Conceptual/Research Synthesis for Ontario's Technology and Learning Fund Report

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Executive Summary

Ontario's evolving, multi-phased 21st Century Teaching and Learning Strategy builds upon strong, positive and collaborative relations between the Ministry of Education and education sector leaders. In a recent report (Schleicher, 2012), the OECD noted that contributing factors to success in Ontario's approach to large scale education improvement include clear recognition that reform is a two-way street, rather than simply something imposed from the top. The OECD also praised Ontario's focus at the school level, where change has to happen, premised on a sense of shared understanding and common purpose at every level of the system, and founded on respectful relations and government confidence in the quality of its teaching force. Ontario's wider approach to system reform has also paid special attention to leadership development, especially for school principals and vice-principals. Ontario's theory of action recognizes a need to both balance and blend knowledge from professional practice and research. The approach includes supports for capacity building and knowledge mobilization, as a means for supporting teachers and school and system leaders in shifting their practices to integrate promising innovations that make a demonstrable difference for student engagement, learning, achievement, and success.

This research synthesis describes illustrative conceptual frameworks and scholarly findings that support how Ontario is accomplishing these important educational improvements.

Ontario's emphasis on effective teaching practices builds on the U.S. National Research Council's (NRC) landmark reports, *How People Learn* (2000), and *How Students Learn* (2005). More recently, the NRC (2012) formulated "deeper learning" as an instructional approach to convey 21st century knowledge and global competencies. Deeper learning is a 21st century instructional approach that equips students with the necessary skills for success in social, economic, and civic life. "Rooted in a profound respect for who students are and what they can do" (Mehta & Fine, 2012, p.33), deeper learning empowers students to create knowledge through content mastery, open-ended, authentic problem-solving, and reflective practice, supported by teachers serving as facilitators, guides, and coaches. Deeper learning is not centered on the teacher, isolated within the confines of a classroom, or a finite process of regurgitating facts. Deeper learning strives to integrate what is known about how people (and experts) learn and what is required for successful participation in contemporary society. Conceptual frameworks, theoretical foundations, empirical research findings, and implementation strategies, and evaluation methods from deeper learning pervade and parallel Ontario's ongoing educational initiatives.

"Effective teaching" provides another set of principles to guide educational improvement. The OECD has delineated core principles for this type of instruction, which have been validated by research spanning many countries. In particular, the recently released *Handbook of Research on Teaching*, *5th Edition* (2016) describes effective uses for technology in teaching global competencies. Ontario's initiatives draw on these important frameworks and research insights.

In the Ontario initiative, Steven Katz has been influential in providing research insights about networked learning communities for educators (Katz, Earl, & Ben Jafaar, 2009) and about leading schools in a data-rich world (Earl & Katz, 2006). Garfield Gini-Newman has contributed evidence-based strategies for critical thinking and question framing, as well as linking formative and summative assessment (Gini-Newman, 2008). Barrie Bennett has provided aid on teacher thinking, learning, and instructional practices (Bennett, 2009).

Assessing student outcomes is another crucial factor in educational improvement. For global competencies, measuring motivation is as important as assessing learning. Ontario's strategies are based on the latest theoretical frameworks, measurement instruments, and research findings in this area, placing it among the leaders in the international community. As with instruction, the Deeper Learning initiatives provide useful approaches and insights for actualizing these types of assessments, and Ontario is applying these ideas as well.

System reform/transformation at scale is important in Ontario's province-wide initiatives. In the past few years, new approaches to this challenge have arisen, including DBIR, North Carolina's Digital Learning Plan, and frameworks for scaling up educational innovations. For example, the North Carolina Digital Learning Plan (NCDLP) is a well-documented and proven model for digitally based educational improvement across a large geographic region. The goal of the NCDLP is to build on North Carolina's current initiatives in digitally based educational improvement to develop a coherent long-term strategy that sets directions and priorities, supports innovation, and provides resources (Friday Institute, 2015). The Plan provides specific recommendations for state-level actions that will guide and support K12 schools in their transitions to digital-age education. It offers one evidence-based model of innovation scaling that may help to inform other jurisdictions' efforts. Overall, Ontario is building on leading-edge frameworks and strategies for systemic innovation using digitally enabled educational improvements. In turn, the Ontario model is emerging as a valuable resource for other regions seeking to accomplish educational transformation at scale.

Leadership strategies require coordinating improvement efforts at many levels, from classrooms to schools to entire boards and regions. At the district level, Ontario school boards are garnering national and international attention and recognition for exemplary practices that contribute to the learning of their peers in other jurisdictions about educational innovation scaling for the 21st century. As a province, Ontario has a well-established leadership strategy and leadership framework, in recognition of the importance of active and learning-centered leadership as second only to classroom teaching in its influence on student achievement and wellbeing.

The district and provincial approaches build on current, leading-edge conceptual frameworks and research findings about leadership for technology-based educational transformation. The work of Michael Fullan and British educator Andy Hargreaves is influential in this work. In 1998, Hargreaves and Fullan co-authored *What's Worth Fighting for Out There?* The central theme of this book was that teacher quality and morale were fundamental to pupil learning and well-being, and strategies for empowering teachers were put forth. A prior volume by Fullan (1997) focused on similar strategies for principals and school leaders. Hargreaves and Fullan subsequently co-authored *Professional Capital: Transforming Every School* (2012) and have served as advisors to Ontario's executive leadership team, Minister, and Premier.

Another advisor who has played a key role in Ontario's school leadership initiatives is Carol Campbell, who has advanced research- and evidence-informed decision making across the ministry and within the sector. She has studied the Teacher Learning and Leadership Program (Campbell, 2013), as well as documenting successful and sustainable practices for raising student achievement in literacy and numeracy (2007).

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Overview of the Ontario Teaching and Learning Strategy

Ontario's evolving, multi-phased 21st Century Teaching and Learning Strategy builds upon strong, positive and collaborative relations between the Ministry of Education and education sector leaders. Through prior provincial leadership and commitments to online learning, since 2006 a provincial e-learning Ontario strategy (now called Technology Enabled Learning Ontario – TELO) has provided established, equitable access to digital learning resources and virtual learning environments. TELO makes available more than 110 online courses for credit, and recently is fostering blended learning, supported by ministry-funded Technology Enabled Learning and Teaching Contacts (TELT Contacts) in English school boards and their counterpart PREAVs in French boards.

For more than a decade, these technology initiatives have been situated within a sustained approach to large scale improvement. Ontario's strengths as a system on the move for continuous improvements in student achievement have been acknowledged by external groups, including the OECD. In a recent report (Schleicher, 2012), OECD noted that contributing factors to success in Ontario's approach to large scale education improvement include clear recognition that reform is a two-way street, rather than simply something imposed from the top. The OECD also praised Ontario's focus at the school level, where change has to happen, premised on a sense of shared understanding and common purpose at every level of the system, and founded on respectful relations and government confidence in the quality of its teaching force. Ontario's wider approach to system reform has also paid special attention to leadership development, especially for school principals and vice-principals, as discussed later in the Leadership section of this report.

Provincial resources and guidance processes, including Board Improvement for Student Achievement and the School Effectiveness Framework, provide and promote research- and evidence-informed decision making for continuous improvement. Further, Ontario's approach has given prominence to the importance of student voice and choice in a number of ways, including the establishment of formal structures such as the Minister's Student Advisory Council (MSAC) as well as vehicles for supporting students' active role as researchers (Students as Researchers projects) and change agents (Speak Up projects). More recently, Ontario's Policy and Program Memorandum No. 159, issued in May, 2016, clarifies a shared commitment of stakeholders to building a culture of collaborative professionalism in Ontario's education system. The core priorities of this commitment include transforming culture and optimizing conditions for learning, working and leading at all levels of the education sector in alignment with Achieving Excellence. All these combined create a larger context centered on collaboration, shared vision, and commitment to student success.

In 2010, in response to requests by education leaders (including directors of education, supervisory officials and principals' groups) for further ministry leadership on digital age learning, the ministry initiated the current 21st Century Teaching and Learning Strategy (initially called the Teaching and Learning in a Digital World initiative). Based on the sector's engagement and high interest by all school districts to be involved in learning forward together as a system, and supported by access to increased provincial funding support, from 2013-14 onward all boards, four school authorities, and the provincial schools have been supported through an allocation model funded by the ministry and administered by the Council of Ontario Directors of Education (CODE) on behalf of the ministry.

The collaborative 21st Century Innovation Research projects are a key component of the 21st Century Teaching and Learning Strategy. The locally-determined innovation projects draw from, and are contributing to, international research evidence and discourse about the impact of technology-enabled and -enhanced innovations in teaching and learning practices for deeper learning and development of 21st century / global competencies.

Ontario's theory of action recognizes a need to both balance and blend knowledge from professional practice and research. The approach includes supports for capacity building and knowledge mobilization, as a means for supporting teachers and school and system leaders in shifting their practices to integrate promising innovations that make a demonstrable difference for student engagement, learning, achievement, and success.

In 2014, after extensive public consultation, the ministry released Ontario's renewed vision and action plan for education, Achieving Excellence. To advance the renewed vision for modernizing and transforming education for deeper learning practices and developing 21st century / global competencies, enabled by technology, the government announced a new $150M Technology and Learning Fund over three years. The TLF builds upon and integrates the earlier phases on 21st Innovation Research, and also provides school boards with enhanced supports for digital technology acquisition (e.g., tablets, cameras, 3-D printers, software) and related professional learning for educators.

The 21st Century Innovation projects have grown from initially involving 46 of 72 school districts, 646 schools and 39,000 students in Round 1 (2011-12) to full-system engagement in 2015-16 involving all 72 school districts, four school authorities, provincial schools, over 2300 schools (out of a total of approx. 5000 schools provincially), over 15,000 educators and more than 265,000 students.

Next steps in the multi-year, multi-faceted, evolving 21st Century Teaching and Learning Strategy include continued knowledge mobilization around effective innovation scaling practices, further TLF investments in keeping with Achieving Excellence's focus on supporting "innovative teaching practices and instructional methods enabled by technology to more precisely engage and address the learning needs of all students," and further progress on 21st century / global competencies to inform curriculum reform. All these steps are in keeping with the commitment in Achieving Excellence to "define and develop measures for higher-order skills, such as critical thinking, communication, collaboration and entrepreneurship," and similar recommendations more recently by the Premier's Highly Skilled Workforce Expert Panel to define an Ontario framework for skills and competencies.

This research synthesis describes illustrative conceptual frameworks and scholarly findings that support how Ontario is accomplishing these important educational improvements.

Effective Teaching Practices

Our perspective on learning is shaped by the landmark reports from the U.S. National Research Council, *How People Learn* (Bransford et al., 2000) and *How Students Learn* (Donovan & Bransford, 2005). These reports provided an overview and summation of the most durable findings from multidisciplinary research on learning, presenting a convergent view with a corresponding practical translation into guidance for research and practice.

The *How Students Learn* report articulates three core learning principles, universal in their applicability across academic subjects:

- Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom.
- To develop competence in an area of inquiry, students must (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application.
- A "metacognitive" approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them. (Donovan & Bransford, 2005, pp. 1-2)

The descriptions below of theoretical and empirical findings about learning and teaching draw on these ideas.

Deeper Learning

Deeper learning is a 21st century instructional approach that equips students with the necessary skills for success in social, economic, and civic life. "Rooted in a profound respect for who students are and what they can do" (Mehta & Fine, 2012, p.33), deeper learning empowers students to create knowledge through content mastery, open-ended, authentic problem-solving, and reflective practice, supported by teachers serving as facilitators, guides, and coaches. Deeper learning is not centered on the teacher, isolated within the confines of a classroom, or a finite process of regurgitating facts. Deeper learning strives to integrate what is known about how people (and experts) learn and what is required for successful participation in contemporary society. In an effort to illuminate and spread this instructional approach, this chapter contextualizes deeper learning, provides working principles that guide the creation of a deeper learning experience, and culls the research for achieving deeper learning at scale.

In part, the rising emphasis on 21st century skills, global competencies, and deeper learning is a recognition that the nature of problems in the world is changing, and that society requires problem-solvers who are prepared in new ways to attain different skills (Dede, 2014). The emphasis in school must shift from teaching what is already known ("learning about") towards teaching how to address "hard" problems, such as global climate change or the appropriate role of government in shaping individual life—topics that are currently not completely understood and that require interpretation among different points of view. This represents a fundamental and challenging shift for educators. Problem *solving*, applying standardized techniques to well understood challenges, is less and less central in modern work and citizenship. In contrast, problem *finding*, learning how to recognize when a situation presents a complex, sometimes tacit problem and knowing how to identify the resources and knowledge needed to resolve the problem, is increasingly important, but is a barely visible part of school curricula today.

Contextualizing Deeper Learning

Although the contemporary global economy requires different skills than those produced by our current nineteenth century factory model of schooling based on order, regularity, and punctuality (Tyack & Cuban, 1995), deeper learning is by no means new. The ideals of deeper learning date back to John Dewey at the beginning of the 20th century (Mehta, 2013a). Dewey argued that "schools should be places where students completed real work – work that had both imaginative and substantive meaning, that leveraged natural curiosities into deep learning, and that built the inter-and intra-personal skills required for successful participation in social, economic, and civic life" (Mehta & Fine, 2012, p. 35). Dewey's theories are confirmed by contemporary cognitive research of how people (and experts) learn. Concurrently, there is a growing consensus that schools are failing, as business leaders, global tests (such as PISA rankings), college professors, and recent graduates proclaim that current K-12 schooling does not adequately prepare students for life beyond school (CISCO, 2008; Wagner, 2008). As a result, deeper learning offers a new way – a way that integrates the needs of different stakeholders to arrive at a useful, successful, and enduring education that creates passionate citizen-workers who can contribute and engage with society.

Deeper learning is situated within "the relationship between the *teacher* and *student* in the presence of *content*", a framework referred to by City, Elmore, Fiarman, and Teitel (2009) as the *instructional core* (p. 22). The relationship between the three components (teacher, student, and content) is often diagrammed as a triangle to illustrate that it is not one particular element but the interchange between three parts working together, which determines the instructional process. Deeper learning strives to affect the instructional core by increasing the level of knowledge and skill that the teacher brings to the instructional process, increasing the level of complexity of the content, and changing the role of the student (City et el., 2009). City et al. note that (2009, pp. 26-27), "the culture of American schools, in its deep structure, is very teacher-centric" (pg. 27), and that Americans are essentially more comfortable changing content and teaching than changing the role of the student in instruction. For example, historically, Americans have paid more attention to "textbook adoptions and curriculum alignment" than to "analyzing students' actual responses to the content, what motivates them to high levels of engagement with the content, and their actual role in the instructional process" (p.26).

This is perhaps why deeper learning is regarded as innovative, because it facilitates a radical shift in the role of the student as a creator of relevant, real-world knowledge.

Principles of Deeper Learning

"There is no consensus on exactly how to define deeper learning" (Mehta & Fine, 2015, p. 4); however, the Hewlett Foundation (n.d.) and Mehta and Fine (2015) offer distinct definitions that have become prominent (active) in the larger discourse. The Hewlett Foundation describes deeper learning as "students *using* their knowledge and skills in a way that prepares them for real life" and posits that deeper learning occurs when learners are able to develop significant understanding of core academic content, exhibit critical thinking and problem-solving, collaborate, communicate, direct their own learning, and believe in themselves, often referred to as "an academic mindset" (Hewlett Foundation, n.d.). According to Hewlett, when deeper learning is present, students "learn more efficiently… and acquire and retain more academic knowledge, believe their studies are important, and are able to apply what they are learning in complex and meaningful ways" (Hewlett Foundation, n.d.). An example of this type of learning, as imagined by Hewlett, is an eighth grade class that reads in English class about a man in Malawi who built a wind turbine to bring electricity to his village and then these eighth graders persevere in designing and building their own wind turbine that they gleefully discover can produce almost six volts of electricity.

Alternatively, Mehta and Fine argue that deeper learning is the integration of three elements: mastery, identity, and creativity (Mehta & Fine, 2015). Mastery is defined as the acquisition of substantive content,

recognition of pattern and expertise, and understanding of the structure of a field or discipline. Identity encapsulates the intrinsic motivation needed for deeper learning and which 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). Creativity describes using and building upon accumulated knowledge to act or make something original within the field; the authors note this is a shift from analyzing how a play is written to writing an original play.

Mehta and Fine contend that the field of education is not far enough along in enacting whole-school deeper learning at scale but note that there is deeper learning happening somewhere in virtually every school. This finding is consistent with the Gates Foundation Measures of Effective Teaching study, which estimates that one out of every five classrooms features at least a moderate amount of critical and/or creative thinking (Kane & Staiger 2012). In order to build a system of "deeper learning for all," Mehta and Fine argue that we need to take the following actions: increase disciplinary rigor and ask more of students; make the boundaries between school and the real-world more porous; develop teachers who have experienced deeper learning and give them opportunities to grow and extend their practice; change opportunities for adult learning in schools; create space for teachers to "unlearn" prior models of schooling; and change accountability and assessment systems.

