledge" (OECD, 2017b, p. 107). **Technology, deeper learning pedagogy, and content** are the three areas of knowledge covered by TPACK which builds on a previous construct developed by Shulman (1986). The model allows for the integration of the *Technological* into the *Pedagogical* and *Content Knowledge* required in teaching and it can be applied across disciplines. Each of the three individual knowledge areas interact to produce Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK) (see Figure 3)

Figure 3: The TPACK Model



Source: Mishra and Koehler (2006); Reproduced by permission.

In order for students to cultivate global competencies, the following **principles, strategies and pedagogical approaches** have been adopted within TDSB's deeper learning environments (see Tables 1, 2, and 3).

Table 1: Principles for Deeper Learning Environments for the Cultivation of Global Competencies at TDSB Schools (Saavedra & Opfer, 2012; OECD, 2016b)

	Principles of Deeper Learning Environments
1	Adopt **learner-centered** models
2	Make learning relevant to the **'big picture'**
3	Teach through the **disciplines**
4	Adopt **new pedagogies**
5	Develop **lower and higher order thinking skills**
6	Encourage **transfer of learning**
7	Teach how to 'learn to learn' or **metacognition**
8	Promote **teamwork**
9	Exploit **technology to support learning**
10	Foster **students' creativity**

Table 2: Strategies for Deeper Learning Environments for the Cultivation of Global Competencies at TDSB Schools (NRC, 2012)

	Strategies of Deeper Learning Environments
1	Using **multiple and varied representations** of concepts and tasks
2	Encouraging **elaboration, questioning and explanation**
3	Using **multiple and varied representations** of concepts and tasks
4	Engaging learners in **challenging tasks**
5	Teaching with **examples and cases**
6	Priming student **motivation**
7	Using **formative assessments**

Table 3: Pedagogical Approaches Contributing to Deeper Learning Environments for the Cultivation of Global Competencies at TDSB Schools (UNESCO, 2015)

	Pedagogical Approaches Contributing to Deeper Learning
1	Focusing on **quality**
2	Fostering **participation**
3	Focusing personalization and **customization of learning**
4	Emphasizing **project and problem-based active learning**
5	Encouraging **collaboration and communication**
6	**Engaging** learners
7	Employing appropriate **learning tools**
8	Designing relevant and **real-world learning** activities
9	Including **every learner** through technology
10	Promoting learning without borders (anytime and anywhere)
11	Encouraging lifelong learning
12	Assessing for deeper understanding and competency
13	Redefining teacher roles and functions

Deeper Learning Practices

The main idea behind deep learning practices is that students learn better when they are deeply engaged and have an enhanced grasp of the learning process. The focus is shifted from passively acquiring knowledge to active discovery of content and meaning by exploring and solving real world problems. This new approach to learning is better suited for modern learners, as it provides students with learning skills that help them compete effectively in a globalized, interconnected, and technology-infused world.

In this new learning environment, classrooms become student-centric learning environments, with students taking greater control of their learning and teachers acting as partners, collaborators, and facilitators to help guide students through the process of learning how to learn. The relationship between the classroom and external world is also changing, as students become virtually connected to and immersed in the world beyond the classroom and school. Deeper learning is being applied in the classroom through a focus on problem and inquiry-

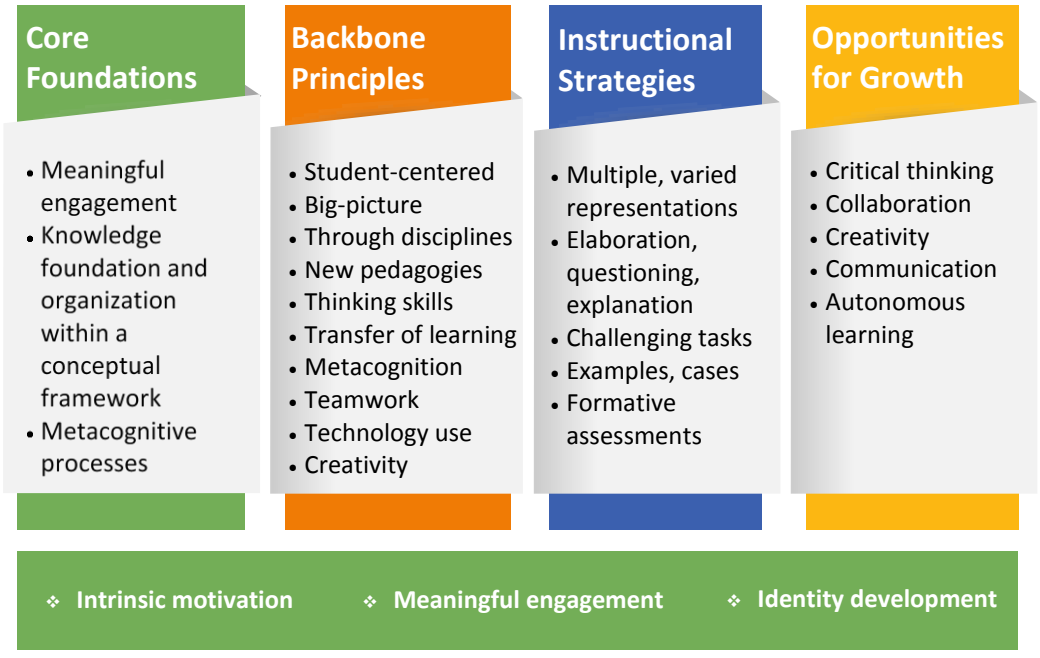
based learning, where students work in project teams focused on solving complex and authentic real-world problems while using and improving their literacy and numeracy skills.

Experiences produced in deeper learning environments, **intrinsically motivate** the students generating **meaningful engagement** which further leads through the accumulation, integration, and interpretation of experience to their **identity development**. Identity building fuels "learners' perceptions about the relevance of content and the way that learning becomes deeper as it becomes a more core part of self" (Mehta & Fine 2015, p. 6).

The effectiveness of teaching in deeper learning environments appears to relate to a variety of teaching practices which in turn is highly correlated to high-quality teacher professional development (TPD). In addition, curriculum-focused TPD appears to be more important than subject matter-focused TPD and "the greater the collaboration in TPD, the better the practices in the classroom" (OECD, 2016c, p. 14).

In summary, deep learning practices expose the students to new pedagogies in authentic learning environments which stimulate meaningful engagement and mastering of transferable knowledge. The deeper learning environments cultivate a number of knowledge, skills, and attitudes which are labelled global competencies. The main attributes of deeper learning environments are depicted in Figure 4.

