Acknowledgement

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Technology Outlook for Singaporean K-12 Education 2012-2017

An NMC Horizon Project Regional Analysis

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An NMC Horizon Project Regional Analysis

by

The New Media Consortium

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Executive Summary

The *Technology Outlook for Singaporean K-12 Education 2012-2017* presents the findings of a research project led by the New Media Consortium (NMC) and intended to inform educational leaders about significant developments in technologies supporting teaching, learning, and creative inquiry in Singaporean K-12 education. The project was a collaboration with SingTel Education and was made possible through their generous support.

All of the research underpinning the report makes use of the NMC's Delphi-based process for bringing groups of experts to a consensus viewpoint, in this case around the impact of emerging technologies on teaching, learning, or creative inquiry in Singaporean K-12 education over the next five years. The same process underlies the well-known *NMC Horizon Report* series, which is the most visible product of an on-going research effort begun a decade ago to systematically identify and describe emerging technologies likely to have a large impact on education around the globe.

The *Technology Outlook for Singaporean K-12 Education 2012-2017* was produced to explore emerging technologies and forecast their potential impact expressly in a K-12 context. In the effort that ran from August through September 2012, a carefully selected group of experts was asked to consider hundreds of relevant articles, news, blog posts, research, and project examples as part of the preparation that ultimately pinpointed the most notable emerging technology topics, trends, and challenges for K-12 education in Singapore over the next five years.

Known as the 2012 Horizon Project Singapore Advisory Board, that group of experts is comprised of notably knowledgeable individuals, all highly regarded in their fields. Collectively the advisory board represents a range of diverse perspectives across the education sector. The project has been conducted under an open data philosophy, and all the interim projects, secondary research, discussions, and ranking instrumentation can be viewed at singapore.wiki.nmc.org. The precise research methodology employed in producing the report is detailed in a special section found at the end of this report.

The 12 "technologies to watch" presented in the body of this report reflect our experts' opinions as to which of the nearly 60 technologies considered will be most important to Singaporean K-12 education over the five years following the publication of the report. As the table on the following page illustrates, the choices of our experts overlap in interesting ways with those who contributed to the *NMC Horizon Report > 2012 K-12 Edition,* which looked at technology uptake from a global perspective, and the *Technology Outlook for Australian Tertiary Education 2012-2017*, which examined similar uptake in an Australian context.

All three of these projects' advisory boards — a group of 112 acknowledged experts — strongly agree that cloud computing, mobile apps, and tablet computing will likely tip into mainstream use within the next year — a trend that spans education across much of the world. Similarly, all three saw gamification or game-based learning as an emerging approach to teaching and learning that would be making its way into schools in the mid-term horizon, along with personal learning environments. They also agreed that natural user interfaces are redefining how we think about and use our devices, with a consensus on the four-to-five year timeframe.

There are many commonalities between the opinions of our Singaporean K-12 experts and the global K-12 experts whose contributions were published in June 2012. Cloud computing, collaborative environments, mobile apps, and tablet computing were all on the near-term horizon for both reports; likewise, gamification or game-based learning, learning analytics, and personal learning environments on the mid-term horizon; and natural user interfaces on the far-term horizon. Meanwhile, the 66 experts from the Singapore and the Australia advisory boards were of like mind that massively open online courses are four to five years away for them.

Comparison of "Short List" Topics Across Three NMC Horizon Research Projects

Technology Outlook for Singaporean K-12 Education 2012-2017	NMC Horizon Report 2012 K-12 Edition	Technology Outlook for Australian Tertiary Education 2012-2017
Time-to-Adoption Horizon: One Year or Less		
Cloud Computing Collaborative Environments Mobile Apps Tablet Computing	Cloud Computing Collaborative Environments Mobiles and Apps Tablet Computing	Cloud Computing Learning Analytics Mobile Apps Tablet Computing
Time-to-Adoption Horizon: Two to Three Years		
Electronic Publishing Gamification Learning Analytics Personal Learning Environments	Digital Identity Game-Based Learning Learning Analytics Personal Learning Environments	Digital Identity Game-Based Learning Open Content Personal Learning Environments
Time-to-Adoption Horizon: Four to Five Years		
Collective Intelligence Internet of Things Massively Open Online Courses Natural User Interfaces	Augmented Reality Natural User Interfaces Semantic Applications Assessment of 21st Century Skills	Digital Preservation Massively Open Online Courses Natural User Interfaces Telepresence

A number of distinct choices distinguished the viewpoints expressed by the Singapore advisory board from their counterparts in other regions of the world: electronic publishing, collective intelligence, and the Internet of Things, although considered by other recent panels, were seen as important priorities for the mid- and far-term horizons in Singapore, but did not make the cut among the two comparison groups.

Top Ranked Trends Across Three NMC Horizon Research Projects

Technology Outlook for Singaporean K-12 Education 2012-2017	NMC Horizon Report 2012 K-12 Edition	Technology Outlook for Australian Tertiary Education 2012-2017
Enhanced electronic books are increasingly being used instead of traditional textbooks.	Paradigms in K-12 teaching are shifting to include online learning, hybrid learning and collaborative models.	People expect to be able to work, learn, and study whenever and wherever they want.
The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators.	The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators.	Increasingly, students want to use their own technology for learning.
Education paradigms are shifting to include online learning, hybrid learning and collaborative models.	As the cost of technology drops and school districts revise and open up their access policies, it is becoming increasingly common for students to bring their own mobile devices.	Education paradigms are shifting to include online learning, hybrid learning and collaborative models.

Gamification was a topic that particularly sparked considerable discussion among the Singapore advisory board members. There was a general consensus that gaming mechanics and the integration of actual games, whether online or in app form, are transformative in K-12 education because they foster more immersive learning experiences and increase student engagement.

A growing number of key universities worldwide are looking to MOOCs as a way to facilitate free learning and extend their courses to a broader audience, but Singapore is the first region that has

identified MOOCs as an area of interest for K-12 — a choice that reflects the nation's stated interest in applying innovation and technology wherever it may help Singapore achieve its vision for learners and learning.

Just as the nuances of the technologies and their associated adoption horizons featured in this report are specific to Singaporean K-12 education, even if there are commonalities with other reports, the trends and challenges selected by the Singapore advisory board distinctly reflect the current drivers and obstacles facing K-12 education in Singapore over the coming five years. For example, the advisory board agreed that the use of enhanced e-books over traditional textbooks is a trend that many schools are responding to by integrating more digital content into curricula.

The experts spent a fair amount of time researching and discussing relevant trends and challenges in the context of Singaporean K-12 teaching, learning, and creative inquiry. A full discussion of trends and challenges identified by the advisory board begins on page 17; the top three from those longer lists are included in the related tables in this summary.

Top Ranked Challenges Across Three NMC Horizon Research Projects

Technology Outlook for Singaporean K-12 Education 2012-2017	NMC Horizon Report 2012 K-12 Edition	Technology Outlook for Australian Tertiary Education 2012-2017
Digitization is not enough; textbooks need to be reinvented.	Digital media literacy continues its rise in importance as a key skill in every discipline and profession.	Economic pressures and new models of education are bringing unprecedented competition to the traditional models of tertiary education.
K-12 must address the increased blending of formal and informal learning.	K-12 must address the increased blending of formal and informal learning.	Appropriate metrics of evaluation lag behind the emergence of new scholarly forms of authoring, publishing, and researching.
Learning that incorporates real life experiences is not occurring enough and is undervalued when it does take place.	The demand for personalised learning is not adequately supported by current technology or practices.	Most academics are not using new and compelling technologies for learning and teaching, nor for organising their own research.