Teaching for Deeper Learning

In Magdalene Lampert's *Deeper Teaching* (2015), a component of Jobs for the Future's Deeper Learning research series, she writes (p.17):

> The question inevitably asked about any ambitious instructional reform is whether it can improve the quality of teaching "at scale." Reformers and researchers concur that extending improvements beyond a single classroom, school, or district is a complicated matter. Researchers find that large-scale change can be initiated and sustained when educational resources are coordinated systematically. The list of resources required for such efforts is relatively long but consistent: curriculum materials; instructional guidance tools, including standards and instructional routines; assessment and record-keeping instruments for teachers and students; common space and time for teachers to learn to use and adapt resources; content-focused instructional leadership; and district support for school-level capacity building (Lampert, Boerst, & Graziani 2011; Cobb & Jackson in press; Bryk et al. 2010). The operant word for linking these resources is coherence—if all of the tools available to improve instruction are not aligned in use, any one tool, by itself, is unlikely to improve instruction (Cohen, Raudebush, & Ball 2003).

In order to ensure the quality instruction described, Lambert (2015) highlights the following three factors that must happen concurrently (p.18):

- Designing **tools for instructional guidance**, including protocols for enacting named and commonly recognized/shared teaching practices in lesson structures and assessments that give teachers and students feedback about whether their goals are being accomplished;
- **Organizing schools to be coherent systems** that support (and do not interfere with) teachers and students in **using those tools**; and
- Building the **individual knowledge** teachers need to use teaching tools and adapt them to particular students with good judgment.

While these actions contribute to deeper teaching, they do not guarantee deeper learning for all. It is also imperative to consider the unique learning needs of the individual child.

Deeper Learning for Students with Disabilities

While the deeper learning principles discussed above can be applied to all contexts, Vaughn and colleagues (2013 & 2014) have developed a set of instructional practices designed specifically to assist students with disabilities in attainment of social studies and high school content. Vaughn and colleagues (2015) suggest three practices (p.7):

> (a) guiding students in creating a **comprehension canopy** (identifying the field's big ideas and key concepts and, over time, explicitly connecting them to specific examples and cases), (b) **defining essential words**, meant to assist students in learning and using the academic vocabulary of the discipline, and (c) **team-based learning**, in which students work independently at first, to demonstrate comprehension, and then with team members to build, correct, and extend learning about content-area issues.

In a mixed abilities classroom, Vaughn and colleagues (2015) suggest that the teacher should pose a concrete and high-level question to frame classroom discussions when introducing a unit; the researchers provide the following example of this comprehension canopy for the Revolutionary War (p. 7):

> The colonists almost lost the war. General George Washington put it best when he said that American victory was "little short of a miracle." The British had the most powerful army in the world; it was made of professional soldiers who were disciplined and well trained. The Colonial Army was mostly made up of farmers and part-time soldiers. They were poorly paid, and few had formal training. How, then, did the colonists win the Revolutionary War?

Vaughn and colleagues (2015) suggest that the teacher return to this overarching question many times over the course of the unit, allowing students to refine and elaborate on their ideas through individual and group work. The teacher should also make it a priority to identify and define key words that are essential for students to understand the academic content and discipline. These researchers acknowledge that the practices of asking framing questions, highlighting new words, and assigning group work may not seem particularly novel; however, according to randomized control group studies, "when teachers make conscientious efforts to apply these practices, students with disabilities (and many without disabilities) see significant improvements in their content knowledge and academic vocabulary, outpacing the gains made by students in matched classes studying the same content" (Vaughn et al., 2015, p.7).

Deeper Learning with Technology

Instructional strategies that promote deeper learning can also be augmented with new tools and media, mirroring the way real-world work settings have changed across many sectors of the economy. According to Dede (2014), "teachers will find it hard to provide deeper learning opportunities without employing technology given that the characteristics of students are changing as their usage of media outside of academic settings shapes their learning strengths and preferences (Dieterle 2009)."

In particular, Dede (2014) notes that new media encourage participation, creation, and sharing. Brown and Thomas (2011) emphasize the importance of playful learning, which includes learning in ways that we formally recognize as play (such as games), but also the broader culture of learners sharing information and pushing boundaries. Brown and Thomas distinguish between "learning about," which is the traditional province of school-based learning; "learning to do," which is often represented in formal education through problem-based and project-based pedagogies; and "learning to be" or "becoming," which is currently centered in informal learning, fundamentally about identity formation, and generative for deep engagement as well as the formation of intrapersonal and interpersonal skills.

In an extensive review of the literature on technology and teaching in the 2016 American Educational Research Association Handbook of Research on Teaching (5th Edition), Barry Fishman and Chris Dede review, Fishman and Dede consider how and under what conditions technology can be productively

employed by teachers to more effectively meet the challenges presented by a rapidly evolving world. They argue that technology as a catalyst is effective only when used to enable learning with richer content, more powerful pedagogy, more valid assessments, and links between in- and out-of-classroom learning. The technologies that Fishman and Dede examined in depth were:

- Collaboration tools, including Web 2.0 technologies and tools that support knowledge building
- Online and hybrid educational environments, which are increasingly being used to broaden access to education, but also have the potential to shift the way we conceive of teaching and learning
- Tools that support learners as makers and creators, and which have deep roots in helping students learn to become programmers of computers (and not just users of them)
- Immersive media that create virtual worlds to situate learning or augment the real-world with an overlay of computational information
- Games and simulations that are designed to enhance student motivation and engagement

They found that all of these technologies can be used in the service of deeper learning. If used strategically and in concert, they can help prepare students for life and work in the 21st century, mirroring in the classroom some powerful methods of learning and doing that pervade the rest of society. Further, they can be used to create a practical, cost-effective division of labor, one that empowers teachers to perform complex instructional tasks. In addition, these media can address the learning strengths and preferences of students growing up in this digital age, including bridging formal instruction and informal learning. And, finally, these technologies can provide powerful mechanisms for teacher learning, by which educators deepen their professional knowledge and skills in ways that mirror the types of learning environments through which they will guide their students.

However, two approaches stand out as particularly powerful, illustrating how teachers can use a combination of those technologies to create opportunities for students to master a wide range of high-level skills and content. Both of the approaches described below—the use of digital teaching platforms and immersive authentic simulations—have been researched in a large number of empirical studies, which have validated their practicality and effectiveness in typical educational settings, and both were selected because the National Educational Technology Plan (USDOE 2010) identified them as particularly promising.

Deeper Learning at the District Level

The following sections draw heavily on Honig and Rainey's research overview (2015) of how school districts can support deeper learning through performance alignment.

Even when district leaders shift their roles to support ambitious teaching and learning, their efforts can often be thwarted by a misalignment of resources and data and/or a lack of coordination between central office units. Honig and Rainey (2015) share an example of one midsized urban district that provided its teachers with intensive, state-of-the-art professional development (live and video-based coaching) in mathematics for many successive years. Nearly all central office professional development days and the allotment of substitute teachers were used for this initiative, which left few resources for other subject areas. While significant improvements were made in student performance in mathematics during this time, student outcomes declined in other areas. Honig and Rainey (2015) note that central office staff recognized this problem, but they lacked reliable data to help inform the quality of teaching in each school and therefore, to align appropriate services to teachers' actual learning needs.

Honig and Rainey (2015) found the mismatch between teacher quality and professional development opportunities to be quite common among school districts; further they observed that curriculum and instructional staff sometimes engage teachers in professional development without first consulting with principals to determine what aligns with the school's overall teaching efforts.

In order to align with the ambitious goals of deeper learning, central office staff and systems must be transformed, rather than simply tinkered with (Honig 2013).

Honig and Rainey (2015) also find that central office staff can succeed in transformation if alignment of daily work meaningfully supports principals as they enable teachers to help all students realize ambitious learning goals. These student goals of deeper learning need to permeate all aspects of the district.

Performance alignment, according to Honig and Rainey (2015), entails a fundamental redesign of many central office functions, including curriculum and instruction, human resources, and principal supervision. Honig and Rainey cite three main design elements common in district performance alignment (p.7):

- Define high-quality teaching and principal and teacher leadership;
- Ensure that principal supervisors are truly focused on supporting principals' instructional leadership growth; and
- Enable all district staff to focus their time and other resources on activities that support schools' pursuit of deeper learning.

For further detail on how school districts can further align to support deeper learning, see Honig and Rainey's research overview (2015), on which this discussion is based.

Challenges to Deeper Learning

It has been difficult to consistently achieve deeper learning because our current accountability structures are limited to summative tests designed to measure "coverage" and "student's memory of a subject" rather than depth of content knowledge (Sizers, 1999, p. 34). Our classrooms are bound to adhere to testing procedures because they are consistently evaluated on the results. Bransford (2000, p. 20) notes that a teacher is put in a bind if s/he is asked "to teach for deeper understanding rather than surface knowledge" but in doing so, produces students who perform poorly on a test because in most districts, teachers are held accountable for student test scores rather than to demonstrations of deeper learning. However, this direct link between summative tests and what is taught in classrooms can be reversed for the seeding of deeper learning. If the content and format of summative tests of accountability were changed to measure principles of deeper learning, then knowledge required of teachers, the classroom content, and student roles (the instructional core) would shift dramatically to incorporate deeper learning. While improving the pipeline of teacher talent, building a professionalized knowledge base, changing the organizational processes to ensure that knowledge is used at the delivery site, and bolstering the partnership between state, district, and school are necessary strategies for professionalizing teaching (Mehta 2013a&b), redesigning summative tests of accountability to measure deeper learning (rather than coverage or regurgitation of facts) is an efficient means to spread this instructional approach, though it is not a structurally transformative strategy.

Practically, in all examples of deeper learning that have been examined closely, schools that teach for deeper learning discount the current summative accountability tests as a serious measure of student learning. Rather, these deeper learning schools recognize summative tests as an immutable hoop through which students must jump and they simultaneously create a local parallel system that measures outcomes that are valued by the school community. Whether through "gateway exhibitions", performance assessments, or portfolio panels, there are alternative ways to measure the products of deeper learning. Deeper learning has been difficult to achieve more consistently because not all schools have the freedom to start anew or from outside the school system. For those schools that are deeply entrenched within the confines of the system, it will take a change in the existing bureaucratic structures to shift to an instructional approach of deeper learning. Changing the content, design, and format of the tests to align with deeper learning would be the strongest leverage point in seeding these principles. "It's time for our profession to advocate for accountability systems that will enable us to teach and test the skills that matter

most" (Wagner, 2008b). In sum, deeper learning is a 21st century instructional approach that incorporates what is known about how people (and experts) learn and what is required for successful participation in social, economic, and civic life to empower students in creating knowledge through cognitively rigorous, open-ended, real-world challenges with ongoing feedback from teachers who serve as facilitators, guides, and coaches. Deeper learning holds great promise for developing life-long, independent learners who meaningfully contribute to society.

Effective teaching strategies are core to deeper learning; the next section culls the research literature on effective teaching.

Effective Teaching

Today's teachers are tasked with preparing students for an emerging context. Current teachers need to prepare students for jobs that do not yet exist, to use technologies that have not yet been invented, and to solve complex problems that have not yet occurred; as a result, teachers must focus on more than transmission of academic content (Schleicher, 2016). In order to cultivate these skills, teaching must be transformed.

In the Ontario initiative, Steven Katz has been influential in providing research insights about networked learning communities for educators (Katz, Earl, & Ben Jafaar, 2009) and about leading schools in a data-rich world (Earl & Katz, 2006). Garfield Gini-Newman has contributed evidence-based strategies for critical thinking and question framing, as well as linking formative and summative assessment (Gini-Newman, 2008). Barrie Bennett has provided aid on teacher thinking, learning, and instructional practices (Bennett, 2009).

In interviewing several hundred business, nonprofit, philanthropic, and education leaders, Wagner identified the following seven skills necessary for successfully preparing students for the 21st Century environment that they will inhabit: (1) critical thinking and problem solving, (2) collaboration and leadership, (3) agility and adaptability, (4) initiative and entrepreneurialism, (5) effective oral and written communication, (6) accessing and analyzing information, and (7) curiosity and imagination. "I have yet to talk to a recent graduate, college teacher, community leader, or business leader who said that not knowing enough academic content was a problem. In my interviews, everyone stressed the importance of critical thinking, communication skills, and collaboration" (Wagner, 2008).

This changing context has profound implications for teachers and teaching. In his 2016 OECD report on teaching excellence through professional learning and policy reform, Schleicher established the following core principles that undergird the learning environment (p.19):

> These principles include making learning central; encouraging engagement; ensuring that learning is social and collaborative; and being sensitive to individual differences and to learners' motivations and attitudes. They also include being demanding of each learner without overload; using assessments to measure students' progress towards these goals, with emphasis on formative feedback; and promoting connections across learning activities and subjects, both in and outside of school.

However, change is difficult and the status quo has many protectors. For example, the 2008 OECD Teaching and Learning International Survey (TALIS) documents that across participating countries, an average of two in three teachers considers the school where they work to be essentially hostile to innovation (Schleicher, 2016).

As a result, Schleicher's OECD 2016 report cites the importance of understanding the design principles and conditions that enable innovation and modern learning environments. Specifically, the report argues the following (p. 17):

> It is therefore important to understand the design principles and conditions that can make innovation and modern learning environments systemic. This is about the interactions between the main players of innovative learning (learners, educators, content and learning resources) and the dynamics that connect those elements (pedagogy and formative evaluation, use of time, and the organization of educators and learners). It also relates to the organizational features and leadership principles, recognizing that learning environments and systems don't change by themselves but need strong design with vision and strategy. And it is about innovative partnerships, which are often neglected in education. This recognizes that isolation within a world of complex learning systems seriously limits potential.

Powerful learning environments are powered by the creation of synergies that enhance professional, social, and cultural capital of students, teachers, families, and the larger community.

Specifically, the OECD report, *What Makes a School a Learning Organization?,* proposes an integrated "school as learning" model that focuses on the following seven principles (2016, p. 1):

- developing and sharing a vision centered on the learning of all students
- creating and supporting continuous learning opportunities for all staff
- promoting team learning and collaboration among all staff
- establishing a culture of inquiry, innovation and exploration
- embedding systems for collecting and exchanging knowledge and learning
- learning with and from the external environment and larger learning system
- modeling and growing learning leadership.

In sum, according to the OECD's 2016 *What Makes a School a Learning Organization,* these seven essential action-oriented components highlight the processes that schools must take to transform themselves into learning organizations. In the next section, we describe the implications for instruction of this new model of learning organizations.

<u>What This Means for Teachers</u>

Research examining subject-matter expertise and pedagogical content knowledge (the knowledge of how to structure learning within a subject area) has shown to have positive effects on student achievement (Wenglinsky, 2000, 2002; Gustafsson, 2003; Wayne and Youngs, 2003). However, according to Schleicher, 2016, p.19):

> Evaluating the impact of pedagogical preparation is made difficult because there is such a wide range of courses under this label, including courses in subject-specific teaching and more generic courses in learning theory, educational psychology, sociology, assessment, measurement and testing, classroom management, and so on. These courses are offered in different sequences and with differing content and intensity. Rice (2003) concludes that pedagogical coursework contributes to teacher effectiveness when combined with content knowledge. According to some, the United States research supports the conclusion that pedagogical preparation contributes to effective teaching, especially subject-specific courses and those designed to develop core skills, such as classroom management, student assessment and curriculum development (Education Commission of the States, 2003).

The pedagogical knowledge base is not fixed; new knowledge emerges from research and/or is shared through professional communities. According to Schleicher (2016, p. 23), the interdisciplinary field known as the "science of learning," which includes the field of educational neuroscience, "has made considerable progress in understanding how the human brain processes, encodes and retrieves information; understanding how the brain works, can inform teachers' pedagogical practice" and can inform the design and structure of lessons that enable deeper learning.

Schleicher 2016 also explores the research strand of expert teachers and provides the following example (p. 26):

> Hattie (2003) drew on an extensive review of research to identify five essential skills that distinguish highly competent teachers. He considers expert teachers as those who can: identify essential representations of their subject, based on how they organize and use their content knowledge; guide learning through classroom interactions by creating optimal classroom environments; monitor student learning and provide feedback; promote effective outcomes through the manner in which they treat students, and their passion for teaching and learning; and influence student outcomes by engaging students, providing challenging tasks and goals, and enhancing "deep" learning or understanding.

In sum, effective teaching in the 21st Century means having subject-matter expertise and pedagogical content knowledge, as well as drawing from the research base on the learning sciences and on teacher expertise. Technology can be a helpful tool in synthesizing these practices.

Illustrative Effective Uses of Technology for Teaching Global Competencies

The following sections draw heavily on Fishman and Dede's research overview (2016) of technology-based teaching strategies effective in teaching students various types of global competencies.