Figure 4: Main Attributes of Deeper Learning Environments Addressing How Students Learn



Global Competencies:
Transferable Types of Knowledge Which Leads to Action

There is little disagreement among experts that subject-specific knowledge together with competencies combine to sustain success in life and improve our future economy. Today, more than ever before, intrapersonal and interpersonal competencies are viewed by educational psychologists as important factors in the learning process and career success. For example, the 5-factor model of personality ("big five" personality traits - conscientiousness, openness, agreeableness, emotional stability, and extroversion), together with cognitive competencies, predicts more than any other factor career success (NRC, 2012). The same authors note that although there is a correlation between personality factors and grade performance in elementary school, this correlation is diminished in later years of schooling. Therefore, the cognitive component could be considered just one factor in career success. Searching for the rest of the non-cognitive factors which can be cultivated by the educational process has been a challenging task for the last 30 years.

Deeper learning environments are associated with "**the ability to *transfer* knowledge**". Since our schools are the most commonly cited factors contributing to human capital and they are responsible to the greatest extend for the quality of early experiences (education), for training, and for work experience (Judge, Higgins, Thoresen, & Barrick, 1999). For this reason they can be viewed as the best places for cultivating deeper learning environments where transferable knowledge can take place. For our schools, which traditionally were engaged in outcomes related to subject-specific knowledge, there is an urgent need to adapt and include ways for teaching the knowledge, skills, and behavioral changes associated to transferable knowledge.

These transferable types of knowledge are deemed necessary to compete in a changing global environment. In "a world that is more competitive globally connected and technologically engaged than any period in history" (Ontario Ministry of Education [OME], 2014, p. 1), global competencies are viewed as a set of 21st century competencies which will enable TDSB students to become global learners. Being a global learner allows students to display a range of knowledge, skills and favorable behavioral changes, which "will lead them to become personally successful, economically productive, and actively engaged citizens," (OME, 2016, p. 3) and contribute to "dissolve tensions and rebuild social capital" (OECD, 2016b, p. 1).

What are Global Competencies?

In educational systems, the product of deeper learning environments is mastery of the content and transferable knowledge which leads to action. As a result of their immersion in deeper learning environments, students are competent of knowing when, why and how to apply content knowledge in novel situations, to answer questions, and solve problems (NRC, 2012; OECD, 2016d). Therefore, transferable knowledge is accompanied by knowledge, skills and favorable behavioral changes (attitudes and values) which are closely intertwined in support for action. At the TDSB we refer to the blend of transferable types of knowledge as **global competencies** (see Figure 5). In literature, global competencies are also referred as 21st century skills, "college and career readiness", "next generation learning", "new basic skills" and "higher-order thinking" (OME, 2016).

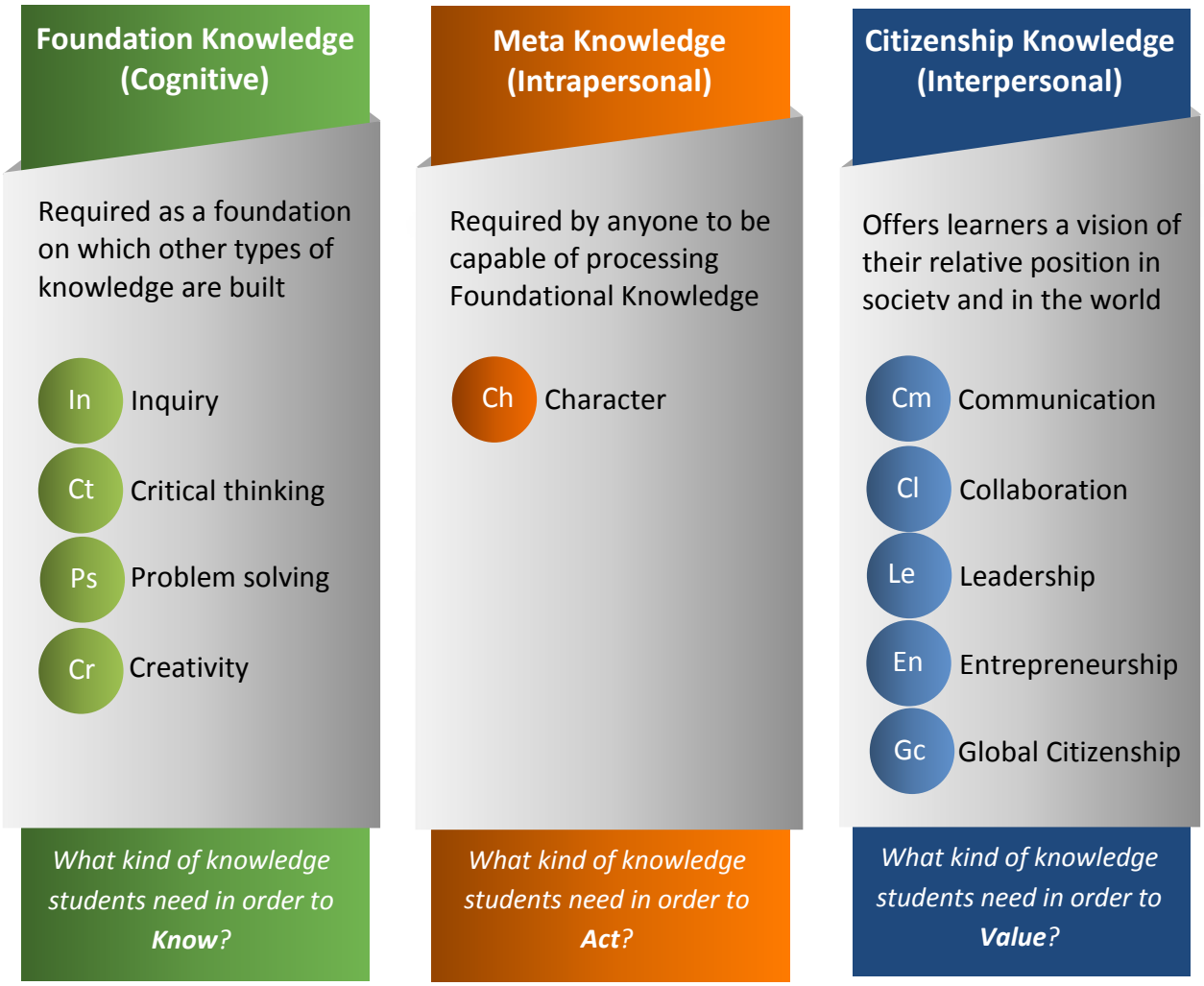
Figure 5: The Product of Deeper Learning Environments is Mastery of the Content and Transferable Knowledge which Leads to Action (OECD, 2016d, p.2 modified with permission)

Types of Global Competencies

We propose three domains of knowledge which contribute to their global learner character of our students: Foundational Knowledge (includes cognitive competencies), Meta Knowledge (includes intrapersonal competencies), and Citizenship, or Humanistic Knowledge (includes interpersonal competencies). The proposal is the result of our systematic analysis of frameworks in the past (Sinay, 2014) and it is inspired by the work of leading experts in the field, primarily by NRC (2012) and the work by others (Binkley et al., 2010; Kereluik et al., 2013; Saavedra & Opfer, 2012).

