ASSESSMENT

Driving Education Transformation

Student Assessment: New Perspectives

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Executive Summary

Assessment matters. Many of the countries that rank as world class on K12 international benchmarking, have instituted comprehensive, balanced assessment and accountability systems that have served as catalysts in their educational transformations into top performers. A closer look reveals that different assessment strategies, at different stages of their trajectory were necessary in order to attain world-class status.

Nations and states across the globe are recognizing that education is key to economic competitiveness and a high standard of living in today's knowledge economy. Their ticket to global competitiveness is integrally linked to the intellectual capital of their citizenry – a natural resource that every country can develop.[1]

In many high performing countries, the principle of developing intellectual capacity of all students resulted in radically new, more balanced assessment and accountability systems that, in turn, served as catalysts for educational transformation.

The centrality of intellectual capital to economic viability serves to level the playing field internationally. Korea is a classic example. A generation ago, Korea educated only a quarter of its citizens and ranked mid-range internationally. Today it ranks first in the world on the latest (2009) international benchmarking results.[2] Over the last 30 years, in order to accomplish this radical transformation, Korea shifted its approach to assessment from one of classifying and sorting, to a more balanced approach. On the one hand, Korea was still interested in using standardized assessments to benchmark to standards and to other countries. As such they used a sampling approach (less than 5% of students at any grade) to track the progress of their education system over time – tracking and reporting progress at the national level only. They balanced this national strategy by entrusting teachers and administrators in their schools with the responsibility for local assessments, both formative and summative. Thus, teachers – who are actively engaged in professional learning – are able to scaffold students appropriately, ensuring that all students are learning. Today the majority of Korean students complete a post-secondary education, earning Korea a ranking in the top third of countries in the world with college-educated adults,[3] in addition to the first in the world status on K12 international benchmarks.

High performing countries such as Korea focus on both benchmarked curriculum standards, and the development of the skills required for viability in today's global, high tech, 21st century economy and society. The 21st century slate of skills includes critical thinking and sound reasoning, creativity and innovation, collaboration, multi-modal learning, self-direction, and others – to be employed in the context of the core subject area standards (i.e., mathematics, reading, writing, science, social studies, etc.). The new focus on 21st century skills is exemplified by this excerpt from the Korean goals for education: *Help students develop the logical, critical, and creative thinking abilities necessary for the further pursuit of academics and for everyday living.*[4]

That need for universal excellence by all students in world-class standards and 21st century skills also requires new approaches to assessment. Tracking the meteoric rise of Korea to first in the world, finds a radical shift in assessment policies. Whereas 30 years ago assessment was used in Korea to sort students into vocational and academic tracks, today there is no individual-level external testing of students before the end of high school. Rather, the system monitors its progress through periodic sampling of less than 5% of students in various grade levels and subject areas, depending on local assessments to guide teaching and learning.

Retrospective research suggests that assessing student performances at the regional or national level, and gathering and using data to inform decision making for formative purposes, are two of the six key interventions that universally influence school improvement efforts. The other four include: strengthening professional development, high standards with aligned curriculum, incentives for high performance, and education policy and law.[5] Yet current and prospective research finds many schools in somewhat of a conundrum regarding student assessment. School systems are finding that current assessments are not up to the task of accurately approximating the high levels of cognition, inquiry, collaboration, and application of standards expected of today's student.

To address this conundrum it is instructive to consider four emerging trends that impact assessment in school systems:

1. *The purpose of student assessment is shifting from strictly summative – assessment of learning – to more formative – assessment for learning*. Nearly every nation in the world recognizes the need for an education system that is innovative and world-class, ensuring that all children meet high standards. Thus, the very purpose of assessment is shifting from that of sorting and categorizing students based on their performances to more formative purposes where student assessment data is used to inform instructional, resource, and administrative decision making.

2. *Assessments have not kept pace with emerging research from the cognitive sciences on how people learn*. Educators now have deep insights, models, and representations of how students learn, what motivates students to learn, and how students can represent and communicate their

Four trends in education are significantly influencing the ways in which educational leaders are shaping their assessment systems:

1. The purpose of assessment in education is shifting from tracking progress to informing progress,
2. Assessments have not kept pace with emerging research on how people learn,
3. Assessments for 21st century skills are lacking, and
4. Uses of technology in assessment are emerging that enable longitudinal analyses from multiple assessments, and the design of next generation, embedded assessments.

understandings of concepts, processes, and knowledge. Unfortunately, current measurement systems are not able to assess such conceptual models and representations in cost effective ways, and some of the current systems serve as barriers to student engagement and motivation to learn.

3. *School systems are adding the new dimensions of 21st century skills to learning standards, but comprehensive, cost effective assessments for these skills are not yet available.* Many school systems have set targets for 21st century skills such as critical and creative thinking, collaboration, self-direction, multimodal learning, and cross-cultural, global awareness. Unfortunately, assessments which cost effectively measure these skills are not yet generally available. Recognizing that what is assessed is taught; nations and states around the world are calling for assessments of 21st century skills.

4. *Educators are beginning to leverage technologies for longitudinal, multi-faceted looks at data from multiple assessments, and in the design of next generation, embedded assessments.* Technologies exist that can make student thinking visible; capture students' thinking, analyses, and understandings in real time; model performance assessments; provide longitudinal reviews of multiple assessments; and provide a steady stream of data such that periodic testing should become unnecessary except perhaps for national, regional, and international benchmarking.

This report addresses the centrality of student assessment to systems change and innovation. Assessment experts stress the synergy between the three elements of assessment: 1) the cognitive representations of the knowledge, processes, skills, and habits we set as learning targets for our students, 2) the establishment of measurements to assess student representations of learning, and 3) the sound psychometric analysis and appropriate interpretation of the results.

Savvy education leaders, seeking to drive educational transformations through effective uses of student assessments, will establish comprehensive, balanced, continuous systems of assessment that use multiple measures across time to assess students, and serve to motivate and engage students in their own learning. They will use standardized measures only to benchmark student outcomes at a systems level to a rigorous set of high quality, academic and 21st century learning standards.

These same experts find that, while the cognitive sciences have made great strides in more deeply understanding and representing student learning, we do not yet have affordable measurements for many of those representations, especially those that require performance measures. In addition, the learning sciences have documented what serves to motivate and engage students in learning. A key motivator is the active engagement of students in setting

their own learning targets, tracking their own progress, and monitoring and adjusting their effort and work based on data.

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Looking forward, many experts predict that, just as technology has provided data streams to track performances in the private sector, technologies exist that hold great promise for education. These technologies at once enable individualized, personalized learning while enabling learner interactions with primary sources, experts, resources, collaborative groups, and teachers. Experts predict that, through technology, assessments will be embedded in formal and informal learning systems to provide a continuous stream of complex performance data on how students understand, think, and reason. Such data streams could eliminate the need to administer periodic assessments as they provide formative feedback to the students, teachers, and parents.

The findings from retrospective and prospective studies suggest that education leaders interested in using student assessment to leverage change should establish a system of assessment that:

As their students move from low to high performance, education systems will need to adjust their accountability policies, placing increased responsibility for accountability in the hands of cohorts of teachers, so as to provide the flexibility and openness to innovation required to reach world-class performance.

- Is aligned to world-class learning standards, and longitudinally tracks their system's progress against international or national benchmarks
- Employs a range of assessments at the classroom, school, district, and national levels all aligned to high standards (content, process, and 21st century skills)
- Continuously provides a stream of data from a range of formative assessments designed as diagnostic to inform students' continuous progress toward attainment of established learning standards and 21st century skills
- Systematically uses assessments to monitor both aggregate and individual student progress in attaining established learning standards and 21st century skills
- Monitors and invests in emergent research and developments (R&D) in assessment.

To optimize the impact of such an assessment system, school systems should:

- Establish data cultures within all schools, involving students, teachers, administrators, and parents in using data to drive continuous improvement
- Support and encourage educators to participate in professional learning communities committed to high student performances enabled through data informed decision making
- Adjust the accountability policies to be more prescriptive, based on standardized tests, during times when the education system is building toward wide scale proficiency; and once achieved, shift accountability to the cadre of teachers, while providing the flexibility required for the system to move beyond proficiency into higher levels of learning.

The way forward for nations and states intent on developing and sustaining world-class education systems with high-performing students will depend on the school system's capacity for adaptability, flexibility, and innovation that leads to world-class performances by students in complex, higher order thinking, reasoning, and problem solving – in the context of academic studies. As such, assessment and accountability will increasingly need to be augmented through technology, evidenced through continuous streams of data through multiple types of assessment, and entrusted to informed, cadres of teachers, accountable to one-another within active professional learning communities.

According to Linda Darling-Hammond (2010), one of the things that differentiates the education systems in these high-achieving countries is their focus on assessments that are school-based, used to inform instruction, rather than only relying on externally designed and administered tests that are used to track and report progress.

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While national and international benchmarking are critical, the way forward to world-class performances by students lies in getting multiple forms of data from technology-enabled, next generation assessments into the hands of informed cadres of teachers who are empowered to work with their students to innovate and personalize higher order learning. Studies show that progress is made when the balance between local and standardized assessment used for accountability is shifted to local assessments by effective teachers who are held accountable through a transparency of teaching within professional learning communities.

