NMC Horizon Project

2016 NMC Technology Outlook

Chinese K-12 Education

A Horizon Project Regional Report

2016 NMC Technology Outlook for Chinese K-12 Education
A Horizon Project Regional Report

is a collaboration between

The New Media Consortium

and

Smart Learning Institute of Beijing Normal University

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Executive Summary

The *2016 NMC Technology Outlook for Chinese K-12 Education: A Horizon Project Regional Report* reflects a collaborative research effort between the New Media Consortium (NMC) and the Smart Learning Institute of Beijing Normal University to inform Chinese school leaders and decision-makers about important developments in technologies supporting teaching, learning, and creative inquiry in K-12 education across the country.

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 Chinese 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 14 years ago to systematically identify and describe emerging technologies likely to have a large impact on education around the globe.

The *2016 NMC Technology Outlook for Chinese K-12 Education* was produced to explore important developments in technology and forecast their potential impact expressly in a Chinese context. In the effort that took place from July through October 2015, a carefully selected panel 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 technology topics, trends, and challenges for Chinese K-12 education over the next five years.

Known as the 2016 Horizon Project China Expert Panel, that group of thought leaders consists of knowledgeable individuals, all highly regarded in their fields. Collectively the panel represents a range of diverse perspectives across the K-12 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 china.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 expert panel identified nine key trends, nine significant challenges, and twelve important developments in educational technology. Each of the twelve developments in educational technology are profiled on a single page that describes and defines the technology and are ranked as very important for Chinese K-12 education over the next year, two to three years, and four to five years.

Every page opens with a carefully crafted definition of the highlighted technology, outlines its educational relevance, points to several real-life examples of its current use, and ends with a short list of additional readings for those who wish to learn more. Preceding those discussions are sections that detail the expert panel's top ranked trends and challenges, and illuminate why they are seen as highly influential factors in the adoption of technology in Chinese schools over the next five years.

The three key sections of this report constitute a reference and straightforward technology-planning guide for teachers, school leaders, 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 Chinese 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 *2016 NMC Technology Outlook for Chinese K-12 Education* is presented.

Introduction

The NMC Horizon Project and the 2016 Horizon Project China Expert Panel recognise that technology adoption in K-12 education is accelerated by trends in policy, leadership, and practice. Therefore, key trends frame the discussion of technology use in Chinese schools. Similarly, a number of challenges are impeding the proliferation of digital tools, and the panel identified a set of significant challenges that reflects the current obstacles facing Chinese K-12 education over the next five years. The top three trends and challenges are included in the related tables in this summary, and are organised by categories described in the next sections of this report.

As Table 1 below illustrates, the choices of the Chinese experts overlap in interesting ways with those who contributed to the *NMC Horizon Report > 2015 K-12 Edition,* which looked at technology uptake from a global perspective, and the *2015 NMC Technology Outlook for Scandinavian Schools*, which provides perspective from a recent expert panel representing Norway, Denmark, and Sweden — altogether a group of 181 acknowledged experts.

Table 1: Top-Ranked Trends Across Three NMC Horizon Research Projects

NMC Horizon Report 2015 K-12 Edition	2016 Technology Outlook Chinese K-12 Education	2015 Technology Outlook Scandinavian Schools
Long-Term Impact Trend		
Rethinking How Schools Work	Shift from Students as Consumers to Students as Creators	Growth of New Professions Entering Schools
Mid-Term Impact Trend		
Shift from Students as Consumers to Students as Creators	Growing Focus on Measuring Learning	Rise of Data-Driven Learning and Assessment
Short-Term Impact Trend		
Increasing Use of Blended Learning	Proliferation of Open Educational Resources	Expansion of Digital Tests

The 2016 Chinese panel's highest ranked trend overlaps with the global panel's selections in one crucial area — the shift from students as consumers to students as creators. Around the world, schools are finding new ways to integrate student-generated content and ideas into educational activities with the understanding that hands-on experiences help students apply what they have learned. This long-term impact trend is further supported by the Chinese experts' inclusion and prioritisation of makerspaces — physical spaces dedicated to creation-oriented learning — as an important development in technology in this report. Thirty DigiBook MakerSpaces, for example, enable students to produce and publish original multimedia content in China's public libraries.[1]

Two trends distinguish Chinese K-12 education from the global landscape. First, the experts emphasise that an increasing number of schools are gathering data related to learning activities to better understand how students are comprehending the material, and then using that data to adjust content and teaching approaches in real time. Beijing Normal University is leading a project to understand how collecting data about learners' interactions, emotions, and knowledge processing can most effectively inform educators about their instruction and curriculum design.

Second, the 2016 Chinese experts acknowledge that open educational resources (OER) have quickly gained traction in school settings across the country. While they currently perceive OER as having a short-term impact on K-12 education, the implications of expanding access to high-quality information and networks are profound. The Ministry of Education built the online National Public Education Resource Service Platform so educators and learning resource providers can participate in an open knowledge exchange, sharing applications and best practices.[2]

Horizon Project panels in general have agreed that trends like these are clear drivers of technology adoption; the 2016 Chinese panel 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, which are grounded in everyday realities that make it difficult to learn about, much less adopt, new tools and approaches.

Table 2: Top-Ranked Challenges Across Three NMC Horizon Research Projects

NMC Horizon Report 2015 K-12 Edition	2016 Technology Outlook Chinese K-12 Education	2015 Technology Outlook Scandinavian Schools
	Solvable Challenge	
Creating Authentic Learning Opportunities	Integrating Technology in Teacher Education	Integrating Technology in Teacher Education
	Difficult Challenge	
Personalising Learning	Creating Authentic Learning Opportunities	Shift to Deep Learning Approaches
	Wicked Challenge	
Scaling Teaching Innovations	Scaling Teaching Innovations	Students as Co-Designers of Learning

As noted in Table 2, above, both the 2016 Chinese and 2015 Scandinavian panels agreed that integrating technology in teacher education is a pressing but solvable challenge that will rely on more frequent professional development opportunities for in-service teachers as well as extensive training woven into educational curriculum for pre-service teachers In Hangzhou City of Zhejiang province, the Education Bureau of Gongshu District already developed a Teachers Learning Network to impart emerging technology skills to the local teachers both online and in face-to-face settings.[3]

The 2016 Chinese experts ranked creating authentic learning opportunities as a difficult challenge impeding technology uptake — regarded by the other two panels but deemed less significant. While school leaders and teachers increasingly acknowledge the importance of providing real-world experiences for students, implementing more project-based learning and simulations, for example, on a countrywide scale is not a small task. This is especially challenging as more Chinese schools adopt blended models; educators must consider how to incorporate online activities where students experience first-hand the ways in which the subject matter impacts them.

Both the 2016 Chinese and 2015 global panels were in consensus that scaling teaching innovations is a wicked challenge faced by K-12 education. There are not yet concrete solutions for efficiently moving progressive pedagogies into widespread practice. Further compounding this challenge is the notion that there is no collective understanding of how to define and evaluate genuine innovation in teaching. A teacher in China may have successfully implemented a challenge-based learning model in their classroom, but that does not mean it will be easy for other teachers or schools to immediately do the same with high-quality outcomes.