The three knowledge systems, and the corresponding 10 key global competencies, reflect the evolution of our understanding of the competencies required by our learners today. The competencies identified in our model are in alignment with current provincial policies (Council of Ontario Directors of Education, 2016; Dede & Frumin, 2016; OME, 2016) (see Figure 6).

Figure 6: The Three Domains of Knowledge and the Corresponding 10 Key Global Competencies which Contribute to the Global Learner Character of TDSB Students



Criteria for Defining Global Competencies at the TDSB

At the TDSB the definitions/descriptions of global competencies are based on the following criteria:

1. Drawing from cognitive psychology, we define ***competency* as a *thinking process*** which includes making observations, posing questions, examining and critically reviewing available information, proposing answers and making predictions (Gordon, 2001; Kuklthau, Maniotes & Caspari, 2007; NRC, 1996; OME, 2013; OME, 2016). It is enhanced by social interactions and includes the willingness to engage with such situations in order to achieve one's personal development.
2. In defining/describing global competencies, the cognitive-psychological approach was selected, over the educational and philosophical approaches. Lai (2011a), citing the work of others (Ennis, 1985; Sternberg, 1986), argues that although the strength of the educational approach to define competencies draws from "classroom experience and observations of student learning [and] it is limited in its vagueness … the concepts … lack the clarity necessary to guide instruction and assessment in a useful way" and the frameworks "have not been tested as vigorously as those developed within either philosophy or psychology" (pp. 8-9). Philosophical criteria in defining/describing global competencies were excluded too since they are based primarily on an *ideal type* of individual under *ideal conditions* and therefore, they are more distant from classroom experience and student observation.

   The **cognitive-psychological approach** appears to be the best way in defining/describing global competencies since they state clearly the real-world skills to be accomplished by learners and clearly define the actions or behaviors learners can do. To add to these advantages, cognitive psychologists have a range of valid and reliable assessment tools of both skills and behaviors, for example, cognitive tests, cognitive interviews, cognitive questionnaires/surveys (Institute of Education Sciences, 2016).

3. For all competencies defined in the present work, the "willingness" of the learner to engage with practices related to each specific global competency is considered mandatory. The "willingness" expresses the affective domain of the competency (attitudes and values) (see Figure 5). All major international educational frameworks include the affective domain of the competencies first documented in the OECD literature (OECD, 2013). For the reasons previously described, each of the 10 TDSB global competencies includes the general statement: "… *It includes the **willingness** to engage with such situations in order to achieve one's potential as a constructive and reflective citizen*…"(OECD, 2013, p. 23)

4. All definitions are written in an **action-driven** manner (e.g., product is learning).

Definitions of TDSB Global Competencies

Global competencies **are highly contextual** and the need to engage the stakeholders of our district is necessary to frame appropriate definitions for each competency. A creative person in Europe may be differently conceptualized in Japan or Canada. In the same way, leadership may take different forms in different countries. Therefore, implicit theories for each competency provided by stakeholders will present a valid basis from where to develop working definitions for each global competency. Based on these definitions, specific descriptors will emerge which can further be used for the construction of assessment tools. All definitions proposed here are working definitions based on literature review and they may need to be modified considering TDSB context.

Foundation Knowledge - Inquiry

In

A thinking process which includes making observations, posing questions, examining, and critically reviewing available information, proposing answers, and making predictions. It is enhanced by social interactions and includes the willingness to engage with such situations in order to achieve one's personal development and as a constructive and reflective citizen.

Inspired by Gordon, 2001; Kuklthau, Maniotes & Caspari, 2007; NRC, 1996; OME, 2013; OME, 2016

Foundation Knowledge - Critical thinking

Ct

A reflective, reasonable, and autonomous thinking process which uses those cognitive skills or strategies to increase the probability of a desirable outcome. It includes the willingness to engage with such situations in order to achieve one's personal development and as a constructive and reflective citizen.

Inspired by Halpern, 1998; Ennis, 1985; Ennis, 2012

Foundation Knowledge – Problem Solving

Ps

A cognitive process, a decision-making process under uncertainty, directed in achieving a goal when no solution method is obvious to the problem solver. It includes the willingness to engage with such situations in order to achieve one's personal development and as a constructive and reflective citizen.

Inspired by Mayer, 1992; OECD, 2013; OECD, 2014; OECD, 2017a

Foundation Knowledge – Creativity

Cr

A product or process that results from seeing and acting on new relationships in novel ways. Its effectiveness is moored with objective social and physical reality. It includes the willingness to engage with such situations in order to achieve one's personal development and as a constructive and reflective citizen.

Inspired by Anderson, 1992; Cachia & Ferrari, 2010; Cropley, 2001; Kneller, 1965; Gardner, 1989; Jackson & Mesick, 1965; Kampylis, 2010; Lubart & Sternberg, 1995; Runco & Jagger, 2012; Sinay & Graikinis, et al., 2017a; 2017b; Tardif & Sternberg, 1988

Meta Knowledge – Character

Ch

An intrapersonal process that results from building mental and moral capacity for autonomous control and metacognitive knowledge. It includes the willingness to engage with such process in order to achieve one's personal development and as a constructive and reflective citizen.

Inspired by NRC, 2012

Citizenship Knowledge – Communication

Cm

An interpretive process used to interact appropriately by sharing ideas, thoughts and opinions in oral, written, listening and digital ways in order to build shared understanding. It includes the willingness to engage with such process in order to achieve one's personal development and as a constructive and reflective citizen.

Inspired by NRC, 2011

Citizenship Knowledge – Collaboration

Cl

A communicative process which enables team participants to work effectively and respectfully together and where they assume shared responsibility for their work by making necessary compromises in order to accomplish a shared goal. It includes the willingness to engage with such process in order to achieve one's personal development and as a constructive and reflective citizen.

Inspired by Asia Society, 2013; Dillenbourg, 1999; Lai, 2011b; MOE, 2016; NRC, 2011; OECD, 2016; Trilling & Fadel, 2009

Citizenship Knowledge – Leadership

Le

A transformational process which emerges from the awareness and management of personal aspirations, strengths and gaps, building capacity, and practice of the ways of thinking and feelings when working with people in teams. It includes the willingness to engage with such processes in order to achieve one's personal development and as a constructive and reflective citizen.

Inspired by Goleman, Boyatzis & McKee, 2002

Citizenship Knowledge – Entrepreneurship

En

The process of acting upon opportunities and ideas and transform them into value for others. The value that is created can be financial, cultural, or social. It includes the willingness to engage with such process in order to achieve one's personal development and as a constructive and reflective citizen.

Inspired by FFE-YE, 2012

Citizenship Knowledge – Global Citizenship

Gc

The process of engaging and identifying in communities beyond own, to recognize, understand and respect different perspectives, take responsibility for actions and be motivated to create change. It includes the willingness to engage with such process in order to achieve one's personal development and as a constructive and reflective citizen.