The Singaporean panel of experts saw doors opening in K-12 to more online, hybrid, and collaborative learning models. These emerging models foster teamwork, communication, and both informal and peer-to-peer leaning. Just as the advisory board believes the ways in which students learn are changing, they also acknowledged the evolving role teachers. With a constantly expanding universe of online resources at students' disposal, it is the responsibility of teachers to become guides and help them navigate the abundance of content and relationships.

Horizon Project advisory boards in general have agreed that trends like these and the full list on page 17 are clear drivers of technology adoption; the Singapore group especially saw such a linkage. At the same time, these panels of experts also agree that technology adoption is often hindered by both local and systemic challenges. Many challenges impacting technology uptake are grounded in everyday realities that often make it difficult to learn about, much less adopt, new tools and approaches.

The need to transform textbooks, for example, continues to dominate conversations in Singapore about improving learning experiences in K-12 education; there is a common belief that merely digitizing or making the print versions of textbooks available online will not adequately meet

these demands. There is a great deal of innovation taking place within publishing companies to address this challenge, but the results are not yet pervasive in schools.

Both the Singapore and global K-12 advisory boards agree that there is a growing need for the K-12 sector to better understand and be a part of the blending of formal and informal learning. The challenge embedded in this topic is that more than ever, students at a younger and younger age are equipped with their own devices — such as mobiles — that they use outside of the classroom to explore subjects that personally interest them. Students do not learn to use these technologies in school, but on their own and at their own pace. Tools such as mobile apps breed discovery of new information for users, and there is a need for schools to leverage and promote these informal learning experiences while integrating them with in-school learning.

The Singapore advisory board also felt that schools do not sufficiently incorporate real-life experiences in their curricula. Models such as challenge based learning, which encourages students to solve local and global problems, are interesting to schools, but have not gained enough traction and are not yet widespread. In order for students to be engaged in the material they are learning, there is a need for it to be tied to their own lives and the community around them.

All of these points and comparisons provide an important context for the main body of the report that follows this summary. There, 12 key technologies are profiled, each on a single page that describes and defines a technology ranked as very important for Singaporean K-12 education over the next year, two to three years, and four to five years. Each of these pages opens with a carefully crafted definition of the highlighted technology, outlines its educational relevance, points to several real life examples of its current use in schools, and ends with a short list of additional readings for those who wish to learn more. Following those discussions are sections that detail the Singapore advisory board's top ten ranked trends and challenges and articulate why they are seen as highly influential factors in the adoption of any of these technologies over the coming five years.

Those key sections, and this report in general, constitute a reference and straightforward technology-planning guide for educators, researchers, administrators, policymakers, and technologists. It is our hope that this research will help to inform the choices that institutions are making about technology to improve, support, or extend teaching, learning, and creative inquiry in Singaporean K-12 education. Educators and administrators worldwide look to the NMC Horizon Project and both its global and regional reports as key strategic technology planning references, and it is for that purpose that the *Technology Outlook for Singaporean K-12 Education 2012-2017* is presented.

Time-to-Adoption: One Year or Less

Cloud Computing

Cloud computing refers to expandable, on-demand services and tools that are served to the user via the Internet from a specialised data centre. Cloud computing resources support collaboration, file storage, virtualization, and access to computing cycles, and the number of available applications that rely on cloud technologies have grown to the point that few institutions do not make some use of the cloud, whether as a matter of policy or not. Cloud computing has come to play an increasingly indispensable role in the utility of the many devices people use in everyday life. Whether connecting at home, work, school, on the road, or in social spaces, nearly everyone who uses the network relies on cloud computing to access or extend their information and applications. As cloud computing has become ever more important, questions related to privacy, data security, and even sovereignty have led to the development of private clouds. Recently, hybrid clouds have been custom-designed to meet specialised security or other critical needs that a commodity cloud cannot.

Relevance for Teaching and Learning in Singaporean K-12 Education

- Cloud computing is being used in computer science programs to simulate virtually any computer, from historical machines to super computers.
- Cloud-based services include a wide range of increasingly powerful tools for almost any platform a user might choose, or any task a user might need to do.
- Dynamic provisioning services offered by cloud providers like Amazon's S3 have transformed how we add storage and processing power, and scale resources.

Cloud Computing in Practice

- As part of the national preparedness for potential pandemics, all of the Learning Management Systems in Singapore used by Ministry of Education schools now operate in the cloud. Marshall Cavendish, for example, provides LMS to schools: go.nmc.org/zduav.
- The Cloud Security Alliance provides educational resources on best practices in cloud computing and is establishing its corporate headquarters in Singapore: go.nmc.org/oxvjj.
- Launched in Singapore, Teamie is a cloud-based social learning platform that facilitates and improves student performance: go.nmc.org/vmfem.
- The Singapore Ministry of Education adopted open standard Internet email and collaboration services via Google Apps for over 30,000 teachers: go.nmc.org/xwovc.

For Further Reading

Address by IDA CEO at CloudAsia 2012
go.nmc.org/tiedv

(Ronnie Tay, *IDA Singapore*, 15 May 2012.) The CEO of Infocomm Development Authority of Singapore speaks at the CloudAsia 2012 Conference to discuss the national progress of cloud adoption, and addresses relevant challenges such as cloud security.

Singapore Cloud Thrusts Boost Adoption, Industry Growth
go.nmc.org/zpuzj

(*Asia Cloud Forum*, 17 May 2012.) Singapore is ranked third, after Australia and Japan, in terms of cloud adoption in the Asia-Pacific region.

Singapore Uni Develops Cloud-Based Multiscreen TV Tech
go.nmc.org/llunv

(Liau Yun Qing, *ZD Net*, 14 August 2012). Nanyang Technological University created a prototype for "Social Cloud TV," a cloud-based platform that feeds television shows and videos to multiple devices, including smart phones.

Time-to-Adoption: One Year or Less

Collaborative Environments

Collaborative environments are online spaces — often cloud-based — where the focus is on making it easy to collaborate and work in groups, no matter where the participants may be. As the typical educator's network of contacts has grown to include colleagues who might live and work across the country, or indeed anywhere on the globe, it has become common for people who are not physically located near each other to nonetheless collaborate on projects. Joint classroom-based projects with students at other schools or in other countries are more and more common strategies used to expose learners to a variety of perspectives. The essential attribute of the technologies in this set is that they make it easy for people to share interests and ideas, to easily monitor their collective progress, and to see how ideas have evolved throughout the process. These tools are compelling and widely adopted because they are not only easy to use, but they are also either very low cost or free, and often accessible with a simple web browser.

Relevance for Teaching and Learning in Singaporean K-12 Education

- A class or project group can assemble a collaborative workspace very quickly using widgets that pull information from a range of sources.
- Collaborative environments are an efficient way for students to work together, whether the groups are composed of students in the same physical class or not.
- Large-scale collaborative environments can facilitate an almost spontaneous development of communities of people who share similar interests.