Fuelled by the key trends and impeded by the significant challenges selected by the panel, the 12 important developments in educational technology presented in the body of this report reflect our experts' opinions as to which of the nearly 50 technologies considered will be most important to Chinese K-12 education over the five years following the publication of the report. All three of these projects' expert panels strongly agree that mobile learning in some form, along with cloud computing, will likely tip into mainstream use within the next year. Both of these near-term topics are making learning more ubiquitous. China has the most Internet users — 642 million — comprising 22% of the world's total Internet usage.[4] In this increasingly connected environment, mobiles and cloud-based applications are rapidly growing in necessity.

Table 3: Comparison of "Final 12" Topics Across Three NMC Horizon Research Projects

NMC Horizon Report 2015 K-12 Edition	2016 Technology Outlook Chinese K-12 Education	2015 Technology Outlook Scandinavian Schools
Time-to-Adoption Horizon: One Year or Less		
Bring Your Own Device Cloud Computing Makerspaces Mobile Learning	Cloud Computing Flipped Classroom Makerspaces Mobile Learning	Bring Your Own Device Cloud Computing Flipped Classroom Games and Gamification
Time-to-Adoption Horizon: Two to Three Years		
3D Printing Adaptive Learning Technologies Information Visualisation Learning Analytics	3D Printing 3D Video Learning Analytics Massive Open Online Courses	Learning Analytics Makerspaces Open Content Social Networks
Time-to-Adoption Horizon: Four to Five Years		
Digital Badges Drones Visual Data Analysis Wearable Technology	Adaptive Learning Technologies Intelligent Grading Technologies Virtual and Remote Laboratories Wearable Technology	The Internet of Things Robotics and Programming Speech-to-Speech Translation Wearable Technology

There are also several other overlaps, indicating China's close alignment with prevalent global trends. The 2016 Chinese and 2015 global panels believe that makerspaces will soon be in widespread practice, as Chinese schools are encouraging students to realise their own creative ideas, from concept to prototype. All three panels were in consensus that learning analytics is poised for mainstream adoption in the next two to three years. However, compared to the 2015 global panel, the 2016 Chinese panel believes that the next incarnation of analytics, adaptive learning, will take more time to proliferate. The three panels also agree that wearable technology is on the far-term horizon, demonstrating a growing interest in embedding technology more deeply into daily activities with the goal of better tracking student movement and behaviour.

Both the 2016 Chinese and 2015 global panels deemed 3D printing as positioned in the mid-term horizon, indicating that the technology is not rapidly advancing but moving at a steady, more incremental pace. Across Asia, students are using increasingly more affordable 3D printers to design and build their own educational tools, such as 3D DNA models.[5]

A number of unique choices distinguished the perspectives expressed by the 2016 Chinese panel from their counterparts. For example, they perceive massive open online courses as an important development in technology as the Chinese school community is embracing the movement toward openness and free learning opportunities. Virtual and remote laboratories were also cited by the panel as technologies worth watching, as they enable students to conduct experiments and engage in lifelike activities in online environments from wherever they are, at any time.

The 2016 Chinese panel proposed a new far-term topic that has never been surfaced before in the NMC Horizon Project — intelligent grading technologies. There is an increasing emphasis in China on not only tracking learning, but also automating assessment and evaluation to free up teachers to spend more time facilitating deep class discussions and hands-on activities.

Key Trends Accelerating Technology Adoption

The technology developments 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 panel member identifies and ranks key trends that are currently affecting teaching, learning, and creative inquiry in Chinese schools, and uses these as a lens for the work of predicting the uptake of emerging technologies. These nine trends, which the panel agreed are very likely to drive technology planning and decision-making over the next five years, are sorted into three categories: long-term impact trends that have been important for some time and will continue to be pervasive in K-12 for five or more years, and mid- and short-term impact trends that have surfaced more recently and whose impact on schools may be briefer.

Long-Term Impact Trends

Driving Ed Tech adoption in Chinese K-12 education for five or more years

Advancing Cultures of Change and Innovation. In order to breed innovation and adapt to economic needs, schools must be structured in ways that spur creativity and entrepreneurial thinking. Educators are working to develop new approaches and programs that stimulate top-down change and can be implemented across a broad range of school settings. Technology is a catalyst for promoting a school culture of innovation in a widespread, cost-effective manner. At the national level, the Ministry of Education of China recognises that the university entrance examination system may limit the implementation of innovative education practices and the promotion of IT. In recent years, they have proposed a series of reforms of the university entrance exam and the university student recruitment system to improve the overall quality of talent, while encouraging more opportunities for the application of educational technology.[6,7]

Shift from Students as Consumers to Students as Creators. A shift is taking place in the focus of pedagogical practice in schools all over the world as students across a wide variety of disciplines are learning by making and creating rather than from the simple consumption of content. Creativity, as illustrated by the growth of student-generated videos and maker communities in the past couple years, is increasingly the means for active, hands-on learning.

Shift to Deep Learning Approaches. There is a growing emphasis in the classroom on deep learning approaches, defined as the delivery of rich core content to students in innovative ways that allow them to learn and then apply what they have learned.[8] Project-based learning, challenge-based learning, and similar methods foster more active learning experiences and are more student-centred. For everyday activities such as reading, Huashan Middle School (Primary School Section) of 2nd Infantry Division of Xinjiang Production and Construction Corps aims to promote a deeper understanding of text; they are using the Learning Cell platform to organise students to read through four stages of mutual initial reading, personalized intensive reading, group study, and reflective rereading, facilitating the students to study deeply and benefit from jointly reading classic works.[9]

Mid-Term Impact Trends

Driving Ed Tech adoption in Chinese K-12 education for the next three to five years

Growing Focus on Measuring Learning. There is an increasing interest in using new sources of data for personalising the learning experience, for on-going formative assessment of learning, and for performance measurement; this interest is spurring the development of a relatively new field — data-driven learning and assessment. A key element of this trend is learning analytics, the application of web analytics, a science used by businesses to leverage big data to identify spending trends and predict consumer behaviour. Education is embarking on a similar pursuit with the aim of learner profiling, a process of gathering and analysing large amounts of detail about individual student interactions in online learning activities. The goal is to build better pedagogies, empower students to take an active part in their learning, target at-risk student populations, and assess factors affecting completion and student success.

Redesigning Learning Spaces. Some thought leaders believe that new forms of teaching and learning require new spaces. As Chinese K-12 education continues to move away from traditional lecture-based programming to more hands-on scenarios, classrooms will start to resemble real-world work and social environments that facilitate organic interactions and cross-disciplinary problem solving. Beijing Shijia Primary School, for example, is following the STSE (science, technology, society, environment) framework for education and has designated four different, exploratory spaces for each subject, allowing for hands-on activities.[10]

Rise of New Forms of Interdisciplinary Studies. According to Sage Publications, interdisciplinary studies refer to educational activities that blend two or more disciplines, such as engineering and art.[11] In the real world and especially in the workforce, skillsets are needed that reflect a comprehensive understanding of different fields. More Chinese schools are finding meaningful ways for students to experience the intersections between disciplines, engaging in activities that combine critical thinking, imagination, and practical application.