Inspired by Banks, 2008; Oxfam, 2006; OME, 2016; Wang & Hoffman, 2016

Digital Fluency: Empowering Learners with Pervasive Digital Technologies to Produce Works of Significance

> *Today, participation in the digital culture depends on the ability to interact in virtual groups of friends and groups of interest, where young people are capable of using applications fluently and on a daily basis.* (Ananiadou & Claro, 2009, p. 10)

The acceleration and deepening of the learning and the cultivation of global competencies relies on the effective use of pervasive digital technologies. Evidence suggests that digital technologies act as an enabler to accelerate and deepen learning "to make learning quicker, clearer, faster, and better" (Fullan & Donnelly, 2013, p. 21). The "new pedagogies" defined by the same authors, include the renewed relationships between students and teachers and assume learning environments where there is immersion in digital technology-enabled teaching (Beggs, Shields, Telfer, & Bernard, 2016, p. 10).

Technology can re-define the learners, the educators, the resources and the content, all core ingredients of pedagogy in innovative learning environments. It acts as an enhancer and enabler of "student-driven learning, collaboration, personalization and flexibility" (OECD, 2017c, p. 46). Digital technology-enabled teaching and learning can augment the instructional strategies that promote deeper learning since they nourish the opportunities for student growth created in- and out-of-classroom for critical thinking, collaboration, creativity, communication, and autonomous learning. Digital technologies are used in the service of deeper learning environments and they are effective learning catalysts "only when used to enable learning with richer content, more powerful pedagogy, more valid assessments, and links between in- and out-of-classroom learning" (Dede & Frumin, 2016, p. 10).

The digitally rich learning environments allow for deeper exploration of assigned materials. Digital tools allow for searching and utilization of information at any time, thus providing flexibility for autonomous learning.

In the newly proposed *Unleashed Learning: A Vision for Learning in TDSB* framework (Malloy, 2016), digital fluency is considered a fundamental 21st century educational outcome of deeper learning environments and enjoys similar status to that of *numeracy* and *literacy.* It empowers learners and teachers to be engaged and produce works of significance by using appropriate digital tools. In addition, digital fluency in deeper learning environments acts as an effective learning catalyst; it provides the means by which the two other traditional core elements, numeracy and literacy, can flourish.

Evolution of Terminology in Technology-Enabled Learning: From Digital Literacy to Competency to Fluency

In the past, terms which were used to describe digital technology use in learning environments, proved to be inadequate in addressing properly the needs of learners and teachers. Miller and Bartlett (2012) state that there is "a profusion of different terms – digital literacy, media literacy, cyber literacy, visual literacy, information technology fluency – [all of which] have emerged that reflect these different approaches to the problem of literacy online" (p. 38). Other related terms include digital competencies, digital skills, digital literacy, eLiteracy, eCompetence, eSkills, ICT literacy, technology literacy, new literacies, media literacy information literacy or multimodality (Ala-Mutka, 2011; Ferrari 2013).

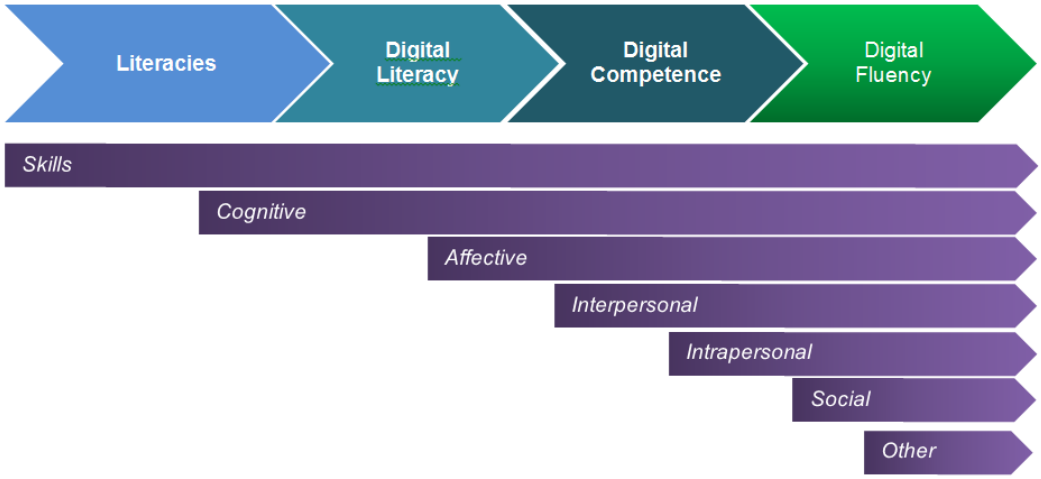
At the TDSB we recognize that the indistinct use of the terms and the ambiguity which surrounds them can result in misunderstandings that can lead to poor communication among practitioners, academicians, and theorists (Eshet-Alkalai, 2004). It was found, that the concept of Digital Fluency provides the most appropriate scaffold for a) the development of the learners' expertise with digital technologies in order to produce works of significance for personal, professional, and social reasons; and b) the development of digital competencies necessary for mastering the digital world and move from mere "skillful" consumers of digital technologies to creative, meaningful, and purposeful use of these technologies in order to reach their goals and to become lifelong learners.

Our analysis of previously used terms to describe the digital needs of learners indicated a number of reasons pointing to the emergence of Digital Fluency as a concept (TDSB Research Team, unpublished manuscript, 2017). Based on this analysis Digital Fluency:

- is wider in scope than previously used terms;
- more dynamic in nature than other static terms;
- more adaptable and sustainable to evolving technological advances;
- integrates clearer the critical, evaluative, and reflective components of the learners which are required for their effective engagement with the digital technologies;
- stays away from strong inferences such as "employability", "ability", "expert skills", "certification schemes", or "performance management";
- avoids language barriers;
- clearly emerges as process-based and reveals a way of thinking about technologies and their relationships to individual and social practices; and
- lacks binary interpretation (i.e., unable to use the binary forms "fluent" or "disfluent") but reveals itself as a continuum of digital literacy (Beetham, McGill, & Littlejohn, 2009; Belshaw, 2011; Demir et al., 2015; Erstad, 2007; 2010; ELINET, 2016; Hall, 2014; NRC, 1999; Martin, 2008; OECD, 2005).

In our analysis we argue that the new digital "literacies" were developed and evolved from pre-digital contexts (e.g., print "literacy") in response to the emergence of digital technologies. They, in turn, gave rise to Digital Literacy which, as a concept, integrated four of the most dominant at the time New Literacies: media, Internet, ICT, and information literacies. Over time, Digital Competency was viewed as more integrative than Digital Literacy. Based on the analysis previously summarized, Digital Fluency is considered more appropriate than its predecessors and overall embodies a range of skills and the cognitive, affective, interpersonal, intrapersonal, and social needs of it users (see Figure 7)

Figure 7: From literacy, to competency, to fluency. Continuum of the evolution of terms used in the past leading to digital fluency and the corresponding attributes associated with each term.