Social Media as a Form of New Literacy Practice

One way to conceive of social media is as a means to learn "new literacies," which are viewed as important for both teachers and students to master as a part of 21st century competencies. These literacies are based on moving from consumption of media to creation of media, including remixing, and can be characterized as play, performance, appropriation, judgment, networking, and negotiation (Ito et al., 2010; Jenkins, Clinton, Purushotma, Robison, & Weigel, 2006). As one illustration, "Tweeting" has been described as a new literacy practice connecting to 21st century learning and communication (Greenhow & Gleason, 2012; Mills & Chandra, 2011). It also can serve as an entry-level form of composition with a public audience for early writers (Kurtz, 2009), where students collectively work to compose and edit tweets about classroom news. The constraint of 140 characters forces students to be thoughtful about what they say and how they express themselves. This positions Web 2.0 tools such as wikis, blogs, *Facebook*, and *Twitter* in a role where they could be used both to introduce core competencies that have long been valued, and also as a bridge to new forms of competencies.

Sanden and Darragh (2011) ask six core questions to determine whether the use of the technology effectively addresses students' sociocultural and pedagogical needs (they pose these questions with respect to literacy instruction, but they could be more broadly applicable). They ask if the classroom use of the technology:

- Advances students' social, emotional, and identity development by giving students agency, ownership, and/or personal voice?
- Provides opportunities for collaborating and sharing information in local and/or global settings?
- Promotes critical literacy opportunities such as evaluating content and considering different points of view?
- Allows for the processing, managing, analyzing, and synthesizing of multiple streams of information?
- Aids in developing literacy strategies for managing different types of text in a variety of contexts?
- Values and utilizes students' cultures, experiences, and funds of knowledge? (Sanden & Darragh, 2011, p. 8)

For example, Sanden and Darragh argue that, "wikis epitomize the potential for new technologies to create an environment in which learning is a collaborative journey" (2011, p. 18). However, the

implication of the frameworks they discuss is that there is a continuum of pedagogical practice for employing wikis (or any technology) and, if a teacher does not move far along that continuum, the value returned by using wikis (or any technology) will be greatly diminished.

The Maker Movement

The recent rise of the maker movement has many parallels to the long-running work of Papert and his colleagues on "constructionism" as a theory of learning (Harel & Papert, 1991). "Makers," are a broad community with deep roots that includes scientists, engineers, crafters, musicians, and all do-it-yourselfers who enjoy understanding and creating, as opposed to merely consuming, technology (New York Hall of Science, 2010, 2013). Work in these spaces encompasses computer programming and other electronics, but also uses materials such as textiles to broaden participation and enhance a focus on design thinking (Peppler & Glosson, 2012). Maker culture is related to apprenticeship learning (Rogoff, 1995) and communities of practice (Wenger, 1998), in which learning is driven by passion and thus learners are motivated to struggle through challenges. Recent attention to makerspaces attempts to understand why they are so powerful (Thomas & Brown, 2011), as well as to build bridges between these informal learning spaces and formal education (Ito et al., 2013).

Environments that support computational thinking and scaffold learners as makers and creators offer many opportunities for realizing extensive technology integration. However, unless done well they can also illustrate how easy it is to convert an ambitious educational experience into a traditional lesson that preserves the discrete role of learner as receiver of knowledge and teacher as deliverer. Tools like *Scratch* and the bridge it provides between the informal and formal learning worlds offer some insight into a pathway to enable deep and transformative learning for students. Approaches that take transformational tools such as computational environments for simulating and tinkering with complex systems offer another pathway, but one that begins with the formal structures of schooling and teaching.

Makerspaces are currently removed from the domain of "formal" teaching. However, these technology-rich environments are a prime example of a context that will grow in importance as a site for 21st century and engaged learning (Collins & Halverson, 2009; Thomas & Brown, 2011). Therefore, it is crucial to help teachers understand how to bridge between formal and informal teaching and learning spaces.

Educational Games

Addressing "hard" problems requires an expansion in the contexts for learning. This may be a shift from self-contained classrooms, in which all required knowledge and resources can be located on a bookshelf (or even within a single textbook), towards learning environments that instead engage students with the broader world either directly or indirectly. Technology can provide resources that support such connections, whether using electronic communication tools to link learners to outside expertise, or by employing games and simulations that enable students to interact in richly complex environments (National Research Council, 2011). Such environments are designed to engage students by helping them see the real-world utility of the knowledge and skills required to identify/resolve problems. Technology such as games and simulations can facilitate transfer of learning for future application by presenting problems with greater complexity and context than is possible in traditional classroom teaching (Bransford & Schwartz, 1999).

A substantial review of research on educational games (Tobias & Fletcher, 2011) delineated findings about the capabilities of these media for teaching and learning. Tobias and Fletcher, in aggregating various studies on the effectiveness of games for education, found that capabilities acquired during gameplay can generalize to non-game environments, including education and training contexts as well as everyday life. As one illustration for transfer of generic intellectual skills, research suggests that some games can increase the speed of mental processing, sensitivity to inputs in the environment, and

flexibility in allocating cognitive and perceptual resources (Anderson & Bavelier, 2011). To attain transfer from the game to curricular tasks and to tasks in the real world, substantial overlap is required between the cognitive processes engaged by the game and those required for the tasks; superficial similarities do not lead to transfer. Teachers play an important role in scaffolding this transfer, by employing pedagogies that stress the links between knowledge and skills in the game or simulation and their applications in life situations.

Overall, Tobias and Fletcher (2011) found that games providing imaginative play, rapid responses, challenges, and competition—at levels appropriate to a player's cognitive constraints (e.g., mental workload, prior knowledge)—could develop knowledge and skills related to academic topics and to life situations. They also found substantial research to support the assertion that well designed games are engaging and motivate most players to spend substantial time interacting with them. The NRC found that simulations and games are worthy of future investment and investigation as a means to improve science learning. These media were seen as having the potential to advance motivation to learn science, conceptual understanding, science process skills, understanding the nature of science, scientific discourse and argumentation, and identification with science and science learning. Although we believe that the early results are promising, the evidence for games in supporting science learning was judged inconclusive, largely due to a very limited base of high quality research findings.

For further detail on the three topics above, see Fishman and Dede's research overview (2016), on which this discussion is based.

Combined, the characteristics of deeper learning, effective teaching, and illustrative transformative technologies discussed in this section are consistent with a vision of teaching for personalization presented in the 2010 National Education Technology Plan (U.S. Department of Education, 2010, pp. 41–42):

> Connected teaching offers a vast array of opportunities to personalize learning. Many simulations and models for use in science, history, and other subject areas are now available online, including immersive virtual and augmented reality environments that encourage students to explore and make meaning in complex simulated situations (Dede 2009). To deeply engage their students, educators need to know about their students' goals and interests and have knowledge of learning resources and systems that can help students plan sets of learning experiences that are personally meaningful. . . . Although using technology to personalize learning is a boost to effective teaching, teaching is fundamentally a social and emotional enterprise. The most effective educators connect to young people's developing social and emotional core (Ladson-Billings, 2009; Villegas & Lucas, 2002) by offering opportunities for creativity and self-expression. Technology provides an assist here as well… Digital authoring tools for creating multimedia projects and online communities for sharing them with the world offer students outlets for social and emotional connections with educators, peers, communities, and the world at large. Educators can encourage students to do this within the context of learning activities, gaining further insights into what motivates and engages students—information they can use to encourage students to stay in school.

A research synthesis that describes "digital teaching platforms" as a way to accomplish this is presented in Dede and Richards (2012). Core to digital teaching platforms and similar visions are diagnostic assessments embedded in learning and formative for further learning and instruction.

Assessing Student Outcomes

The 2012 National Research Council report, *Education for Life and Work*, presents a consensus view of 21st century skills (see Table 1), also described as global competencies. These skills are arrayed across cognitive, intrapersonal and interpersonal dimensions (National Research Council, 2012, pp. 12–13).

Cognitive Outcomes	***Intrapersonal Outcomes***	***Interpersonal Outcomes***
Cognitive processes and strategies	Intellectual Openness	Teamwork and Collaboration
Knowledge	Work Ethic and Conscientiousness	Leadership
Creativity	Positive Core Self-Evaluation	Communication
Critical Thinking	Metacognition	Responsibility
Information Literacy	Flexibility	Conflict Resolution
Reasoning	Initiative	
Innovation	Appreciation of Diversity	

Table 1: Dimensions of advanced knowledge and skills (read in columns, not across rows).

Mastery involves both understanding how to apply advanced knowledge and skills in real world contexts—for which all three dimensions are important—and demonstrating proficiency via effective, authentic performances. The NRC report references deeper learning as an instructional approach to accomplish this goal. What makes mastery even more complex is that much of the decision-making and task completion associated with a complex performance becomes tacit through repeated practice. Thus, what underlies proficiency is largely hidden from view, making it a complex task to describe it fully and accurately for training/learning (Working Group on Postsecondary Learning, 2013), as well as to assess complex proficiencies that use multiple global competencies simultaneously.

In particular, where current schooling focuses primarily on knowledge and skills in the "Cognitive Outcomes" dimension, 21st century schooling must also emphasize "Intrapersonal Outcomes" and "Interpersonal Outcomes" to best prepare students for the changing nature of work and citizenship. This is challenging, because many of the skills listed below are very difficult to measure, making assessment difficult. Also, because many of the intra- and interpersonal skills have an affective component, measuring student motivation is important not simply because engagement, self-efficacy, and tenacity promote learning; but also because motivation is a crucial educational outcome in its own right.

Measuring Motivation

The next three paragraphs draw heavily on Fishman and Dede's research overview (2016). Theories about motivation from social psychology describe various reasons why participants might become highly engaged in an extended, rich learning experience and might be motivated to frequently seek out this experience. Aspects of a deeper learning experience that promote intrinsic motivation include intrapersonal factors such as challenge, control, fantasy, and curiosity, as well as interpersonal factors such as competition, cooperation, and recognition (Bartle, 2003). The challenge dimension of engagement is heightened when a participant achieves a state of flow through facing challenges that are difficult but surmountable at his or her current level of skill (Csikszentmihalyi, 1988). Other generic, intrinsic factors that heighten motivation include the perceived humanistic value of an activity in light of personal and cultural preferences (Brophy, 1999) and perceived personal competence (self-efficacy, growth mindset) in accomplishing the goals of an activity (Dweck, 2002; Schunk & Pajares, 2005).

A personal trait related to self-efficacy and identified as important in educational success is academic tenacity. The U.S. Department of Education report, *Promoting grit, tenacity, and perseverance: Critical factors for success in the 21st century* (2013), describes the interrelationships among concepts such as

persistence, tenacity, grit, perseverance, and conscientiousness when applied to educational contexts. The report documents how important these traits are for success in school and life; it suggests teaching strategies for fostering these traits and for seeing one's abilities in a subject as mutable rather than fixed. These instructional strategies include (U.S. Department of Education, 2013, pp. 77–80):

- Students need to have the opportunity to take on long-term or high-order goals that, to the student, are "worthy" of pursuit.
- Students need a rigorous and supportive environment to help them accomplish these goals and develop critical psychological resources. These resources include teachers' fostering positive academic mindsets (e.g., my ability and competence grows with my effort), effortful control by students (e.g., staying focused despite distractions), and strategies and tactics (e.g., project planning skills).

Lepper and Henderlong (2000) described various ways that extrinsic incentives used in academic settings to promote participating in an activity, but unrelated to the intrinsic nature of the experience, can undercut learning and intrinsic motivation, if overdone. They discussed how personal choice, the use of meaningful contexts, emphasizing learning goals, and providing appropriate levels of challenge aid with internalizing intrinsic motivation. Ryan and Deci (2000) delineated how factors such as modeling by others to whom learners feel attached, perceived competence of the learner, and personal autonomy are powerful for ensuring that educational experiences that begin with extrinsic motivators culminate in participants having strong intrinsic motivation.

The material that follows is closely based on Fredricks, McColskey, Meli, Mordica, Montrosse, and Mooney (2011). Academic settings are limited contexts for developing and assessing motivation, compared to the options available for informal learning throughout life. Historically, educational definitions of academic motivation have been more limited than the overview from social psychology presented above. For example, Fredricks, Blumenfeld, and Paris (2004) propose that student engagement has multiple dimensions: behavioral, emotional, and cognitive.

- *Behavioral engagement* draws on the idea of participation and includes involvement in academic, social, or extracurricular activities; it is considered crucial for achieving positive academic outcomes and preventing dropping out (Connell & Wellborn, 1990; Finn 1989).
- *Emotional engagement* focuses on the extent of positive (and negative) reactions to teachers, classmates, academics, and school. Positive emotional engagement is presumed to create student ties to the institution and influence students' willingness to work (Connell & Wellborn, 1990; Finn 1989).
- *Cognitive engagement* is defined as the student's level of investment in learning; it includes being thoughtful and purposeful in the approach to school tasks and being willing to exert the effort necessary to comprehend complex ideas or master difficult skills (Fredricks, Blumenfeld, & Paris, 2004).

Instruments used by educators to measure academic motivation have usually been based around this framework. The emphasis is on macro-behaviors (e.g., attendance, grades, suspensions) rather than micro-behaviors (e.g., engagement with a learning experience; self-efficacy, growth mindset, and tenacity regarding that experience). As such, the application of these instruments to measure sophisticated pedagogies like deeper learning is quite limited. Self-assessment for these dimensions of motivation is the most-used strategy to overcome this difficulty.

As part of the increased focus on school accountability over the past 15 years, more attention has been paid to studying and reporting the effectiveness of motivational interventions designed to improve student outcomes. Currently, many school reform models, programs, and student interventions focus on enhancing engagement to improve achievement and school completion rates. Examples of interventions

that have identified and measured engagement as an important student outcome include the three examples discussed next.

The Institute for Research and Reform in Education (IRRE) has worked in nine districts nationwide to implement First Things First, a school reform model in which schools commit to improving engagement and strengthening relationships between students and adults (http://www.irre.org). IRRE assists schools in collecting meaningful data on student engagement. As an illustration of this, freshman academies and four-year thematic SLCs were implemented by IRRE in two quite different contexts—the Talent Development High School model (a freshman academy) in Baltimore and Philadelphia, and First Things First (a four-year thematic SLC) in Kansas City, Kansas (Kemple et al, 2015). Among other findings from this research, IRRE found that SLCs, while having substantial value, should be seen as a platform for supporting other needed reforms in high schools and should not be seen as a stand-alone or self-sufficient school improvement strategy.

Check and Connect is aimed at students identified as at risk of dropping out (http://www.ici.umn.edu/checkandconnect). The program is designed to improve engagement by maximizing personal contact and opportunities to build trusting relationships with a mentor or monitor. Behavioral engagement (as reflected in attendance, grades, and suspensions) is checked regularly and used to help mentors strengthen students' connection with school. Christensen (2009) found that, as a sustained innovation, Check & Connect improves persistence, enrollment, access to relevant educational services, student involvement in IEP transition planning, and attendance for students with emotional/behavioral disabilities.

The National Center for School Engagement (NCSE) partners with school districts, law enforcement agencies, courts, and state and federal agencies to support youths and their families in improving engagement (http://www.schoolengagement. org). NCSE supports truancy reduction programs and helps schools track data on attendance and school engagement. In a study of four programs, NCSE (2009) found that early intervention is important, as is integrating truancy services into the school environment, and that community organizations were a powerful ally in improving school attendance.

For more detail on current approaches for measuring motivation and using this to improve academic outcomes, see the Fredricks et al report (2011) referenced earlier as the basis for this discussion.

The Asian nation that has come furthest towards addressing motivation and learning for global competencies is Singapore, through a series of information and communication technology (ICT) masterplans. The Intelligent Nation (iN) 2015 Plan sets forward this vision for the future of education in Singapore (iN Steering Committee, 2015, pg. 8):

> Using infocomm, the Education and Learning sector seeks to deliver a more engaging learning experience to meet the diverse needs of learners. Here, the EdVantage programme seeks to make the dream of "classrooms without walls" a reality. This includes providing each student with a personalised infocomm device, to serve as a doorway to textbooks, lessons and projects and catalysing the development of learning applications and content. This will be supported by a seamless and pervasive broadband infrastructure.

This technology infrastructure can enable many aspects of deeper learning, If accompanied by extensive adoption of the sophisticated instructional approaches described earlier, this pervasive usage of infocomm both encompasses learning within school and reaches beyond the classroom in life-wide ways. At this level, which is not frequently observed in any nation at present, teachers are adept at orchestrating learning across a range of providers within and beyond the school, and at customizing instructional conditions for learners. Collaborative learning approaches are maximally effective at this level, as is engagement and transfer of skills from school to life.

South Korea is another Asian nation that has made extensive investments in technology infrastructure, as both a means of economic advancement and educational improvement. Their focus on learning technologies began in 2005 and has continued through a series of five year plans, similar to Singapore's approach (Grzybowski, 2013). By emphasizing engaging and interactive instruction, the South Korean technology infrastructure in education is creating a foundation for implementing deeper learning and motivation.

Measuring Learning

The following two sections draw heavily on David T. Conley's (2014) *A New Era for Educational Assessments*, a component of Jobs for the Future's *Deeper Learning* research series.