Short-Term Impact Trends

Driving Ed Tech adoption in Chinese K-12 Education for the next one to two years

Growth of Discovery-Based Learning. The discovery-based learning approach is a facet of inquiry-based learning in which students are drawing on the learning material as well as their own life experiences to solve problems. In this model, students grapple with open-ended questions, applying critical thinking and sometimes conducting experiments to answer them. An important aspect of discovery-based learning is creating opportunities for students to interact with the environment around them, which often calls for students to work outside of the classroom and in real-world contexts.

Increasing Use of Blended Learning Designs. Leveraging best practices in online and face-to-face methods, blended learning is on the rise in schools. The affordances of blended learning offers are now well understood, and its flexibility, ease of access, and the integration of sophisticated multimedia and technologies are high among the list of appeals. Recent developments of business models for schools are upping the ante of innovation in these digital environments, which are now widely considered to be ripe for new ideas, services, and products. In China, Education Bureau of Putuo District, Shanghai created a learning platform that encompasses micro-videos on subjects and analyses each student's learning trajectory.[12] This kind of progress in learning analytics, along with a combination of cutting-edge asynchronous and synchronous tools, continues to advance the state of online learning.

Proliferation of Open Educational Resources. Open educational resources (OER) are “teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use and repurposing by others.”[13] An understanding of the term “open” is essential to following this trend in schools; often mistaken to simply mean “free of charge,” advocates of openness have worked towards a common vision that defines it more broadly — not just free in economic terms, but also in terms of ownership and usage rights. The Ministry of Education of China’s National Public Service Platform For Educational Resources leverages cloud computing technology to promote the interconnection of regional education resource platforms and enterprise resource service platforms for all levels of education for easy sharing and application.[14]

Significant Challenges Impeding Technology Adoption

Along with the trends discussed in the preceding section, the expert panel noted a number of significant challenges faced in Chinese schools that are impeding the uptake of emerging technologies. Because not all challenges are of the same scope, the discussions here are sorted into three categories defined by the nature of the challenge. The NMC Horizon Project defines solvable challenges as those that we both understand and know how to solve; difficult challenges are ones that are more or less well understood, but for which solutions remain elusive. Wicked challenges, the most difficult, are categorised as complex to even define, and thus require additional data and insights before solutions will be possible.

Solvable Challenges

Those which we both understand and know how to solve

Improving Digital Literacy. With the proliferation of the Internet, mobile devices, and other technologies that are now pervasive in education, the traditional view of literacy as the ability to read and write has expanded to encompass understanding digital tools and information. This new category of competence is affecting how Chinese schools address literacy issues in their curriculum objectives and teacher development programs. Harbin Xiangbin Primary School is already addressing this problem; they recently built a digital learning environment of the formation of what they are calling a "smart classroom." In this setting, students are tasked with understanding and using technology in creative ways.[15]

Integrating Technology in Teacher Education. Despite the widespread agreement on the importance of digital competence, training in the supporting skills and techniques is rare in teacher education and in the preparation of teachers. As teachers begin to realise that they are limiting their students by not helping them to develop digital competence skills, the lack of formal training is offset through professional development. The Gongshu District Education Bureau of Hangzhou city, Zhejiang Province established the teacher network learning studio to expand teachers' access to high-quality, technology-focused professional development through online and in-person opportunities,[16] and the Education Bureau of Xinji City, Hebei Province is building an information technology network that promotes teacher training. Local corporations, such as Intel, have also developed online teacher training platforms.[17]

Rethinking the Roles of Teachers. Educators are increasingly expected to be adept at a variety of technology-based and other approaches for content delivery, learner support, and assessment; to collaborate with other professors and lecturers both inside and outside their schools; to routinely use digital strategies in their work with students; to act as guides and mentors in promoting student-centred learning; and to organise their own work and comply with administrative documentation and reporting requirements. Students add to these expectations through their own use of technology to socialise, organise, and informally learn on a daily basis.

Difficult Challenges

Those we understand but for which solutions are elusive

Balancing our Connected and Unconnected Lives. With the abundance of content, technologies, and overall participatory options, schools need to help find a balance between connected and unconnected life. With technology now at the centre of many daily activities, it is important that learners understand how to balance their connected life with other developmental needs. Chinese schools and teachers should lead the way to ensure learners do not get lost and absorbed by the abundance of information and technology, and encourage mindful use of technology so that students stay aware of their digital footprint.

Competing Models of Education. New models of education, such as massive open online courses, are bringing unprecedented competition to schools, especially for students whose needs are not being well served by the current system. For school leaders and policymakers, the challenge is to meet such competition head on, offering high-quality alternatives to students who need them. As new platforms emerge, there is a growing need to frankly evaluate models and determine how to best support collaboration, interaction, deep learning experiences, and assessment at scale.

Creating Authentic Learning Opportunities. Authentic learning, especially experiences that bring real-life experiences into the classroom, is still all too uncommon in schools. Authentic learning is seen as an important pedagogical strategy, with great potential to increase the engagement of students who are seeking some connection between the world as they know it exists outside of school, and their experiences in school that are meant to prepare them for that world. Use of learning strategies that incorporate real-life experiences, technology, and tools that are already familiar to students, and interactions from community members are examples of approaches that can bring authentic learning into the classroom. Beijing Shidade Education Technology Co., LTD provides students with diverse learning modules; they created many interactive English dialogue online scenarios, complete with multimedia curriculum resources and big data management evaluation tools, to provide students with more opportunities to experience English language learning in authentic contexts.

Wicked Challenges

Those that are complex to even define, much less address

Problems for Online Education Enterprises. As the virtualisation of learning increases, education companies are playing a bigger role in the production of online learning platforms, software, and learning management systems. However, education thought leaders in China are growing concerned over the lack of government regulation of these products and services, fearing that they are not entirely aligned with goals of national education agendas. Furthermore, educators are often not involved in the development of online learning resources, causing apprehension that the resulting tools do not accurately match schools' needs and sufficiently address improving student learning outcomes.

Scaling Teaching Innovations. Chinese schools are not yet adept at moving teaching innovations into mainstream practice. Innovation springs from the freedom to connect ideas in new ways. Schools generally allow teachers to connect ideas only in prescribed ways — sometimes these lead to new insights, but more likely they lead to rote learning. Current school promotion structures do not always reward innovation and improvements in teaching and learning, or help to spread those successful practices across schools and districts. A pervasive aversion to change limits the diffusion of new ideas, and too often discourages experimentation.

Teaching Complex Thinking. It is essential for young people both to understand the networked world in which they are growing up and also — through computational thinking — to understand the difference between human and artificial intelligence, learn how to use abstraction and decomposition when tackling complex tasks, and deploy heuristic reasoning to complex problems. Mastering modes of complex thinking does not make an impact in isolation; communication skills must also be mastered for complex thinking to be applied meaningfully.