The following seven action steps related to assessment are offered for school systems striving for world-class learning systems:

1. *Establish a vision for world-class learning standards for all students that includes 21st century skills*

2. *Research, discuss, and innovate around these standards – within communities of interest*

3. *Engage students as partners in assessment of these standards*

4. *Design a fair, balanced, and comprehensive assessment system that serves to motivate and engage students in learning*

5. *Establish a data culture within your schools that encourages assessment for learning*

6. *Use technology as a design element for next generation assessments*

7. *Report summative data publicly at the systems level (national, state, or district level) only*

During the 2010 release of the latest PISA results, OECD Secretary-General Angel Gurría stressed that, *"Better educational outcomes are a strong predictor for future economic growth."*[7] In today's knowledge economy, economic viability is intricately linked to the degree to which a nation's educational system engages students in higher order, inquiry-based learning.[8] The OECD report also indicated that, "*Countries of similar prosperity can produce very different educational results.*" [9] Assessment and accountability play a large role in transforming an education system into a learning organization that empowers every child to succeed.

An Introduction

In many high performing countries, the principle of developing intellectual capacity of all students has resulted in radically new, more balanced assessment and accountability systems that, in turn, served as catalysts for educational transformation.

Innovation is fueling today's global, knowledge-based society. The combination of human ingenuity and emergent technologies is disrupting conventional norms of communication, work, economics, politics, entertainment, and time. As the complexity and rate of change in society increase, the challenge to the education community to keep pace is intensifying. In today's world all students must be prepared with 21st century skills to think and act critically and creatively, collaborate and communicate effectively, and navigate and learn successfully in an interconnected, complex, technological world.

Countries such as Korea, Finland, and Singapore, and municipalities such as Shanghai-China have had the foresight to see that to be competitive in a global, knowledge-based economy requires a highly educated populace. Today, students in these countries are the top-performers on international tests.

These countries realize that their greatest natural resource is the intellectual capital of their populace – a renewable resource. That insight has instigated the redesign of their school systems. The early transformation of these high performing systems had four key elements in common: a 21st century vision for all learners, strong commitment to education as a national priority, investment in teachers, and a comprehensive, balanced, and continuous system of assessment.

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It is the latter, this system of assessment, that is the focus of this article. We will discuss four trends that are causing nations and states to redesign their assessment and accountability systems, provide some definitions for a range of assessments, and discuss how assessment practices are different in different countries depending on their level of student performance and their core educational and cultural beliefs.

In addition to this retrospective look, this article will summarize current discussions around what constitutes next generation assessments, why such assessments are so critical to education systems worldwide, and what actionable steps nations and states can take now to get started.

Assessment will be discussed as a lever for education transformation in the context of education policy, research and evaluation, curriculum, professional development, and information and communication technology (ICT).

What Is Assessment and Why Is It Important?

The nature of a school system's assessments directly influences its culture of learning. Systems that engage teachers in using a range of assessment, with a focus on informing thoughtful teaching, serve to create cultures of learning that increase student motivation and engagement in learning. Conversely systems that restrict assessment to standardized tests for the purpose of publicly reporting results for schools, and in some cases, classrooms, serve to create cultures where many students are demotivated and disengaged in learning, often resulting in high dropout rates.[10, 11]

In order to more deeply understand student assessment, a formal definition is in order. The U.S. National Research Council (NRC), notes that, "The terms *educational measurement, assessment,* and *testing* are used almost interchangeably in the research literature to refer to a process by which educators use students' responses to specially created or naturally occurring stimuli to draw inferences about the students' knowledge and skills." [12]

> *Student assessment is the process by which educators use students' responses to specially created or naturally occurring stimuli to draw inferences about the students' knowledge and skills.*
>
> *- James Popham as cited by the U.S. National Research Council (2001)*

Educators typically classify assessments as formative or summative. Formative assessments are conducted during the learning process and are intended to inform decisions related to teaching and learning in a continuous stream of information. In contrast, summative assessments are conducted after learning, with the intent of measuring student learning following specific instruction.

Formative assessment is often described as an ongoing process that provides a flow of evidence to reveal compelling evidence of student learning – including content knowledge and inquiry and reasoning skills, so that gaps can be identified and learning activities modified in order to close such gaps. Formative assessment is often referred to as "assessment for learning," or "assessment as learning." It often engages the student as a partner in her own learning, providing the feedback necessary for her to set short term and long term learning goals, self-monitor progress, take responsibility for seeking help when it is needed, and reflect on assessment results in order to improve.[13, 14] It is considered low stakes, in that it is typically scored only for formative purposes, and not used to grade the student. That said, some summative assessments do serve a

dual role, where they may contribute to the student's grade and the results may be reviewed to inform the student's reflections on their own learning, or the teacher's adjustment of curriculum and instruction in order to scaffold student learning.

Some examples of the type of formative assessment commonly used by teachers (and, at times, by students) to elicit data include:

- Active learning strategies in the classroom (e.g., questioning, reflective thinking, dialog, thumbs up/down, think/pair/share, and others);
- Classroom observation from: consultations, interviews, group work, classroom discussions, using protocols, checklists, or rubrics, electronic response systems, and other tools;
- Portfolios for the collection of student artifacts (i.e., multimodal/multimedia) using scoring systems, rubrics;
- Student reflection: journaling, blogging, and podcasting;
- Public exhibitions, critiques, and discussions of student work;
- Learning activities: simulations, games, lab activities, field trips, social networking, online threaded discussions, and group work; and
- Diagnostic assessments.

The assessment literature indicates that learning improvement through formative assessment depends on the following key factors:[15]

- The provision of effective feedback to students;
- The active involvement of pupils in their own learning;
- Adjustments to teaching to take account of the results of assessment;
- A recognition of the profound influence assessment has on the motivation and self-esteem of pupils, both of which are crucial influences on learning; and
- The need for pupils to be able to self-evaluate and understand how to improve.

Formative assessment has become a prominent focus in education reform. Black and Wiliam have conducted one of the most comprehensive reviews of literature on formative assessment. Their review indicated that formative assessment results in statistically significant gains in student achievement.[16] It also increases students' motivation to learn – thus their engagement in learning – by providing feedback that enables them to take specific actions to improve.[17] Formative assessment processes are actionable steps that nations and states can take to insure continuous improvement processes are informed accurately and reliably by data.

Summative assessments, on the other hand, are conducted for the purpose of determining progress to date, based on past work. They are used to determine whether a student has attained a certain level of competency after completing a particular phase of education, or to gauge the impact of a unit of instruction, program or policy after a period of implementation. They may be

conducted at the classroom, district, state, national, or international levels and are graded, with aggregate results for populations and subpopulations often reported publicly.[18]

The most common forms of summative assessments are:

- Large-scale standardized tests,
- End-of-course or unit tests,
- Placement tests,
- Benchmarking assessments,
- Short cycle assessments, and
- International benchmarking.

Summative assessments are often used as a basis to inform decisions related to student promotions and placements, differentiation of instruction, pedagogy, curriculum, administrative planning (e.g., resource selection, teacher assignments, professional development), and policy decisions. For example, readiness assessments for kindergarten students may be used as diagnostic tools to inform instructional programs for the classroom at the beginning of the year. Then in the spring, the assessment may serve dual purposes, first as a summative tool to determine the degree to which the kindergarten student achieved the goals of the program, then as a formative tool for use by the student's first grade teacher the next fall to determine groupings, instruction, and differentiation. She might use the data to anticipate the range of readiness levels of her students and adjust the timing of classroom activities, the resources to align to their needs, or her pacing of instruction.

The high stakes summative assessments – often in the form of standardized tests -- are typically administered by external scoring procedures. As nations and states establish programs intended to scaffold all children toward deep learning and high achievement, they are designing high stakes assessments that include performance assessments. For example, in 2006, the Programme for International Student Assessment (PISA) piloted online science assessments such as student explorations and understanding of genetic breeding of plants.[19] In the U.S. the 2009 National Assessment of Educational Progress (NAEP) piloted interactive computer tasks in an attempt to assess student inquiry in science.[20]

In addition, new high stakes assessment models have emerged that actively engage teachers in critical components of such high stakes assessments. For example, in Victoria, Australia, school-based assessments at Grades 11 and 12 are integrated with centralized external exams. The Victoria Curriculum and Assessment Authority (VCAA) established a number of courses for high schools and universities; faculty from both levels of institution work together to develop syllabi and exams. Classroom tasks, including experiments, research papers, and presentations, comprise 50% of the exam and are developed and conducted during the year by classroom

teachers as their students are ready. These tasks are aligned to the final exam and provide the students with opportunities to get feedback and improve prior to the external exam.

For example, an exam question might ask the students to describe how a particular virus presents, design a drug to kill it, and then plan a process for testing the effectiveness of the drug. Prior to the assessment that includes such a question, students would have been prepped by preparing slides using a microscope in a laboratory or developing a research paper on pathogens.