Collaborative Environments in Practice

- At the 2012 Google Apps for Education Singapore Summit, presentations and hands-on workshops informed educators seeking collaboration tools for classroom: go.nmc.org/biyww.
- In the First Peoples' Project, children on five continents have used technology to share their respective cultures in a digital cultural exchange: go.nmc.org/zytbi.
- The international eLanguages project facilitates collaboration between teachers and classrooms around the world. Teachers can select or propose projects for their classes to take part in, exchange ideas with other teachers, and share resources: go.nmc.org/gsgvm.
- The Flat Classroom Project joins K-12 students to collaborate virtually on assignments with real world relevance: go.nmc.org/psoan.

For Further Reading

Collaborative Learning Environments Sourcebook
go.nmc.org/bkjvl

(CriticalMethods.org; accessed 3 September 2012.) This online book describes and provides links to a wide variety of collaboration resources and tools.

Learning Reimagined: Participatory, Peer, Global, Online
go.nmc.org/xshrq

(Howard Rheingold, *DMLCentral*, 22 July 2011.) This article addresses the implications of using open educational resources to influence the pedagogy behind self-organizing peer learning groups.

Social Collaboration Platform for Students Wiggio Hits 1M Users, Launches Paid Version
go.nmc.org/ktomi

(Sarah Perez, *Tech Crunch*, 25 April 2012.) Wiggio is an online collaboration suite that thousands of students are using worldwide. The founder and CEO discusses the latest version and how it can be easily used by fourth graders.

Time-to-Adoption: One Year or Less

Mobile Apps

There is a revolution that is taking place in software development that parallels the changes in recent years in the music, publishing, and retail industries. Mass market is giving way to niche market, and with it, the era of highly priced large suites of integrated software is giving way to a new view of what software should be. Smartphones such as the Galaxy, iPhone, and Android have redefined what we mean by mobile computing, and in the past three to four years, the small, often simple, low-cost software extensions to these devices — apps — have become a hotbed of development. New tools are free or sell for as little as 99 cents, making it easier for people — even students — to develop apps.

A popular app can see millions of downloads in a very short time, and that potential market has spawned a flood of creativity that is instantly apparent in the extensive collections available in the app stores. These retail phenomena provide an easy, fast, and totally new way to deliver software that reduces distribution and marketing costs significantly. Apple's app store opened in July 2008; Google's followed in October of that year. By July 2012, more than 50 billion apps had been sold or downloaded; simple but useful apps have found their way into almost every form of human endeavor. Mobile apps are particularly useful in education as they enable students to learn and experience new concepts wherever they are, often across multiple devices.

Relevance for Teaching and Learning in Singaporean K-12 Education

- Apps with built-in social features enable learners to share their questions or findings with each other in real-time. For example, productivity apps such as Evernote and Edmodo make it possible to exchange of notes, assignments, drawings, videos, and more.
- Augmented reality-enhanced apps allow users to visit cultural sites and view their history (i.e. what the landmarks looked like during different time periods) through their mobile.
- Leveraging the cameras, microphones, and other tools inherent in mobiles, many apps help students create rich media. This is especially convenient for work done outside of the classroom as students can record interviews; collect data for experiments; and more.

Mobile Apps in Practice

- Greenridge Primary School piloted the Singapore Zoo's River Safari app, which uses location-based and image recognition technology: go.nmc.org/lgork.
- The Interactive Heritage Trails use mobile apps to guide learners through specific routes in Singapore so they can experience all of the cultural sites live: go.nmc.org/wanfd.
- Sixteen Singapore schools are using Trail Shuttle, a mobile app that promotes self-directed learning: go.nmc.org/bcocq.
- The SquareCrumbs app, piloted at the School of Science and Technology in Singapore, fosters interactive learning through a real-time feedback feature: go.nmc.org/cqdiz.

For Further Reading

Innovators of Acclaimed Singapore Math Program Develop Pioneering Math App for iPad
go.nmc.org/cxjoz

(Houghton Mifflin Harcourt, 5 January 2012.) Publisher Houghton Mifflin Harcourt launched an education app for tablets based on the renowned Singapore math model.

Singapore Startups Woo Kids with Play-and-Learn Apps
go.nmc.org/lxmoj

(Susheela Menon, *Startup Central*, 14 June 2012.) Several start-ups have emerged in Singapore that create educational apps for children. This article describes companies that are designing apps that integrate simulation, interaction, and learning with entertainment.

Time-to-Adoption: One Year or Less

Tablet Computing

In the past two years, advances in tablets have captured the imagination of educators around the world. Led by the incredible success of the iPad, which at the time of publication had sold more than 85 million units, other similar devices such as the Samsung Galaxy Nexus, Kindle Fire, the Nook, Sony's Tablet S, and the Microsoft Surface have also begun to enter this rapidly growing market. In the process, the tablet (a form that does not require a mouse or keyboard) has come to be viewed as a new technology in its own right, one that blends features of laptops, smartphones, and earlier tablet computers with always-connected Internet, and thousands of apps with which to personalise the experience. As these new devices have become more used and understood, it has become even clearer that they are independent and distinct from other mobile devices such as smartphones, e-readers, or tablet PCs. With significantly larger screens and richer gesture-based interfaces than their smartphone predecessors — and a growing and ever more competitive market — they are ideal tools for sharing content, videos, images, and presentations because they are easy for anyone to use, visually compelling, and highly portable.

Relevance for Teaching and Learning in Singaporean K-12 Education

- As a one-to-one solution, tablets present an economical, flexible alternative to laptops and desktops due to their lower cost, greater portability, and access to apps.
- Tablets are conducive to engaging in learning outside the classroom, with a suite of tools for capturing data in real-time and collaborating on projects.
- Tablets are easily adaptable to almost any learning environment, with tens of thousands of educational applications emerging as part of a new software distribution model.

Tablet Computing in Practice

- Developed by researchers at Nanyang Technological University in Singapore and Rice University in Houston and, the I-slate is a low cost tablet device that is designed for classrooms that lack electricity: go.nmc.org/lrpkz.
- In South Africa, the Key School for Specialised Education is using the iPad to help autistic students with their communication skills: go.nmc.org/ipada
- Pressmart announced the launch of Mobile Learning Classroom Application, a tablet-based education solution for schools that will be piloted across schools Singapore, Malaysia, Australia, and India in late 2012: go.nmc.org/fhzsp.

For Further Reading

Best Practices for Deploying iPads in Schools
go.nmc.org/httex

(Matt Levinson, *Mindshift*, 29 August 2012.) As more schools deploy iPads, teachers look for guidelines on the process so they can plan their teaching strategies accordingly. This article discusses how to put a system in place for iPad use in the classroom.

Intel Releases Rugged Education Tablet for the Developing World
go.nmc.org/intel

(Josh Smith, *GottaBe Mobile*, 10 April 2012.) Intel created a tablet called "Studybook" that is resistant to water and dust, as well as durable when dropped. The device is a good fit for mobile labs in which students take tablets out with them for field research.

iPad Implementation at Nanyang Girls' School in Singapore
go.nmc.org/hafge

(ICT for Educators, 20 May 2011.) This report describes the implementation and philosophies behind the iPad one-to-one pilot project that is taking place at Nanyang Girls' School in Singapore.