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 specialised data centres and consume almost no local processing or storage resources. Cloud computing resources support collaboration, file storage, virtualisation, and access to computing cycles, and the number of available applications that rely on cloud technologies has grown to the point that few education institutions do not make some use of the cloud, whether as a matter of policy or not. Over the past few years, cloud computing has been firmly established as an efficient way for businesses to protect data, develop applications, deliver software and online platforms, and collaborate. China touts the world's largest Internet user base, with mobile being the preferred form of access. As such, cloud computing has become an important part of the national technology strategy. In 2014, the international organisation Cloud Standards Customer Council predicted a 200% growth in cloud delivery infrastructure over a two-year period, anticipating more innovation around bolstering efficiency and agility of cloud services.[18] Major Chinese companies, including Alibaba, are challenging Amazon Web Services' position as leaders in this space.[19] Schools in China are well positioned to take advantage of cloud-based strategies to boost collaboration, productivity, and mobility in teaching and learning.

Relevance for Teaching, Learning, or Creative Inquiry

- At the school level, flexible options for computing, bandwidth, and storage offered by providers can be reconfigured on the fly, and in most cases are considerably cheaper than the capital and operational costs of dedicated data centres.
- At the user level, secure cloud resources are less expensive than licensed products, and they increase access to storage, tools, media, and educational materials for learners.
- Cloud-based services support collaborative learning competencies, encouraging students to work simultaneously on a document in the same room or across continents.

Cloud Computing in Practice

- Chinese cloud services provider 3Tcloud implemented a large-scale cloud initiative across the country to improve resource allocation and reduce maintenance costs for learning resources and research and evaluation tools: bit.ly/1OJFuPP.
- Nanhai District of Foshan, Guangdong province uses cloud technology to share resources within the district and schools in other regions for collaboration, communication, assessment, analytics, and data storage: bit.ly/1MWV8a5.
- The National Public Service Platform for Education Resource leverages the cloud to house a central repository where users can share or find open educational resources for any level of education: bit.ly/1Qg5OBh.

For Further Reading

China Focus: "Internet Plus" to Fuel Innovation, Development
bit.ly/1LBP2Gj

(Xinhua News Agency, 5 March 2015.) China has implemented its "Internet Plus" action plan to initiate economic development and expand access to education by improving mobile Internet, cloud computing, big data, and the Internet of things and better integrating them within a variety of sectors.

EMC: Emotion-Aware Mobile Cloud Computing in 5G
bit.ly/1jWJcb2

(Min Chen et al., IEEE Network, March/April 2015.) This paper proposes that recent advancements in 5G are paving the way for mobile cloud computing that will help provide resource-intensive mobile services such as personalised, emotion-aware functionality.

Time-to-Adoption: One Year or Less

Flipped Classroom

The flipped classroom refers to a model of learning that rearranges how time is spent both in and out of class to shift the ownership of learning from the educators to the students. In the flipped classroom model, valuable class time is devoted to higher cognitive, more active, project-based learning where students work together to solve local or global challenges — or other real-world applications — to gain a deeper understanding of the subject. Rather than the instructor using class time to dispense information, that work is done by each student after class, and could take the form of watching video lectures, listening to podcasts, perusing enhanced e-book content, or collaborating with peers in online communities. Students access the online tools and resources any time they need them. Teachers can then devote more time to interacting with each individual. After class, students manage the content they use, the pace and style of learning, and the ways in which they demonstrate their knowledge; the instructor adapts instructional and collaborative approaches to suit their learning needs and personal learning journeys.

Relevance for Teaching, Learning, or Creative Inquiry

- Flipped classroom concepts and providing Chinese students with a more diverse set of learning resources can support self-directed learning.
- More active learning is an important component of the flipped classroom: lectures can be watched with ensuing online discussions unfolding at home, while teachers can use class time for hands-on activities or trips outside of the building.
- The online component of the flipped classroom enables students to repeat vital learning activities, such as re-watching videos and running virtual experiments as often as needed, in order for them to fully grasp the subject matter.

Flipped Classroom in Practice

- JianPing High School in the Pudong area of Shanghai has found success using a flipped classroom approach combined with structured planning, use of technology, and strong leadership and encouragement from teachers: bit.ly/1GnizX2.
- No. 1 Middle School of Changle in Shandong province uses the "Sunshine Micro-Course" platform in partnership with Shandong Publishing Group Co., LTD to provide technical support for a flipped classroom in which students use tablets to participate: bit.ly/1PBJksC.
- Yantai Xianghe Middle School leverages the Learning Cell platform developed by the "Mobile Learning" Ministry of Education - China Mobile Joint Laboratory to give students access to courseware, videos, and assessments, with features that enable them to collaboratively work on any device: bit.ly/1ROdUhS.

For Further Reading

Five Observations about Flipped Learning in Asia
bit.ly/1OfWxGr

(Jon Bergmann, Turning Learning on its Head, 28 September 2015.) In a flipped classroom pioneer's travels to Asia, he concluded that there is an increasing interest in this design due to three outcomes: an increase in student achievements measured by higher test scores, more student-teacher interaction, and a shift to project-based learning.

Implementing the Flipped Classroom in Elementary and Secondary Schools in China (PDF)
bit.ly/1RMMucz

(Jianying Yang, Nanchong, P. R. China, ICELAIC, 2014.) The flipped classroom model has potential to raise learner autonomy and inquiry-based learning in Chinese schools, but educators must first overcome four key obstacles: lack of technology, poor quality of videos, poor classroom design, and lack of parental engagement.

Time-to-Adoption: One Year or Less

Makerspaces

The driving force behind makerspaces is rooted in the maker movement, a following of artists, tech enthusiasts, engineers, builders, tinkerers, and anyone else who has a passion for making things. The formation of the movement stems from the success of the Maker Faire, a gathering that launched in 2006, and has since propagated itself into numerous community-driven events all over the world. The turn of the 21st century has signalled a shift in what types of skillsets have real, applicable value in a rapidly advancing world. In this landscape, creativity, design, and engineering are making their way to the forefront of educational considerations as tools such as 3D printers, robotics, and 3D modelling web-based applications become accessible to more people. In China, an increasing number of community makerspaces, called Chaihuo, are populating major cities and mass production hubs.[20] There are at least 130 makerspaces dispersed in Beijing, Shenzhen, and Shanghai, and thought leaders there believe they are fostering significant innovation across the country because they promote open communities and exchanges of ideas.[21] The question of how to renovate classrooms to address the needs of the future is being answered through makerspaces that offer tools and the learning experiences needed to help learners carry out their ideas.

Relevance for Teaching, Learning, or Creative Inquiry

- Makerspaces equipped with technologies and construction supplies are all-purpose workshops that represent the power of creation in both the virtual and physical world.
- Makerspaces that can be accessed outside of scheduled classes provide a place for teachers and students to pursue making activities on their own or participate in extracurricular camps that promote design skills with a variety of tools.
- Pedagogies such as inquiry-based learning and design thinking, which encourage planning, construction, and delivery, can be carried out in makerspaces.