An inspection system audits the quality of the tasks assigned and graded by local teachers, the resultant level of student work, and the scoring of exams by the teachers. Once the external exam results are available, the VCAA uses them to statistically match the level and spread of each school's local assessments to that of the external assessment. This process creates a synergy whereby teachers' participation in the yearlong series of local assessments improves instruction, while students are assured of an equitable curriculum throughout the state.[21]

In contrast to these innovative examples, most large-scale testing programs remain largely comprised of multiple-choice assessments, resulting in "an overreliance on simple, highly structured problems that tap fact retrieval and the use of algorithmic solution procedures."[22]

Elements of Sound Assessments

As the example from Victoria demonstrates, in order for educators to use assessments effectively, they need to plan such assessments carefully, to ensure fairness, equity, external validity, reliability, and timeliness of feedback, and to ensure they are measuring the learning they are targeting. Experts indicate that assessments include the following interdependent components: 1) a learning target; 2) the student response that will indicate the target has been met; 3) the assessment task that should elicit the response; and 4) an interpretation of the evidence, drawing inferences from the evidence.[23] See examples below in Figure 1.

Figure 1: Components of an Assessment

Four components	Mathematics example at middle school level
1) Learning Target	Student will analyze proportional relationships and use them to solve real-world problems.
2) Student Response Expected	From the assessment task, the student should recognize it as a proportionality problem, distinguish it from other relationships, and use his understanding of proportionality to solve this multi-step problem.
3) Assessment Task	All the evidence a crime lab has from a crime scene is a footprint. Develop a toolkit the lab can use to figure out how tall their suspect is. Explain why your rule works.*
4) Interpretation of Evidence	The teacher would use a rubric that includes elements of problem solving and solving proportionality problems to score the solution.

* Koellner-Clark, Kr. & Lesh, R. (2003). Whodunit? Exploring proportional reasoning through the footprint problem. *School Science and Mathematics,103,* p. 1.

The first step in effectively using assessments for formative purposes is to clearly identify the learning target. One of the ways teachers ensure students accomplish the full spectrum of learning goals is by classifying their learning targets and associated assessment into categories such as the following:

1. Know what (Declarative)
2. Know how (Procedural)
3. Know why (Schematic)
4. Know when, why, and how to apply (Strategic)
5. Know own learning (Metacognitive)

In the example above (**Figure 1**), the learning target would be classified as strategic, as the student would need to recognize that this problem is a proportion problem and then determine how to apply his knowledge about proportionality to the problem (i.e., knowing when, why, and how to apply information on proportionality).

This type of classification system for teachers is critical. Teachers not only need to know which standards are being addressed, they need to understand the level of learning their students are accomplishing. As an example, suppose two young students, Sally and Maria, were administered an assessment and both received a score of 74% on the science section. What will inform instructional decisions based on this assessment is the analysis the teacher does as to what errors students are making. Knowing, for example, that Maria made mistakes on every type of question, from declarative to strategic, and Sally erred only on schematic questions, will more strategically inform that teacher's and student's next steps in the learning process.

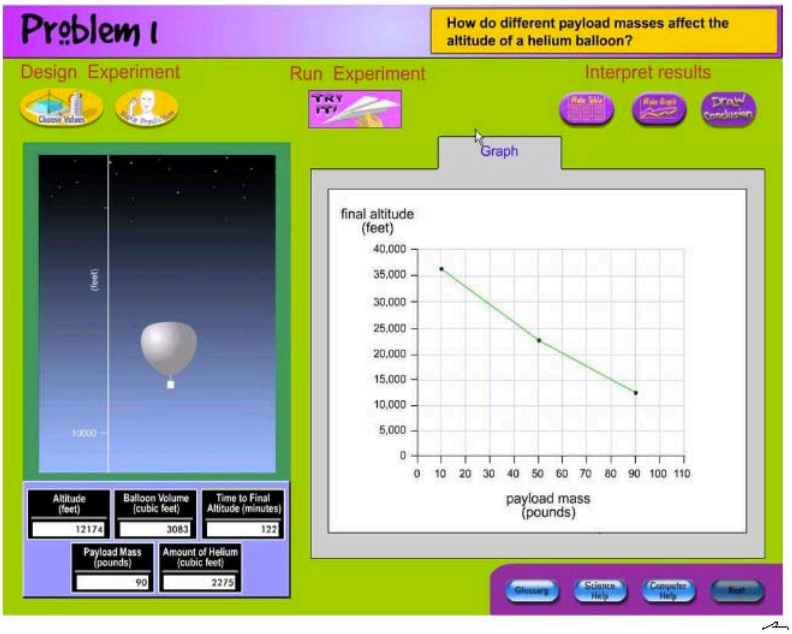
Let's take a look at a few assessment examples through this lens.

Example 1: Test Item from the 2006 NAEP Science Assessment

In this example from the U.S.-based National Educational Assessment of Progress (NAEP), eighth grade students were assessed while they designed and conducted an experiment on the relationship between the altitude of a helium balloon and its payload, while the amount of helium held constant (see pictorial below).[24, 25] The students were to: 1) determine how the different payload masses affect the altitude of the balloon; and 2) determine the relationship between the amount of helium put in the balloon and the altitude that the balloon could reach, and (3) determine the affect of different payloads on the altitude of the balloon.

Prior to taking the assessment, students engaged with the online simulation interface through a tutorial that introduced them to the visuals, an online glossary, and the tools available for charting and calculating. Then the students were asked to solve several helium balloon problems and explain their findings. As they solved the problems, the interface tracked their keystrokes. It

used that data, plus analyses of student explanations, to score the students' scientific inquiry exploration skills, and scientific inquiry synthesis skills within the context of physics.



Source: Bennett, R. E., Persky, H., Weiss, A. R., Jenkins, F. (2007). *Problem-solving in technology-rich environments. A Report from the NAEP Technology-Based Assessment Project*. Research and Development Series. Institute of Education Sciences, NCES 2007-466. Washington, DC: U.D. Department of Education.

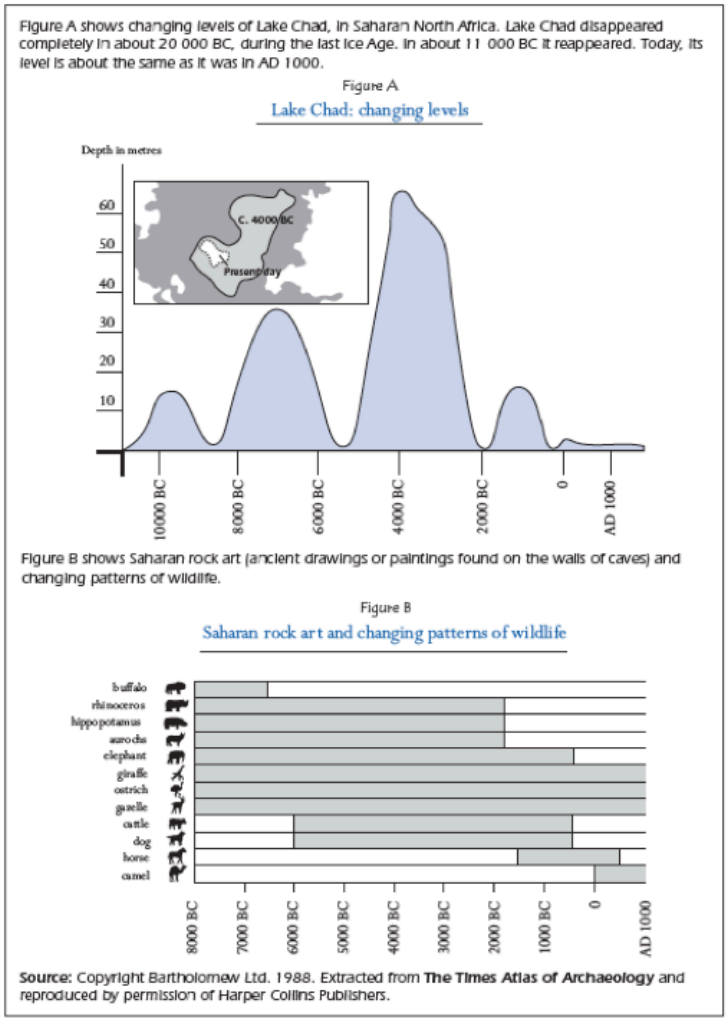
Initial reactions by students during the piloting phase of this helium balloon task were positive. They stated it was the first time they had ever learned something as they took a test.

Analysis: This task was very specifically defined (as opposed to ill-structured or open-ended for inquiry problems). Because the students learned how to solve this type of problem through the tutorial, the assessment became procedural (know how).

Level of Assessment in the Helium Balloon Problem				
Know what (Declarative)	Know how (Procedural)	Know why (Schematic)	Know when, why, and how to apply (Strategic)	Know own learning (Metacognitive)
	X			

Example 2: Test Item from the 2006 PISA Science Assessment

The following example is an item from the 2006 PISA science international assessment. It provides datasets in two different visual formats and asks a question that requires the student to analyze both charts, juxtapose several pieces of information in order to infer a connection between the water levels of Lake Chad over time, and the specific time periods in which species inhabited the land surrounding the lake, and interpret the results. While this is an example of a multiple choice test item, it is considered a problem solving assessment of moderate difficulty.



Question: Lake Chad

For this question you need to draw together information from Figure 1 and Figure 2. The disappearance of the rhinoceros, hippopotamus and aurochs from Saharan rock art happened:

At the beginning of the most recent Ice Age.