According to Conley (2014), increasingly, educators and parents are voicing their dismay over current testing and accountability *(*Gewertz, 2013, 2014; Sawchuk, 2014). Similarly, economist and education scholar Thomas Kane (2012a) notes that all measures are flawed in some way – for example, test-based student measures may have predictive power, yet they don't offer insight into a teacher's strengths and weaknesses; classroom observations may require multiple observations to craft a reliable gauge of teacher practice; and student surveys are less predictive of student achievement gains than the measures themselves.

We turn to brain and cognitive science to gather additional context for measuring learning.

Brain and Cognitive Science

Recent brain research underscores the shift towards performance assessments that measure and encourage deeper learning. In particular, Hinton, Fisher, and Glennon (2012) provide strong evidence that the human brain is more malleable than previously thought. Conley 2014 writes (p.10):

> Intelligence was long assumed to be a unitary, unchanging attribute, one that can be measured by a single test. However, that view has come to be replaced by the understanding that intellectual capacities are varied and multi-dimensional and can be developed over time, if the brain is stimulated to do so.

In addition, Dweck, Walton, and Cohen (2011) find that student attitudes towards learning academic material are at least as important as their aptitude. Conley (2014) writes (p.10):

> For generations, test designers have used "observed" ability levels ascertained from test scores to steer them into academic and career pathways that match their natural talents and capabilities. But the reality is that, far from helping students find their place, such test results can also serve to discourage many students from making the sorts of sustained, productive efforts that would allow them to succeed at a more challenging course of study.

Recent research also challenges the notion that the human brain is organized by discrete bits of information (Donovan, Bransford, & Pellegrino 1999; Pellegrino & Hilton 2012). In Conley (2014), current evidence shows (p. 10):

> …that the brain is quite sensitive to the importance of information, and it makes sense of sensory input largely by determining its relevance (Medina, 2008). Thus, the longstanding preoccupation with breaking subject-area knowledge down into small bits, testing students' mastery of each one, and then teaching those bits sequentially, may in fact be counterproductive. Rather than ensuring that students learn systematically, piece by piece, this approach could easily deny them critical opportunities to get the big picture and to figure out which information and concepts are most important.

Therefore, Conley (2014) argues that rather than being taught and tested on discrete skills, high school students should deepen foundational knowledge acquired in earlier grades and apply and extend that

knowledge to new subjects, tasks and challenges. High school students need opportunities to demonstrate their conceptual, big-picture understanding and show that they grasp the significance of what they have learned.

A Broad Range of Assessments

Assessments can be described as falling along a continuum (see Figure 1) that ranges from measuring discrete pieces of content knowledge to capturing integrated and holistic demonstrations of student understanding. According to Conley (2014, p.12),

> It is not necessary or even desirable to choose just one approach and reject the others. A number of districts are now creating school assessment models that combine elements from multiple approaches, which promises to give them a much more detailed and useful picture of student learning than if they insisted on a single approach.

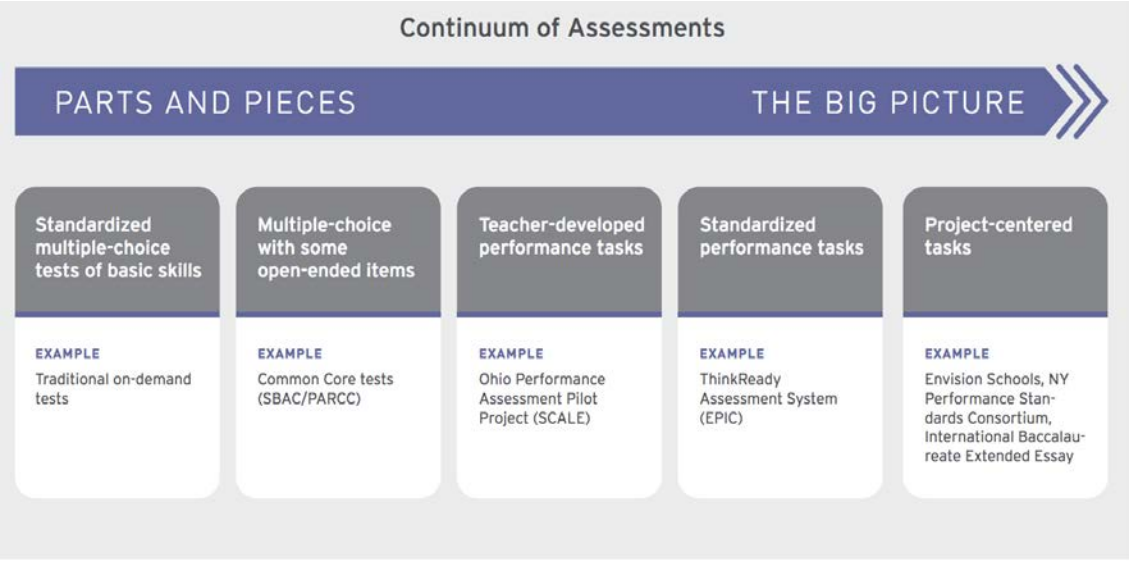

Figure 1: Continuum of Assessments

A range of student assessment information collected over time, according to Conley (2014), equips educators with a deeper and more full understanding of student capabilities and mastery than a single form of assessment. For more information on this continuum of assessments, see Conley's research overview (2014) on educational assessments.

The challenge then becomes how to effectively evaluate and select measures.

Selecting Measures of 21st Century Competencies

Soland, Hamilton, and Stecher (2013) developed a framework (see Figure 2) for educators to use in evaluating measures of 21st century competencies; these considerations fall into three categories: instructional, practical, and technical, as noted (p.9):

> When determining which test to use, potential users of assessments must consider the purposes of the assessment (Haertel 1999; Messick 1994; Kane 2012). In general, there are four broad purposes for which assessments might be used: (1) monitoring system performance, (2) holding schools or individuals accountable for student learning, (3) setting priorities by signaling to teachers and parents which competencies are valued, and (4) supporting instructional improvement (Schwartz et al. 2011).

Considerations When Selecting Measures of 21st Century Competencies

Instructional
Formative or summative
Actionable information to teachers
Useful feedback to students
Grade/context appropriate
Engaging, meaningful, and authentic for students
Encourages effective teaching and learning
Practical
Cost
Ease of training
Ease of scoring
Ease of administration
Ease of technological implementation
Technical
Reliability
Validity
Fairness

Figure 2: Important Dimensions for Measures of 21st Century Competencies

With regard to instructional considerations, it is important to consider whether the measure is to be used for formative or summative purposes (e.g. to inform ongoing instruction or to determine whether interaction was effective after it has taken place). Soland, Hamilton, and Stecher (2013) provide the following example (p.10).

> …the use of frequent formative assessment in elementary reading might help a teacher determine whether a student is struggling with vocabulary, phonemic awareness, phonics, or comprehension. In fact, many scholars argue that formative assessment is a process rather than a test (Heritage 2010) and that effective formative assessment practice involves teachers setting goals, engaging in frequent feedback cycles with students, adjusting instructional practices in response to assessment data, and engaging students in the assessment process by providing individualized instruction and opportunities for self-assessment (Black et al. 2003; Heritage 2010; Herman, Osmundson, and Silver 2010).

In contrast, summative assessments evaluate teaching and learning after it has transpired. Soland, Hamilton, and Stecher (2013) provide the example of Advanced Placement examinations used at the end of an accelerated course to determine if the student has mastered course content.

With regard to the practical, cost is an important factor in evaluating and selecting an assessment. The complexity of the test format often drives the cost; therefore, Soland, Hamilton, and Stecher (2013) note that some 21st-century competencies maybe more expensive to test than prior traditional measures.

In addition to instructional and practical considerations, educators must also think about the technical quality of the measure -- whether it captures what it claims to measure and whether it provides consistent and meaningful results. While technical criteria may be more complicated from a statistical perspective, these considerations are critical when evaluating and selecting an assessment.

In their research, Soland, Hamilton, and Stecher (2013) also created guidelines – not rules – that might help to improve the implementation of selected assessments (see Figure 3). As always, implementation will vary from location to location and local priorities should dictate the weight of criteria and decision-making.

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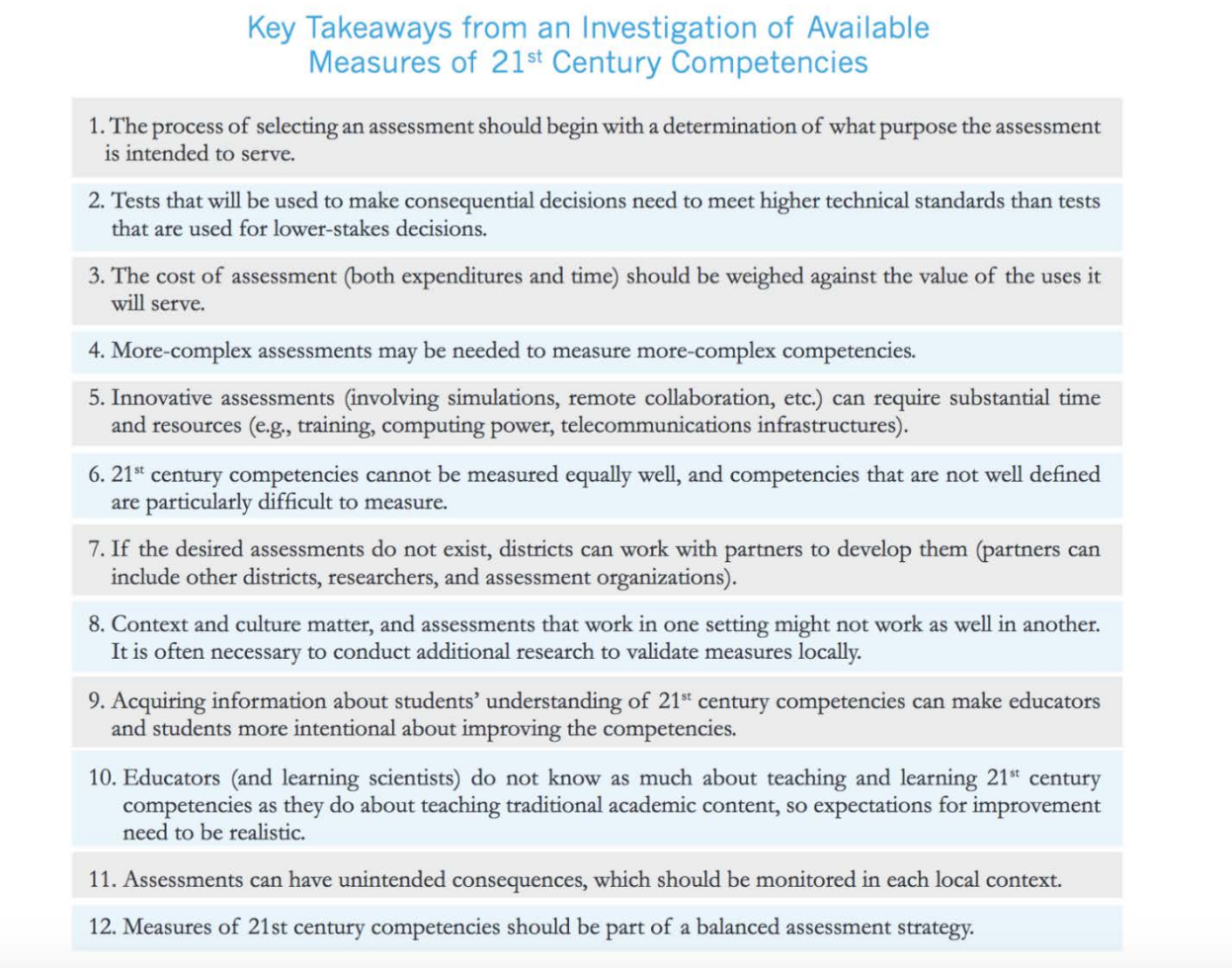

Figure 3: Guidelines for Implementing Measures of 21st Century Competencies

For more detailed information on these guidelines, see Soland, Hamilton, and Stecher's research overview (2013) entitled *Measuring 21st Century Competencies: Guidance for Educators*.

To actualize these assessment guidelines, policy must be created and enacted.

Policy Recommendations for Assessments

The 2013 OECD report entitled *Synergies for Better Learning: An International Perspectives on Evaluation and Assessment* provides a review of a five-year international study of 38 countries' perspectives on evaluation and assessment. As a result of this study, the OECD arrived at suggested policy recommendations, which include (p. 2-3):

Focus on improving classroom practices: The point of evaluation and assessment is to improve classroom practice and student learning. With this in mind, all types of evaluation and assessment should have educational value and should have practical benefits for those who participate in them, especially students and teachers.

Put students at the center: Because the fundamental purpose of evaluation and assessment is to improve student learning, students should be placed at the center. They should be fully engaged with their learning and empowered to assess their own progress (which is also a key skill for lifelong

learning). It is important, too, to monitor broader learning outcomes, including the development of critical thinking, social competencies, engagement with learning and overall well-being. These are not amenable to easy measurement, which is also true of the wide range of factors that shape student learning outcomes. Thus, performance measures should be broad, not narrow, drawing on both quantitative and qualitative data as well as high-quality analysis.

The OECD 2013 report cautions against assessments that are not comprised of "worthy" authentic learning tasks and that do not provide supportive and actionable feedback based on the results.

Assessments and Continuous Improvement

In an effort to develop system learning that supports continuous improvement at all levels of the system, Conley and Darling-Hammond (2013) suggest the following five actions:

- Involving educators in the development and scoring of assessments so that they deeply learn the standards and have opportunities to share practice
- Means for documenting best practices and disseminating knowledge through online platforms sharing studies and highlighting exemplars, school study visits
- Conferences focused on the sharing and development of practice
- Feedback loops to students, educators, and schools about their work (e.g., through exhibitions, educator evaluation systems, and school quality reviews)
- Collaboration opportunities within and across schools and networks.

In conclusion, based on the aforementioned research, a successful system of assessments might be described as measuring complementary measures that contribute to a comprehensive picture of the quality of learning in classrooms, schools, and school systems and that encourage and reflect deeper learning and authentic evidence of student readiness for college and career success. For further information refer to the Addendum for Measuring Learning on page 44.

System Reform/Transformation at Scale

Designing effective, scalable, and sustainable policies and programs in education is challenging. Programs that work in one setting may not work in another. Programs supported through grants may not last once funding ends. Many programs require more resources and know-how than individual researchers and educators can provide to make them work for all students.

Design-Based Implementation Research (DBIR) is an approach to organizing research and development intended to address these challenges. It is an emerging approach to relating research and practice that is collaborative, iterative, and grounded in systematic inquiry. DBIR builds the capacity of systems to engage in continuous improvement, so that we can accomplish the transformation of teaching and learning we seek. For further information, see Introduction to learn DBIR.

Framework: North Carolina Digital Learning Plan

The North Carolina Digital Learning Plan (NCDLP) is a well-documented and proven model for digitally based educational improvement across a large geographic region. This brief summary highlights its conceptual frameworks and current accomplishments. More detail is available at http://ncdlplan.fi.ncsu.edu/

The goal of the NCDLP is to build on North Carolina's current initiatives in digitally based educational improvement to develop a coherent long-term strategy that sets directions and priorities, supports innovation, and provides resources (Friday Institute, 2015). The Plan provides specific recommendations for State actions that will guide and support K-12 schools in their transitions to digital-age education.

Guiding Principles

The NCDLP builds upon a core set of guiding principles that reflect both relevant research and input from North Carolina educators and other stakeholders:

- Focus on teaching and learning, enabled and enhanced by technology.
- Leverage existing innovations, expertise, and resources from throughout North Carolina, while also building upon national and international models and research.
- Build school and district leadership capacity throughout the State.
- Engage teachers, administrators, students, parents, and other stakeholders.
- Ensure equity of educational opportunity for all students throughout North Carolina.
- Plan for long-term sustainability, continuous improvement, and an educational return on investment.

These parallel the principles driving the Ontario initiative.

Recommendations

The six areas of recommendations in the NCDLP are delineated in Figure 4.

Figure 4: Six Areas of Recommendations in the North Carolina Digital Learning Plan

Three themes that are particularly important from a regional perspective are a) human capacity, b) policy and funding, and c) regional and state support systems.

Human Capacity

The NCDLP recommendations for the human capacity theme are:

1. Develop and implement digital learning competencies for teachers and administrators.
2. Provide professional development for school and district leaders, instructional support staff, and technical staff.
3. Develop a network of professional development facilitators to prepare teachers for digital learning.
4. Guide teacher and administrator preparation programs to ensure that their graduates are ready for digital-age schools.

These are important sequential steps for the Ontario initiative.

Policy and Funding

The NCDLP recommendations for policies and funding are:

1. Update State policies to provide the support and flexibility needed for local digital learning innovations.
2. Provide guidance to help educators address privacy, security, copyright, and responsible use issues.
3. Develop new State and local funding models to support and sustain digital-age learning.
4. Provide additional supports to ensure equity of digital learning opportunities for all students.

The equity theme is particularly important, so that digitally based educational improvement initiatives narrow rather than widen current achievement gaps between various populations.

