NMC

Horizon Report > 2011 K-12 Edition

The NMC Horizon Project identifies and describes emerging technologies likely to have a large impact on teaching, learning, research, or creative expression within education around the globe.

Contents

The NMC Horizon Report: 2011 K-12 Edition is a publication of the New Media Consortium.

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Executive Summary

The NMC Horizon Report series is the most visible outcome of the NMC Horizon Project, an ongoing research effort established in 2002 that identifies and describes emerging technologies likely to have a large impact on teaching, learning, research, or creative expression within education around the globe. This volume, *The NMC Horizon Report: 2011 K-12 Edition* examines emerging technologies for their potential impact on and use in teaching, learning, and creative expression within the environment of pre-college education. The hope is that the report is useful to educators worldwide, and the international composition of the advisory board reflects the care with which a global perspective was assembled. While there are many local factors affecting the practice of education, there are also issues that transcend regional boundaries, questions we all face in K-12 education, and it was with these in mind that this report was created. *The NMC Horizon Report: 2011 K-12 Edition* is the third in the K-12 series of reports and is produced by the NMC in collaboration with the Consortium for School Networking (CoSN), and the International Society for Technology in Education (ISTE), with the generous support of HP's Office of Global Social Innovation.

Each edition of *The NMC Horizon Report* introduces six emerging technologies or practices that are likely to enter mainstream use in the educational community within three adoption horizons over the next one to five years. Each report also presents critical trends and challenges that will affect teaching and learning over the same time frame. To identify these areas, the project has drawn on an ongoing conversation among knowledgeable persons in the fields of business, industry, and education; on published resources, current research, and practice; and on the expertise of both the NMC community and the communities of the members of the NMC Horizon Project's K-12 advisory board, an international body of experts in education, technology, and other fields.

The advisory board, chosen to broadly represent a range of perspectives in K-12 education, engaged in a discussion around a set of research questions intended to surface significant trends and challenges and to identify a wide array of potential technologies for the report.

The NMC Horizon Report: 2011 K-12 Edition **examines emerging technologies for their potential impact on and use in teaching, learning, and creative expression within the environment of pre-college education.**

Over the course of a few weeks, the advisory board came to a consensus about the six topics that will appear here. The examples and readings under each topic area are meant to provide practical models as well as access to more detailed information. Wherever possible, an effort was made to highlight the innovative work going on among elementary, middle, and high schools around the world. The precise research methodology employed in producing the report is detailed in a special section that follows the body of the report.

The report's format is consistent from year to year, opening with a discussion of the trends and challenges identified

by the advisory board as the most important to consider over the next five years. The format of the main section closely reflects the focus of the NMC Horizon Project itself, centering on the applications of emerging technologies to education and creativity. Each topic is introduced with an overview that describes what it is, followed by a discussion of the particular relevance of the topic to teaching, learning, or creativity. Examples of how the technology is being, or could be applied to those activities are given. Finally, each section closes with an annotated list of suggested readings and additional examples that expand on the discussion in the report and a link to the project and discipline examples collected during the research process by project staff, the advisory board, and others in the growing NMC Horizon Project community.

Key Trends

The technologies featured in each edition of *The NMC Horizon Report* 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 creativity, and uses these as a lens for its later work. 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 an impact they are likely to have on education in the next five years. The following five trends have been identified as key drivers of technology adoptions for the period of 2011 through 2016; they are listed here in the order they were ranked by the advisory board.

Sense-making and the ability to assess the credibility of information are paramount.

1 The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators. This multi-year trend was again ranked very highly, indicating its continued influence. Institutions must consider the unique value that each resource 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.

2 As IT support becomes more and more decentralized, the technologies we use are increasingly based not on school servers, but in the cloud. The continuing acceptance and adoption of cloud-based applications and services is changing not only the ways we configure and use software and file storage, but even how we conceptualize those functions. It does not matter where our work is stored; what matters is that our information is accessible no matter where we are or what device we choose to use. Globally, in huge numbers, we are growing accustomed to a model of browser-based software that is device-independent. While some challenges still remain, specifically with notions of privacy and control, the promise of significant cost savings is an important driver in the search for solutions.