Makerspaces in Practice

- At the second Jinqiao Mini Maker Faire, hosted at Concordia International School, young makers showcased a variety of inventions ranging from new and improved furniture designs to handmade rockets to deep ocean exploring robots: bit.ly/1RU26dZ.
- Thirty DigiBook MakerSpaces are providing a place where students create and publish original multimedia content in public libraries across China: bit.ly/1jxorTM.
- Zhejiang Wenzhou Middle School has established a makerspace sponsored by Shanghai DFRobot Company to encourage interdisciplinary research, identify, and solve everyday problems, and experiment with and learn to improve technology: bit.ly/1Nr6gq8.

For Further Reading

Hacking with Chinese Characteristics: The Promises of the Maker Movement against China's Manufacturing Culture
bit.ly/1W3PYbo

(Silvia Lindtner, Researchgate, 10 August 2015.) A researcher describes why China's maker culture is unique due to its roots in Shanzhai, which reflects an open ecosystem of component producers, design solution houses, vendors, and assembly lines.

How Maker Faire Found Its Way to Shenzhen
bit.ly/1KkiMpe

(Gold Mohammadi, *Makezine*, 17 June 2015.) China's first Maker Faire in Shenzhen has since spurred a thriving maker culture with ten makerspaces in the city and at least ten school-based makerspaces in progress. The Shenzhen government has also declared a Maker Week in June with a host of events and competitions.

Time-to-Adoption: One Year or Less

Mobile Learning

As smartphones and tablets become more capable and user interfaces more natural, old methods of computing seem place-bound and much less intuitive. People increasingly expect to be connected to the Internet and the rich tapestry of knowledge it contains wherever they go, and the majority of them use a mobile device to do so. In 2014, mobiles became the number one way people in China accessed the web;[22] in China, there are nearly 1.3 billion registered mobile phone users.[23] The unprecedented evolution of these devices and the apps that run on them has opened the door to myriad uses for education. Learning institutions all over the world are adopting apps into their curricula and modifying websites, educational materials, resources, and tools so they are optimised for mobile devices. The significance for teaching and learning is that these devices have the potential to facilitate almost any educational experience, allowing learners to organise virtual video meetings with peers all over the world, use specialised software and tools, and collaborate on shared documents or projects in the cloud, among many other things. Although there are still likely many uses that have not been realised yet, over the past several years mobile learning has moved quickly from concept to widespread reality.

Relevance for Teaching, Learning, or Creative Inquiry

- As a 1:1 solution, mobiles present an economic, flexible alternative to laptops and desktops due to the devices' lower cost, greater portability, and access to apps.
- Mobile apps with built-in social features enable learners to share their questions or findings with each other in real time. For example, social networking apps such as "WeChat" make it possible to exchange ideas, notes, assignments, and videos.
- Students can leverage the cameras, microphones, and other tools inherent in mobiles to do fieldwork or 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 Learning in Practice

- Luochuan School of Shanghai and Intel collaborated to create a 1:1 digital mobile learning environment that has enhanced project-based learning and allowed the school to implement a competency-based learning curriculum: bit.ly/1MKAYd7.
- The Qualcomm 21st Century Classroom Program launched an initiative that supports mobile broadband-based learning at No.2 Middle School in Guang'an City of Sichuan province, as well as Mengya Primary School and Wenxing Middle School in Yilong Town, as part of a larger strategy to alleviate poverty: bit.ly/1QsW976.
- A teacher at Beijing Royal School studied how the Mobile Learning Project has empowered young women to study science through data and anecdotal evidence: bit.ly/1PtuvIU.

For Further Reading

How Tablets have Changed Classroom Learning in China
bit.ly/1GdkVYE

(Liu Yang, CCTV, 25 April 2015.) As devices enter Chinese classrooms, some experts believe that tablets can help manage big classrooms by personalising instruction. However, some leaders caution that simply using them to consume e-books is not enough.

Mobile Learning Plugs China's Education Gap
bit.ly/1OIldzj

(Aida Aki, Mobiliya, 2 October 2015.) This interview with the founder and CEO of Mobiliya Technologies sheds light on the impact of a mobile learning program led by the China Development Research Foundation that allows students in rural areas to connect with classrooms in cities to receive remote instruction.

Time-to-Adoption: Two to Three Years

3D Printing

Known in industrial circles as rapid prototyping, 3D printing refers to technologies that construct physical objects from three-dimensional (3D) digital content such as 3D modelling software, computer-aided design (CAD) tools, computer-aided tomography (CAT), and X-ray crystallography. A 3D printer builds a tangible model or prototype from the electronic file, one layer at a time, through an extrusion-like process using plastics and other flexible materials, or an inkjet-like process to spray a bonding agent onto a very thin layer of fixable powder. The deposits created by the machine can be applied very accurately to build an object from the bottom up, layer by layer, with resolutions that are more than sufficient to express a large amount of detail. The process even accommodates moving parts within the object. Using different materials and bonding agents, colour can be applied, and parts can be rendered in plastic, resin, metal, tissue, and even food. This technology is commonly used in manufacturing to build prototypes of almost any object (scaled to fit the printer, of course) that can be conveyed in three dimensions. In Summer 2015, market research firm ResearchMoz predicted that the Chinese 3D printing market will reach $1.6 billion by 2016.[24] As more Chinese schools create makerspaces, they are looking increasingly to 3D printers as tools to stimulate more hands-on learning and design thinking.

Relevance for Teaching, Learning, or Creative Inquiry

- 3D printing allows for authentic exploration of objects that may not be readily available to schools, including animal anatomies, ancient artefacts, and toxic materials.
- 3D printing shows promise as a rapid prototyping and production tool, providing students with the ability to touch, hold, and even take home a concrete model of their idea.
- The exploration of 3D printing, from design to production, as well as demonstrations and participatory access, opens up new possibilities for learning activities.

3D Printing in Practice

- Fourth-grade students at Shijia Primary School are using 3D printing at an afterschool program organised by the school's science and technology museum: bit.ly/1RS3k9N.
- Taigong Primary School of Zibo develops 3D printing teaching materials suitable for various classes, and the students design individual works independently, learning valuable critical thinking and technology application skills: bit.ly/1Ik46Mx.
- With the help of a network of partners, Guangzhou University hosted ten hours of 3D printing classes for educators and announced a plan to offer 3D printing courses to over 300,000 students within the 230 K-12 schools located in Guangzhou City: bit.ly/1KrYigz.

For Further Reading

Education Use Driving Low-Cost 3D Printer Purchases
bit.ly/1Ro3jtw

(Dian Schaffhauser, *THE Journal*, 30 September 2015.) China's Ministry of Industry and Information Technology's National Additive Manufacturing Industry Promotion Plan 2015-2016 aims to offer comprehensive training to educators and to create courses for 3D printing that will educate its students, beginning with its 400,000 elementary schools.

Evaluation of Suitability of Rapid Prototyping Techniques for Use by Children
bit.ly/1WeJdsJ

(Rafat Saleh Madani et al., *Journal of Multidisciplinary Engineering Science and Technology*, January 2015.) This study evaluates various 3D printing methods and materials to measure how well each can accommodate a child-led approach to making.