Regional and State Support Systems

The NCDLP recommendations for regional and state support systems are:

1. Establish the North Carolina Digital Learning Collaborative to manage the recommended State programs.
2. Establish Regional Digital Learning Networks to support digital learning initiatives and foster collaborations.
3. Implement a digital learning progress dashboard and data-informed continuous improvement processes.

This empowers province-wide support for local initiatives.

Ontario's Use of the North Carolina Digital Learning Plan

The North Carolina Digital Learning Plan (NCDLP) is a well-documented and proven model for digitally based educational improvement across a large geographic region. For these reasons, the Ministry of Education asked Dr. Dede to profile key features of the NCDLP as part of his interactive keynote session for Ontario school board leadership teams attending the Annual 21st Century Teaching and Learning Roundtable event in February 2016.

Subsequently, the web-links to the NCDLP resources were made available to all Ontario school districts and profiled as a useful resource that boards were encouraged to consider as part of the key messages in professional learning opportunities (live and videotaped) that supported the rollout of the Technology and Learning Fund (TLF) online action planning and reporting tool that is a requirement for all districts in accounting for their use of TLF funding each year.

Anecdotally, the ministry is aware that some school boards are beginning to apply and integrate the NCDLP framework as a resource to support the board's strategic planning and board improvement planning processes. At a provincial level, the ministry team is also using the NCDLP framework as one of the lenses it applies as it reviews district online reports and plans for evidence of how Ontario practices are aligned with leading international research on effective innovation scaling for deeper learning practices, enabled and enhanced by technology. The ministry team is also supporting capacity building and professional learning for school and system leaders in a variety of means. This includes plans for profiling resources such as the NCDLP framework as part of the ministry's menu of virtual and voluntary professional learning sessions the ministry team is developing for offer during the 2016-17 school year.

Overall, Ontario is building on leading-edge frameworks and strategies for systemic innovation using digitally enabled educational improvements. In turn, the Ontario model is emerging as a valuable resource for other regions seeking to accomplish educational transformation at scale.

Framework: Scaling Up Educational Improvements

Research has documented that in education, unlike other sectors of society, the scaling of successful instructional programs from a few settings to widespread use across a range of contexts is very difficult, even for innovations that are economically and logistically practical (Dede, Honan, & Peters, 2005). In fact, research findings typically show substantial influence of contextual variables (e.g., the teacher's content preparation, students' self-efficacy, and prior academic achievement) in shaping the desirability, practicality, and effectiveness of educational interventions (Barab & Luehmann, 2003; Schneider & McDonald, 2007). Therefore, achieving scale in education requires designs that can flexibly adapt to effective use in a wide variety of contexts across a spectrum of learners and teachers. Clarke and Dede (2009) document the application of a five-dimensional framework, based on Cynthia Coburn's work (2003), for scaling up to the implementation of the River City multi-user virtual environment for middle school science:

- *Depth* concerns the quality or effectiveness of the innovation. An educational innovation has depth to the extent that its implementation and use leads to changes that are desired by the innovation designer.
- *Sustainability* concerns the extent to which the innovation is maintained in ongoing use. An educational innovation is sustained if those persons who implemented the innovation continue to use it.
- *Spread* is the extent to which large numbers of people or organizations adopt an innovation. Spread is the sum of each adoption decision, which can be measured by adopters trying an educational innovation, going through training or licensing it, or buying it.
- *Shift* is a decentralization of ownership over the creation of an innovation. Adopters, through adaptation behavior, can significantly change an innovation or come to share in representing it to other, later potential adopters.
- *Evolution* concerns learning from adopters by the original creators of an innovation. When creators change their own practice or work as a result of others' good ideas, they evolve.

Figure 5 presents a more detailed overview of this framework about designing for scale. This framework has been successfully applied in a wide variety of context (Dede, 2006; Dede, Rockman, & Knox, 2007; Dede, 2013; Dearing et al, 2015). Ontario's usage of this suite of strategies for scaling builds on a solid foundation of both theoretical validity and proven results across a range of innovations and settings.

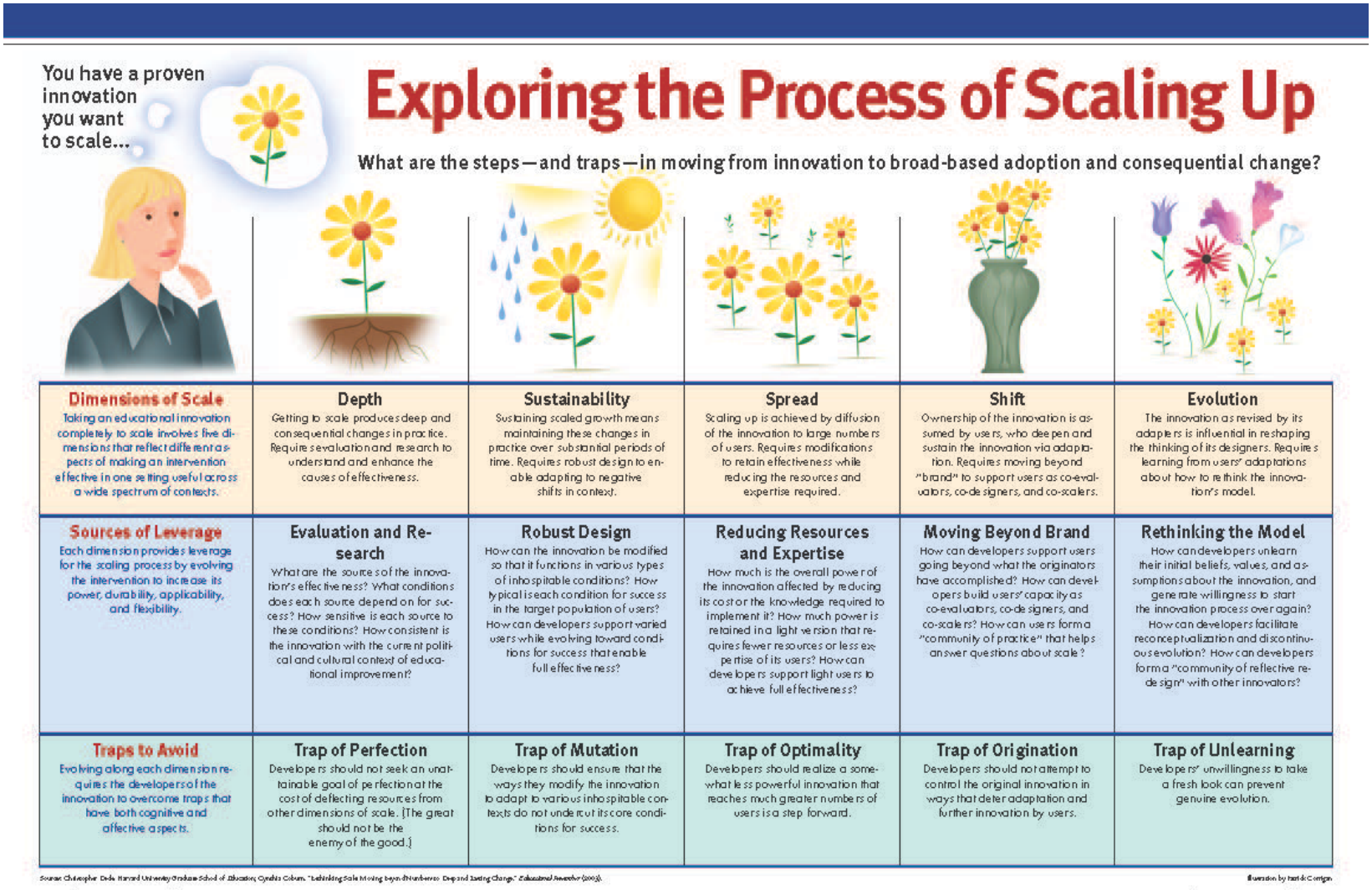

Figure 5. The Process of Scaling Up

Ontario's Use of the Innovation Scaling Framework

An important goal since the start of Ontario's evolving 21st Century Teaching and Learning Strategy is to inform its approach with leading international research in the emerging field of '21st century learning,' with a particular focus on guiding and supporting Ontario school districts in moving beyond 'pockets of innovation' toward systematizing and scaling effective practices in their jurisdiction. The 21st century Innovation Research is a collaborative research investigation co-sponsored by the Ministry of Education and CODE together with Ontario's 72 school districts, four school authorities and the provincial schools. An external research team reports on the overall and individual project results each year, applying a common research framework for gathering impact evidence across all jurisdictions' locally-determined projects.

An illustration of exemplary usage of the scaling framework is provided by York Catholic DSB in its board narrative. Its project (Board-wide Implementation of ePortfolio in Support of Creating Pathways to Success: An Education, Career/Life Planning Program) was an initiative focused mostly on the "spread" element within school communities as a major contributor to system scaling. To that end, each elementary school had a team of three teachers receive direct training within their division to capture evidence of student thinking and learning. "These same teachers then worked with an administrator to develop a school-wide implementation and training plan that responded to the needs and circumstances of the school, with a view to scale and spread to every teacher and student in the school."

Annual roundtable events co-sponsored by the ministry and CODE support professional learning for district leadership teams and always include the objective of situating Ontario's innovation work in a context of international trends and research on 21st century learning and innovation scaling.

Dr. Chris Dede is an advisor and critical friend for this multi-year endeavour, sharing his experience and expertise with Ontario school and system leaders and with the ministry in a variety of ways, including through his keynote address at each annual Roundtable event. Dr. Dede's expert knowledge on innovation scaling is directly influencing and guiding Ontario's way forward as a system. He first brought the Dede and Coburn Innovation Scaling framework to the attention of Ontario leaders during his keynote at the Roundtable 2013, with the framework and a videoclip of his remarks made available to delegates (and others) by posting on the ministry-sponsored EDUGAINS web-site.

In 2014, the government announced a new $150M Technology and Learning Fund (TLF) over three years and the ministry integrated the earlier 21st century innovation research as a component of the TLF. The ministry created an online action planning and reporting tool and related TLF guide, for school board reporting and accountability in connection to their TLF allocations. Dede and Coburn's Innovation Scaling Framework was made readily available as a planning resource to support school districts in their TLF innovation research projects in 2014-15, and, in the 2015-16 update of the online reporting and action planning tool, the Innovation Scaling framework was integrated into the tool and related professional learning supports (live and videotaped).

Leadership Strategies

The following section draws heavily on Honig and Rainey's research overview (2015), as previously referenced in the section on deeper learning at the district level (see this document page 9).

In order to achieve ambitious instruction and a coherent system of performance, central office leaders need to not just tinker with current systems but transform them (Honig, 2013). In order to create this reality, Honig and Rainey (2015) cite three main design elements common in district performance alignment (p.7):

- Define high-quality teaching and principal and teacher leadership;
- Ensure that principal supervisors are truly focused on supporting principals' instructional leadership growth; and
- Enable all district staff to focus their time and other resources on activities that support schools' pursuit of deeper learning.

District Priority #1: Define high-quality teaching and principal and teacher leadership

Honig and Rainey (2015) identify the following four action items to define and develop high quality teaching and principal and teacher leadership (p.8):

- Include a manageable number of elements or a process for use that involves selecting certain elements to focus growth
- Distinguish elements by their proximity to student learning
- Differentiate definitions by type of staff member when appropriate (e.g., grade level)
- Use in the context of process that helps users develop a shared understanding of the definitions

Clear and explicit definitions of high quality teaching and corresponding principal instructional leadership must be developed collaboratively by teachers and principals at the school level. According to Honig and Rainey (2015, p. 8):

> Such joint sense-making is fundamental to professional learning, providing educators with a common image, or mental model, of the kind and level of performance to which they aspire, and which they can use to guide improvements in their practice (Collins et al. 2003). We have found that teachers and principals are likely to benefit from district improvement efforts when they have opportunities to participate in defining their professional standards and deciding which of them to prioritize (e.g., Turnbull et al. 2015; Honig et al. 2010; Honig 2013).

Definitions of high-quality teaching and principal instructional leadership can also support coherence in central offices. For example, according to Honig and Rainey (2015, p.8):

> School districts that have successfully improved the quality of the teachers and principals that they hire use such definitions to focus recruitment, screening, and selection processes, and they frequently use performance tasks to gauge how well a candidate performs in relation to those targets… Many teachers and principals in our partner districts report that when district staff neglect to prioritize their goals, they tend to resort to checklist-style observations—simply marking off whether or not they see evidence of particular practices, rather than collecting the detailed information about classroom teaching and principal leadership that would allow them to provide meaningful feedback or assess the value of a particular professional development strategy.

However, Honig and Rainey (2015) also caution that while definitions of high-quality teaching and principal instructional leadership are necessary, they are not sufficient. District leaders need to comprehensively address central office performance, asking themselves: What would the office look like

if it were truly designed to support instructional leadership, high quality teaching, and ultimately deeper learning? (p.9)

District Priority #2: Ensure that principal supervisors are truly focused on supporting principals' instructional leadership growth

Honig and Rainey (2015) identify the following three action items to support principals' instructional leadership (p.10):

- Define the role as a dedicated support to principals' growth as instructional leaders
- Reinforce the focus of principal supervisors on the specific teaching moves that research has associated with improved instructional leadership
- Develop a system of support for principal supervisors to develop their expertise

Honig and Rainey (2015) have found that principal supervisors typically spend the bulk of their time engaged in administrative tasks, such as monitoring schools' compliance with federal, state, and district policies and conducting principal evaluations, rather than supporting principals' growth as instructional leaders. Principals often needed intensive and personalized supports, which district principal supervisors are in unique positions to support.

District Priority #3: Enable all district staff to focus their time and other resources on activities that support schools' pursuit of deeper learning.

Honig and Rainey (2015) identify the following three action items to enable better central office support of deeper learning in schools (p.11):

- Ensure that all central office work meaningfully contributes to a common theory of action related to improving the quality of classroom teaching and ultimately student learning.
- Start with the redesign of Curriculum & Instruction and Human Resources:
    - Generate rich, meaningful data about the quality of teaching and leadership in every school relative to the districts' standards, strategic plan goals, and the school's improvement goals. Promising systems for generating such data include decision- or question-oriented data dashboards and school improvement planning processes that lead schools through such data gathering.
    - Encourage the collaborative use of such data by staff of Curriculum & Instruction, Human Resources, and schools, as well as by principal supervisors, to identify capacity gaps and promising points of leverage for broader improvements in teaching and learning. Points of leverage include the strategic movement of staff to ensure better fit between person and position and the provision of high-quality professional learning opportunities.
- Engage non-instructional units in ensuring that their work, too, contributes meaningfully to a common theory of action about how every aspect of central office work, singly and with others, contributes to improvements in teaching and learning.

District leaders must have access to the right data at the right time to enable system-wide improvement and must continually question where teachers are in relation to the instructional goals and what supports are needed to address the existing gaps. This will ensure targeted efforts, rather than blanketed professional development "solutions."

As an exemplary illustration of applying these principles, the Bruce-Grey Catholic DSB documented in its board narrative how:

> This year, our organizational structure focused around professional learning in hub session in order to set a focus of working towards the board math goal. We also focused on IT through our Strategic Plan and will continue to address at the system level for both sustainability and moving forward with 21st Century competencies. We have people who sit on many committees and work in different capacities, who are able to see links and embed our plan of scaling forward with modern learning within their learning hubs. A collaborative approach allows us to all work toward the common goal of improving students' ability to communicate their math thinking through the processes.

For further detail on leadership strategies for central offices, see Honig and Rainey's research overview (2015) on which this discussion was based.

Ontario's Use of Leadership Frameworks

Ontario has a well-established leadership strategy and leadership framework, in recognition of the importance of leadership as second only to classroom teaching in its influence on student achievement and well being. As an illustration, the Simcoe County DSB describes in their board narrative:

> Although the bulk of new educator learning happens in classrooms alongside our students, our shift in culture has been focused on whole system learning rather than limiting new learning to classroom teachers. The idea of learning and modeling from the classroom to the boardroom has helped us deepen our new learning.

Ontario Leadership Strategy

The Ontario Leadership Strategy was developed to foster leadership of the highest possible quality in schools and school boards.

School and system leaders play a critical role in creating the conditions of success, increasing student achievement, reducing gaps in student achievement and increasing public confidence in publicly funded education.

The district and provincial approaches build on current, leading-edge conceptual frameworks and research findings about leadership for technology-based educational transformation. The work of Michael Fullan and British educator Andy Hargreaves is influential in this work. In 1998, Hargreaves and Fullan co-authored *What's Worth Fighting for Out There?* The central theme of this book was that teacher quality and morale were fundamental to pupil learning and well-being, and strategies for empowering teachers were put forth. A prior volume by Fullan (1997) focused on similar strategies for principals and school leaders. Hargreaves and Fullan subsequently co-authored *Professional Capital: Transforming Every School* (2012) and have served as advisors to Ontario's executive leadership team, Minister, and Premier.

Another advisor who has played a key role in Ontario's school leadership initiatives is Carol Campbell, who has advanced research- and evidence-informed decision making across the ministry and within the sector. She has studied the Teacher Learning and Leadership Program (Campbell, 2013), as well as documenting successful and sustainable practices for raising student achievement in literacy and numeracy (2007).