In the middle of the period when Lake Chad was at its highest level.

After the level of Lake Chad had been falling for over a thousand years.

At the beginning of an uninterrupted dry period.

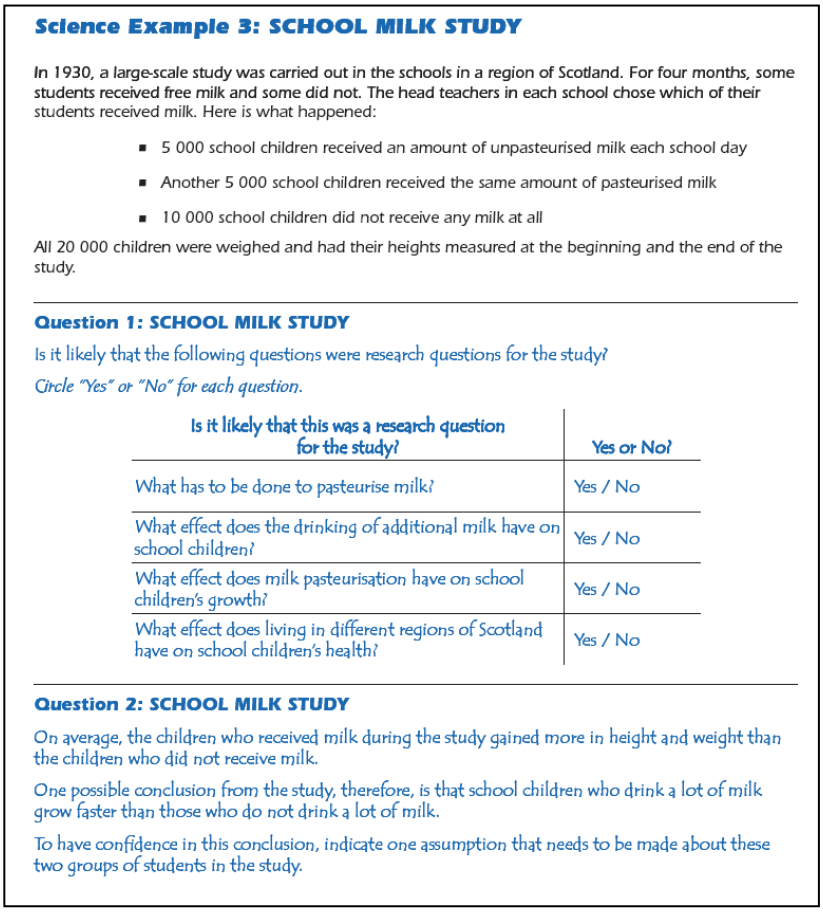
Source: OECD (2006). Assessing scientific, reading, and mathematical literacy: A framework for PISA 2006, pp. 66-67. Accessed 12/28/10 from http://www.oecd.org/dataoecd/63/35/37464175.pdf.

Analysis: This task required that students interpret two different types of charts to understand a relationship. It was rated of moderate difficulty by PISA. Many students mistakenly chose answer D, suggesting that they were drawing on familiar knowledge, thus reinforcing the fact that those students who did select the right answer probably interpreted the information in front of them. The correct answer is C.

Level of Assessment for Lake Chad Test Item from PISA 2006				
Know what (Declarative)	Know how (Procedural)	Know why (Schematic)	Know when, why, how to apply (Strategic)	Know own learning (Metacognitive)
		X		

Example 3: Test Item from the 2006 PISA Science Assessment

The following test item is from the 2006 PISA science assessment. The item is assessing the student's understanding of research studies. This item requires that students have a working knowledge of research procedures in setting up a study. It taps the student's prior knowledge. A student who had not studied research design would not be able to answer the questions correctly.



Science Example 3: SCHOOL MILK STUDY

In 1930, a large-scale study was carried out in the schools in a region of Scotland. For four months, some students received free milk and some did not. The head teachers in each school chose which of their students received milk. Here is what happened:

- 5 000 school children received an amount of unpasteurised milk each school day
- Another 5 000 school children received the same amount of pasteurised milk
- 10 000 school children did not receive any milk at all

All 20 000 children were weighed and had their heights measured at the beginning and the end of the study.

Question 1: SCHOOL MILK STUDY

Is it likely that the following questions were research questions for the study?

Circle "Yes" or "No" for each question.

Is it likely that this was a research question for the study?	Yes or No?
What has to be done to pasteurise milk?	Yes / No
What effect does the drinking of additional milk have on school children?	Yes / No
What effect does milk pasteurisation have on school children's growth?	Yes / No
What effect does living in different regions of Scotland have on school children's health?	Yes / No

Question 2: SCHOOL MILK STUDY

On average, the children who received milk during the study gained more in height and weight than the children who did not receive milk.

One possible conclusion from the study, therefore, is that school children who drink a lot of milk grow faster than those who do not drink a lot of milk.

To have confidence in this conclusion, indicate one assumption that needs to be made about these two groups of students in the study.

Source: OECD (2006). Assessing scientific, reading, and mathematical literacy: A framework for PISA 2006, pp. 34. Accessed 12/28/10 from http://www.oecd.org/dataoecd/63/35/37464175.pdf.

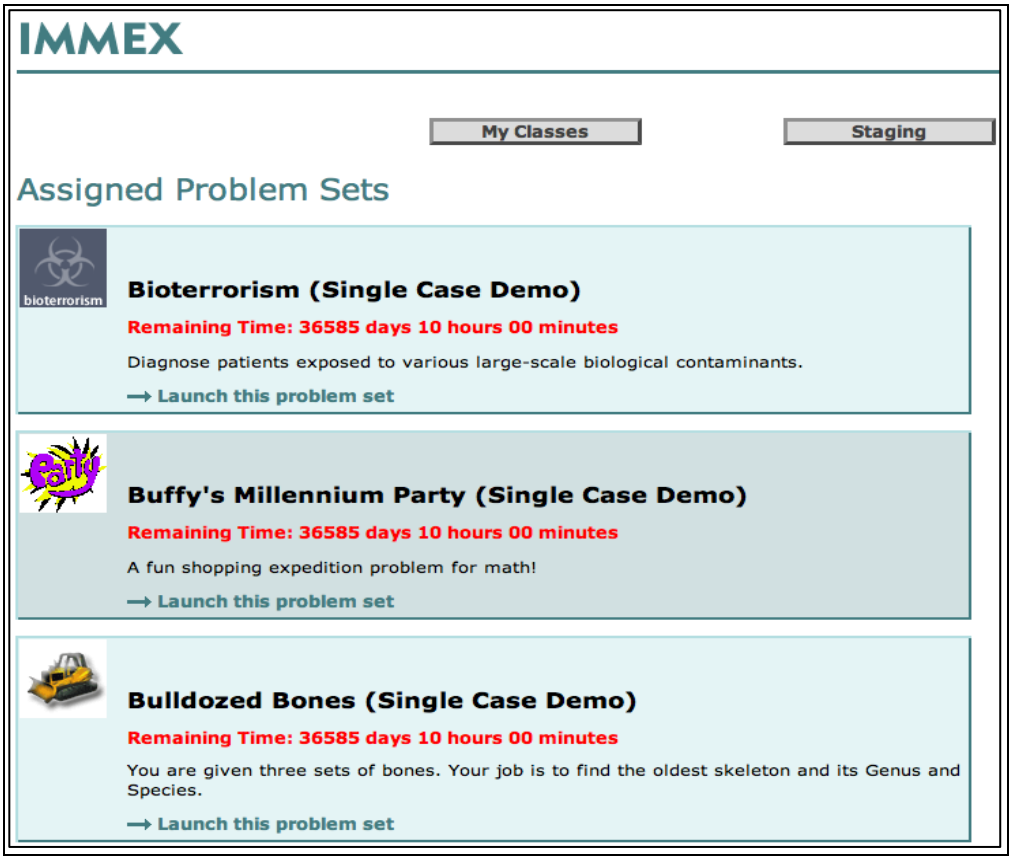
Analysis: This task required that students identify possible purposes of the study. Since both questions tap into their prior knowledge as to study design, it is declarative (know what). The correct answers are: N Y Y N, and for question 2, the assumption is that all other factors for the two groups remained constant.