Time-to-Adoption: Two to Three Years

3D Video

3D video is not an entirely new technology, having been around in the film industry for many decades. However, the technologies that deliver this immersive form of video viewing are improving. New cameras, better viewing glasses, projection systems, software, and displays are starting to bring 3D video into its own at the consumer level, enabling new forms of creative expression and imaging. 3D video requires the capture of two images simultaneously, the same way our eyes do. Once captured, this dual imagery must be displayed or projected in a way our eyes and brain can resolve enough to be believable with the assistance of specialised eyewear. New LED-based systems that do not require special glasses show considerable promise, and consumer displays and televisions with 3D technologies began to appear on the markets in 2010; they have become popularised through more affordable models by companies such as LG and Toshiba. Contemporary applications and software are enabling people of all ages to produce their own 3D videos.

Relevance for Teaching, Learning, or Creative Inquiry

- 3D video has the potential to provide contextual, in situ learning experiences that foster exploration of real world settings in virtual simulations to provide more clarity around complex science concepts, for example.
- Advancements in 3D learning technology, innovated by companies such as Eon Reality, have allowed for the integration of 3D quizzes, texts, and callouts for real-time knowledge checks embedded in videos.
- Tools such as AutoCAD and Learn SketchUp are making it easier for even young students to create their own 3D videos, learning 21st century technological skills of 3D modelling and animation in the process.

3D Video in Practice

- At the Bangkok Christian College, students are using "Project Spark," a 3D video game, to develop their logical and critical thinking skills: bit.ly/12qm502.
- The Educational Equipment Research and Development Centre of the Ministry of Education introduced a dome-screen projection technology, known as "Magic Planet," which generates a digitised 3D display of the globe for world geography. The technology has helped facilitate educational science opportunities, an important part of the Ministry of Education of China's countrywide 11th Five-Year Plan: bit.ly/1Teubhi.
- A Shenzhen technology company that is developing a virtual reality smart glass is in negotiations with a 3D video maker and an education group to provide a platform and content: bit.ly/1VSMrMR.

For Further Reading

11 Resources Pointing to the Promise of 3D Video in Education
bit.ly/1ffxkOj

(Bernard Bull, Etale - Digital Age Learning, 25 March 2014.) An education professor explores a number of usage scenarios for 3D video in K-12 schools, including resources for math, science, and anatomy.

Effect of Visual 3D Animation in Education (PDF)
bit.ly/1TCIxYF

(Syeda Binish Zahra, European Journal of Computer Science and Information Technology, January 2016.) This study demonstrates how 3D graphics and animation can impact learning by both providing opportunities for students to express their creativity as well as enhancing learning content by making it more memorable and engaging.

Time-to-Adoption: Two to Three Years

Learning Analytics

Learning analytics is an educational application of web analytics, a science that is commonly used by businesses to analyse commercial activities, identify spending trends, and predict consumer behaviour. Education is embarking on a similar pursuit into data science with the aim of learner profiling, a process of gathering and analysing large amounts of detail about individual student interactions in online learning activities. The goal is to build better pedagogies, empower students to take an active part in their learning, target at-risk student populations, and assess factors affecting completion and student success. For Chinese learners, educators, and researchers, learning analytics is starting to provide crucial insights into student progress and interaction with online texts, courseware, and learning environments used to deliver instruction. Students are beginning to experience the benefits of learning analytics as they engage with mobile and online platforms that track data to create responsive, personalised learning experiences.

Relevance for Teaching, Learning, or Creative Inquiry

- If used effectively, learning analytics can help surface early signals that indicate a student is struggling, allowing teachers and schools to address issues quickly.
- The science behind learning analytics in online environments can be used to create adaptive software that caters to a student's individual learning curve in real time.
- When correctly applied and interpreted, learning analytics will enable teachers to more precisely identify students' learning needs and tailor instruction appropriately.

Learning Analytics in Practice

- 17zuoye is an emerging online education platform that accrues information about a student's development in learning. Chinese teachers use this technology to distribute homework to their students and then analyse the data accumulated to track students' understanding of the material and report progress to parents: knewt.ly/1OH81Fx.
- The School of Educational Technology at Beijing Normal University is currently exploring how collecting multidimensional data related to interaction, emotion, knowledge processing, and knowledge construction can provide insight into learning behaviour to support both students and educators.
- Researchers at Chongqing University use educational data mining to accumulate and map out information about students' interactions with one another inside the classroom. These analyses are then used to optimise student study habits by creating schedules that are most efficient based on student behaviour: bit.ly/1kl1q6E.

For Further Reading

A Chinese Perspective on Learning Analytics
bit.ly/1jUbW4o

(Xiaoqing Gu, Learning Analytics Community Exchange, 17 February 2015.) A professor broadens the scope of learning analytics by incorporating data from both blended learning environments and online learning sources. Within the context of China's K-12 system, iPads are equipped with customised software that tracks student learning.

A Conceptual Design Framework for Big Data Based Learning Analysis (PDF)
bit.ly/1LIIlCe

(Zheng,Yanlin and RuanBig, Shigui, International Conference on Education, 2015.) This article examines one process of collecting big data, highlighting the importance of understanding where data comes from, what it represents, and how it can be used to understand the process of student learning.

Time-to-Adoption: Two to Three Years

Massive Open Online Courses

When the term was coined in the US in 2008, massive open online courses (MOOCs) were conceptualised as the next evolution of networked learning. The essence of the original MOOC concept was a web course that people could take from anywhere across the world, with potentially thousands of participants. The basis of this concept was an expansive and diverse set of content, contributed by a variety of experts, educators, and instructors in a specific field, and aggregated into a central repository, such as a web site. What made this content set especially unique was that it could be “remixed” — the materials were not necessarily designed to go together but became associated with each other through the MOOC. A key component of the original vision was that all course materials and the course itself were open source and free — with the door left open for a fee if a participant taking the course wanted university credit for the work. Since those early days, interest in MOOCs has evolved quickly, fuelled by high-profile entrants like Coursera and edX in the popular press. In these new examples, "open" generally equates to "no charge." Ultimately, many challenges remain to be resolved in supporting learning at scale. While thus far massive open online courses have been more geared towards higher education and are not yet prominent in Chinese K-12 schools, the most compelling aspect of MOOCs is they are framing important discussions about online learning that simply could not have taken place before the advent of actual experiments.

Relevance for Teaching, Learning, or Creative Inquiry

- As new pedagogies emphasise personalised learning, there is a demand for learner-centred online opportunities. MOOCs have the potential to scale across the country.
- MOOCs make creative use of several educational technologies and emerging instructional approaches, including blended learning, video lectures, and badges.
- When placed online through MOOCs, a diverse set of learning resources is easily accessible to teachers and can support self-directed learning for free professional development.

Massive Open Online Courses in Practice

- Alibaba and Peking University launched a platform called “Chinese MOOCs” that offers a variety of free, open courses from Chinese universities that award students with certificates upon completion: bit.ly/1iDvauc.
- Beijing Digital School is a MOOC platform with courses, activities, and other resources to provide high-quality educational support to K-12 education: bit.ly/1kKMkaB.
- Shanghai Jiaotong University was the first university in mainland China to sign an agreement with Coursera, and has since launched its own “CnMooc platform” to offer MOOCs from which students can earn credits: bit.ly/1iDtznZ.