What is the leadership strategy?

The Ontario Leadership Strategy is a comprehensive plan of action. The strategy supports student achievement and wellbeing by attracting and developing skilled and passionate school and system leaders.

The strategy has two goals:

1. Attract the right people to the principalship

2. Help principals and vice-principals develop into the best possible instructional leaders

The Ontario Leadership Framework is central to the Ontario Leadership Strategy. It describes a set of core leadership competencies and effective practices for principals, vice-principals and supervisory officers.

The Leadership Framework is made up of two parts:

1. Leader competencies and practices that have been shown to be effective in improving student achievement.
2. System practices and procedures that boards should have in place to support school and system leaders to be effective.

https://education-leadership-ontario.ca/en/

http://www.edu.gov.on.ca/eng/policyfunding/leadership/

The OLF and OLS work in tandem with related provincial resources and guidance processes for research- and evidence-informed decisions for continuous improvement, including the Board Improvement for Student Achievement resources and cycle, the School Effectiveness Framework and more recently, Ontario's Renewed Mathematics Strategy.

Ontario's renewed education vision and action plan, Achieving Excellence, commits the province / ministry to 'invest in innovative teaching practices and instructional methods enabled by technology to more precisely engage and address the learning needs of all students,' and to 'work with teachers, principals, and supervisory officials and their professional associations to identify and share effective and innovative teaching practices that include the use of technology.' (Achieving Excellence: A Renewed Vision for Education in Ontario, April 2014, p. 6 & 7). The introduction of a new $150M Technology and Learning Fund over three years, beginning in 2014, is advancing the province's education vision and commitments in these areas, by investing in deeper learning practices and fostering 21st century / global competencies, enabled by technology. TLF investments support Innovation Research projects in all Ontario school boards; they also support professional learning partnerships to foster a shared vision and leadership at every level for Ontario's renewed education vision, with provincial groups that include provincial principals' associations, supervisory officials' associations, and the Council of Ontario Directors of Education (CODE) among other key education partners.

TLF funding for Ontario school districts provides enhanced supports for digital technology acquisitions and related professional learning for educators, and Innovation Research projects to support research and evidence-informed decision making for system transformation oriented to deeper learning practices and competencies. The external research team that is reporting on the impacts of the locally determined TLF Innovation Research projects in boards has consistently reported findings on "the growing understanding that leadership is the key to scaling innovative practice. A shift in mindsets within schools is occurring because there is strong leadership and support. For example, principals were reported to be playing a strong role as instructional coach and that they are developing technical fluency with system tools. There is continued support for administrators and leaders as they recognize the advantages offered by the digital world." (unpublished, Preliminary Findings Local Innovation Research Projects in Ontario Round 5 draft Aug. 2016).

In line with the findings by Honig and others, CSC's report on Ontario Innovation Research (round 5 draft) also reports that "Systems reported less on infrastructure needs and challenges than in previous Rounds of study and are focusing more on the human impact of change such as support for teachers and building bridges between and among different board personnel in order to provide a more coordinated platform for technology use across the district.

The ministry's reporting and action planning framework design reinforces the important contribution that clarity on the board's 'common theory of action' related to improving and changing pedagogy and ultimately student learning, combined with related monitoring and measuring processes to gather related data for evidence-informed decisions make to the district's effectiveness in innovation scaling for improved student outcomes.

Illustrating the importance of team-based professional learning in this process, the Simcoe CDSB describes in its board narrative:

> In our third system inquiry, staff elementary and secondary are participating in our STEAM (Science, Technology, Engineering, Arts, Mathematics) - Integrated Learning Inquiry. Each elementary school team is comprised of the Teacher Librarian and two Grade 7 or 8 teachers. In secondary schools, the team is comprised of the Teacher Librarian and three teachers from Science, Technology, Arts and/or Mathematics. Our goal in STEAM education is to give students opportunities to build skills, including problem-solving, as well as conceptual understanding across subject areas while applying those skills to authentic task. Evidence of the learning is being captured in our Digital Learning Stories which are open and transparent document: Each learning story is accessible to the system to view and comment.

Professional learning is also highlighted by the Avon Maitland DSB in its board narrative:

> We have invested Teacher Technology coaches, elementary (itinerant) and secondary (job-embedded) teachers, assigned to schools to support tech-enabled teaching and learning. " "...teachers have been afforded opportunities for networked learning both during and outside of instructional tie, and during the summer, where they have had opportunities to dig into topics such as blogging, challenge/problem based learning, and foundational skills training.

The CSC reports for Round 5 will soon appear. Evidence in the school board action plans for 2016-17 suggests movement toward using data to design more differentiated, job-embedded, and in some cases, ongoing self-directed professional learning opportunities as well as team-based professional learning that includes the principal as co-learner, moving away from blanket professional learning event offerings for staff.

Conclusion

This research synthesis has described illustrative conceptual frameworks and scholarly findings that support how Ontario is accomplishing its evolving, multi-phased 21st Century Teaching and Learning Strategy.

Ontario's emphasis on effective teaching practices builds on the U.S. National Research Council's (NRC) landmark reports, *How People Learn* (2000), and *How Students Learn* (2005). More recently, the NRC (2012) formulated "deeper learning" as an instructional approach to convey 21st century knowledge and global competencies. Conceptual frameworks, theoretical foundations, empirical research findings, and implementation strategies, and evaluation methods from deeper learning pervade and parallel Ontario's ongoing educational initiatives.

"Effective teaching" provides another set of principles to guide educational improvement. The OECD has delineated core principles for this type of instruction, which have been validated by research spanning many countries. In particular, the recently released *Handbook of Research on Teaching*, *5th Edition* (2016) describes effective uses for technology in teaching global competencies. Ontario's initiatives draw on these important frameworks and research insights.

Assessing student outcomes is another crucial factor in educational improvement. For global competencies, measuring motivation is as important as assessing learning. Ontario's strategies are based on the latest theoretical frameworks, measurement instruments, and research findings in this area, placing it among the leaders in the international community. As with instruction, the Deeper Learning initiatives provide useful approaches and insights for actualizing these types of assessments, and Ontario is applying these ideas as well.

System reform/transformation at scale is important in Ontario's province-wide initiatives. In the past few years, new approaches to this challenge have arisen, including DBIR, North Carolina's Digital Learning Plan, and frameworks for scaling up educational innovations. Overall, Ontario is building on leading-edge frameworks and strategies for systemic innovation using digitally enabled educational improvements. In turn, the Ontario model is emerging as a valuable resource for other regions seeking to accomplish educational transformation at scale.

Leadership strategies require coordinating improvement efforts at many levels, from classrooms to schools to entire boards and regions. Ontario has a well-established leadership strategy and leadership framework, in recognition of the importance of active and learning-centered leadership as second only to classroom teaching in its influence on student achievement and wellbeing. Its approaches build on current, leading-edge conceptual frameworks and research findings about leadership for technology-based educational transformation.

Next steps in the multi-year, multi-faceted, evolving 21st Century Teaching and Learning Strategy include continued knowledge mobilization around effective innovation scaling practices, further TLF investments in keeping with Achieving Excellence's focus on supporting "innovative teaching practices and instructional methods enabled by technology to more precisely engage and address the learning needs of all students," and further progress on 21st century / global competencies to inform curriculum reform. All these steps are in keeping with the commitment in Achieving Excellence to "define and develop measures for higher-order skills, such as critical thinking, communication, collaboration and entrepreneurship," and similar recommendations more recently by the Premier's Highly Skilled Workforce Expert Panel to define an Ontario framework for skills and competencies.

Addendum for Measuring Learning

Selecting Measures of 21st Century Competencies

Soland, Hamilton, and Stecher (2013) developed a framework (see Figure 2) for educators to use in evaluating measures of 21st century competencies; these considerations fall into three categories: instructional, practical, and technical, as noted (p.9):

> When determining which test to use, potential users of assessments must consider the purposes of the assessment (Haertel 1999; Messick 1994; Kane 2012). In general, there are four broad purposes for which assessments might be used: (1) monitoring system performance, (2) holding schools or individuals accountable for student learning, (3) setting priorities by signaling to teachers and parents which competencies are valued, and (4) supporting instructional improvement (Schwartz et al. 2011).

Considerations When Selecting Measures of 21st Century Competencies

Instructional
Formative or summative
Actionable information to teachers
Useful feedback to students
Grade/context appropriate
Engaging, meaningful, and authentic for students
Encourages effective teaching and learning
Practical
Cost
Ease of training
Ease of scoring
Ease of administration
Ease of technological implementation
Technical
Reliability
Validity
Fairness

Figure 2: Important Dimensions for Measures of 21st Century Competencies

With regard to instructional considerations, it is important to consider whether the measure is to be used for formative or summative purposes (e.g. to inform ongoing instruction or to determine whether interaction was effective after it has taken place). Soland, Hamilton, and Stecher (2013) provide the following example (p.10).

> …the use of frequent formative assessment in elementary reading might help a teacher determine whether a student is struggling with vocabulary, phonemic awareness, phonics, or comprehension. In fact, many scholars argue that formative assessment is a process rather than a test (Heritage 2010) and that effective formative assessment practice involves teachers setting goals, engaging in frequent feedback cycles with students, adjusting instructional practices in response to assessment data, and engaging students in the assessment process by providing individualized instruction and opportunities for self-assessment (Black et al. 2003; Heritage 2010; Herman, Osmundson, and Silver 2010).

In contrast, summative assessments evaluate teaching and learning after it has transpired. Soland, Hamilton, and Stecher (2013) provide the example of Advanced Placement examinations used at the end of an accelerated course to determine if the student has mastered course content.

With regard to the practical, cost is an important factor in evaluating and selecting an assessment. The complexity of the test format often drives the cost; therefore, Soland, Hamilton, and Stecher (2013) note that some 21st-century competencies maybe more expensive to test than prior traditional measures.

In addition to instructional and practical considerations, educators must also think about the technical quality of the measure -- whether it captures what it claims to measure and whether it provides consistent and meaningful results. While technical criteria may be more complicated from a statistical perspective, these considerations are critical when evaluating and selecting an assessment.

In their research, Soland, Hamilton, and Stecher (2013) also created 12 guidelines – not rules – that might help to improve the implementation of selected assessments (see Figure 3). As always, implementation will vary from location to location and local priorities should dictate the weight of criteria and decision-making.

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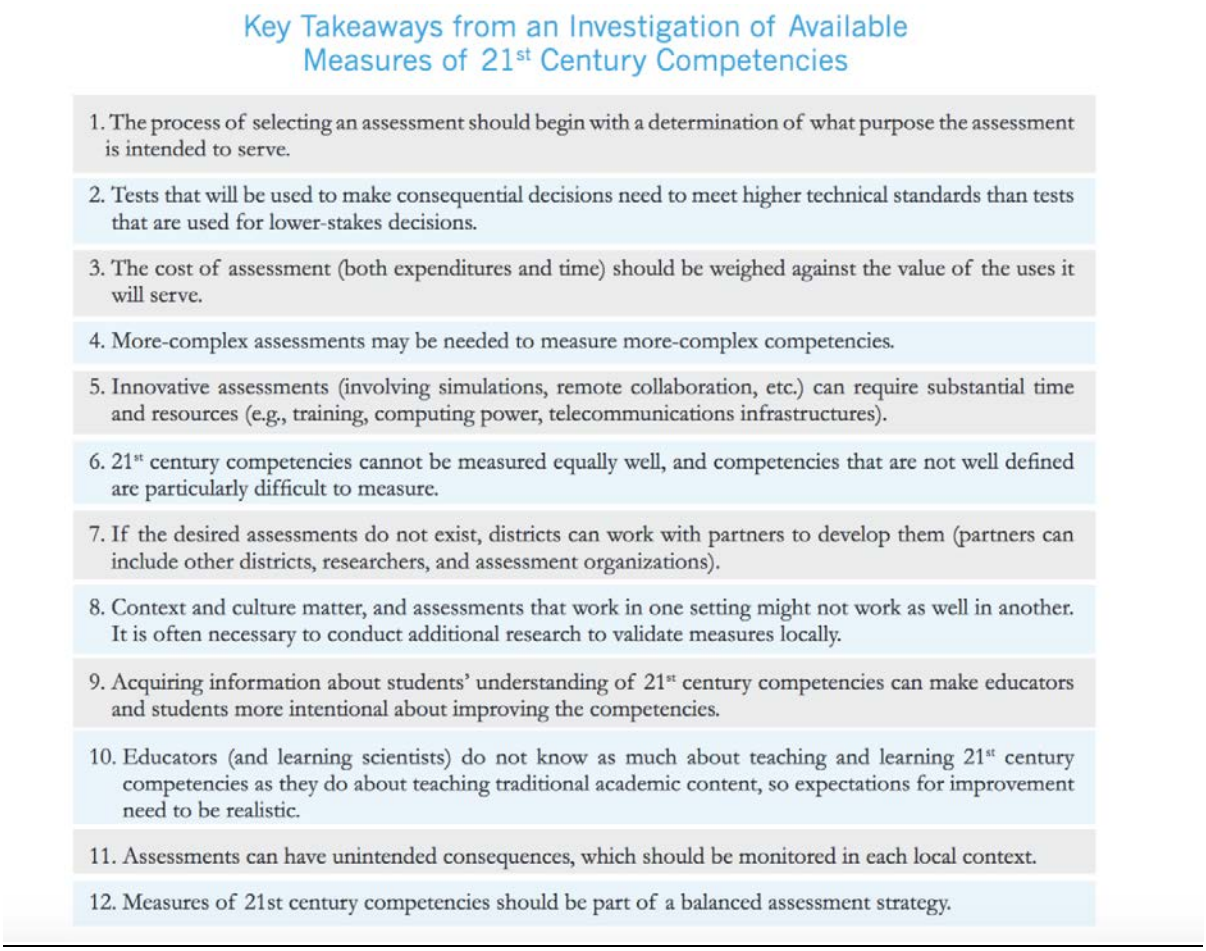

Figure 3: Guidelines for Implementing Measures of 21st Century Competencies

The following discussion provides a synopsis of the 12 guidelines for implementing measures of 21st Century competencies.

Twelve Key Takeaways from an Investigation of Available 21st Century Measures

The following section summaries the 12 guidelines featured in Soland, Hamilton, and Stecher's research overview (2013) entitled *Measuring 21st Century Competencies: Guidance for Educators*.

#1: The process of selecting an assessment should begin with what purpose it is intended to serve.

The first thing educational leaders should consider when thinking about adopting an assessment is its purpose. For example, why do we want to measure critical thinking? How will the resulting information be used? There are a number of possible purposes that might be served by an assessment, and each might lead to different assessment choices (Soland, Hamilton, & Stecher, p. 39) Schools and school systems are at greater risk of adopting assessments that do not measure exactly what is valued when measurement products, such as tests and instruments, are the initial focus. It is critical to first understand the intended purpose of the assessment and then to locate an appropriate assessment that will support the desired purpose and provide the desired information.

#2: Tests that will be used to make consequential decisions need to meet higher technical standards than tests that are used for lower-stakes decisions.

Rigorous technical standards are critical for assessments used to make decisions about student -- or teacher -- placement, attainment, and accountability. When test scores carry important consequences, it is vital that a student's score not be influenced by an individual rater or task. In addition, technical standards should not be ignored for instruments used only for formative assessments. If the reliability of a test is low, then those scores will not provide useful even for low-stakes decisions.

#3: The cost of assessment (both expenditures and time) should be weighed against the value of the uses it will serve.

Educational resources, including money and time, are typically limited. As a result, both cost and time need to be factored into decisions of assessment selection. Unfortunately, it is rarely possible to do a clear cost–benefit analysis of an assessment, because it is difficult to measure accurately either costs or benefits. However, the decision to adopt a costly or time-consuming test usually brings reductions in other areas, such as instructional time and/or professional development. Therefore, costs of money and time should be carefully thought through when adopting an assessment.

#4: More-complex assessments may be needed to measure more-complex competencies.

Although some 21st century competencies can be measured individually with an established, low-cost assessment that uses paper and pencil, other assessments measuring multiple competencies or especially complex competencies require more innovative formats. As the complexity of the competency increases, so too does its measurement, which usually results in more costly computer-based formats.

#5: *Innovative assessments (involving simulations, remote collaboration, etc.) can require substantial time and resources (e.g., training, computing power, telecommunications infrastructures).*

Many assessments of 21st century competencies involve computer simulations of real-world scenarios that are often demanding of school resources. When determining whether to invest in a software of online assessment package, districts and schools must consider their technological capacity and then determine the level of investment possible, given all other budget demands, in order to have a multi-faceted, real-world assessment. These real-world, scenario-based, computer assessments often involve a student partnering with an avatar, rather than a live peer, because an avatar can be controlled, increasing reliability and validity. Manipulating an avatar's response to a situation also allows for eliciting of specific skills not tied to academic mastery, such as critical thinking and resilience.

#6: 21st century competencies cannot be measured equally well, and competencies that are not well defined are particularly difficult to measure.