3 Technology continues to profoundly affect the way we work, collaborate, communicate, and succeed. Increasingly, technology skills are also critical to success in almost every arena, and those who are more facile with technology will advance while those without access or skills will not. The digital divide, once seen as a factor of wealth, is now seen as a factor of education: those who have the opportunity to learn technology skills are in a better position to obtain and make use of technology than those who do not. Evolving occupations, multiple careers, and an increasingly mobile workforce contribute to this trend.

4 People expect to be able to work, learn, and study whenever and wherever they want to. This highly ranked trend, also noted last year, continues to permeate all aspects of daily living. Life in an increasingly busy world where learners must balance demands from home, work, school, and family poses a host of logistical challenges with which mobile students must cope. A faster approach is often perceived as a better approach, and as such people want easy

and timely access not only to the information on the network, but to their social networks that can help them to interpret it and maximize its value. The implications for informal learning are profound, as are the notions of "just-in-time" learning and "found" learning, both ways of maximizing the impact of learning by ensuring it is timely and efficient.

5 The perceived value of innovation and creativity is increasing. Innovation is valued at the highest levels of business and must be embraced in schools if students are to succeed beyond their formal education. The ways we design learning experiences must reflect the growing importance of innovation and creativity as professional skills. Innovation and creativity must not be linked only to arts subjects, either; these skills are equally important in scientific inquiry, entrepreneurship, and other areas as well.

Critical Challenges

Along with current trends, the advisory board notes critical challenges that schools face, especially those that are likely to continue to affect education over the five-year time period covered by this report. Like the trends, these are 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. Those challenges ranked as most significant in terms of their impact on teaching, learning, and creative inquiry in the coming years are listed here, in the order of importance assigned to them by the advisory board.

1 Digital media literacy continues its rise in importance as a key skill in every discipline and profession. The challenge is due to the fact that despite the widespread agreement on its importance, training in digital literacy skills and techniques is rare in teacher education and school district professional development programs. As teachers begin to realize 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.

2 Economic pressures and new models of education are presenting unprecedented competition to traditional models of schools. Across the board, institutions are looking for ways to control costs while still providing a high quality of service. Schools are challenged by the need to support a steady — or growing — number of students with fewer resources and staff than before. As a result, creative institutions are developing new models to serve students, such as providing open content over the network. As these pressures continue, other models may emerge that diverge from traditional ones. Simply capitalizing on new technology, however, is not enough; the new models must use these tools and services to engage students on a deeper level.

Digital literacy is less about tools and more about thinking.

3 The demand for personalized learning is not adequately supported by current technology or practices. The increasing demand for education that is customized 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.

4 A key challenge is the fundamental structure of the K-12 education establishment — aka "the system." As long as maintaining the basic elements of the existing system remains the focus of efforts to support education, there will be resistance to any profound change in practice. Learners have increasing

opportunities to take their education into their own hands, and options like informal education, online education, and home-based learning are attracting students away from traditional educational settings. If the system is to remain relevant it must adapt, but major change comes hard in education.

5 **Many activities related to learning and education take place outside the walls of the classroom and thus are not part of our learning metrics.** Students can take advantage of learning material online, through games and programs they may have on systems at home, and through their extensive — and constantly available — social networks. The experiences that happen in and around these venues are difficult to tie back to the classroom, as they tend to happen serendipitously and in response to an immediate need for knowledge, rather than being related to topics currently being studied in school.

These trends and challenges are having a profound effect on the way we experiment with, adopt, and use emerging technologies. These aspects of the world that surround and permeate education serve as a framework for considering the probable impacts of the emerging technologies listed in the sections that follow.

Technologies to Watch

The six technologies featured in *The NMC Horizon Report* are placed along three adoption horizons that indicate likely time frames for their entrance into mainstream use for teaching, learning, or creative applications in the K-12 environment. The near-term horizon assumes the likelihood of entry into the mainstream for schools within the next twelve months; the mid-term horizon, within two to three years; and the far-term, within four to five years. It should be noted that *The NMC Horizon Report* is not a predictive tool. It is meant, rather, to highlight emerging technologies with considerable potential for our focus areas of teaching, learning, and creative expression. Each of them is already the focus of work at a number of innovative schools around the world, and the work we showcase here reveals the promise of a wider impact.