Digital Fluency at the Toronto District School Board

At the TDSB we define Digital Fluency from a developmental perspective as a dynamic, graduated and evolving process of lifelong learning in which the learners engaged meaningfully with digital technologies.

> ***Digital Fluency*** *is a dynamic, evolving, and graduated aptitude which empowers the users of digital technologies to reach high levels of digital expertise and produce works of significance by exploring, accessing, organizing, interpreting, evaluating, realizing and creating digital information and ideas in order to enhance learning in other domains and participate successfully in society.*

Learners accomplish this by mastering a range of digital competencies: cognitively engaging in the digital world; ethically, safely, and critically searching, interpreting and using information; collaborating and communicating effectively ideas; confidently reformulating

knowledge; and creatively expressing and constructing meaningful information which promotes civic action (TDSB Research Team, 2017, Unpublished Research Report). [2]

Digital Fluency is a Fundamental Educational Outcome

In the newly proposed *A Vision for Learning in TDSB, Digital Fluency* is considered a fundamental 21st century learner outcome of deep learning environments and enjoys **similar status to *Numeracy* and *Literacy*** (see Figure 1). Digital Fluency provides the means by which numeracy and literacy can flourish. Educational systems in other countries rank digital fluency within the curriculum at the same level as numeracy and literacy (Norwegian Ministry of Education and Research, 2006; Welsh Government, 2015; 2016).

Description of Digital Fluency

Being digitally fluent is similar to fluency in another language (Resnick, 2001); for example, someone who uses another language with native-like efficiency does not include only standardized expressions, but involves complex articulation of words and ideas, remixes accepted knowledge, and by "making up things" with existing words. All these are expressed effortlessly, with elegance and automaticity. "We acquire language and become increasingly proficient over time and eventually reach a level of fluency" (JISC, n.d., para. 2).

To produce works of significance, digital fluency requires the user to have a deeper proficiency with digital technology, which goes beyond functional IT skill acquisition and competency, involves the cognitive and affective domains, and requires the learner to use digital tools creatively. "Fluency with new technologies involves not only knowing how to use technological tools, but also knowing how to **construct things of significance** with those tools" (Papert & Resnick, 1995, as cited in Resnick, n.d., p. 2). In this way, digital fluency accommodates the higher-level, metacognitive, and reflective elements of those participants engaged with digital environments.

Digital fluency also incorporates socio-emotional components. Gee, Hull, and Lankshear (1996) argued that the acquisition of fluency is part of the "social practice" that users of digital tools develop **"native-like" expertise** in the presence of specific beliefs and values they hold about digital technology and in the presence of discussion and social interaction about the opportunities the digital tools offer.

[2] Inspired by Papert, S., & Resnick, M. (1993); UNESCO (2016).

Three Stages to Digital Fluency

a. **Access and Awareness**: When technological infrastructure is available to the users and barrier-free access to digital technologies is offered, learners will gradually advance their expertise and acquire higher levels of digital proficiency during their engagement with digital technology.

b. **Situated Practices and Participation**: The gradual development of the skills will allow learners to apply the new knowledge about digital tools to improve their learning and to increase in confidence and expertise. The increase in complexity of skills required for progress through this stage allows learners to apply skills within a variety of different contexts by participating in different digital environments. As they progress to this level, learners improve their academic and ICT competencies, apply them in their own learning, and use them in personal and social contexts.

c. **Identity**: As learners move progressively to the top of the pyramid, they become increasingly confident and independent in selecting and using tools and produce works of significance contributing in this way to their identity development. Engagement, intentionality, self-awareness, connectedness, confidence and adaptability, will be part of the *identity* stage (*I am*) of the learners (Sharpe, 2014b) when they reach the highest level of digital fluency. For Sharpe (2014a), identity equals the "need to consider the digital self and one's online presence" (p. 125). For Mehta and Fine (2015), identity is one of the three elements responsible for the emergence of deeper learning and relates to intrinsic motivation. At the identity stage, the learners create their own learning environment and actively participate in communities of knowledge.

Structure: The Essential Competencies of Digital Fluency

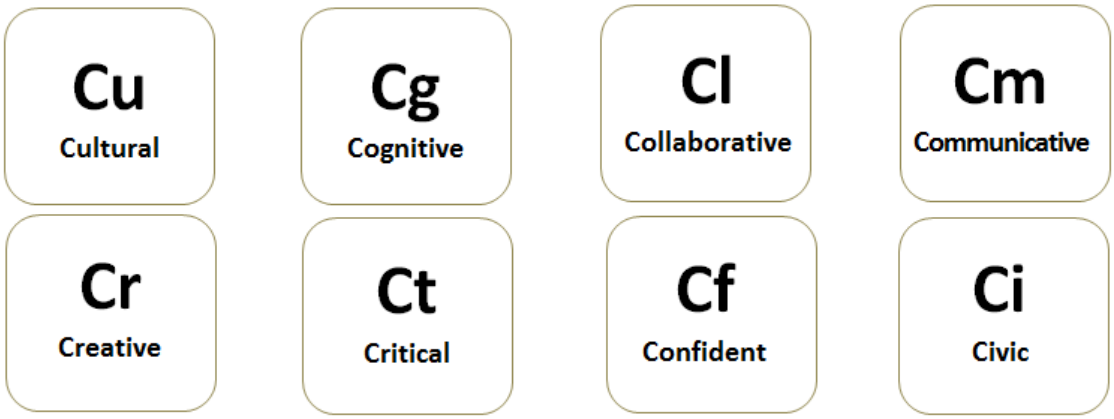
Being fluent requires competencies. Individual digital competencies form the ingredients of digital fluency. We propose a matrix of eight essential digital competencies which are flexible, evolving, and mutually reinforcing. The Digital Fluency Model integrates all essential digital competencies into an effective conceptualization of the needs of learners in the digital era. It is important to emphasize that digital competencies described in our model need to be contextualized and our model of digital fluency may not be

> appropriate for all people or, indeed, for one person over all their lifetime. Updating of understanding and competency will be necessary as individual circumstances change, and as changes in the digital information environment bring the need for new fresh understanding and new competencies; as Martin (2006a) puts it, digital literacy is 'a condition, not a threshold'. (Bawden, 2008, p. 28)

Belshaw (2011) argues that digital literacies are transient, that is, "they change over time, may involve using different tools or developing different habits of mind, and almost always depend upon the context in which an individual finds herself" (p. 204). The elemental components that define digital literacies need to be broadly defined to allow contextualization, and negotiation within organizations and institutions. At the same time, they need to be detailed enough and measurable in order to be practical in the classroom. Belshaw's research literature review and analysis of different digital literacy frameworks spearheaded the proposal of eight essential elements of digital literacies and Belshow's (2011) eight essential components of digital literacies form the eight essential digital competencies required by the learners in our Digital Fluency Model.