Despite all of the advances in measurement and technology, some competencies are still difficult to measure well; this phenomenon occurs when there are several overlapping component skills, which lack clear delineation and definition. For example, there are several assessments that measure leadership styles; however, there is not an assessment tool with high levels of reliability and validity for measuring a student's overall leadership ability (regardless of style) because leadership is a multi-faceted construct that includes communication, collaboration, and creativity. Although advances in technology are likely to improve the quality and feasibility of measuring some skills, technology is not likely to support measuring competencies that are not clearly defined.

#7: If the desired assessments do not exist, districts can work with partners to develop them (partners can include other districts, researchers, and assessment organizations).

Many of the new assessments were developed in joint ventures between educators, government agencies, and search organizations with psychometric expertise. For example, the Programme for International Student Assessment's (PISA) Collaborative Problem-Solving (CPS) test was developed by education policy makers and educators in collaboration with the Educational Testing Service (ETS). While this partnership relied on support from organizations staffed with professional psychometricians, some governments have relied on internal expertise; the Queensland Performance Assessment involved consultation with external psychometricians at universities but was largely developed through collaboration between the Queensland government and local schools. New measures can be developed through partnerships if the assessments do not meet local needs.

#8: Context and culture matter, and assessments that work in one setting might not work as well in another. It is often necessary to conduct additional research to validate measures locally.

While a particular measure might be validated for predictive value in one setting, it may not be predictive in all settings or under all circumstances. Extra caution is warranted when considering measures of 21st century competencies, such as interpersonal and intrapersonal skills, because these may be more culturally and contextually dependent than traditional academic skills. As possible, the validity score of a given measure should always be confirmed locally.

#9: Acquiring information about students' understanding of 21st century competencies can make educators and students more intentional about improving the competencies.

Measuring 21st century competencies can make the process of cultivating these skills more intentional for teachers and students. For example, for teachers, an awareness of how a construct is measured can result in the increased use of such measures in assignments and scoring rubrics. As a result, students also become more attuned to the importance of these competencies and think about them more concretely when doing their work. In addition, the assessment process also provides a shared vocabulary. For example, teachers might attend a professional development session and be able to discuss specific competencies and have concrete student data to augment these conversations. Students and parents can also benefit from these concrete discussions, if this vocabulary and data is explicitly used in report cards and parent-teacher conferences/meetings.

#10: Educators (and learning scientists) do not know as much about teaching and learning 21st century competencies as they do about teaching traditional academic content, so expectations for improvement need to be realistic.

Although new research on teaching 21st century competencies is emerging all of the time (Saavedra and Opfer 2012), there is much uncertainty around best practices for instruction of 21st century competencies. This emerging uncertainty contributes to confusion around addressing results from (or, gaps in) competency assessments. Lack of clarity around instructional approaches results from research studies which note that certain skills may be influenced by factors outside of school; more information is needed to understand how teachers can expect to influence these competencies. For example, some schools in the United States and Asia are actively measuring and teaching creativity, which research suggests can be taught (Ball, Pollard, and Stanley 2010; Shallcross 1981; Sternberg 2010). Nonetheless, it is unclear whether creativity is driven more by factors inside or outside the classroom and what this means for classroom practice (Craft et al. 1997; Dudek 1974). As a result, in many schools, there is confusion around how to best use data from 21st century competency assessments to have the greatest influence on improving these skills.

#11: Assessments can have unintended consequences, which should be monitored in each local context.

The decision to adopt 21st century assessments usually reflects a desire to promote attention and mastery of these competencies. However, despite potential benefits, every test carries risks of unintended and undesirable consequences. For example, measuring a student's motivation could help a student understand his/her strengths and weaknesses and foster improvement in this competency. If used alternatively, these same results could lead to this student receiving labels that hinder development by generating self-fulfilling prophecies. Another unintended consequence might be revealed in an unanticipated or unwanted change in instructional practice as a response to the assessments. For example, high stakes testing can narrow the curriculum when teachers feel pressure to teach to the test. Many of these unintended consequences can be avoided through careful design of testing accountability policies and through monitoring of the use of test scores.

#12: Measures of 21st century competencies should be part of a balanced assessment strategy.

The adoption of innovative assessments measuring 21st century competencies should not come at the expense of other, proven, more common assessments. It is still essential to ensure that students are mastering core academic content. Innovative measures are not meant to replace existing measures, but instead, augment these measures with a more balanced, holistic system of assessments in schools and school systems.

In an effort to illustrate the principles examined above, the following discussion provides two brief case studies of innovative 21st century assessments – Alelo Language and Culture Simulations and Queensland Performance Assessments.

Case Studies of 21st Century Measures

To further contextualize the principles above, two examples below – Alelo Langiage and Culture Simulations and Queensland Performance Assessments – highlight cutting-edge measures and the practical, technical, and instructional considerations.

Alelo, a company that spun off from a project at the University of Southern California, uses social simulation to teach foreign languages. In an online platform, students interact with an avatar in the selected foreign language, allowing students to learn through interactions with a native speaker in a culturally-specific, skill-appropriate level. For example, a student learning Spanish and planning to travel

to Argentina will interact with an avatar that will use local pronunciations and particular idioms. If a student speaks in a way that is not culturally-specific for a given country, the avatar will react accordingly. The measures built into the program are mainly formative rather than summative, allowing students opportunities to retry scenarios and thereby generate improved outcomes from their interactions.

With regard to practical considerations, Alelo's simulation blends curriculum and measurement, designed to mirror the real process by which individuals develop language fluency with native speakers by receiving real-time feedback. With regard to technical considerations, Alelo's simulations are real-time and informal, which lowers traditional reliability and validity estimates. Instead, research conducted by the developers has shown that learning in the simulation compares with learning in a classroom, especially for long-term fluency outcomes. With regard to instructional considerations, Alelo is currently expanding into K-12 and higher education environments, so very little information is available on classroom uses. Alelo has been used extensively by the military and has won numerous awards, suggesting that the interface is straightforward and academically beneficial (Johnson and Zaker 2012). Alelo's research in Denmark showed that although the software is expensive, Alelo generates overall savings by reducing the need for in-class conversation time.

Queensland Performance Assessments (QPAs) measure academic knowledge, as well as problem-solving, communication, and meta-cognition. In response to Australia's high-stakes university entrance exams of the 1970s, Queensland developed its own externally moderated school-based assessment system. Rather than rely on a single data point at a precise moment in time, the new assessment system is built on purposeful, systematic, and ongoing data collection of student learning over time and is designed to create a tighter link between instruction and assessment. To achieve this goal, teachers across schools develop the tests – even those for high-stakes decisions – based on national standards and with support from psychometric experts from Queensland Studies Authority (QSA). According to the QSA, the approach promotes teacher professionalism (Queensland Studies Authority, 2010).

With regard to practical considerations, the primary feature of the QPAs is that they are extremely loose on format and tight on scoring; teachers can develop a test in any format they want, as long as the standards used to determine proficiency are clear and comparable across schools. With regard to technical considerations, one might expect reliability to be a major problem under this testing framework but evidence suggests the contrary; in a study conducted by the QSA over more than a decade, consistency across rating of student work has been shown to be quite high (Queensland Studies Authority, 2010). With regard to instructional considerations, the QPAs involve a series of tradeoffs when it comes to implications for teachers. While there is a tighter link between instruction and assessment and an increase in teacher professionalism and responsiveness to different learning styles, the system requires significant resources and compels teachers to devote a significant portion of their time to assessment development and to serving on panels to ensure cross-school comparability.

Conclusion

This report was intended to acquaint educators and school and system leaders with guidance in comparing measures to implement in an assessment system.

Bibliography

Anderson, A. F. et D. Bavelier « Action game play as a tool to enhance perception, attention, and cognition », dans S. Tobias et J. D. Fletcher (éditeurs), *Computer games and instruction*, 2011, pp. 307–330, Hershey, PA, Information Age Publishers.

Barab, S. A. et A. L. Luehrmann « Building sustainable science curriculum: Acknowledging and accommodating local adaptation », *Science Education*, 2003, n° 87, pp. 454–467.

Bartle, R. A., *Designing virtual worlds* (1re édition), Berkeley, CA, New Riders Publishing, 2003.

Bennett, B., « The artful science of instructional integration », dans R. Marzano, (éditeur), *On excellence in teaching*, Bloomington, IN, Solution Tree, 2009.

Ball, L., E. Pollard, and N. Stanley. (2010). Creative graduates, creative futures. *CGCF Higher Education*. Retrieved from http://homepages.lboro.ac.uk/~adjjw/CreativeGraduatesCreativeFutures_ResearchReport_01.10.pdf

Black, P., C. Harrison, C. Lee, B. Marshall et D. William, « Assessment for learning:« »Putting it into practice », Londres, Angleterre, Open University Press, 2003. Consulté à l'adresse http://oro.open.ac.uk/24157/.

Bransford, J., *How people learn: Brain, mind, experience and school*, Washington, D.C., National Academy Press, 2000. Consulté à l'adresse : http://www.nap.edu/catalog.php?record_id=9853.

Bransford, J. D. et D. L. Schwartz « Rethinking transfer: A simple proposal with multiple implications », *Review of Research in Education,* 1999, n° 24, pp. 61-100.

Brophy, J., « Toward a model of the value aspects of motivation in education: Developing appreciation for… », *Educational Psychologist*, 1999, vol. 34, n° 2, pp. 75–85.

Brown, J. S. et D. Thomas, *A new culture of learning: Cultivating the imagination for a world of constant change*, New York, NY, CreateSpace Independent Publishing Platform, 2011.

Campbell, C., J. Comper et S. Winton « Successful and sustainable practices for raising student achievement in literacy and numeracy », *Changing Perspectives – ASCD Ontario*, février 2007, pp. 31-36.

Campbell, C., A. Lieberman et A. Yashkina, *The Teacher Learning and Leadership program: Research project and executive Summary*, Toronto, Fédération des enseignantes et enseignants de l'Ontario, 2013.

Christenson, S., « The relevance of engagement for students at-risk of educational failure: Findings and lessons from Check & Connect research », dans J. Morton (éditeur), *Engaging young people in learning: Why does it matter and what can we do? : Conference proceedings*, pp. 36–84, Wellington, Nouvelle-Zélande, NZCER Press, 2009.

CISCO, *Equipping every learner for the 21st century: An action plan for educational transformation*, 2008. Consulté à l'adresse : http://gelponline.org/sites/default/files/related_documents/equipping_every_learner_for_the_21st_century.pdf.

City, E. A., R. F. Elmore, S. E. Fiarman et L. Teitel, *Instructional rounds in education: A network approach to improving teaching and learning*, Cambridge, Harvard Education Press, 2009.

Clarke, J. et C. Dede, « Robust designs for scalability », dans L. Moller, J. B. Huett et D. M. Harvey (éditeurs), *Learning and instructional technologies for the 21st century: Visions of the future*, pp. 27–48, New York, NY, Springer, 2009.

Coburn, C.E., « Rethinking scale: Moving beyond numbers to deep and lasting change », *Educational Researcher*, 2003, vol. 32, n° 6, pp. 3-12.

Collins, A. et R. Halverson, *Rethinking education in the age of technology: The digital revolution and schooling in America*, New York, NY, Teachers College Press, 2009.

Conley, D. T., *A New Era for Educational Assessment*, Jobs for the Future: Deeper Learning Research Series, Boston, MA, Jobs for the Future, 2014.

Conley, D. T. et L. Darling-Hammond, *Creating systems of assessment for deeper learning*, Stanford, CA, Stanford Center for Opportunity Policy in Education, 2013. Consulté à l'adresse : https://edpolicy.stanford.edu/sites/default/files/publications/creating-systems-assessment-deeper-learning_0.pdf.

Connell, J. P. et J. G. Wellborn, « Competence, autonomy, and relatedness: a motivational analysis of self-system processes », dans M. R. Gunnar et L. A. Sroufe (éditeurs), *Self-processes and development: Minnesota Symposium on Child Psychology (vol. 23)*, Chicago : University of Chicago Press, 1991.

Craft, A., J. Dugal, G. Dyer, B. Jeffrey, and T. Lyons. (1997). *Can You Teach Creativity?* Nottingham, UK: Education Now. file://localhost/Retrieved from http/::oro.open.ac.uk:20308:.

Csikszentmihalyi, M., « The flow experience and human psychology », dans I. S. Csikszentmihalyi et M. Csikszentmihalyi (éditeurs), *Optimal experience: Psychological studies of flow in consciousness*, pp. 15–35, Cambridge, Angleterre, Cambridge University Press, 1988.

Darling-Hammond, L. et J. Bransford (éditeurs), *Preparing teachers for a changing world*, San Francisco, Jossey Bass, 2007.

Dearing, J. W., C. Dede, D. Boisvert, J. Carrese, L. Clement, E. Craft, P. Gardner, J. Hyder, E. Johnson, D. McNeel, J. Phiri, et M. Pleil, « How educational innovators apply diffusion and scale concepts », dans Chee-Kit Looi et Laik-Woon Teh, *Sustaining and Scaling Educational Innovations*, pp. 81-104, New York, Springer, 2015.

Dede. C., « Reaching scale beyond a school-level innovation », *School Administrator*, 2013, vol. 70, n° 4, pp. 33-37.

Dede, C. et J. Richards (éditeurs), *Digital teaching platforms: Customizing classroom learning for each student*, New York, Teacher's College Press, 2012.

Dede, C., S. Rockman, et A. Knox, « Lessons Learned from Studying How Innovations Can Achieve Scale », *Threshold*, 2007, vol. 5, n° 1, pp. 4-10.

Dede, C., « Scaling Up: Evolving Innovations beyond Ideal Settings to Challenging Contexts of Practice », dans R. K. Sawyer (éditeur), *Cambridge Handbook of the Learning Sciences*, pp. 551-566, Cambridge, Angleterre, Cambridge University Press, 2006.

Dede, C., J. Honan et L. Peters (éditeurs), *Scaling up success: Lessons learned from technology-based educational innovation*, New York, Jossey-Bass, 2005.

Dieterle, E., « Neomillennial learning styles and River City », *Children, Youth, and Environments*, 2005, vol. 19, n° 1, pp. 245-278.

Donovan, M.S., Bransford, J.D., & Pellegrino, J.W., eds. 1999. *How People Learn: Bridging Research and Practice*. Washington, DC: National Academy Press.

Donovan, M.S. et J. D. Bransford (éditeurs), *How students learn: Bridging research and practice*, Washington, D.C., National Academy Press, 2005.

Dweck, C. S., « Messages that motivate: How praise molds students' beliefs, motivation, and performance (in surprising ways) », dans J. Aronson (éditeur), *Improving academic achievement: Impact of psychological factors on education*, pp. 37–60, San Diego, CA, Academic Press, 2002.

Dweck, C.S., G. M. Walton, G. L. Cohen, *Academic tenacity: Mindsets and skills that promote long-term learning*, Seattle, WA, Gates Foundation, 2011. Consulté à l'adresse : https://ed.stanford.edu/sites/default/files/manual/dweck-walton-cohen-2014.pdf.

Dudek, S. Z. (1974). Creativity in young children—Attitude or ability? *Journal of Creative Behavior* 8(4): 282–92.

Earl, L. et S. Katz, *Leading schools in a data-rich world: Harnessing data for school improvement*, Thousand Oaks, CA, Corwin, 2006.

Finn, J. D., « Withdrawing from school », *Review of Educational Research*, 1989, n° 59, pp. 117-142.

Fishman, B. et C. Dede, « Teaching and technology: New tools for new times », dans D. Gitomer et C. Bell (éditeurs), *Handbook of Research on Teaching, 5e édition* (American Educational Research Association), pp. 1269-1334*,* New York, NY, Springer, 2016.

Fredricks, J., W. McColskey, J. Meli, J. Mordica, B. Montrosse et K. Mooney, *Measuring student engagement in upper elementary through high school: a description of 21 instruments*, Issues & Answers Report, REL 2011–No. 098, Washington, D.C., U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Southeast, 2011. Consulté à l'adresse http://ies.ed.gov/ncee/edlabs.

Fredricks, J. A., P. C. Blumenfeld et A. Paris, « School engagement: potential of the concept: state of the evidence », *Review of Educational Research*, 1989, n° 74, pp. 59-119.

Friday Institute for Educational Innovation, *Summary: North Carolina digital learning plan*, Raleigh, NC, Friday Institute for Educational Innovation, North Carolina State University, 2015. Consulté à l'adresse : http://ncdlplan.fincsu.wpengine.com/wp-content/uploads/sites/10/2015/09/NCDLP_Summary8.31.15.pdf.

Fullan, M., *What's worth fighting for in the principalship,* New York, Teachers College Press, 1997.

Gini-Newman, G. et L., « Infusing a spirit of inquiry », dans R. Case et P. Clark (éditeurs), *Anthology of Social Studies: Issues and Strategies for Secondary Teachers*, Vancouver, Pacific Educational Press, 2008.

Greenhow, C. et B. Gleason, « Twitteracy: Tweeting as a new literacy practice », *The Educational Forum*, 2012, vol. 76, n° 4, pp. 464-478.