Time-to-Adoption: Two to Three Years

Electronic Publishing

Now that it is firmly established in the consumer sector, electronic publishing is beginning to demonstrate capabilities that challenge the boundaries between print and digital, still image and video, and passive and interactive. Modern digital workflows support all manner of possible publication, from traditional print to digital, web, and video. Building in the full spectrum of potential publishing avenues — print, web, video, mobiles and tablets, and interactives — from the beginning is not only a way to streamline production overall, but also to increase the reach of the materials produced by leveraging the content over a wide range of media. Modern media companies have been at the vanguard of this conversion. Magazine writers, for example, will produce a piece so that it will work in the magazine, on the web, and in video — and the finished product may appear in any or all of those outlets. Schools are looking to electronic publishing to bring digital content to students, which often costs less to produce and update than traditional textbooks. Recently, publishers have been developing enhanced e-books that include video, audio, and other rich media to be better tailored to how students actually learn.

Relevance for Teaching and Learning in Singaporean K-12 Education

- Electronic publishing offers institutions unprecedented opportunities of scale and richness by reorganizing the way images, audio and video content, and layers of textual data are conceptualised during the design process.
- Modifying publishing workflows brings educational institutions in line with industry standard practices and allows them to reach entirely new audiences.
- New tools, such as iBook Author, enable all kinds of people, including K-12 students, to create and disseminate their own e-books.

Electronic Publishing in Practice

- Apple recently extended iTunes U for the K-12 community, enabling teachers to publish their content for free download: go.nmc.org/jfjcd.
- Brain Hive has announced an on-demand eBook lending service for K-12 schools: go.nmc.org/skhlt.
- Public schools in Florida are gradually transitioning from textbooks to digital textbooks by 2015: go.nmc.org/ekqrx.

For Further Reading

Are Apps The Future of Book Publishing?
go.nmc.org/zoqfh

(Alex Knapp, *Forbes*, 30 March 2012.) Book apps are becoming a popular method of enhancing books and making them available for tablets or e-readers, with videos, sound effects, social media capabilities, and more.

How Schools are Reacting to Apple's Entry into Education
go.nmc.org/rilhe

(Heather Kelly, *Venture Beat*, 21 January 2012.) Apple now offers interactive K-12 textbooks that cost much less than regular textbooks and their iBooks Author allows anyone to publish their own interactive e-book. This article discusses the implications for schools.

Using E-Books in School
go.nmc.org/xuonk

(*The Journal*, accessed 26 September 2012.) Some schools are working with textbook publishers and e-reader vendors to bring digital textbooks to students. This article describes experiences of some of the schools using digital textbooks and based on those, divulges the positive aspects as well as the drawbacks.

Time-to-Adoption: Two to Three Years

Gamification

Gamification refers to the integration of games or gaming mechanics into educational experiences. This topic has gained considerable traction over the past decade as games have proven to be effective learning tools, and beneficial in cognitive development and the fostering of soft skills among students, such as collaboration, communication, problem-solving, and critical thinking. The forms of games grow increasingly diverse and some of the most commonly used for educational purposes include alternate reality games (ARG), massively multiplayer online games (MMO), and global social awareness games. Most games that are currently used for learning across a wide range of disciplines share similar qualities: they are goal-oriented; have strong social components; and simulate some sort of real world experience that students find relevant to their lives. As game-based learning garners more attention in academia, developers are responding with games expressly designed to support immersive, experiential learning. Another major component of this topic is the gamification of learning, in which aspects of games are incorporated into learning exercises. For example, students may receive karma points or badges or move up to a new level after performing well during an activity.

Relevance for Teaching and Learning in Singaporean K-12 Education

- Educational games can be used to teach cross-curricular concepts that touch on many subjects in an engaging way.
- Gamification offers opportunities for both discovery-based and goal-oriented learning, and can be a very effective way to develop teambuilding skills.
- Simulations and role-playing games allow students to re-enact difficult situations to try new responses or pose creative solutions.

Gamification in Practice

- Developed by the National Institute of Education in Singapore, the "Legends of Alkhimia" video game supports middle and high school chemistry curriculum: go.nmc.org/legen.
- Gaming company Rockmoon is collaborating with FutureSchools@Singapore to promote the use of a mobile app that supports self-directed, immersive learning: go.nmc.org/ixhrv.
- Singapore's premier independent game studio has been commissioned by Singapore's Ministry of Education to develop a massively multi-player online game that will incorporate speech recognition and intelligent tutoring technology: go.nmc.org/nrccn.

For Further Reading

The 50 Best Videos For Teachers Interested In Gamification
go.nmc.org/jvxny

(Jeff Dunn, *Edudemic*, 12 September 2012.) These 50 videos share what experts, teachers, and students think about learning through gamification and gaming.

Gamifying the Classroom
go.nmc.org/devev

(Fora.tv, accessed 26 September 2012.) In his presentation for the Gamification Summit NYC 2011, Ananth Pai, a recognised leader in the gamification movement, describes his gamified third grade classroom.

Research Results on Serious Play in Classrooms
go.nmc.org/gymez

(Jessie Chuang, *Classroom Aid*, 22 May 2012.) The National Institute of Education in Singapore embarked on a three-year study to find out how learning and teaching is facilitated through computer games in classrooms.

Time-to-Adoption: Two to Three Year

Learning Analytics

Learning analytics refers to the interpretation of a wide range of data produced by and gathered on behalf of students to assess academic progress, predict future performance, and spot potential issues. Data are collected from explicit student actions, such as completing assignments and taking exams, and from tacit actions, including online social interactions, extracurricular activities, posts on discussion forums, and other activities that are not typically viewed as part of a student's work. The goal of learning analytics is to enable teachers and schools to tailor educational opportunities to each student's level of need and ability. Learning analytics promises to harness the power of advances in data mining, interpretation, and modelling to improve understanding of teaching and learning, and tailor education to individual students more effectively. Still in its very early stages, learning analytics is an emerging scientific practice that hopes to redefine what we know about learning by mining and investigating the vast amount of data produced by students as they engage in academic activities.

Relevance for Teaching and Learning in Singaporean K-12 Education

- The promise of learning analytics is that when correctly applied and interpreted, it will enable teachers to more precisely identify students' learning needs and tailor instruction appropriately.
- If used effectively, learning analytics can help surface early signals that indicate a student is struggling, allowing teachers and schools to address issues quickly.

Learning Analytics in Practice

- The mobile app GoSoapBox allows students to anonymously ask questions to their teachers and participate in discussions via smartphone, tablet, or laptop: go.nmc.org/xofii.
- Rancocas Valley Regional High School is collecting real-time feedback of standards-based declarative and procedural knowledge: go.nmc.org/bclnm.
- Teachers at Crescent Girl's School use WriteToLearn, which analyses written text based on linear algebraic models, to evaluate writing assignments. The software also shows students how to correct their mistakes: go.nmc.org/musok.

For Further Reading

Big Data for Education: Data Mining, Data Analytics, and Web Dashboards
go.nmc.org/hcvwt

(Brookings Institution, 4 September 2012.) This report explains how learning software can collect data and provide instant feedback to teachers and students.

Data Mining and Online Learning
go.nmc.org/nyhsn

(Jim Shimabukuro, *Educational Technology & Change Journal*, 7 August 2011.) The author helps educators incorporate learning analytics into their daily workflows.

Exploring the Khan Academy's Use of Learning Data and Learning Analytics
go.nmc.org/rttpc

(K. Walsh, *Emerging EdTech*22, April 2012.) The Khan Academy created a "Teacher Toolkit," which includes graphic reports to help teachers personalise the learning process.