For Further Reading

EdTech and MOOC Times in China
bit.ly/1RHuRMJ

(Michael Trucano, The World Bank, 12 May 2015.) The Zhongguancun MOOC Times building is a think tank housing three-dozen companies working in various parts of China’s online education economy. Services include helping people prepare for professional certifications and a search engine dedicated to online learning content.

Internet Courses Go Through Learning Curve
bit.ly/1RUoFzM

(Liu Wei, Li Na, *China Daily*, 12 October 2015.) The Chinese Ministry of Education is working with major universities to offer MOOCs supported by subsidies under the National Outline for Medium and Long-term Education Reform and Development (2010-2020).

Time-to-Adoption: Four to Five Years

Adaptive Learning Technologies

Adaptive learning technologies refer to software and online platforms that adjust to individual students' needs as they learn. Adaptive learning is a "sophisticated, data-driven, and in some cases, nonlinear approach to instruction and remediation, adjusting to a learner's interactions and demonstrated performance level, and subsequently anticipating what types of content and resources learners need at a specific point in time to make progress."[25] In this sense, contemporary educational tools are now capable of learning the way people learn; enabled by machine learning technologies, they can adapt to each student's progress and adjust content in real time or provide customised exercises when they need it. Many educators envision these adaptive platforms as patient tutors that can provide personalised instruction on a large scale. There are two levels to adaptive learning technologies — the first platform reacts to individual user data and adapts instructional material accordingly, while the second leverages aggregated data across a large sample of users for insights into the design and adaptation of curricula.

Relevance for Teaching, Learning, or Creative Inquiry

- Adaptive learning dashboards are often viewable by students so they can gain a better understanding of what habits and activities are helping them learn more effectively.
- Adaptive learning technologies link specific concepts and skills to how students are interacting with the material, signalling algorithms to serve up more resources when they need help better comprehending the subject matter.
- If applied effectively, adaptive learning can foster more personalised learning for students while providing institutions with key insights about the efficacy of their instruction.

Adaptive Learning Technologies in Practice

- The Chinese Word Learning System (CWLS) is a flashcard-based language-learning tool that leverages online platforms that adjust to individual students' needs as they learn over time. CWLS adapts to students' demonstration of proficiency: bit.ly/1We4GSx.
- In the Shanxi Province of China, interactive digital platform provider UMeWorld and China Mobile recently shared plans to expand a K-12 adaptive learning system, UMFun. More than 240,000 students and teachers have joined UMFun, and the companies are expecting to make the platform available to four additional provinces: on.mktw.net/1Moryou.
- More than 150 eighth-grade science students participated in a study exploring the effects a scaffolding adaptive learning system has on education. The research, conducted by the National Changhua University of Education, Taiwan, indicates that those students exposed to the system reported a better cognitive understanding of the content: bit.ly/1N2TT7R.

For Further Reading

The Adaptive Teaching in the Setting of Big Data (PDF)
bit.ly/1LqhixB

(Li He, International Conference on Education, 2014.) This paper describes how an adaptive learning system can leverage interactive learning modules, data collection, assessment and analysis, and a prediction system to deliver optimal learning content to learners based on their behaviours and preferences.

Exploring New Opportunities in Adaptive Learning in China
bit.ly/1iydGPN

(China Briefing, 14 August 2015.) This article describes some of the current barriers to adaptive learning, which has yet to prove its full potential because the current tools on the market have fallen short of educators' and investors' expectations.

Time-to-Adoption: Four to Five Years

Intelligent Grading Technologies

Intelligent grading technologies refer to learning assessment tools that are being increasingly embedded in virtual environments. As more instructional videos and materials are being placed online, enabling students to learn anytime, automated feedback and scoring capabilities have the potential to enhance learning content, making it more interactive and helpful. At the most basic level, companies such as Canon have developed intelligent grading solutions that are essentially test creators that leverage cloud-based content management software so that educators can administer tests, view the results, and access the system from anywhere.[26] More recently, the advent of adaptive learning platforms such as McGraw Hill's ALEKS have opened new doors for intelligent grading by enabling teachers to use interactive features and quizzes to continuously assess learning, while highlighting areas where students need improvement. Furthermore, as students are increasingly being encouraged to demonstrate their newfound knowledge through methods of their choice, questions have arisen about how to best assess their learning. This is especially tricky for teachers who are promoting hands-on activities and looking for ways to scale evaluations for entire classes. While fairly aspirational, the next incarnation of intelligent grading technologies have the potential to automate the assessment of creative displays.

Relevance for Teaching, Learning, or Creative Inquiry

- Intelligent grading technologies can free up teachers from scoring every assignment manually, giving them more time to focus on facilitating hands-on learning activities and deep discussions.
- Intelligent grading technologies standardise the way that creative learning exercises are evaluated, helping to perpetuate common frameworks across schools and districts.
- When online learning environments have assessments embedded, students get a better sense of how they are grasping concepts between major exams.

Intelligent Grading Technologies in Practice

- The company Turnitin has leveraged natural language processing to automate the scoring of essays and short answer texts by recognizing content-based patterns: bit.ly/1Rn9q3I.
- Impression Technology Co. LTD Beijing has created two apps, "Rapid Calculation" and "Know Box," which cover a variety of disciplines such as political history and to information technology; the apps provide instant feedback to students as they work through activities with apps, freeing up teachers to better interact with students: bit.ly/20NkIm7.
- Pearson's TELL platform is an interactive tablet-based language proficiency assessment that automatically identifies each student's proficiency level and diagnoses their ability and skill level: bit.ly/1HKWMnM.

For Further Reading

Automated, Adaptive Guidance for K-12 Education
bit.ly/1Sk4Kd2
(Libby Gerard et al., ResearchGate, April 2015.) Automated scoring technologies and adaptive guidance for students within online learning environments can help students to deepen their explanations and understanding of complex ideas.

Automatic Grading and Feedback for Open Response Mathematical Questions
bit.ly/1QjhqDy
(Andrew S. Lan et al., arxiv, 18 January 2015.) Researchers from Rice University developed a data-driven framework for mathematical language processing that automatically evaluates the correctness of solutions to open response mathematical questions.

Time-to-Adoption: Four to Five Years

Virtual and Remote Laboratories

Virtual and remote laboratories reflect a movement among education institutions to make the equipment and elements of a physical science laboratory more easily available to learners from any location, via the web. Virtual laboratories are web applications that emulate the operation of real laboratories and enable students to practice in a "safe" environment before using real, physical components. Students can typically access virtual labs 24/7, from wherever they are, and run the same experiments over and over again. Some emerging virtual lab platforms also incorporate reporting templates that populate with the results of the experiments so that students and teachers can easily review the outcomes. Remote laboratories, on the other hand, provide a virtual interface to a real, physical laboratory. Institutions that do not have access to high-calibre lab equipment can run experiments and perform lab work online, accessing the tools from a central location. Users are able to manipulate the equipment and watch the activities unfold via a webcam on a computer or mobile device. This provides students with a realistic view of system behaviour and allows them access to professional laboratory tools from anywhere, whenever they need. Additionally, remote labs alleviate some financial burden for institutions as they can forgo purchasing specific equipment and use the remote tools that are at their disposal.