Near-term Horizon

On the near-term horizon — that is, within the next 12 months — are cloud computing and mobiles. Both appeared in *The NMC Horizon Report: 2010 K-12 Edition*, and their reappearance here is not only an indication of continued interest in these technologies but, more significantly, that the technologies continue to evolve. The strong interest in cloud computing has shifted from its previous focus on free productivity tools to a way to trim the costs of running district data centers, such as data storage, backups, and infrastructure maintenance. Mobiles, on the other hand, have moved to the near-term horizon this year as new, always-connected tablets such as the iPad have changed the debate around allowing personal devices on campuses.

> **Cloud computing** has already transformed the way users of the Internet think about computing and communication, data storage and access, and collaborative work. Cloud-based applications and services are available to many school students today, and more schools are employing cloud-based tools all the time. Now schools are looking to outsource significant parts of their infrastructure, such as email and backups, to cloud providers. Together, these developments have contributed considerably to the adoption of cloud computing approaches at K-12 schools across the globe.

> **Mobiles** are a category that defies long-term definitions. With more than 1.2 billion new mobile devices produced each year, the pace of innovation in the mobile markets is unprecedented. Mobiles, especially smartphones and tablets, enable ubiquitous access to information, social networks, tools for learning and productivity, and hundreds of thousands of custom applications. Mobiles were listed in previous years because they could capture multimedia, access the Internet, or geolocate. Now they are effectively specialized computers for the palm of your hand, with a huge and growing collection of software tools that make use of their accelerometers, compasses, cameras, microphones, GPS, and other sensors.

Second Adoption Horizon

The second adoption horizon is set two to three years out, where we will begin to see widespread adoptions of two technologies with a growing importance: game-based learning and open content. Games are clearly part of mainstream popular culture; consumer use of open content is growing. Both have been demonstrated as effective tools for learning in a number of schools already, and both are expected to see much broader use in pre-college education over the next two to three years. Game-based learning also appeared on the mid-term horizon in *The NMC Horizon Report: 2010 K-12 Edition*. While continuing to develop in some very interesting ways, the growth of game-based learning has been constrained due to the lack of quality educational games and game platforms. Open content is new to the K-12 report this year, with interest driven by a growing range of open source textbooks and a wider recognition of the collaborative philosophy behind creating and sharing free content.

> **Game-based learning** has grown in recent years as research continues to demonstrate its effectiveness for learning. Games for education span the range from single-player or small-group card and board games all the way to massively multiplayer online games and alternate reality games. Those at the first end of the spectrum are easy to integrate into the curriculum, and have long been an option in many schools; but the greatest potential of games for learning lies in their ability to foster collaboration and engage students deeply in the process of learning. Once educational gaming providers can match the volume and quality of their consumer-driven counterparts, games will garner more attention.

> **Open content** is the current form of a movement that began a decade ago, when universities such as MIT began to make their course content freely available. Ten years later, schools have also begun to share a significant amount of curricula, resources, and learning materials. There is a growing variety of open content from K-12 organizations and schools, and in many parts of the world, open content represents a profound shift in the way students study and learn. Far more than just a collection of free online course materials, the open content movement is increasingly a response to the rising costs of education, the desire to provide access to learning in areas where such access is difficult, and an expression of student choice about when and how to learn.

Far-term Horizon

On the far-term horizon, set at four to five years away from widespread adoption are learning analytics and personal learning environments. Neither of these two technologies is commonly found in school settings today and both remain at the experimental and conceptual levels. Nonetheless, the high level of interest and research in each of these areas — not to mention their game-changing potential — indicates that they are worth following closely.

The six technologies featured in *The NMC Horizon Report* are placed along three adoption horizons that indicate likely time frames for their entrance into mainstream use for teaching, learning, or creative applications in the K-12 environment.

> **Learning analytics** loosely joins a variety of data-gathering tools and analytic techniques to study student engagement, performance, and progress in practice, with the goal of using what is learned to revise curricula, teaching, and assessment in real time. Building on the kinds of information generated by Google Analytics and other similar tools, learning analytics aims to mobilize the power of data-mining tools in the service of learning and embrace the complexity, diversity, and abundance of information that dynamic learning environments can generate.