Based on Belshaw's (2011) work, and on the belief that digital attributes require context to be learned, we propose that digital fluency can be developed by building on eight essential digital competencies (see Figure 8).

Figure 8: The eight essential digital competencies (8Cs): Cultural, Cognitive, Collaborative, Communicative, Confident, Creative, Critical, and Civic (note that the Constructive element in Belshaw's (2011) proposal has been replaced with the Collaborative digital competency)



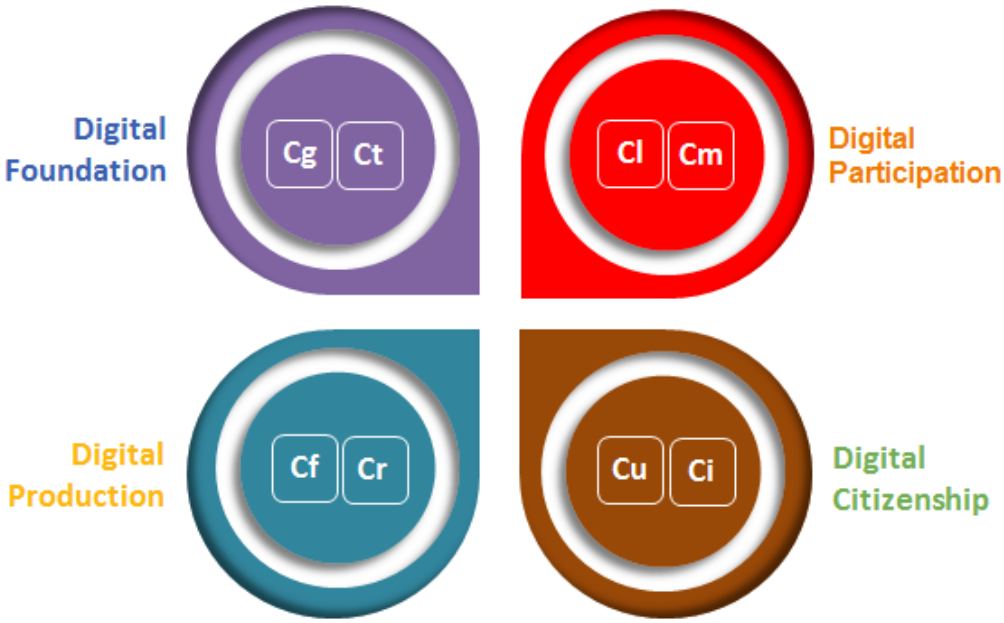
As Belshaw (2011) initially proposed for the essential elements of digital literacies, in our Digital Fluency Model all eight essential digital competencies are deeply interconnected. They are considered equally important, although some may dominate over the others in certain contexts. The collaborative and communicative digital competencies are highly symbiotic with other competencies. The significance of each competency emerges once a dialogue around contextualizing each of the essential digital competencies has started within the TDSB. The definitions and descriptions of each digital competency are not to be considered permanent but "provisional, revisable and temporary" (Belshaw, 2015, p. 56). Therefore, at the TDSB we expect to revise the existing and future definitions and descriptors of these eight essential

competencies of digital fluency, since digital fluency by itself is transient and changes over time as well.

Although there is a need to define digital competencies in such a way as to be operational in practice, the definitions for the eight essential digital competencies proposed for our model were prepared by keeping in mind that these can change in time and adapted to specific situations under different context. Belshow (2011) argues that "whilst this does not allow for effective soundbites and fails the test of fitting nicely upon one PowerPoint slide it is, nevertheless, an ultimately more accurate and responsive approach" (p. 167).

In our Digital Fluency model, the essential digital competencies are organized into four strands as depicted in Figure 9.

Figure 9: The Four Strands of the Digital Fluency Model.
Each Strand Includes Two of the Eight Essential Digital Competencies



Strands: Further Information

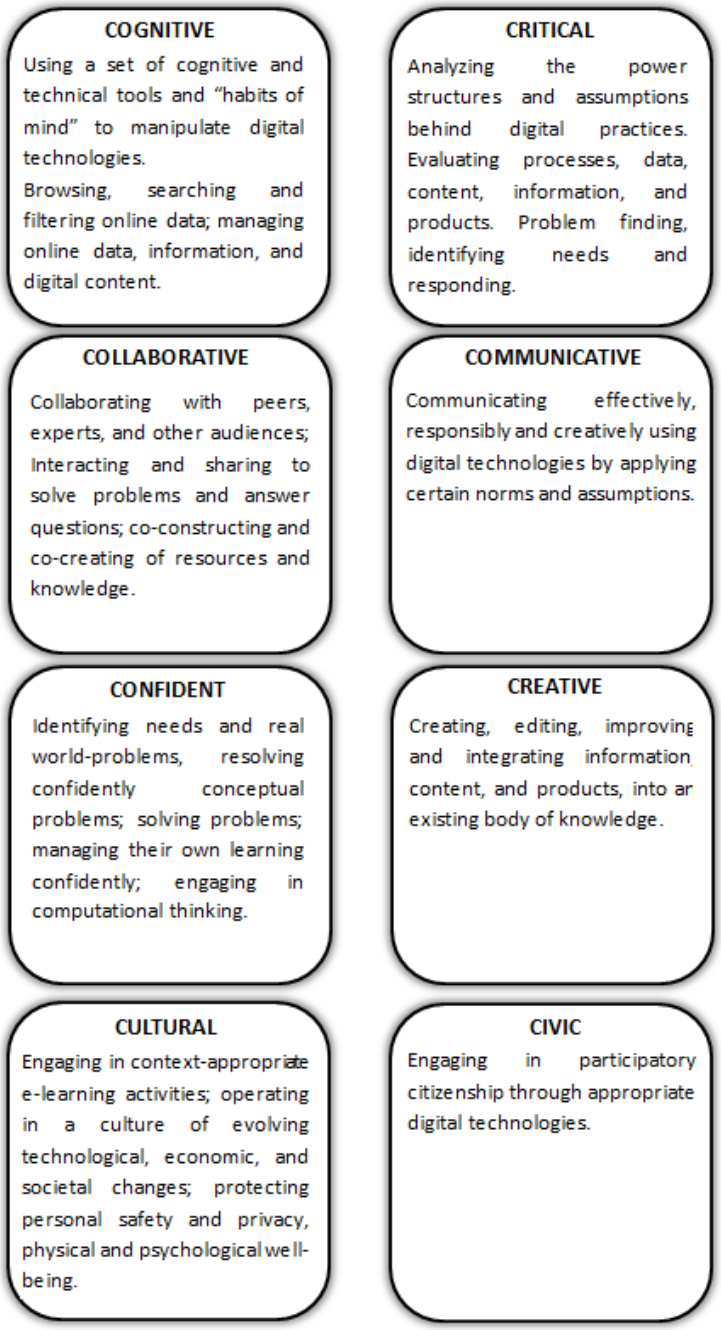
Digital Foundation	
Cognitive	**Critical**
Learners master the use of digital tools, software, platforms, and networks and empower themselves with new sets of "cognitive tools" to create works of significance. By doing so, they expand their knowledge by promoting certain "habits of mind" coordinated with the digital world. By using cognitive skills (involving logical, intuitive, and creative thinking), they are able to articulate information needs, browse, evaluate, store, manage, and retrieve data and information.	Learners use critically and responsibly digital technologies and systems. They evaluate the validity, reliability, usefulness, accuracy and trustworthiness of information encountered and select appropriate sources. Overall, learners are able to "make informed judgements about what [they] find on-line … forming a balanced assessment by distinguishing between content and its presentation" (Gilster, 1997, p. 2). Therefore, learners use the higher level cognitive skills to critically assess and consume digital information found online.