Learning and Knowledge Analytics
go.nmc.org/igyjh

(George Siemens; accessed 3 September 2012.) Renowned learning analytics expert George Siemens frequently updates this website with his insights on the topic, from keynotes to presentations, to blog posts.

Time-to-Adoption: Two to Three Years

Personal Learning Environments

Personal learning environments (PLEs) are a loosely defined term used to describe tools that support self-directed and group-based learning, focus on individual learning goals and needs, with great capacity for flexibility and customization. The term has been evolving for some time, but has crystalized recently around the personal collections of tools and resources a person assembles to support their own learning — both formal and informal. The conceptual basis for PLEs has shifted significantly in the last two years, as smartphones, tablets, and apps have begun to emerge as compelling alternatives to browser-based PLEs and e-portfolios. There has been a corresponding move away from centralised, server-based solutions to distributed and portable ones. Using a growing set of free and simple tools and applications, or even a personally assembled collection of apps on a tablet, it is already easy to support one's ongoing social, professional, and learning activities with a handy collection of resources and tools that are always with you. While the concept of PLEs is still fairly fluid, it is clear that a PLE is not simply a technology but an approach or process that is individualised by design, and thus different from person to person.

Relevance for Teaching and Learning in Singaporean K-12 Education

- The notion of a PLE is a useful way for students to think about the collections of apps they might assemble on a smartphone or tablet to help them support their learning and learning-related work.
- PLEs may cater to students with differing learning styles; for instance, visual learners might be able to obtain material from a different source than auditory learners do.
- Students using PLEs may benefit from the practice of keeping track of, and curating, their own resource collections.

Personal Learning Environments in Practice

- A former teacher is creating an open cloud service that leverages crowd sourced tagging to share and organise educational content, such as e-books, videos, and apps, into customizable learning maps: go.nmc.org/genome.
- "Innovative Technologies for an Engaging Classroom" is a pan-European project that joins policy-makers with educators to develop scalable learning environments: go.nmc.org/itec.
- Nan Chiau Primary School and Microsoft launched the WE Learn mobile education project, which incorporates smartphones in order to foster collaborative environments and inquiry-based 21st century curriculum: go.nmc.org/nyxfm.

For Further Reading

Role of Teacher in Personal Learning Environments
go.nmc.org/blkyk

(Zaffar Ahmed Shaikh and Shakeel Ahmed Khoja, *Digital Education Review, No. 21*, 2012.) This paper describes how a teacher's role has transformed as personal learning environments and social learning technologies gain traction.

Self-Directed Learning with ICT: Theory, Practice and Assessment (PDF)
go.nmc.org/pcobx

(Tan Seng, Shanti Divaharan, Lynde Tan, and Cheah Horn Mun, *Singapore Ministry of Education*, 2011.) Published by the Ministry of Education in Singapore, this research is intended to explore and promote self-directed learning methodologies to teachers.

This Time It's Personal
go.nmc.org/person

(Jennifer Demski, *The Journal*, 4 January 2012.) Changing classroom infrastructure to make it more student-centred is better for incorporating technology in transformative ways.

Time-to-Adoption: Four to Five Years

Collective Intelligence

Collective intelligence is a term for the knowledge embedded within societies or large groups of individuals. It can be explicit, in the form of knowledge gathered and recorded by many people; or it can be tacit or implicit, referring to the intelligence that results from the data generated by the activities of many people over time. New and vast information stores are being created in real-time by thousands of people in the course of their daily activities, some explicitly collaborating to create collective knowledge stores, some contributing implicitly through the patterns of their choices and actions. The data in these new information stores has come to be called collective intelligence, and both forms have already proven to be compelling applications of the network. Explicit knowledge stores, such as Wikipedia, refine knowledge through the contributions of thousands of authors; implicit stores allow the discovery of entirely new knowledge by capturing trillions of key clicks and decisions as people use the network in the course of their everyday lives. Google uses tacit data to continuously refine its search and ad results. Discovering and harnessing the intelligence in such data — revealed through analyses of patterns, correlations, and flows — is enabling more accurate predictions about people's preferences and behaviours, and helping users understand and map relationships, and gauge the relative significance of ideas and events.

Relevance for Teaching and Learning in Singaporean K-12 Education

- Collective intelligence promotes peer-to-peer learning through knowledge networks that grow by the minute as people share the information they've gained in specific disciplines and fields.
- Implicit knowledge stores provide insight on the learning choices we make by tracking our online searches and activity, and ultimately direct us to the discovery of new information.
- Knowledge networks such as Wikipedia encompass multiple points of view and allow people to make instant updates to research and topics, unlike in printed textbooks by a single author.

Collective Intelligence in Practice

- The Khan Academy is a vast but highly curated collection of videos that supplement school curriculum: go.nmc.org/jlwbj.
- Researchers working with the National Institute of Education in Singapore are compiling data to describe Singaporean students' civic knowledge: go.nmc.org/ggpbc.

For Further Reading

Crowd Computing and Human Computation Algorithms at Collective Intelligence (video)
go.nmc.org/yptvv

(Rob Miller, 2012 Collective Intelligence Conference.) A researcher explores the infrastructures of collective intelligence at a National Science Foundation event.

Interview with Pierre Lévy on Collective Intelligence Literacy
go.nmc.org/smzwz

(Pierre Lévy, *Flat Classroom*, 20 October 2011.) A media scholar discusses collective intelligence in the context of new media and digital networks, and the skills and philosophies people need to contribute to the conversation.

Wikis for Participatory Learning by Eric Charles Thompson (PDF)
go.nmc.org/fhwgv

(Kiruthinka Ragupathi, *Technology in Pedagogy, No. 5*, September 2011.) An Associate Professor and chair of Graduate studies in the Department of Sociology at the National University of Singapore shares his experience of integrating wikis into his classes to foster participatory and peer-to-peer learning.

Time-to-Adoption: Four to Five Years

The Internet of Things

The Internet of Things has become a sort of shorthand for network-aware smart objects that connect the physical world with the world of information. A smart object has four key attributes: it is small, and thus easy to attach to almost anything; it has a unique identifier; it has a small store of data or information; and it has a way to communicate that information to an external device on demand. The Internet of Things extends that concept by using TCP/IP as the means to convey the information, thus making objects addressable (and findable) on the Internet. Objects that carry information with them have long been used for the monitoring of sensitive equipment or materials, point-of-sale purchases, passport tracking, inventory management, identification, and similar applications. Smart objects are the next generation of those technologies — they "know" about a certain kind of information, such as cost, age, temperature, colour, pressure, or humidity — and can pass that information along easily and instantly upon electronic request. They are ideal for digital management of physical objects, monitoring their status, tracking them throughout their lifespan, alerting someone when they are in danger of being damaged or spoiled — or even annotating them with descriptions, instructions, warranties, tutorials, photographs, connections to other objects, and any other kind of contextual information imaginable. The Internet of Things makes accessing these data as easy as browsing the web.

Relevance for Teaching and Learning in Singaporean K-12 Education

- Attached to scientific samples, TCP/IP-enabled smart objects already are alerting scientists and researchers to conditions that may impair the quality or utility of the samples.
- Pill-shaped microcameras are used in medical diagnostics and teaching to traverse the human digestive tract and send back thousands of images to pinpoint sources of illness.
- TCP/IP enabled sensors and information stores make it possible for geology and anthropology departments to monitor or share the status and history of even the tiniest artefact in their collections of specimens from anywhere to anyone with an Internet connection.