> **Personal learning environments (PLEs)** refer to student-designed learning approaches that encompass different types of content — videos, apps, games, social media tools, and more — chosen by a student to match his or her personal learning style and pace. Despite the use of the word "environment" in the name, the notion of a collection or a physical or online space is somewhat irrelevant to a PLE. The goal is for students to have more control over how they learn, and for teachers to set expectations that their students will be more engaged in understanding and applying their learning strategies. Personal learning environments are currently more of a theoretical construct, as they have not been widely put into practice. The notion is of intense interest to many educators who see PLEs as having considerable potential to engage students in ways that best suit their individual learning needs.

Each of these technologies is described in detail in the body of the report. These sections open with a discussion of what the technology is and why it is relevant to teaching, learning, and creative inquiry.

At the center of the process is an international advisory board whose role is to select the topics in the report.

Examples of the technology in practice, especially in schools, are listed to illustrate how it is being adopted at the current time. Our research indicates that all six of these technologies, taken together, will have a significant impact on learning-focused organizations within the next five years.

The NMC Horizon Project

Since March 2002, under the banner of the NMC Horizon Project, the New Media Consortium has held an ongoing series of conversations and dialogs with hundreds of technology professionals, campus technologists, faculty leaders from colleges and universities, teachers and other school professionals, and representatives of leading corporations from more than two dozen countries. In the ensuing years, these conversations have resulted in the publication each January of a report focused on emerging technologies relevant to higher education. At the center of the process is an international advisory board whose role is ultimately to select the topics in the report, via a consensus-based process. As they work, the advisory board engages in lively dialogs around a wide range of articles, published and unpublished research, papers, scholarly blogs, and websites. The result of these dialogs is a list of the key technologies, trends, challenges, and issues that knowledgeable people in technology industries, education, and learning-focused organizations are thinking about.

In 2008, the NMC embarked on a new series of regional and sector-based companion editions of *The NMC Horizon Report*, with the dual goals of understanding how technology is being absorbed using a smaller lens, and also noting the contrasts between technology use in one area compared to another. This report, *The NMC Horizon Report: 2011 K-12 Edition*, is the third in the series focusing on pre-college education. The flagship *NMC Horizon Report*, focused on higher education, is translated into multiple languages every year. Over all editions, the readership of the reports is estimated at over 1,000,000 worldwide, with readers in more than 75 countries.

Like the university-focused effort from which it emerged, the K-12 project, referred to informally as *Horizon.K12*, uses qualitative research methods to identify the technologies selected for inclusion in the report, beginning with a survey of the work of other organizations, a close examination of topics previously detailed in *The NMC Horizon Report* series, and a review of the literature with an eye toward spotting interesting emerging technologies. When a new cycle is started, little is known, or even can be known, about the appropriateness or efficacy of many of the emerging technologies for these purposes, as the NMC Horizon Project expressly focuses on technologies not currently in widespread use in schools.

By engaging a wide community of interested parties, and diligently searching published research, the

Internet, and other sources, enough information is gathered early in the process to allow the members of the advisory board to form an understanding of how each of the discovered technologies might be in use in settings outside of education, to develop a sense of the potential the technology may have for educational settings, and to envision applications of the technology for teaching, learning, and creativity. The findings are discussed in a variety of settings — with teachers, industry experts, technologists, and of course, the Horizon advisory board. Of particular interest to the advisory board every year is finding educational applications for these technologies that may not be intuitive or obvious.

The 45 members of this year's K-12 advisory board were purposely chosen to represent a broad spectrum of K-12 education, as well as key writers and thinkers from business and industry. They engaged in a comprehensive review and analysis of research, articles, papers, blogs, and interviews; discussed existing applications, and brainstormed new ones; and ultimately ranked the items on the list of candidate technologies for their potential relevance to teaching, learning, and creative expression. This work took place entirely online and may be reviewed on the project wiki at k12.wiki.nmc.org.

Each *NMC Horizon Report* is produced over a period of just a few months so that the information is timely and relevant. This year, the effort to produce *The NMC Horizon Report: 2011 K-12 Edition* began in February 2011 and concluded when the report was released in June 2011, a period of just over three months. The six technologies and applications that emerged at the top of the final rankings — two per adoption horizon — are detailed in the sections that follow.

Each of those sections includes detailed descriptions, links to active demonstration projects, and a wide array of additional resources related to the six profiled technologies. Those profiles are the heart of *The NMC Horizon Report: 2011 K-12 Edition,* and will fuel the work of the NMC Horizon Project throughout 2011-12.