Digital Participation	
Collaboration	**Communication**
An enabler of openness associated with engagement and innovation. Learners successfully collaborate to co-construct and co-create content, ideas, information, and products related to their corresponding grade level using a variety of digital environments and media. Blogs, wikis, chats, skype, hangouts, social media, learning platforms, Google Docs, Evernotes, Workflow, are some examples which provide the grounds for digital interaction. Co-authoring, co-constructing technology enhanced models, joining an authentic and student-centered project, following leaders, emailing, commenting on ideas, asking, sharing, discussing, co-creating, joining, or organizing online activities are some approaches encouraging digital collaboration.	Learners access, understand, and create formal and informal digital communications effective for a given situation or for different contexts. Creative communicators exchange information and ideas effectively and responsibly using a variety of digital tools, media, and formats. Communicating and collaborating effectively are two of the core digital competencies in digital environments. They allow students to interact and reflect on their knowledge and attitudes under different contexts and situations to solve real-world problems, answer questions, and produce meaningful outcomes targeted in the curriculum.

Digital Production	
Confident	**Creative**
Problem-solving is a transversal and generic skill which requires specific competencies: effective communication, collaboration, and skills to manage complexity. It involves the effective use of data, planning and prioritizing, experimenting, troubleshooting, and managing for results. Learners solve real-world problems using computer applications and supported by computational thinking (logic and fundamental knowledge of how computers "think"). They are familiar with terminology and processes of digital technologies. Learners anticipate and manage complexity with confidence.	Learners create, either individually or collaboratively, new content, ideas, information and products by modeling, remixing, repurposing, adapting, modifying, and refining existing ones using digital media across contexts. Synthetic thinking leads learners in creatively recycling and creating new combinations form existing ideas, information or materials. Creativity emerges at the intersection of digital information consumption and production. Since learners consume but at the same time are encouraged to produce information, they are forced to become more digitally creative. Learners create a set of instructions that computers can understand (coding).

Digital Citizenship	
Cultural	**Civic**
Cultural mandates the use of technology to be adapted to local, personal, or social environments. It requires the use and awareness of digital technology specifically adapted to various contexts. Cultural aspects of digital technology continuously evolve. Learners are aware of personal safety and privacy issues in online environments. They operate within an E-safe learning environment protecting personal safety and privacy, health and well-being.	Develops and helps the acquisition of the concepts of democracy and global citizenship as individuals become participants in society. Being aware of digital technologies for social well-being and social inclusion. Self-organizing in online networks for promoting participatory citizenship.

The definition of each digital competency is included in the following figure[3]:



[3] The definitions of digital competencies were inspired by: Ala-Mutka (2011); Belshaw (2015); British Columbia Digital (n.d.); Digital Collaboration. (2013); Engauge (2003); European Union (2017); Ferrari (2012); Hall, Atkins & Fraser (2014); JISC (n.d.); International Society for Technology in Education (2016); Leicester City Council (2013); Martin & Grudziecki (2007); OECD (2001); Ravitz (2014); Welsh Government (2016); White (2013).

Developmental Nature of Digital Fluency

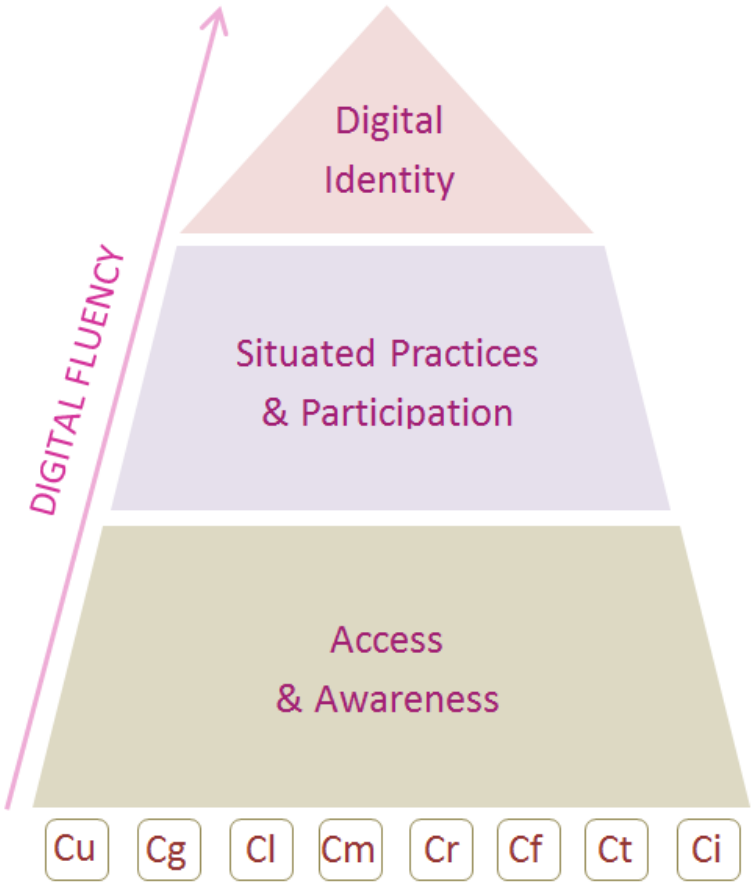
As learners are immersed in deeper learning environments, they are provided with access to pervasive digital technologies, services, resources, and spaces. Taking advantage of this learning environment and in the presence of new pedagogies, learners evolve their competencies associated with digital technologies. In essence, they improve subject-specific knowledge, skills, and behavioral approaches associated with digital technologies in a collaborative and social context.

Digital Fluency is a construct based on developmental processes. It is conceptualized as an evolving aptitude of learning with technologies, which progresses as learners and teachers engage in digital environments. It is graduated in the sense that it requires from the user an increasingly more sophisticated level of engagement with digital tools. It is also dynamic, because the technology continuously evolves and the learner is engaged with it in a lifelong learning process. In addition, it "should not be regarded as an end state that is independent of a domain, but rather as something that develops over a lifetime in particular domains of interest and that has a different character and tone depending on which domains are involved" (NRC, 1999, p. 3).