Internet of Things in Practice

- Cosm is a platform that connects devices and apps so they can store and exchange data. Developers are using it to create their own smart products: go.nmc.org/kzhep.
- In Rio de Janeiro, scientists are deploying ground and airborne smart sensors to predict heavy rains and mudslides up to 48 hours in advance: go.nmc.org/mzytn.
- MIT's Amarino is a toolkit that allows smartphone users to control the lights in a room and detect exposure levels to potentially harmful environmental factors: go.nmc.org/uyllx.

For Further Reading

Futurist's Cheat Sheet: Internet of Things
go.nmc.org/cpfez

(Dan Rowinski, *Read Write Web*, 31 August 2012.) The author explores a world where objects have their own IP addresses and communicate with each other via WiFi or cellular networks.

How the "Internet of Things" Is Turning Cities Into Living Organisms
go.nmc.org/cxmqs

(Christopher Mims, *Scientific American*, 6 December 2011.) If city systems are able to react to information stored in the cloud, they can respond to new environmental conditions.

The Internet Gets Physical
go.nmc.org/yirhc

(Steve Lohr, *The New York Times*, 17 December 2011.) Smart devices are linking humans to their environment in ways that will benefit energy conservation, health care, and more.

Time-to-Adoption: Four to Five Year

Massively Open Online Courses (MOOCs)

Coined in 2008 by Stephen Downes and George Siemens, massively open online courses (MOOCs) are conceptualised as the evolution of networked learning. MOOCs have not yet achieved their envisioned potential, but early experiments are promising. The essence of a MOOC is that it is a web course that people can take from anywhere across the world, with potentially thousands of participants. The basis of each MOOC is an expansive and diverse set of content, contributed by a variety of experts, educators, and instructors in a specific field, and then aggregated into a central repository, such as a web site. What makes this content set especially unique is that it is "remixed" -- the materials are not necessarily designed to go together but become associated with each other through the MOOC. A key component of the original vision is that all course materials and the course itself are open source and free — with the door left open for a fee if a participant taking the course wishes university credit be transcripted for the work. Interest in MOOCs has evolved at an unprecedented pace, fueled by high profile entrants like Coursera, Udacity, and MITx. In these examples, the notion has shifted away from open content or even open access, to an interpretation in which "open" equates to "no charge." The pace of development in the MOOC space is so high that it is likely that a number of alternative models will emerge over the coming year. Ultimately, the models that attract the highest numbers of participants are gaining the most attention, but many challenges remain to be resolved in supporting learning at scale.

Relevance for Teaching and Learning in Singaporean K-12 Education

- MOOCs allow learners who want to participate in quality learning opportunities to do so without having to go through the process of applying to a particular institution.
- MOOCs focus on learning rather than institutional requirements; they offer the potential for building a network of learners who come together to explore topics of mutual interest.
- When more learners and institutions participate in MOOCs by sharing content, it leads to sustainability of the MOOC ecosystem over time.

Massively Open Online Courses in Practice

- Based out of the University of Mary Washington, DS106 is a MOOC that teaches the tools and skills of crafting digital narratives: go.nmc.org/hnxdt.
- Coursera, a start-up by two Stanford University professors, is offering over 30 free online classes, including science fiction and health policy. A "calibrated peer-review" system is currently in the works: go.nmc.org/course.
- MITx offers a wide variety of MIT courses for free to a global, virtual community of students. MITx courses can be taken on their own or used to supplement existing classes and labs on the physical campus: go.nmc.org/mitx.

For Further Reading

Bitter Reality of MOOConomics
go.nmc.org/qulms

(Calro Salerno, *Inside Higher Ed*, 9 August 2012.) This article discusses a flaw in the current MOOC model, arguing that paid institutions will still be able to infer more highly prestigious degrees, though the model may evolve into something more transformative.

Is Peer Input as Important as Content for Online Learning?
go.nmc.org/peer

(Nathan Maton, *Mindshift*, 24 April 2012.) This article discusses how important community and social aspects of MOOCs are in free online universities such as P2PU, which is proving to be an effective distance-learning model.

Time-to-Adoption: Four to Five Years

Natural User Interfaces (NUIs)

It is already common to interact with a new class of devices entirely by using natural movements and gestures. Smartphones, tablets, game consoles, and the new class of "smart TVs" are part of a growing list of devices built with natural user interfaces that accept input in the form of taps, swipes, and other ways of touching; hand and arm motions; body movement; and increasingly, natural language. These are the first in an evolving array of alternative input devices that allow computers and devices to recognise and interpret natural physical gestures as a means of control. Natural user interfaces allow users to engage in virtual activities with movements similar to what they would use in the real world, manipulating content intuitively. The idea of being able to have a completely natural interaction with your device is not new, but neither has its full potential been realised. What makes natural user interfaces especially interesting is the burgeoning high fidelity of systems that understand gestures, facial expressions, and their nuances, as well as the convergence of gesture-sensing technology with voice recognition, which allows users to interact in an almost natural fashion, with gesture, expression, and voice communicating their intentions to devices.

Relevance for Teaching and Learning in Singaporean K-12 Education

- Blind, dyslexic, or otherwise disabled students can leverage natural user interfaces to reduce their dependence on keyboards.
- Natural user interfaces allow users to easily perform precise manipulations that can be difficult to manage with a mouse or controller.
- Natural user interfaces facilitate the convergence of a user's thoughts with their movements and voice, which appeals to kinetic learners who learn by acting.

Natural User Interfaces in Practice

- Alberta Education is exploring the use of Microsoft Kinect in developing young students' motor skills while encouraging active learning: go.nmc.org/microki
- The Digital Graffiti Wall enables users to paint on any surface and make a screen capture of the artwork that can be uploaded online and to social media platforms: go.nmc.org/pxdox.
- In the "Classroom Tomorrow, Today" project, math teachers use Kinect apps to dynamically teach math concepts through the motion of the user: go.nmc.org/hodut.
- Purdue University created Handy-Potter, a natural user interface that can modify and create shapes in 3D based on hand gestures: go.nmc.org/whfhc.

For Further Reading

The Human Voice, as Game Changer
go.nmc.org/voice

(Natasha Singer, *The New York Times*, 31 March 2012.) This article paints a picture of how the voice-enabled future will materialise as we begin to interact in new ways with everyday objects, such as refrigerators, thermostats, alarm systems, and other devices.

Mobile Speech Recognition Platforms Projected to Grow
go.nmc.org/cwivf

(Julien Happich, *EE Times*, 26 September 2012.) This article discusses how cloud-based platforms allow speech recognition technology to be delivered through mobile apps.

Natural User Interfaces
go.nmc.org/cvtqw

(Charles Xie, *The Advanced Educational Modeling Laboratory*, 21 August 2012.) The head of the Mixed Reality Labs project explains Natural Learning Interfaces, NUIs that allow users to interact with simulations on a computer.

Top Ten Trends

The technologies featured in the NMC Horizon Project are embedded within a contemporary context that reflects the realities of the time, both in the sphere of education and in the world at large. To assure this perspective, each advisory board researches, identifies, and ranks key trends that are currently affecting the practice of teaching, learning, and creative inquiry in education, and uses these as a lens for its work in predicting the uptake of emerging technologies in whatever sector is their focus.