Level of Assessment for the Test Item from 2006 PISA: School Milk Study				
Know what (Declarative)	Know how (Procedural)	Know why (Schematic)	Know when, why, how to apply (Strategic)	Know own learning (Metacognitive)
X				

Example 4: Sample Problem from IMMEX

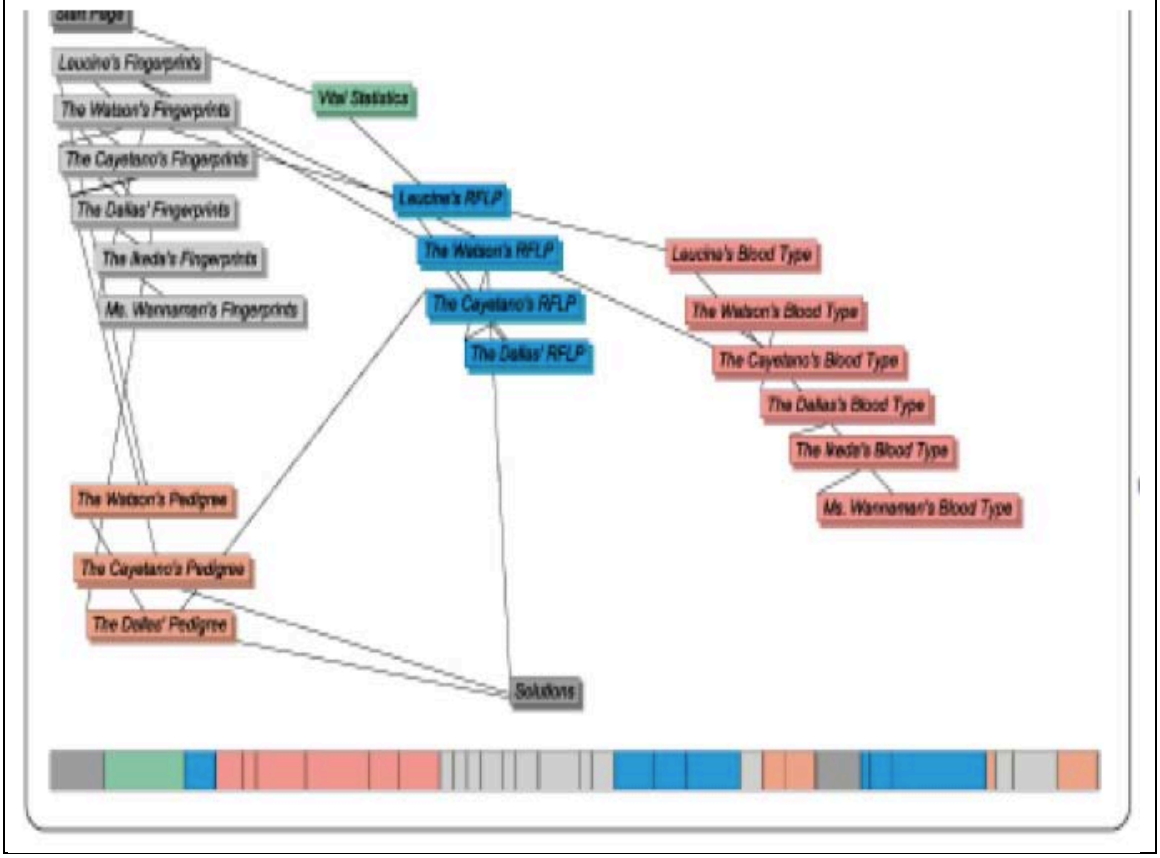
It is a challenge to find assessment tasks in the strategic category – i.e., higher order thinking. This example from the Interactive Multi-Media Exercises (IMMEX) program at UCLA uses computer technology to present real-world, case-based, higher order problems to students in the context of a rich set of resource clues. The technology tracks every keystroke, documenting student actions and data-mining strategies used to solve the problem, and displays a map of the strategies, color coded as to their potential contribution to the problem solving. IMMEX uses sophisticated artificial intelligence models to identify strategies. Research studies on IMMEX find it to be reliable in its analysis of student problem solving skills.[26] The figure below (Assigned Problem Sets) lists three of the cases the students can solve individually or in teams. The figure further below (IMMEX Search Path Map) is an example of one of the strategy maps produced for students after they completed one of the tasks.

IMMEX is an example of the potential use of simulations and games in assessment.[27]



Source: Personal correspondence with UCLA developer, Ron Stevens. Used with permission.

Immex Search Path Map based on a student's problem solving strategies



Source: Personal correspondence with UCLA developer, Ron Stevens. Used with permission.

Analysis: Each of the cases in IMMEX requires students to apply problem-solving strategies to solve a problem. Thus, the IMMEX problems are classified as strategic. In addition, each problem solving exercise in IMMEX produces a strategy map, which offers students the opportunity to reflect on their problem solving strategies and how their strategies compare to those of experts, thus it is also classified as a metacognitive item.

Level of Assessment in the IMMEX problem sets.				
Know what (Declarative)	Know how (Procedural)	Know why (Schematic)	Know when, why, how to apply (Strategic)	Know own learning (Metacognitive)
			X	X

The range and scope of these assessment examples are indicative of the complexity of the issues facing educators today. There are challenges to face in dealing with the validity and reliability of approximating each student's progress on multiple learning standards, as well as the 21st century skills that many nations and states are embracing. The complexity and challenges speak to the

need for strong assessment literacy among all educators and the issues have initiated a worldwide call for a "next generation of assessments."

Next Generation Assessments

Many educators are stymied by the limitations of today's assessments, and are calling for new directions and investments in research and development to inform the next generation of assessments for both academic and 21st century learning standards. Groups that have been active in research and development in this area include:

- *ATS21C*
  The international project for Assessment and Teaching of 21st Century Skills (ATC21S), initiated by Cisco, Intel, and Microsoft, provides research and development in 21st century assessments. Their work is focused on five topics: 21st century skills; classroom learning environments and formative evaluation; methodological issues; technological issues; and policy frameworks for new assessments. They will develop products as follows:

  - Clear, operational definitions of 21st century skills;
  - Solutions to technical psychometric problems that confront those seeking to develop tests of these skills;
  - Strategies for delivering assessments using information and communication technology (ICT); and
  - Classroom-based strategies for helping students develop 21st century skills.

  According to their website they will develop and test innovative assessment tasks as prototypes for use in the classroom. The prototypes and their allied strategies will be in the public domain and available to be used freely by others in development of assessment tasks or tests. Their website is: http://atc21s.org/about.aspx.

- *American Recovery and Reinvestment Act: Education Assessment Grants*
  The U.S. Department of Education has invested $330 million in grants to assist states in the redesign of assessments for the 21st century. Two large consortia were awarded grants under this program. The SMARTER Balanced Assessment Consortium (SMARTER) will focus on formative assessments and the use of technology for assessing student growth over time through computer adaptive testing. The second consortium, the Partnership for the Assessment of Readiness for College and Careers (PARCC) will focus on developing assessments for critical thinking. One of the strategies PARCC anticipates using is to replace an end-of-year high-stakes test with a series of assessments throughout the year. The assessments will be aligned with the Common Core Standards, the U.S. national standards

developed in 2010-2011.[1] Both of the consortia plan to deliver their assessments online. The website for SMARTER is at ***www.k12.wa.us/smarter/***, and for PARCC is at *http://www.fldoe.org/parcc/*.

- *OECD*
  The Organisation for Economic Co-operation and Development (OECD) Programme for International Student Assessment (PISA) evaluates the quality, equity, and efficiency of school systems in some 70 countries that, together, make up 90% of the world economy. By testing between 4,500 and 10,000 15-year-old students in each country, OECD PISA provides an internationally standardized assessment and has become a powerful tool for countries wanting to improve their education systems. Four assessments have been carried out since 2000.[28]

These and other renowned organizations, individuals, and other entities indicate that next generation assessments should:[29, 30, 31]

- *Align with developments in 21st century learning*
  - Address adaptability, unpredictability, and creativity
  - Align with emergent research in the learning sciences, and include the role of motivation, engagement, and self-direction to learning
- *Serve all students*
  - Personalize learning
  - Embody Universal Designs for Learning (i.e., accommodate all learners needs through the use of technology)
  - Be fair
  - Generate information that can be acted upon, and which provides productive and usable feedback for all intended users
  - Make students' thinking visible
  - Build capacity for students to use data for learning
- *Optimize the potential of technology through innovative design*
- *Be psychometrically sound*
  - Be technically sound
  - Be valid for the purpose for which the assessment is intended
  - Be transparent
- *Be part of a comprehensive and well-aligned system of assessments designed to support the improvement of learning at all levels of the educational hierarchy*
  - Be responsive and add value to teaching and learning

[1] The Common Core Standards in mathematics and English Language Arts were developed by consortia of educators in the U.S. in 2010. Many U.S. states have committed to realigning their educational systems to the Common Core within the next few years. The science standards are under development.

- Provide productive and usable feedback for all intended users
- Build capacity for educators to use data for teaching, learning, and leadership

21st Century Assessment Systems

One of the common beliefs inherent in the work described above is today's education assessment systems are lagging behind advances in the learning sciences and the education visions for the 21st century – and, in fact, may be preventing nations and states from fully embracing innovation and education transformation.

As noted above, assessments involve interdependencies between 1) definitions of the learning target; 2) the response that will indicate the target has been met (i.e., work from the cognitive sciences); 3) the assessment task that should elicit the response (i.e., work from the measurement sciences); and 4) an interpretation of the evidence (i.e., work from the psychometric sciences). Experts suggest the lack of viable measurements for observation of students' 21st century learning is serving as a barrier to the leveraging of emergent research and achievements in the cognitive sciences and psychometric sciences. The bottom line is that investments should be made to advance the measurement sciences.[32]

While the nature of student assessments is evolving, nations and states should also consider how those assessments are being used formatively, to inform continuous improvement and inform instructional, curricular, and administrative decisions, and summatively, for accountability purposes.

A world-class system of assessment is defined by three key elements.[33]

- Comprehensiveness. The system of assessment should include a range of assessments designed to provide evidence of learning standards and constructs. It should include multiple assessments to inform accountability and to improve decision making at multiple levels of the system from policy to practice.