Digital Fluency is represented by different levels of sophistication. In our model the learners are expected to continuously improve their digital competencies. Gains in digital competencies are expected as the learner moves from the base of the pyramid to higher levels of digital fluency towards the tip of the pyramid (see Figure 10). The model is inspired by the developmental process described by Beetham and Sharpe (2011) for their four-stage development of digital literacy framework, by the four stage developmental process described by Rees and Loughlin (2015) for their digital literacy framework, and by three stage conceptual model of digital literacy by Martin and Grudziecki (2006).

The developmental nature of digital fluency can be compared with the three models aforementioned, however, digital fluency differs from them in considerable ways, most importantly by the way which the development of competencies (and not skills), are considered within the digital fluency pyramid. By placing the essential digital competencies at the bottom of the digital fluency pyramid, we project a developmental process of these competencies from Awareness and Access, to Participation and Practice, to Fluency. We also consider important differences between the models, the distinction between digital competencies, and digital skills (for definitions see Appendix A). Digital fluency, as digital literacy, **can't be certified** since it is a personal attribute and it has to be built on the personal profile of the learner (Martin & Grudziecki, 2006).

Figure 10: Digital fluency as a pyramid depicting the developmental nature of the aptitude. At the base of the pyramid there are eight essential digital competencies all of which contribute to the development of digital fluency (TDSB Research Team 2017, Unpublished Research Report).



The development of digital competencies involves meta-cognitive processes during which the students learn how to apply technology, cultivate the skills necessary for manipulating digital tools, and maintain positive attitudes and values toward digital environments. The flexible matrix emerging from our model allows each of the eight essential digital competencies to be developed within each developmental stage of digital fluency.

Essential Digital Competency	Developmental Stage of Digital Fluency		
	Awareness and Access	Situated Practice and Participation	Identity
Cognitive	↑	↑	↑
Critical	↑	↑	↑
Collaborative	↑	↑	↑
Communicative	↑	↑	↑
Confident	↑	↑	↑
Creative	↑	↑	↑
Cultural	↑	↑	↑
Civic	↑	↑	↑

The Digital Fluency Pyramid Model integrates the eight essential digital competencies (8Cs) into an effective conceptualization of the needs of learners in the digital era. By having the digital competencies distributed at the base of the pyramid, the attention is focused around the centrally-organized concept of the developmental nature of digital fluency.

The Model is open and flexible to accommodate essential competencies which are considered important in different digital environments and are affected by social cultures and pressures. The continuous development of new digital tools and the changes in how we do and what we do with them, affects the essential digital competencies identified during a particular period of time. Some essential competencies will be more resistant to endure the changing nature of technology, whereas others will be more volatile to resist these changes. As time advances, new essential competencies can emerge which can be assimilated in the Digital Fluency Pyramid Model and contribute to the digital fluency of the learners.

Mastering the digital competencies, that is, possessing the “thinking processes” which include making observations, posing questions, examining, and critically reviewing available information, proposing answers, and making predictions, is required for effective catalysis of the opportunities for student growth leading to gains in global competencies. The deeper the learners engage meaningfully with digital technologies, the higher the level of sophistication of their digital fluency.

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APPENDIX A

Definitions Used in the Framework

Definitions of basic terms used in the Global Competencies in Deeper Learning Environments, Enabled by Pervasive Digital Technologies Framework

Term	Definition	Source
Deeper Learning	Deeper learning is **complex, intricate and multifaceted** instructional approach aligned to the three core foundations of learning: meaningful engagement; organization of factual knowledge; and use of metacognitive practices.	Bransford (2000); Dede & Frumin (2016); Donovan & Bransford (2005)
Knowledge	The outcome of the assimilation of information through learning. The body of facts, principles, theories and practices that is related to a field of work or study.	Ferrari (2013, p. 37)
Skills	The ability to apply knowledge and use know-how to complete tasks and solve problems. Skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).	Ferrari (2013); CEDEFOP, (2014).
Attitudes	Motivators of performance, the basis for continued competent performance. They include values, aspirations and priorities.	Ala-Mutka (2011, p. 18)
Competency	A "thinking process" which includes making observations, posing questions, examining and critically reviewing available information, proposing answers and making predictions. It is enhanced by social interactions and includes the willingness to engage with such situations in order to achieve one's personal development and as a constructive and reflective citizen.	TDSB Research Team; Inspired from Gordon, 2001; Kuklthau, Maniotes & Caspari, 2007; NRC, 1996; OME, 2013; OME, 2016.
New Pedagogies	A new model of learning partnerships between and among students and teachers, aiming toward deep learning goals and enabled by pervasive digital access	Fullan & Donnelly (2013, p. 11)
Pedagogical Competency	The theoretical knowledge, teaching skills, attitudes and values applied by the teacher to promote quality of teaching and student learning	TDSB Research Team. Inspired by Apelgren & Giertz (2010)
Global Learners	Learners which are literate, connected, interconnected and interdependent. They care, are self-regulated and know their impact; they identify and solve problems using imagination, creativity, and innovation to promote a civic, democratic society.	Sinay (2014, p. 21)
Global Competencies	Transferable knowledge accompanied by skills and favorable behavioral changes (attitudes and values) which are closely intertwined in support for action. It includes the willingness to engage with context situations in order to achieve one's potential as a constructive and reflective citizen.	TDSB Research Team. Inspired by OECD (2013); OECD (2016d).
Social Inclusion	"The process of improving the terms on which individuals and groups take part in society"	The World Bank (2017)

Well-being	State of complete physical, social and mental health which enables the individual to contribute to her or his community.	TDSB Research Team. Inspired by EU (2017), World Health Organization (2014)
Digital Fluency	**Digital Fluency** is a dynamic, evolving, and graduated aptitude which empowers the users of digital technologies to reach high levels of digital expertise and produce works of significance by exploring, accessing, organizing, interpreting, evaluating, realizing and creating digital information and ideas in order to enhance learning in other domains and participate successfully in society. Users accomplish this by mastering a range of digital competencies: cognitively engaging in the digital world; ethically, safely, and critically searching, interpreting and using information; collaborating and communicating effectively ideas; confidently reformulating knowledge; and creatively expressing and constructing meaningful information which promotes civic action.	TDSB Research Team. Inspired by Papert & Resnick (1993); UNESCO (2016)
Digital Technology	"Any product that can be used to create, view, distribute, modify, store, retrieve, transmit and receive information electronically in a digital form"	European Union (2017, n.p.)
Digital Competencies	Digital competencies include a spectrum of knowledge, skills and attitudes related to learning collaboratively in digital environments and contributing to the digital fluency of the learners.	TDSB Research Team.
Digital Environment	"A context, or a "place", that is enabled by digital technology and digital devices, often transmitted over the internet, or other digital means, e.g., mobile phone network".	European Union (2017, n.p.)