An important example of that work is the Horizon.K12 Toolkit. For the second year, the Consortium for School Networking (CoSN), with the support of HP's Office of Global Social Innovation, is again preparing a K-12 toolkit to accompany the report, aimed at school and district leaders, board members, policymakers, teacher groups, and others. The toolkit, to be released under a Creative Commons license, will help these key groups maximize the impact of the report in their schools and help their constituencies gain an understanding of new applications of technology to support teaching and learning and successfully plan for their implementation.

For those wanting to know more about the processes used to generate *The NMC Horizon Report* series, many of which are ongoing and extend the work in the reports, we refer you to the report's final section on the research methodology.

Cloud Computing

Time-to-Adoption Horizon: One Year or Less

The emergence of very large "data farms" — specialized data centers that host thousands of servers — has created a surplus of computing resources that has come to be called the cloud. Growing out of research in grid computing, cloud computing transforms once-expensive resources like disk storage and processing cycles into a readily available, cheap commodity. Development platforms layered onto the cloud infrastructure enable thin-client, web-based applications for image editing, word processing, social networking, and media creation. Many of us use the cloud, or cloud-based applications, without even being aware of it. Applications including Flickr, Google, YouTube, and many others use the cloud as their platform, using storage space and computing resources from many available machines as needed.

Overview

The "cloud" is a term used to describe the vast collections of networked computers, typically housed in regionally distributed and redundant data centers that comprise the totality of the Internet. Cloud computing is a set of strategies that distribute data, applications, and computing cycles across the many machines in such data centers, and even across data centers. Cloud computing currently includes three broad areas of development: cloud-based applications, which are designed for many different tasks and hosted in the cloud; development platforms for creating cloud-based applications; and massive computing resources for storage and processing.

In *The NMC Horizon Report: 2010 K-12 Edition*, cloud computing was positioned in the one-to-two year horizon because of the adoption of cloud-based applications; for example, YouTube and Google docs began making entrances in schools and fell into a widely accepted pattern of mainstream use. K-12 institutions were motivated by easy ways to enable students and faculty to share ideas and assignments online. This year, the enthusiasm has been directed towards the next level of cloud computing: enterprise platforms and data backup and storage. Schools are moving resource-intensive applications, such as email, off site backup, and web hosting into the cloud. Google Apps (go.nmc.org/xpthl) is leading the effort to make that an easy transition, helping companies to write software that will run within the Google Apps environment, allowing it to appear alongside student email and share documents. As a result, learning management systems, such as LearnBoost, are integrating Google Apps into their programs (go.nmc.org/zketu).

One of the biggest attractions of cloud computing is that it is saving schools money and resources. After email and other infrastructure applications have been moved to the cloud, they no longer require much development intervention or extra expense. The Kentucky Department of Education recently selected a cloud solution that provides its schools with tools for communication and collaboration. The estimated state savings is more than $6 million over the next four years (go.nmc.org/bkuly). The interest in cloud computing has created a resurgence of client-server applications which, while not truly cloud-based solutions, offer many of the same affordances of cloud computing. One example is HP's SchoolCloud (go.nmc.org/tfwvo), which provides many cloud features through a thin-client solution that does not require an Internet connection.

Data storage is cheap in cloud-based environments — pennies per gigabyte — so cheap that it is often provided in surprising quantities for free. There are cloud-based counterparts to many common software tools from email to word processing and spreadsheets. Schools are becoming better versed in the technology

and some are developing their own cloud-based environments, utilizing solutions such as MobileMe (go.nmc.org/kdbpe). There is no single computer that can be pointed to as housing these applications. To the end user, the cloud is invisible, and the technology that supports the applications does not matter — the fact that the applications are always available is key.

While the many advantages of the cloud are easy to detail, there are cautions as well. Unlike traditional software packages that are installed on a local computer, can be easily backed up, and are available as long as the operating system supports them, cloud-based applications are online services and require a persistent Internet connection. Entrusting work and data to the cloud is a commitment of trust that the service provider will continue to be there, even in the face of the changing market and other conditions. Nonetheless, the economics of cloud computing are increasingly compelling. For many institutions, cloud computing offers a cost-effective solution to the problem of how to provide services, data storage, and computing power to a growing number of Internet users without investing capital in physical machines that need to be maintained and supported.