- Balance. The system of assessment should align to standards, with clearly established sequences and knowledge structures, with coherence across the system. It should be implemented within school and classroom cultures that integrate formative and summative assessment processes systemically in practice.

- Continuity. The system of assessment should include a continuous stream of evidence on students' learning progressions to inform decision making.

The assessment system is an embodiment of the principles of a nation or state's education vision and values. Several of the high performing countries on the PISA have redesigned their assessment systems to accommodate new core values in education – e.g., highly educating all students and extending learning standards to include 21st century learning. A case in point is Finland, whose current education system exemplifies this new approach. Finland dismantled their rigid tracking system and is now more focused on formative, local assessment in the context of an inquiry curriculum, cohorts of highly trained educators working collaboratively to meet the needs of all students, independent learning, and student self-reflection, while also monitoring system wide achievements on international benchmarks.

In the next section we take a look at some of the high performing countries' approaches to assessment.

World-class Assessment Systems: Yesterday and Today

As our discussion turns to attributes of those countries considered to have "world-class" education systems, it is informative to consider the results of international benchmarking assessments. One of the key international benchmarks for K12 educational systems is the Programme for International Student Assessment (PISA). The Organisation for Economic Co-operation and Development (OECD) periodically conducts the PISA assessments, which involve 15-year-olds in countries around the world.

The latest results (2009) for reading, mathematics, and science indicate Korea and Finland are first and second in the world, followed by Hong Kong-China, Singapore, Canada, New Zealand, and Japan, with the municipality of Shanghai-China also weighing in with high rankings.[34] During the 2010 release of the latest PISA results, OECD Secretary-General Angel Gurría stressed that, *"Better educational outcomes are a strong predictor for future economic growth."*[35] In today's knowledge economy, economic viability is intricately linked to the degree to which a nation's educational system engages students in higher order, inquiry-based learning.[36] The OECD report also indicated that, "*Countries of similar prosperity can produce very different educational results.*" [37]

Despite historical, cultural, and economic differences, there are some emerging commonalities among world-class performing nations on the PISA:[38, 39]

- They have established clear, high quality learning standards for students.
- Their learning standards emphasize complex thinking and problem solving.
- Their use of assessments strongly aligns to the principles of learning from the research from the cognitive sciences (i.e., student motivation, engagement, efficacy for learning, self-reflection, and self-direction).

- They place a high priority on, and are committed to, high-quality education that is clearly evidenced by all – students, parents, community, government, school administrators and, of course, teachers.
- They staff their schools with highly-educated, effective educators, within a culture where the profession of teaching is respected, revered, and supported through strong recruitment, incentive, and professional learning structures.
- They provide their students and teachers with access to resources, including learning technologies/the Internet, libraries, etc.
- They have established assessment and accountability systems that use standardized assessments at the system level (nation, state, district) to monitor attainment of learning standards and rankings on international K12 benchmarks such as PISA, and they use and highly value classroom and school assessments to inform decision making and continuous improvement of learning.
- They consistently work to ensure that all students benefit through school cultures focused on inquiry, student growth, and innovation.

Assessments have been evolving over time to meet shifting priorities for education. As policy leaders publicly recognize the tight link between economic viability, quality of life and their system of education, they also acknowledge the need for a more balanced system of assessments.

A recent international study by McKenzie shed some light on this issue of balanced systems of assessment. McKenzie researchers were interested in studying education systems that were making sustained and steady progress on international assessments such as PISA, yet represented the entire spectrum of student performance, from poor through excellent. The researchers began by selecting 20 education systems from both developing and developed countries around the globe. One striking variation between countries at the poor and excellent extremes of the continuum was their approach to assessment. The countries at the poor end of the spectrum used the standardized assessments of basic skills to drive change.[40]

How nations successfully use assessment as a lever for change differs depending on whether they are building toward proficiency of core standards, or a step beyond, striving toward world-class competition. The former typically uses standardized testing in combination with prescribed learning, while the latter moves a large percentage of the responsibility for accountability into the hands of teachers - who are empowered through opportunities for professional growth and innovation, while held accountable through peer collaboration and public, transparent teaching.

- Mourshed, et al. (2010)

In contrast, those countries that had already achieved wide scale proficiency and were striving for higher order learning drove change through collective commitment to goals, transparency of practice, and peer interaction within the professional learning communities where teachers conducted lesson studies and analyzed pedagogical approaches that resulted in more complex, higher order learning. A close look indicated that historically this trend held for the 20 countries studied – how nations use assessment as a lever for change differs depending on whether they are building toward proficiency of core standards, or are striving toward world-class competition. The former typically uses standardized testing in combination with prescribed learning, while the latter moves a large percentage of the responsibility for accountability into the hands of teachers - who are empowered through opportunities for professional growth and innovation, while held accountable through peer collaboration and public, transparent teaching.

Four Trends Influence Radical Change in Assessment Systems

Retrospective and prospective research finds many school systems in somewhat of a conundrum regarding student assessment. To address this issue, it is instructive to consider how the following four trends are influencing student assessment in school systems:

1. *The purpose of student assessment is shifting from strictly summative to more formative.*

2. *Emerging research from the cognitive sciences has provided educators with deep insights into how people learn, but assessment has not kept pace.*

3. *School systems are adding the new dimension of 21st century skills to learning standards, but there are not yet assessments for these skills.*

4. *Educators are leveraging technologies for longitudinal, multi-faceted looks at data from multiple assessments, and to design next generation assessments.*

Trend 1:
The purpose of student assessment is shifting from strictly summative (i.e., assessment of learning), to more formative (i.e., assessment for learning).

The fundamental purpose for assessments is shifting from sorting and classifying students to collecting evidence that will inform continuous growth of all students toward world-class learning goals and standards.

One of the most notable trends among high performing countries on the PISA has been in the redefinition of the very purpose of student assessment by policy makers. In the past, assessments were used to sort and classify students according to a bell curve. One of the key purposes was the

identification of those students who would qualify to continue into post secondary education.[41] According to U.S. researcher Richard Stiggins, "The role of schools has changed. Previously schools sorted students from the highest to the lowest achievers — with some succeeding at learning while others tumbled into chronic failure. But schools have evolved into places where all students are expected to meet increasingly rigorous academic standard." [42]

Nations achieving at world-class levels recognize their most important national resource is the intellectual capital of their citizenry. With this in mind, they are taking the steps necessary to afford all children high quality educational opportunity.

Korea is a classic example. A generation ago, Korea educated only a quarter of its citizens. Today the majority of its students complete a post-secondary education.[43] This earns Korea a ranking in the top third of countries in the world with college-educated adults. And, as noted earlier, Korea is ranked first in the world in the most recent (2009) PISA results.[44]

A generation ago, Korea educated only a quarter of its citizens. Today the majority of its students complete a post secondary education. This earns Korea a ranking in the top third of countries in the world with college-educated adults, in addition to being ranked #1 in the world on the 2009 PISA.

Similarly, Singapore consistently ranks in the top five nations on PISA, despite the fact that nearly 80% of families live in public housing. Children in Singapore attend public schools that offer high quality educational experiences within spacious, well-lighted learning environments, resourced with instructional technologies. Schools are staffed by highly respected teachers and administrators who work collaboratively, focusing students on high intellectual pursuits as well as civic, social, and personal goals.[45]

The McKenzie report mentioned above is also instructive here due to three study design factors. First, it studies only systems that have demonstrated sustained, wide spread, significant improvements in student performances, as measured by established measures. Second, it generalizes the interventions that correlate with such successes across countries. And third, it looks at the variations among systems based on which stage of the journey – from low student performance to world-class – that the system was at, at the time of the study.

As noted, the systems selected by McKenzie were all making steady, sustained progress, albeit at different achievement levels. In those focused on moving their students toward proficiency (poor end of the continuum) the educators used standardized assessments of basic skills at the classroom and individual student level, with the intent of ensuring all students became proficient. Whereas those focused on moving beyond proficiency to world class competitiveness adjusted

their use of standardized assessments to the system level, and used locally administered classroom assessments of subject matter and higher order thinking to inform progress.

Another difference that set the countries apart was related to accountability. In most of the high-performing systems, growth targets were set at the system level (national, state, or district) and high stakes, standardized assessments were used to track and report progress at that level only. With some exceptions, most of those high performing systems did not set highly visible growth targets at the lower levels (school and classroom), but instead they provided the capacity, support, and resources to improve – and continued to monitor overall progress at the system level.

It seems they committed to growth targets as a system, but focused on effective teaching, rather than growth targets, to achieve growth at the local level. An interviewee from one of the Asian systems explained, "We want our schools to focus on getting the process right. If they follow the process, they will get good results. But if they focus on targets, they can end up taking shortcuts in the process." A second explanation was the belief that "naming and shaming" serves to demotivate staff, resulting in less openness to learning. Instead staff members expend their energy "protecting themselves and finding ways to make their students look good on tests."[46] In contrast, other countries (including only one high-performing country) indicated they did set and publicly monitor school and classroom targets. They commented on the value of transparency to instigate and shape discussions related to the reasons behind variances across schools and classrooms.