Grzybowski, M., « Educational technologies in South Korea », *General and Professional Education*, 2013, n° 1, pp. 3-9.

Gustafsson, J. E., « What do we know about effects of school resources on educational results? », *Swedish Economic Policy Review*, 2003, n° 10, pp. 77-110.

Haertel, E. H., « Performance assessment and educational reform », *Phi Delta Kappan*, 1999, vol. 80, n° 9, pp. 662-666.

Harel, I. et S. Papert. (éditeurs), *Constructionism*, Norwood, NJ, Ablex Press, 1991.

Hargreaves, A. et M. Fullan, *Professional Capital: transforming teaching in every school,* New York, Teachers College Press, 2012.

Hargreaves, A. et M. Fullan, *What's worth fighting for out there,* New York, Teachers College Press, 1998.

Haertel, E. H. (1999). "Performance Assessment and Educational Reform." Phi Delta Kappan 80(9): 662–6.

Heritage, M., *Formative assessment and next-generation assessment systems: Are we losing an opportunity*, National Center for Research on Evaluation, Standards, and Student Testing (CRESST) and the Council of Chief State School Officers (CCSSO), Washington, D.C., CCSSO, 2010. Consulté à l'adresse http://www.sde.idaho.gov/site/formativeInterim/docs/Formative_Assessment_Next_ Generation_2010.pdf.

Herman, J. L., E. Osmundson et D. Silver, *Capturing quality in formative assessment practice: Measurement challenges* (CRESST Report), Los Angeles, CA, Center for Research on Evaluation, Standards, and Student Testing, 2010.

Hewlett Foundation, *What is Deeper Learning? (aucune date).* Consulté à l'adresse : http://www.hewlett.org/programs/education/ deeper-learning/what-deeper-learning.

Hinton, C., Fischer, K.W., & Glennon, C. (2012). *Mind, Brain, and Education*. Boston, MA: Jobs for the Future, Nellie Mae Education Foundation.

Honig, M. I., *From tinkering to transformation: Strengthening school district central office performance*, Washington, D.C., American Enterprise Institute, 2013. Consulté à l'adresse : https://www.aei.org/publication/from-tinkering-to-transformation-strengthening-school-district-central-office-performance/.

Honig, M. I., M. Copland, L. Rainey, J. Lorton et M. Newton, *Central office transformation for district-wide teaching and learning improvement*, Seattle, WA, University of Washington, Center for the Study of Teaching and Policy, 2010. Consulté à l'adresse : https://depts.washington.edu/ctpmail/PDFs/S2-CentralAdmin-04-2010.pdf.

Honig, Meredith I. et Lydia R. Rainey, *How school districts can support deeper learning: The Need for performance alignment,* Jobs for the Future: Deeper Learning Research Series, Boston, MA, Jobs for the Future, 2015. Consulté à l'adresse : http://www.jff.org/sites/default/files/publications/materials/How-District-Central-Offices-can-Support-DL-at-Scale-092515.pdf.

Honig, M. I., N. Venkateswaran, P. McNeill et J. Myers Twitchell, (en cours d'examen), « Research use as learning: The case of fundamental change in school district central offices », *American Educational Research Journal*,

iN2015 Steering Committee, *Innovation, integration, internationalization: The iN2015 Plan*, 2015. Consulté à l'adresse : http://unpan1.un.org/intradoc/groups/public/documents/unpan/unpan032993.pdf.

Ito, M., S. Baumer, M. Bittanti, D. Boyd, R. Cody, B. Herr-Stephenson, … L. Tripp, *Hanging out, messing around, and geeking out: Kids living and learning with new media*, Cambridge, MA, MIT Press, 2010.

Ito, M., K. Gutierrez, S. Livingstone, W. R. Penuel, J. Rhodes, K. Salen, … S. C. Watkins, *Connected learning: An agenda for research and design*, Irvine, CA, Digital Media and Learning Research Hub, 2013.

Jenkins, H., K. Clinton, R. Purushotma, A. J. Robison et M. Weigel, *Confronting the challenges of participatory culture: Media education for the 21st century*, Chicago, IL, John D. and Catherine T. MacArthur Foundation, 2006.

Johnson, W. L., and S. B. Zaker. (2012). The power of social simulation for Chinese

language teaching. *Proceedings of the 7th International Conference and Workshops on Technology and Chinese Language Teaching in the 21st Century.* http://www.tacticallanguage.com/files/TCLT7_Presentation_Johnson_Zakar_May2012.pdf.

Kane, T., « Capturing the dimensions of effective teaching: Student achievement gains, student surveys, and classroom observations », *Education Next*, 2012a, vol. 12 , n° 4, pp. 35-41.

Kane, T., « Validating score interpretations and uses », *Language Testing*, 2012b, vol. 29, n° 1, pp. 3-17.

Kane, T. et D. Staiger, *Gathering feedback for teaching: Combining high-quality observations with student surveys and achievement gains*, Seattle, WA, Bill & Melinda Gates Foundation, 2012. Consulté à l'adresse : http://k12education.gatesfoundation.org/wp-content/uploads/2015/12/MET_Gathering_Feedback_Practioner_Brief.pdf.

Kane, T. (2012a). Capturing the dimensions of effective teaching: Student achievement gains, student surveys, and classroom observations. *Education Next*, 12 (4), 35-41.

Katz, S., L. Earl et S. Ben Jaafar, *Building and connecting learning communities: The power of networks for school improvement*, Thousand Oaks, CA, Corwin, 2009.

Kemple, J. J., J. P. Connell, A. Klem, N. Legters et J. Eccles, *Making the move: How freshman academies and thematic small learning communities can support successful transitions to and through high school*, Adelphia, NJ, Institute for Research and Reform in Education, 2015. Consulté à l'adresse http://www.irre.org/publications/making-move-how-freshman-academies-and-thematic-small-learning-communities-can-support.

Kurtz, J., « Twittering about learning: Using Twitter in an elementary school classroom », *Horace*, 2009, vol. 25, n° 1, p. 4.

Ladson-Billings, G., *The dreamkeepers: Successful teachers of African American children*, San Francisco, CA, Wiley, 2009.

Lambert, M., *Deeper teaching*, Jobs for the Future: Deeper Learning Research Series, 2015. Consulté à l'adresse : http://www.studentsatthecenter.org/sites/scl.dl-dev.com/files/Deeper-Teaching-120315.pdf.

Lepper, M. R. et J. Henderlong, « Turning “play” into “work” and “work” into “play”: 25 years of research on intrinsic versus extrinsic motivation », dans C. Sansone et J. M. Harackiewicz (éditeurs), *Intrinsic and extrinsic motivation: The search for optimal motivation and performance*, pp. 257-307, New York, NY, Academic Press, 2000.

Medina, J., *Brain Rules: 12 Principles for Surviving and Thriving at Work, Home, and School*, Seattle, WA, Pear Press, 2008.

Mehta, J., « From bureaucracy to profession: Remaking the educational sector for the twenty-first century », *Harvard Educational Review*, 2013, vol. 83, n° 3, pp. 463-488.

Mehta, J., *The allure of order: High hopes, dashed expectations, and the troubled quest to remake American schooling*, New York, Oxford University Press, 2013.

Mehta, J. et S. Fine, *The why, what, where, and how of deeper learning in American secondary schools*, Jobs for the Future: Deeper Learning Research Series, 2015. Consulté à l'adresse : http://www.studentsatthecenter.org/sites/scl.dl-dev.com/files/The-Why-What-Where-How-121415.pdf.

Mehta, J. et S. Fine, « Teaching differently… Learning deeply », *Phi Delta Kappan*, 2012, vol. 94, n° 2, pp. 31-35. Consulté à l'adresse : http://tinyurl.com/kdqklaq.

Messick, S., « The interplay of evidence and consequences in the validation of performance assessments », *Educational Researcher*, 1994, vol. 23, n° 2, pp. 13-23.

Mills, K. A. et V. Chandra, « Microblogging as a literacy practice for educational communities », *Journal of Adolescent & Adult Literacy*, 2011, vol. 55 n° 1, pp. 35-45.

National Center on School Engagement, *Four lessons learned from truancy demonstration sites*, Denver, CO, NCSE, 2009. Consulté à l'adresse : http://schoolengagement.org/wp-content/uploads/2014/03/LessonsLearnedfromFourTruancyDemonstrationSites.pdf.

National Research Council, *Learning science: Computer games, simulations, and education*, Washington, D.C., Board on Science Education, Division of Behavioral and Social Sciences and Education, 2011b.

National Research Council, *Education for life and work: Developing transferable knowledge and skills in the 21st century*, Washington, D.C., National Academy Press, 2012.

New York Hall of Science, *Proceedings from the "Innovation, Education, and the Maker Movement" Workshop*, New York, NY, New York Hall of Science, 2010. Consulté à l'adresse : http://www.nysci.org/media/file/MakerFaireReportFinal122310.pdf.

New York Hall of Science, *Making meaning [M2]*, New York, NY, New York Hall of Science, 2013. Consulté à l'adresse : http://beta.informalscience.org/images/research/2013-05-24_Making%20Meaning%20Report.pdf.

Odden, A., *Strategic management of human capital: Improving instructional practice and student learning in schools*, New York, NY, Routledge, 2011.

OCDE, *Lessons from PISA for the United States, Strong Performers and Successful Reformers in Education*, Paris, Éditions OCDE, 2011.

OCDE, *Lessons from PISA for Japan, Strong Performers and Successful Reformers in Education,* Paris, Éditions OCDE, 2012.

OCDE, *Synergies for better learning: An international perspective on evaluation and assessment, OECD reviews of evaluation and assessment in education*, Paris, Éditions OCDE, 2013.

OCDE, *What makes a school a learning organization? A guide for policy makers, school leaders, and teachers*, Paris, Éditions OCDE, 2016.

Pellegrino, J. et M. Hilton (éditeurs), *Education for life and work: Developing transferable knowledge and skills in the 21st century*, Washington, D.C., National Academy Press, 2012.

Peppler, K. et D. Glosson, « Stitching circuits: Learning about circuitry through e-textile materials », *Journal of Science Education and Technology*, 2012, pp. 1-13.

Queensland Studies Authority. (2010). School-based assessment: The Queensland System. Queensland, Australia. http://www.qsa.qld.edu.au/downloads/approach/school-based_assess_qld_sys.pdf.

Rogoff, B., *Observing sociocultural activity on three planes: Participatory appropriation, guided participation, and apprenticeship*, dans Wertsch, J., P. Del Rio et A. Alvarez (éditeurs), *Sociocultural studies of mind,* pp. 139-164, New York, NY, Cambridge University Press, 1995.

Ryan, R. M. et E. L. Deci, « Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being », *American Psychologist*, 2000, vol. 55, n° 1, pp. 68-78.

Saavedra, A. R., and V. D. Opfer. (2012). *Teaching and Learning 21st Century Skills: Lesson from the Learning Sciences*. New York: Asia Society.

Sanden, S. et J. Darragh, « Wiki use in the 21st-century literacy classroom: A framework for evaluation », *Contemporary Issues in Technology and Teacher Education*, 2011, vol. 11, n° 1, pp. 6-20.

Sawchuk, S., « New York union encourages districts to boycott field tests », *Education Week*, 30 mai 2014. Consulté à l'adresse : http://blogs.edweek.org/edweek/teacherbeat/2014/05/new_york_union_encourages_dist.html?qs=new+york+common+core.

Schleicher, A., éditeur, *Preparing Teachers and Developing School Leaders for the 21st Century: Lessons from around the World,* Paris, Éditions OCDE, 2012. *http://dx.doi.org/10.1787/9789264xxxxxx-en.*

Schleicher, A., éditeur, *Teaching excellence through professional learning and policy reform: Lessons from around the world, International Summit on the Teaching Profession,* Paris, Éditions OCDE, 2016. http://dx.doi.org/10.1787/9789264252059-en.

Schneider, B. et S.-K. McDonald, éditeurs, *Scale-up in education: Ideas in principle* (Volume I) et *Scale-up in Education: Issues in practice* (Volume 2), New York, NY, Rowman & Littlefield, 2007.

Schunk, D. H. et F. Pajares, *Competence beliefs in academic functioning*, dans Elliot, A. J. et C. S. Dweck (éditeurs), *Handbook of competence and motivation*, pp. 85-104, New York, NY, Guilford Press, 2005.

Shallcross, D. J. (1981). *Teaching Creative Behavior: How to Teach Creativity to Children of All Ages*. Englewood Cliffs, NJ: Prentice-Hall.

Sizer, T., *Horace's compromise*, Boston, Houghton Mifflin, 1984/2004.

Sizer, T. et N. Sizer, *The students are watching*, Boston, Beacon Press, 1999.

Swanson, E., J. Wanzek, S. Vaughn, G. Roberts et A. M. Fall, « Improving reading comprehension and social studies knowledge among middle school students with disabilities », *Exceptional Children*, 2015, vol. 81, n° 4, pp. 426-442.

Schwartz, H., L. S. Hamilton, B. M. Stecher et J. L. Steele, *Expanded measures of school performance*, Santa Monica, CA, RAND Corporation, 2011.

Soland, J., L. S. Hamilton et B. M. Stecher, *Measuring 21st century competencies*, New York, NY, Asia Society, 2013.

Sternberg, R. J. (2010). Teach creativity, not memorization. *The Chronicle of Higher Education*. Retrieved from http://www.yosoyartista.net/bobbyo_files/2010-11-07-8BA990.pdf.

Thomas, D. et J. S. Brown, *A new culture of learning: Cultivating the imagination for a world of constant change*, Lexington, KY, CreateSpace, 2011.

Tobias, S. et J. D. Fletcher (éditeurs), *Computer games and instruction*, Hershey, PA, Information Age Publishers, 2011.

Turnbull, B., D. Riley et J. MacFarlane, *Districts taking charge of the principal pipeline*, Washington, D.C., Policy Studies Associates, Inc, 2015.

Tyack, D. et L. Cuban, *Tinkering toward utopia*, Cambridge, Harvard University Press, 1995.

U.S. Department of Education, *Transforming American education: Learning powered by technology*, Washington, D.C., U.S. Department of Education, 2010. Consulté à l'adresse : http://www.nationaledtechplan.org/theplan/NETP_Final.pdf.

U.S. Department of Education, *Promoting grit, tenacity, and perseverance—key factors for success in the 21st century*, Washington, D.C., U.S. Department of Education, 2013. Consulté à l'adresse : http://pgbovine.net/OET-Draft-Grit-Report-2-17-13.pdf.

Vaughn, S., E. A. Swanson, G. Roberts, J. Wanzek, S. J. Stillman-Spisak, M. Solis et D. Simmons, « Improving reading comprehension and social studies knowledge in middle school », *Reading Research Quarterly,* 2013, vol. 48, n° 1, pp. 77-93.

Vaughn, S., G. Roberts, E. A. Swanson, J. Wanzek, A. M. Fall et S. J. Stillman-Spisak, « Improving middle-school students' knowledge and comprehension in social studies: A replication », *Educational Psychology Review*, 2014, vol. 27, n° 1, pp. 31-50.

Vaughn, S., L. Danielson, L. Holdheide et R. Z. Edmonds, *Deeper learning for students with disabilities,* Jobs for the Future: Deeper Learning Research Series, 2015. Consulté à l'adresse : http://www.jff.org/sites/default/files/publications/materials/Deeper-Learning-for-Students-with-Disabilities-072816.pdf.

Villegas, A. M. et T. Lucas, « Preparing culturally responsive teachers: Rethinking the curriculum », *Journal of Teacher Education*, 2002, vol. 53, n° 1, pp. 20-32.

Wagner, T., *Global achievement gap,* New York, Basic Books, 2008.

Wagner, T., « Rigor redefined », *Education Leadership*, 2008, vol. 66, n° 2, pp. 20-25. Consulté à l'adresse : http://www.ascd.org/publications/educationalleadership/oct08/vol66/num02/Rigor-Redefined.aspx.

Wayne, A. J. et P. Youngs, « Teacher characteristics and student achievement gains: A review », *Review of Educational Research*, 2003, vol. 73, n° 1, pp. 89-122.

Wanzek, J., S. Vaughn, S. C. Kent, E. A. Swanson, G. Roberts, M. Haynes et M. Solis, « The effects of team-based learning on social studies knowledge acquisition in high school », *Journal of Research on Educational Effectiveness*, 2014, vol. 7, n° 2, pp. 183-204.

Wenger, E., *Communities of practice: Learning, meaning, and identity*, Cambridge, R.-U., Cambridge University Press, 1998.

Wenglinsky, H., « How schools matter: The link between teacher practices and student academic performance », *Education Policy Analysis Archives*, 2002, n° 10, pp. 12-42.

Wenglinsky, H., *How teaching matters: Bringing the classroom back into discussions of teacher quality*, Princeton, NJ, Educational Testing Service, 2000.

Working Group on Postsecondary Learning, *New technology-based models for postsecondary learning: Conceptual frameworks and research agendas*, Washington, D.C., Computing Research Association, 2013. Consulté à l'adresse : http://cra.org/uploads/documents/resources/rissues/Postsecondary_Learning_Report.pdf.