Relevance for Teaching, Learning, or Creative Inquiry

- Because virtual laboratories do not involve real equipment or chemicals, students feel more comfortable making mistakes and run experiments in complete safety.
- Teachers play back videos of the experiments students have run online, pinpoint areas for improvement or further discussion, and acknowledge students who have excelled.
- Virtual and remote laboratories increase access to science tools, allowing learners to use them via wireless or cellular networks. In school settings, it solves a number of issues involved with having children around potentially dangerous materials and processes.

Virtual and Remote Laboratories in Practice

- Beijing No. 65 Middle School is using a virtual computer graphics laboratory technology that combines computer simulation, artificial intelligence, sensors, network parallel processing, and computer-aided generation of high-tech simulation systems to allow virtual simulation for multidisciplinary experiments, testing, and research: bit.ly/1M7rADh.
- The Ministry of Human Resource Development in India developed Virtual Labs, which offers 1,500 experiments across multiple disciplines: bit.ly/1iXiyy9.
- Researchers from the University of Geneva and Tsinghua University are leading an international challenge called LEGO2NANO in which students are building a low-cost atomic force microscope to study air pollution in Beijing. The goal is to create a virtual lab where Chinese children can share and analyse their results interactively: bit.ly/1P14WhV.

For Further Reading

Examining Teachers' Practical Experiences with Virtual Labs in High School Science
bit.ly/1Sn9kam

(Shaaban Fundi, Kibogoji, 24 April 2014.) A teacher explores the evidence around the effectiveness of virtual laboratories and their use in high school science classrooms, using narrative inquiry to investigate teachers' practical experiences with these tools.

Virtual Laboratories in Teaching and Learning Science
bit.ly/1ksoT6t

(SCIENTIX, 20 August 2015.) SCIENTIX, the community for science education in Europe, produced a detailed description of virtual lab environments that is divided into four categories: simulations, network applets, virtual labs, and virtual reality laboratories.

Time-to-Adoption: Four to Five Years

Wearable Technology

Wearable technology refers to computer-based devices that can be worn by users, taking the form of an accessory such as jewellery, eyewear, or even actual items of clothing such as shoes or a jacket. The benefit of wearable technology is that it can conveniently integrate tools that track sleep, movement, location, and social media interactions, or, in the case of Oculus Rift and similar gear,[27] it can enable virtual reality. There are even new classes of devices that are seamlessly integrated with a user's everyday life and movements. Over the past two years, Google Glass has been one of the most heavily discussed wearables,[28] enabling users to see information about their surroundings displayed in front of them. New smart watches from Apple, Samsung, Sony, and Pebble are already allowing users to check emails and perform other productive tasks through a tiny interface. Thanks to the quantified self movement, today's wearables not only track where a person goes, what they do, and how much time they spend doing it, but now what their aspirations are and when those can be accomplished.[29] Currently in China, the most popular wearable devices are bracelets such as Bong X, Huawei Talk Band 2, and Xiaomi Mi Fitness Band, which track movement, exercise, and other health-related activities.[30] There are tremendous implications for physical education, nutrition, and health classes in K-12 education.

Relevance for Teaching, Learning, or Creative Inquiry

- Effective wearable devices become an extension of the person wearing them, allowing them to comfortably engage in everyday activities, such as checking and responding to emails and other tasks that help teachers and students to stay productive on-the-go.
- Students already spend time in formal classroom settings, gathering data about themselves or research topics they have been assigned. Quantified self-enabled wearables tap into this interest to make the data collection process much easier.
- Wearable devices such as Oculus Rift provide a virtual reality-enhanced experience for users, making simulation activities more realistic and immersive.

Wearable Technology in Practice

- Korean start-up company Dot is working on an active Braille smart watch based on haptic technology that will display information and messages as they are updated in real time as Braille characters on the device's face: bit.ly/1SJa6Ol.
- Students at Shunde Desheng Primary School of Foshan City wear smart bracelets connected to a physical health cloud-based platform to track their movement in real time.
- Vuzix and Lenovo have partnered to offer smart glasses featuring Bluetooth, GPS, and Chinese language support: zd.net/1HEUOuh.

For Further Reading

Right Time for Wearable Devices
bit.ly/1kG8P0y

(Shi Jing, *China Daily*, 19 October 2015.) China's wearables market has gained major traction; leading Chinese companies are designing products that are wearable or incorporate operating systems that allow them to run on current wearables.

Wearable Technology and Apps Could Yield Leap Forward for PE, Says Charity
bit.ly/1e0UbNT

(Nicola Slawson, *The Guardian*, 23 June 2015.) Publisher Tancent and gaming technology company Razer have teamed up in China to create a unique gaming experience that rewards physical activity based on tracking steps, calories burned, and hours slept through a wristband. This article describes the benefits of such technology in physical education.

Methodology

The process used to research and create the *2016 NMC Technology Outlook for Chinese K-12 Education: A Horizon Project Regional Report* is very much rooted in the methods used throughout the NMC Horizon Project. All publications of the NMC 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 panel of experts that first considers a broad set of important developments in technology, challenges, and trends, and then examines each of them in progressively more detail, reducing the set until the final listing of trends, challenges, and important developments in educational technology 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 *2016 NMC Technology Outlook for Chinese K-12 Education* can be found at china.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 expert panel. The panel 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, more than 1,500 internationally recognised practitioners and thought leaders have participated in the NMC Horizon Project Expert Panels.

Once the expert panel 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. Panel 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 selection of 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 expert panel 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 technology developments, trends, and challenges from the panel:

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

   c. *What are the emerging technologies you see developing to the point that Chinese schools and educational programmes should begin to take notice during the next four to five years?*

3. *What key trends do you expect to accelerate the uptake of emerging technology across Chinese K-12 education?*
4. *What do you see as the significant challenges impeding emerging technology uptake across Chinese K-12 education?*

One of the expert panel'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 expert panel moves to a unique consensus-building process based on an iterative Delphi-based methodology.

The responses to the research questions are systematically ranked and placed into adoption horizons by each panel 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 china.nmc.org.

2016 Horizon Project China Expert Panel

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Shufeng Ding
Tianjin Educational Technology Centre

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Beijing Education Technology and Equipment Centre

Youwen Feng
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Kai Gao
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Libo Gao
Yidu International School of Guiyang City

Yu Gao
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Zhengwei Gong
Beijing Institute of Technology

Shaoqing Guo
Northwest Normal University

Dongxing Jiang
Tsinghua University

Jane Jiang
Middlesex County College

Jianli Jiao
South China Normal University

Dongmei Li
The Affiliated High School of Peiking University

Zhang Li
Mississippi State University Libraries

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End Notes

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