This implies a difference in belief as to what motivates students. While most educational systems have shifted into systems that intend to educate all children, not all educational systems are using student assessment in ways that support what the cognitive science says about how people best learn and what motivates students to learn. Some of the differences are explained in the next section on principles of learning.

Student self-efficacy, motivation, mindsets on intelligence, and self-regulation all influence whether and at what rates and depth students learn. Therefore, our assessment systems must align with these influences to ensure that students are engaged and motivated, not demoralized by our approach to assessment. The achievement gains associated with formative assessment have been described as "among the largest ever reported for educational interventions."

- Black & Wiliam (1998)

Trend 2: *Assessment has not kept pace with emerging research from the cognitive sciences on how people learn.*

Educators now have deep insights, models, and representations of how students learn and how

students can represent and communicate their understandings of concepts, processes, and knowledge. Unfortunately, current measurement systems are not able to assess such conceptual models and representations in cost effective ways.

In order for students to learn, they must be motivated, they must believe they can control the rate and depth of their own learning, and they must be fully engaged. Assessment systems are only now being designed that take those factors into account, in part by focusing on growth models, understanding the need for personalized learning plans, recognizing the important role students play in setting learning targets, managing their own learning, reflecting on results, and adjusting to increase effectiveness**.** Yet there is much left undone.

This second trend references the emerging research from the cognitive sciences over the last two decades in understanding more fully how people learn. Student self-efficacy, motivation, mindsets on intelligence, and self-regulation all influence whether and at what rates and depth students learn.[47] [48] Therefore, our assessment systems must align with these influences to ensure that students are engaged and motivated, not demoralized by our approach to assessment.[49] The achievement gains associated with formative assessment have been described as "among the largest ever reported for educational interventions."[50] While many teachers incorporate aspects of formative assessment into their teaching, it is much less common to find formative assessment practiced systematically.

A school that embodies sound principles of learning is High Tech High, a charter high school in San Diego, CA. The three core principles upon which the school is designed are common intellectual mission, personalization, and adult world connection.[51] According to Larry Rosenstock, the founder of the school, "High Tech High (HTH) makes no distinction between 'college prep' and 'technical' education; the program qualifies all students for college and success in the world of work. Enrollment is non-selective, and there is no tracking at HTH. The curriculum is rigorous, providing the foundation for entry and success at the University of California and elsewhere. Assessment is performance-based: all students develop projects, solve problems, and present findings to community panels. All students are required to complete an academic internship, a substantial senior project, and a personal digital portfolio. Teacher teams have ample planning time to devise integrated projects, common rubrics for assessment, and common rituals by which all students demonstrate their learning and progress toward graduation." [52]

The formative assessment, in part through public exhibitions of student work, serves to motivate and engage students as it provides opportunities for others to provide feedback on the student's work. It opens up situations where students can discuss their work, make visible their reasons for specific directions, emphasis, and interpretations, and step back to reflect on their work. This type of assessment also enables teachers to engage students in the study of concepts within authentic, real-world situations, enable them to see how theoretical concepts apply to the real

world, and provide opportunities for students to apply concepts learned in one domain, such as mathematics, science, social studies, and language arts. This approach enables students to reflect on their work and recommit to improvements, which deepens their learning and moves them into more complex, higher levels of thinking. This also enables students to engage in learning, set learning targets, plan how they will meet those targets, execute those plans, and then, based on feedback, reconsider, revise, and resubmit. Students can become "agents of their own learning."[53]

Many such school systems still use the assessment systems and techniques that were used to sort students, (i.e., punishment and rewards in the form of grades). Despite the fact that motivation and attribution theories clearly demonstrate the importance of the student establishing confidence and belief in his/her capacity to learn, many education systems continue to attempt to change students' achievement levels by using the reward and punishment system. While that does achieve transparency, it also often serves to further demoralize students, which can lead to less effort expended in subsequent tasks and increases in dropout rates.

Cognitive science research would instead suggest that, while the teachers and students should be aware of students' current achievement levels, awareness on the part of the student is not sufficient for improvement. To get out of that downward spiral, students need to become motivated to learn, to begin believing they are in control of their own learning gains, and to learn how to make the necessary changes in their approaches to learning to achieve success. Formative assessment processes can do just that, by getting the student involved in setting learning goals, establishing plans for expending effort to achieve those goals, and tracking their own progress over time. The solution lies in a balanced approach to assessment, accompanied by instruction informed by the latest cognitive sciences, especially related to motivation and self-regulation.

Trend 3: *School systems are adding the new dimensions of 21st century skills to learning standards, but there are not yet comprehensive, cost-effective assessments for these skills.*

Many school systems have set targets for 21st century skills such as critical and creative thinking, collaboration, self-direction, multimodal learning, and cross-cultural, global awareness – within the context of the academic curriculum. Unfortunately, assessments to measure these skills cost effectively are not yet generally available. Recognizing that what is assessed is taught, nations and states around the world are calling for assessments of 21st century skills.

The most radical transformation of high-performing countries is in the type of education they strive to offer their citizens and the value their governments and citizens place on that education.

This third trend is the extension of learning standards (and assessments) to include 21st century skills knowledge. In recognition of the need to prepare students to thrive in a complex, rapidly

changing, global society, education systems have expanded their goals to go beyond academic goals to focus on learning processes such as inquiry, critical thinking, collaboration, communication, creativity, and multimodal knowledge construction. Some education systems are beginning to include performance assessments to gather evidence on students' capabilities in applying complex, higher order thinking to real-world situations.

In a 2010 survey conducted by the National School Board Association in the U.S., 43% of respondents indicated their districts had already created new school assessments to measure 21st century skills such as problem solving, teamwork, and critical thinking. And 35% listed "assessing 21st century skills" as the top educational priority that Congress and the Obama administration should address. The inclusion of the assessment of "electronic reading" in the latest PISA assessments, the development of a problem-solving PISA assessment in 2003, and the international Assessment and Teaching of 21st Century Skills project supported by Cisco, Intel, and Microsoft, speak to the international interest in these new 21st century expectations. The McKenzie report mentioned earlier also noted that those education systems excelling on international benchmarks were adding new standards in these highly complex processes.

At this juncture there is a global call to action for the development of a new generation of assessments. Policy makers recognize that, until assessments are available and affordable for evidencing progress against the 21st century skills, it will be difficult to integrate these skills into the learning culture of schools.

Trend 4: *Educators are beginning to leverage technologies for longitudinal, multi-faceted looks at data from multiple assessments, and in the design of next generation assessments.*

Technologies exist that can make student thinking visible; capture students' thinking, analysis, and understandings in real time; adapt in real-time to the responses of individual students; model performance assessments; provide longitudinal reviews of multiple assessments; and provide a steady stream of data such that periodic testing should become unnecessary except perhaps for national, regional, and international benchmarking.

> *"The type of observations and evidence of learning that technology-based assessments allow is unparalleled."*
>
> - Jody Clarke-Midura and Chris Dede, Harvard University. P. 20 [54]

While policy leaders are calling for next generations of assessments and assessment systems that use emerging technologies, to date the most common shifts have been in the migration of current assessments to digital and online forms changing how data are collected, stored, linked, analyzed, and accessed.

Schools have made significant strides in establishing the technological infrastructure to enable online assessments. For example, in the U. S. Commonwealth of Virginia alone, over a million assessments are administered online to K12 students each year. Virginia has accomplished cost efficiencies in time, test production, and travel and, has leveraged the online system to link students who do poorly on the assessments with online remediation courses. In the U.S., due to federal requirements for data reporting, school districts and the states have invested in longitudinal data systems, student information systems, and data warehouses. The U.S. federal grant program, "Race to the Top," which involves 20 states, will continue that emphasis. It requires that states use growth models linking student achievement to teacher effectiveness, and thus is highly dependent on longitudinal data.

The benefits of technology use in assessment to date have been mostly related to timeliness, reduction in printing costs and paper use, and efficiency, rather than innovative approaches to assessment challenges. An exception is the increasing numbers of school districts that are using computer-adaptive tests – tests that adjust in real-time to the student's responses during the administration of the tests. For one 5th grade class, the assessment might present 7th grade questions to some students and 3rd grade questions to others. Thus high-performing students are not asked questions that are simple for them, and low-performing students are not asked questions that are too difficult, that frustrate them. This type of assessment is extremely helpful in assessing the current proficiency levels of individual students. Such data informs teachers the level at which to challenge all students at their appropriate levels.

The unsophisticated measurement tools of today serve as a millstone around the neck of the 21st century learner.