These trends are surfaced through an extensive review of current articles, interviews, papers, and new research. Once identified, the list of trends is ranked according to how significant of an impact they are likely to have on education in the next five years. The following trends have been identified as key drivers of technology adoptions in Singaporean K-12 education for the period of 2012 through 2017; they are listed here in the order they were ranked by the advisory board.

1) Enhanced electronic books are increasingly being used instead of traditional textbooks. As e-book technology advances, digital textbooks contain more dynamic content, including audio, videos, and other interactive features. Traditional textbooks are cumbersome and can take years to update and reprint when there is new information and discoveries to be added. E-books, however, can be more easily revised and disseminated.

2) The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators. Institutions must consider the unique value that each adds to a world in which information is everywhere. In such a world, sense-making and the ability to assess the credibility of information are paramount. Mentoring and preparing students for the world in which they will live is again at the forefront. Teachers must act as guides that help learners navigate through all of the content and understand how to assess it for quality.

3) Education paradigms are shifting to include online learning, hybrid learning and collaborative models. Budget cuts have forced institutions to re-evaluate their education strategies and find alternatives to the exclusive face-to-face learning models. Students already spend much of their free time on the Internet, learning and exchanging new information -- often via their social networks. Institutions that embrace face-to-face/online hybrid learning models have the potential to leverage the online skills learners have already developed independent of academia. We are beginning to see developments in online learning that offer different affordances than brick-and-mortar schools, including opportunities for increased collaboration while equipping students with stronger digital skills. Hybrid models, when designed and implemented successfully, enable students to be at school for some activities, while using the network for others, taking advantage of the best of both environments.

4) Interest is growing in the use of learning analytics as a tool for personalised student learning. Learning analytics models and tools have proven successful in identifying at-risk students early enough to help them to be successful. What is perhaps most compelling about the topic is the ability for educators to use the data captured by these tools and adapt their teaching styles in real-time. Some companies are taking this notion a step further and building social learning platforms that act as personal learning environments with built in learning analytics that assess students' performance based on the learning approaches they have chosen.

5) The world of work is increasingly collaborative, driving changes in the way student projects are structured. As more and more employers are valuing collaboration as a critical skill, silos both in the workplace and at school are being abandoned in favour of collective intelligence. To facilitate more teamwork and group communication, projects rely on tools including wikis, Google Docs, Skype, and online forums. Projects are increasingly evaluated not just on the overall

outcome, but also on the success of the group dynamic. In many cases, the online collaboration tool itself is an equally important outcome as it stores — and even immortalises — the process and multiple perspectives that led to the end results.

6) People expect to be able to work, learn, and study whenever and wherever they want. This trend is certainly true for most adults, and many well-paying jobs literally can be done from anywhere that has a mobile Internet connection. It is also true for many of today's school-age children, who live their lives in a state of constant connection to their peers, social groups, and family. The implications for formal learning are profound. The flipped classroom, for example, uses the resources on the Internet to free up valuable teacher classroom time, and fundamentally changes the teacher-student relationship. When students know how to use their network connections for more than texting, learning becomes much more serendipitous, opening the door to "just-in-time" learning, and "discovered" learning.

7) There is a new emphasis in the classroom on more challenge-based and active learning. Challenge-based learning and similar methods foster more active learning experiences, both inside and outside the classroom. As technologies such as tablets and smartphones now have proven applications in schools, educators are leveraging these tools, which students already use, to connect the curriculum with real life issues. The active learning approaches are decidedly more student-centred, allowing them to take control of how they engage with a subject and to brainstorm and implement solutions to pressing local and global problems. The hope is that if learners can connect course material with their own lives and their surrounding communities, then they will become more excited to learn and immerse themselves in the subject matter.

8) The growing availability of bandwidth will dramatically change user behaviours in teaching, learning and research over the next five years. The advent of cloud computing has alleviated the burden of storing software, email services, and other applications locally. Increased bandwidth is fundamental to full use of the Internet, and allows video, large data sets, and sophisticated mappings to be downloaded in seconds, making their impact immediate. Students and educators can now connect and collaborate with more ease, transfer files and information quicker, and store more new content.

9) Increasingly, students want to use their own technology for learning. As new technologies are developed at a more rapid pace and at a higher quality, there is a wide variety of different devices, gadgets, and tools from which to choose. Utilizing a specific device has become something very personal — an extension of someone's personality and learning style — for example, the iPhone vs. the Android. There is comfort in giving a presentation or performing research with tools that are more familiar and productive at the individual level. And, with handheld technology becoming mass produced and more affordable, students are more likely to have access to more advanced equipment in their personal lives than at school.

10) As the cost of technology drops and school districts revise and open up their access policies, it is becoming increasingly common for students to bring their own mobile devices. A growing number of schools are launching "Bring Your Own Device" (BYOD) programs so that students can use the devices they already own in class as well as in the informal and out-of-school environments they are ubiquitous in now. This is happening partly because of how BYOD impacts budgets; schools can spend less money on technology overall if students use their own, while funneling the funds they do spend to help students who cannot afford their own devices. The interest in BYOD programs can also be attributed to an attitude shift as schools are beginning to better understand the capabilities of smartphones and other devices that still remain banned in most schools.

Top Ten Challenges

Along with the trends discussed in the preceding section, the advisory board noted a number of important challenges faced by Singaporean K-12 educators. Like the trends, the ten challenges described below were drawn from a careful analysis of current events, papers, articles, and similar sources, as well as from the personal experience of the advisory board members in their roles as leaders in education and technology. The ten challenges ranked as most significant in terms of their impact on teaching, learning, or creative inquiry in Singaporean K-12 education in the coming five years are listed here, in the order of importance assigned them by the advisory board.

1) Digitization is not enough; textbooks need to be reinvented. Many textbooks are cumbersome and outdated, with long print cycles and an ever more expensive set of ancillary materials. There has been a growing amount of attention placed on digitizing textbooks so that they are available online and are easier to update with new information. However, simply converting a print textbook to digital form does not solve the problem. People learn best through a combination of audio, video, and even tactile or kinetic experiences. The e-book movement must address these needs by incorporating more enhanced material that appeals to different learning styles and can be accessed from whatever devices a student chooses.

2) Singapore schools must address the increased blending of formal and informal learning. Traditional lectures and subsequent testing are still dominant learning vehicles in schools. In order for students to get a well-rounded education with real world experience, they must also engage in more informal in-class activities as well as learning to learn outside the classroom. Most schools are not encouraging students to do any of this, nor to experiment and take risks with their learning. A new model, called the "flipped classroom," is opening the door to new approaches. The flipped classroom uses the abundance of videos on the Internet to allow students to learn new concepts and material outside of school, thus preserving class time for discussions, collaborations with classmates, problem solving, and experimentation. The approach is not a panacea, and designing an effective blended learning model is key, but the growing success of the many non-traditional alternatives to schools that are using more informal approaches indicates that this trend is here to stay for some time.

3) Learning that incorporates real life experiences is not occurring enough and is undervalued when it does take place. This challenge is an important one in K-12 schools, because it results in a lack of engagement in learning on the part of students who are seeking some connection between their own lives and their experience in school. Use of technology tools that are already familiar to students, project-based learning practices that incorporate real-life experiences, and mentoring from community members are a few practices that support increased engagement. Practices like these may help retain students in school and prepare them for further education, careers, and citizenship in a way that traditional practices are failing to do.