As assessments have migrated to digital and online formats, issues have arisen in terms of:[55, 56]

- Fairness related to dual modes – i.e., paper and electronic versions – and student facility with technology
- Impact of onscreen visuals
- Capacity of teachers to assess students' digital artifacts across media
- Capacity for universal design for learning
- Equitable distribution of hardware and software
- Security issues in using student-owned devices for assessment purposes
- Balancing turnaround time with assurances of validity

Meanwhile, others are looking beyond cost efficiencies to meet existing challenges in assessment. For example, Dr. Mike Russell, from Boston College, developed an online product, NimbleTools, that offers nearly 20 accommodations for use by special needs students during testing. The device offers audio text or text-to-speech, magnification, masking tools that allow

students to focus on small sections of the test, presentation settings, sign language, and auditory calming.[57]

On other fronts, the U. S. National Assessment Governing Board for the National Assessment of Educational Progress (NAEP) recommended in 2007 that test makers introduce interactive computer tasks for the following situations:[58]

- Scientific phenomena that cannot easily be observed in real time, such as seeing things in slow motion (e.g., the motion of a wave) or speeded up (e.g., erosion caused by a river). It is also useful when it is necessary to freeze action or replay it.
- Modeling scientific phenomena that are invisible to the naked eye (e.g., the movement of molecules in a gas).
- Working safely in lab-like simulations that would otherwise be hazardous (e.g., using dangerous chemicals) or messy in an assessment situation.
- Situations that require several repetitions of an experiment in limited assessment time, while varying the parameters (e.g., rolling a ball down a slope while varying the mass, the angle of inclination, or the coefficient of friction of the surface).
- Searching the Internet and resource documents that provide high fidelity situations related to the actual world in which such performances are likely to be observed.
- Manipulating objects in a facile manner, such as moving concept terms in a concept map.

Overall, the literature suggests current and next generation uses of technology for assessment have the potential to:[59, 60]

- Enable educators to use embedded student assessments within the natural learning environment.
- Use online interactive simulations, gaming and other digital environments to capture student data, again within the learning activity.
- Create communities of learners in support of formative peer assessment.
- Widen the range of skills assessed.
- Provide unprecedented diagnostic information.
- Accomplish cost efficiencies.
- Reduce duplicative assessment.
- Create adaptive assessments.
- Offer longitudinal and multiple assessments of students.
- Monitor student work through digital portfolios.
- Create the capacity to assess collaborative knowledge building.
- Provide real-time, performance assessments that meet psychometric standards.

Technology systems can provide educators, students, and parents with timely access to individual and aggregated longitudinal data, along with linkages to other datasets related to interventions deemed influential to student learning. This longitudinal access to linked datasets provides educators with insights into student learning that enable teachers to personalize and differentiate learning with a precision never before possible.

The technology also enables educators and students to maintain new forms of evidence of student work in digital formats through online portfolios. The use of digital portfolios enables students to demonstrate complexities of learning through student artifacts and reflections and to show growth over time through comparisons of actual student work. On the instructional side, technology provides new venues for composition and production with multimodal media. The technology also allows for ease and sophistication of analysis and interpretation of student data using new analytics. For example, technology programs are now as accurate as humans in scoring short answer assessments.[61]

It is striking across the four trends just reviewed, how measurement has failed to match the significant progress of the learning sciences over the last two decades, and failed to address the need for assessments of 21st century skills. Educators now know that students learn best in real-world situations, when tapping prior knowledge, while collaborating in participatory cultures, and while constructing their own sense making of the world. Unfortunately, while educators, students, and communities can create exciting, research based models, simulations, and authentic learning situations that maximize deep learning in students, the assessment community has yet to step up to measure such constructs in real time, over time. Until that happens, the unsophisticated measurement tools of today serve as a millstone around the neck of the 21st century learner.

This represents a call to action to scale up the assessment models that work, increase the sophistication of the analysis tools to maximize data driven decision making, and invest in research and development in next generation assessment tools.[62, 63]

Strategies for Scaling Up to 21st Century Assessments

Consider the results of the 2009 PISA assessments of a half million 15-year-olds in more than 70 economies across the world.[64] The strongest performances were from Korea, Finland, Hong Kong-China, Singapore, Canada, New Zealand, Japan, and Shanghai-China. These are countries that have invested in education reform and transformation – including new approaches to student assessment. For example, high-ranking Finland relies on its teachers to design local assessments to evaluate student outcomes on national standards, along with a voluntary national assessment at two grade levels. Similarly, Singapore has moved more toward assessments of critical thinking and reasoning that are open-ended, with teachers encouraged to assess continually using a variety of methods including classroom observations, journaling in mathematics, oral and written communications and tests, as well as practical and investigative tasks. In the U.S., which ranks

mid-range to low-range on the PISA assessments, the balance in assessment shifts to an increased emphasis on standardized assessments. Yet, U.S. experts are also calling for increased focus on more authentic, transparent, open-ended assessments that lend themselves to exploration, creativity, understanding, and sharing.

The way education systems approach the assessment of student learning defines its potential for growth, reform and innovation. According to Linda Darling-Hammond, "…most assessment in high-achieving countries is school-based rather than externally designed and administered."[65]

Leveraging Assessment for Educational Transformation

One of the key factors in the transformations of high performing countries on international benchmarks has been a redesign of their assessment systems. By its very nature, assessment is imprecise. The evidence collected about what students know and are able to do is only an approximation of the students' true knowledge and competencies. Therefore, multiple assessments – appropriately applied and interpreted – are optimal in order to achieve the closest approximation possible.

The findings from retrospective and prospective studies suggest that education leaders interested in using student assessment to leverage change should establish a system of assessment that:

- Longitudinally tracks their system's progress against international or national benchmarks.
- Employs a range of assessments at the classroom, school, district, and national levels all aligned to high standards (content, process, and 21st century skills).
- Continuously provides a stream of data from a range of formative assessments designed as diagnostic to inform students' continuous progress toward attainment of established learning standards and 21st century skills.
- Systematically uses assessments to monitor both aggregate and individual student progress in attaining established learning standards and 21st century skills.
- Monitors and invests in emergent research and developments (R&D) in next generation assessments.

It is not enough to establish a comprehensive system of assessments to approximate the students' learning. The data, information, and knowledge gleaned from that array of assessments must be effectively used to provide a continuous feedback loop to students and teachers to drive continuous improvement, accountability, and educational innovation.

To optimize the impact of world-class assessment systems described above, school systems should:

- Establish data cultures within all schools, and engage students, teachers, administrators, and parents in using data to drive continuous innovation for improvement.

- Support and encourage educators to participate in professional learning communities committed to high student performances enabled through data informed decision making.

- Adjust the accountability policies to maximize impact. During times when the education system is building toward wide scale proficiency, use more prescriptive instructional programs accompanied by periodic standardized tests. Once proficiency is achieved, shift accountability to the cadre of teachers, while providing the flexibility required for the system to move beyond proficiency into higher levels of learning.

Steps Toward World-Class Learning

Actionable steps that will lead a nation or state toward a dynamic, world-class assessment system that continually results in higher performances by students include:

1. **Establish a vision for world-class standards for all students that includes 21st century skills**
   Formally establish your education system's vision for 21st century learning; vision is the first step toward assessing those skills. A critical step moving forward with next generation assessment is clarity in the learning targets and the cognitive structures that define those targets.

2. **Research, discuss, and innovate around these standards – within communities of interest**
   Convene teams to conduct the research and investigations necessary to bring your vision to life. Maintain openness and flexibility in how students will exhibit these skills and the range of assessments necessary to approximate your students' attainment of those skills. Visit leading districts, discuss with universities, perhaps benchmark with business and industry. Once the construct is set for 21st century skills, it will shape the array of assessments required to assess student progress related to such skills.

3. **Engage students as partners in assessment of these standards**
   Formative assessment systems won't function unless students play an active role in their own learning. Empower students to take an active, responsible role in assessment for learning.

4. **Design a fair, balanced, and comprehensive assessment system that serves to motivate and engage students in learning**

Establish a balanced, comprehensive, and coherent assessment system with international benchmarking at the system level. For each learning standard and 21st century skill, teams can build conceptual models and plan how multiple assessments will be used to evidence students' growth. Strive for a balance between the formative and summative components of the assessment system. Ensure it is comprehensive by using multiple assessments to triangulate data for the best approximation of what students know and are able to do. Ensure it is coherent in that it is producing a stream of data (on students) that provides continuous updates on each student. Let the system evolve. Establish it as a dynamic system that expects to adapt and innovate over time. Be open to hybrid or blended models for high stakes assessments – focus on performance assessments.

5. **Establish a data culture within your schools that encourages assessment for learning**
   Build capacity through communities of practice and implement with thoughtful planning. The quality of the formative component of a system depends on the thoughtfulness and expertise with which students, teachers, parents, administrators, and community use data. Establish a healthy, inquisitive, analytic, and committed community within a culture of assessment.

6. **Use technology as a design element for next generation assessment**
   Consider technology as a design element and engine supporting the assessment system. Tap into the potential of technology in assessment. Become knowledgeable about that potential and use technology innovatively as a design element during the development phase and in cycles as implementation occurs. The untapped potential is in the power of the technology to enable educators to conduct embedded assessments (collecting data continuously as students learn) and performance assessments that enable educators to gauge student growth in complex, higher order thinking skills. As 2011 unfolds, track the key international developers, begin piloting with gaming, and invest in the pioneers to conduct pilots in this arena.

7. **Report summative data publicly at the systems level (national or state level) only**
   Consider reporting your results from standardized tests or international benchmarks at the national or state level only. Low performing schools know who they are. Don't embarrass them. Instead provide them with the leadership, professional development, effective teachers, and resources they need to close that achievement gap.

These seven actionable steps, along with the reports descriptions of world-class assessment systems should serve as levers to higher quality learning systems. While this report is focused only on assessment, readers should note that educational transformations also leverage policy, curriculum standards and assessment, information communications technology, and research and evaluation.

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