4) There is a disconnect between the goals of assessment and personalised learning. As personal learning environments and other models of individualised learning are gaining traction in schools, forms of assessment for these models are lagging. Whereas the goal for personalised learning is to create experiences that appeal to a student's specific learning style, pace, and needs, many current assessment tools focus on scalability and the capacity to extract data from a standard set of assignments — such as multiple choice tests and papers. The major challenge ahead for assessment is to capture ways to measure the quality of learning from different types of student outputs, including videos, and other rich media.

5) The demand for personalised learning is not adequately supported by current technology or practices. The increasing demand for education that is customised to each student's unique

needs is driving the development of new technologies that provide more learner choice and control and allow for differentiated instruction. It has become clear that one-size-fits-all teaching methods are neither effective nor acceptable for today's diverse students. Technology can and should support individual choices about access to materials and expertise, amount and type of educational content, and methods of teaching.

6) Digital media literacy continues its rise in importance as a key skill in every discipline and profession. Despite the widespread agreement on the importance of digital media literacy, training in the supporting skills and techniques is still very rare in teacher education. As classroom professionals begin to realise that they are limiting their students by not helping them to develop and use digital media literacy skills across the curriculum, the lack of formal training is being offset through professional development or informal learning, but we are far from seeing digital media literacy as a norm. This challenge is exacerbated by the fact that digital literacy is less about tools and more about thinking, and thus skills and standards based on tools and platforms have proven to be somewhat ephemeral.

7) Most academics are not using new and compelling technologies for learning and teaching. Many teachers and administrators have not undergone training on basic digitally supported teaching techniques, and most do not participate in professional development opportunities. This issue is due to several factors, including a lack of time, a lack of expectations that they should, and the lack of infrastructure to support the training. Many think a cultural shift will be required before we see widespread use of more innovative ideas and technologies. Many caution that as this unfolds, the focus should not be on the technologies themselves, but on the pedagogies that make them useful.

8) Putting 21st century technology into 19th century schools is a major undertaking. The 19th century school systems are still ubiquitous, from the outdated, industrial nature of old buildings to the old learning models and processes upheld therein. Schools must adopt 21st century technology to overcome the challenge of the current linear archetypes. These new tools are the antidote; organic and non-linear, 21st century technology facilitates the freedom for students to quickly discover information whenever they need it. In turn, they develop more sophisticated skill sets that open the doors to two- and four-year universities and better jobs.

9) The development of personalised assessment is more complex that is typically realised. There is a growing demand for assessment tools that can address a wide array of learning outcomes. Many current assessment tools are one-size-fits-all solutions, in that they are able to mine data and convey patterns from one learning indicator, such as test results. As schools move away from these and other traditional forms of evaluation, the focus must become assessing an individual students' accomplishments and concept mastery. Creating models for personalised assessment requires an understanding of many different methods of knowledge acquisition and the goals of that knowledge acquisition, such as collaboration and leadership skills.

10) We are not using digital media for formative assessment the way we could and should. Assessment is an important driver for educational practice and change, and over the last years we have seen a welcome rise in the use of formative assessment in educational practice. However, there is still an assessment gap in how changes in curricula and new skill demands are implemented in education; schools do not always make necessary adjustments in assessment practices as a consequence of these changes. Another assessment gap is related to the lack of innovative uses of digital media in formative assessment. Many tools are still tied to outdated LMS and do not have the ability to assess critical data sets, such as 21st Century Skills acquisition.

Methodology

The process used to research and create the *Technology Outlook for Singaporean K-12 Education 2012-2017: An NMC Horizon Project Regional Analysis* is very much rooted in the methods used throughout the NMC Horizon Project. All publications of the NMC's Horizon Project are produced using a carefully constructed process that is informed by both primary and secondary research. Dozens of technologies, meaningful trends, and critical challenges are examined for possible inclusion in the report for each edition. Every report draws on the considerable expertise of an internationally renowned advisory board that first considers a broad set of important emerging technologies, challenges, and trends, and then examines each of them in progressively more detail, reducing the set until the final listing of technologies, trends, and challenges is selected.

Much of the process takes place online, where it is captured and placed in the NMC Horizon Project wiki. This wiki, which has grown into a resource of hundreds of pages, is intended to be a completely transparent window onto the work of the project, and contains the entire record of the research for each of the various editions. The section of the wiki used for the *Technology Outlook for Singaporean K-12 Education 2012-2017* can be found at singapore.wiki.nmc.org.

The procedures for selecting the topics that are in this report include a modified Delphi process now refined over years of producing the *NMC Horizon Report* series, and it began with the assembly of the advisory board. The board as a whole was intended to represent a wide range of backgrounds and interests, yet with each member bringing a particularly relevant expertise. To date, hundreds of internationally recognised practitioners and experts have participated in the NMC Horizon Project Advisory Boards; in any given year, a third of advisory board members are new, ensuring a flow of fresh perspectives each year.

Once the advisory board for a particular edition is constituted, their work begins with a systematic review of the literature — press clippings, reports, essays, and other materials — that pertains to emerging technology. Advisory board members are provided with an extensive set of background materials when the project begins, and are then asked to comment on them, identify those that seem especially worthwhile, and add to the set. The group discusses existing applications of emerging technology and brainstorms new ones. A key criterion for the inclusion of a topic is the potential relevance of the topic to teaching, learning, or creative inquiry. A carefully selected set of RSS feeds from dozens of relevant publications ensures that background resources stay current as the project progresses. They are used to inform the thinking of the participants throughout the process.

Following the review of the literature, the advisory board engages in the central focus of the research — the research questions that are at the core of the NMC Horizon Project. These questions are designed to elicit a comprehensive listing of interesting technologies, challenges, and trends from the advisory board:

1. Which of these key technologies will be most important to Singaporean K-12 education within the next five years?
2. What key technologies are missing from our list? Consider these related questions:
    a. What would you list among the established technologies that some Singaporean schools and programs are using today that arguably ALL institutions and programs should be using broadly to support or enhance teaching, learning, or creative inquiry?
    b. What technologies that have a solid user base in consumer, entertainment, or other industries should Singaporean schools and programs be actively looking for ways to apply?

   c. What are the key emerging technologies you see developing to the point that Singaporean schools and programs should begin to take notice during the next four to five years?
3. What trends do you expect to have a significant impact on the ways in which Singaporean schools and programs approach our core missions of teaching, learning, and creative inquiry?
4. What do you see as the key challenges related to teaching, learning, and creative inquiry that Singaporean schools and programs will face during the next five years?

One of the advisory board's most important tasks is to answer these questions as systematically and broadly as possible, so as to ensure that the range of relevant topics is considered. Once this work is done, a process that moves quickly over just a few days, the advisory board moves to a unique consensus-building process based on an iterative Delphi-based methodology.

In the first step of this approach, the responses to the research questions are systematically ranked and placed into adoption horizons by each advisory board member using a multi-vote system that allows members to weight their selections. Each member is asked to also identify the timeframe during which they feel the technology would enter mainstream use — defined for the purpose of the project as about 20% of institutions adopting it within the period discussed. (This figure is based on the research of Geoffrey A. Moore and refers to the critical mass of adoptions needed for a technology to have a chance of entering broad use.) These rankings are compiled into a collective set of responses, and inevitably, the ones around which there is the most agreement are quickly apparent.

For additional detail on the project methodology or to review the instrumentation, the ranking, and the interim products behind the report, please visit the project wiki, which can be found at singapore.wiki.nmc.org.

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