Relevance for Teaching, Learning, or Creative Expression

Schools are increasingly taking advantage of ready-made applications hosted on a dynamic, ever-expanding cloud that enables end users to perform tasks that have traditionally required site licensing, installation, and maintenance of individual software packages. Email, word processing, spreadsheets, presentations, collaboration, media editing, and more can all be done inside a web browser, while the software and files are housed in the cloud. More advanced documentation has been created as an increasing amount of schools are using these types of resources. Skyline High School in Ann Arbor, Michigan, for example, compiled an extensive how-to guide for other schools to reproduce their successful Curriculum & Portfolio Integration project (go.nmc.org/fmjmn).

Whereas last year marked a transition to using the cloud for personal productivity and collaboration, this year the focus is on the institution-level efficiency and cost savings that cloud computing facilitates. In some cases, schools turn to commercial providers for such services, but in others, schools are working together to create private clouds. For example, The Learning Curve, a not-for-profit educational consortium of 40 Massachusetts school districts, is working with private sector partners IMG Software and the EMC Corporation to provide affordable cloud computing options on shared servers that will fully integrate the various districts' proprietary data management tools (go.nmc.org/hfqlh).

In addition to productivity applications, services such as Flickr, YouTube, Blogger, and others, comprise a set of increasingly powerful cloud-based tools for almost any task a user might need to do. Applications like Splashup (go.nmc.org/llnqb) or JayCut (go.nmc.org/bwnel) make it easy for students to experiment with photo and video editing. With tools like SlideShare (go.nmc.org/xgsws) or SlideRocket (go.nmc.org/dmcln), they can publish presentations and slide shows. Further, it is very easy to share content created with these tools, both in terms of collaborating on its creation and in distributing the finished work.

Browser-based applications are accessible for a variety of computer and even mobile platforms, making these tools available anywhere the Internet can be accessed. In addition to the inherent convenience cloud computing offers, the overall cost-effectiveness is a major appeal. Moving enterprise applications that have significant data storage demands to the cloud greatly reduces the need for schools to support, maintain, and manage the underlying infrastructure.

One of the biggest attractions of cloud computing is that it is saving schools money and resources.

Because of the ubiquity of low cost personal productivity and collaboration tools, coupled with the growing number of low cost enterprise solutions, schools

have new resources to apply to a one-to-one learning environment. These parallel developments, both drawing on resources within the cloud, are changing the way we are thinking about personal computing, with profound applications for the classroom. VizZle (go.nmc.org/qmkhg), for example, features peer-reviewed libraries of interactive lessons, whiteboards, touchscreens, and more in an online package designed to make the production and use of visually rich lessons easy. The reason cloud computing is so relevant in the near-term horizon is that it has opened doors for more flexibility, more space, more collaboration, and ultimately, more creative uses of Internet resources for educators to incorporate in their classrooms.

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A sampling of applications of cloud computing across the curriculum includes the following:

> **English.** Saline Area Schools, comprised of around 5,500 students in southeast Michigan, are using the entire suite of Google Apps to replace their email infrastructure and share spreadsheets, videos, and more, including using Google Docs to annotate and edit each other's stories (go.nmc.org/bqwwr).

> **History.** ArcGIS Online, developed by ESRI, includes a suite of web-based mapping tools that are used across the curriculum. As one example, history teachers use the tools to quickly create custom maps of battles, journeys, and other significant events (go.nmc.org/bksvu).

> **Science.** Northwestern University has created iLab Central, an authentic, virtual laboratory that resides in the cloud and is accessible to high school students of all socio-economic backgrounds. Students can plug in variables and run experiments on professional lab equipment that they may not otherwise have access to in their classrooms (go.nmc.org/oanwi).

Cloud Computing in Practice

The following links provide examples of how cloud computing is being used in schools.

Kerpoof
go.nmc.org/qkcvb
Targeted at elementary and middle school students, Kerpoof Studio is a cloud-based application that enables children to make animated movies, artwork, and more. The site also contains downloadable lesson plans for teachers.

LearnBoost
go.nmc.org/nkoan
LearnBoost is a new classroom management platform run through the cloud that enables K-12 teachers to track student grades and progress, create standards-aligned lesson plans, generate analytics and reports, share progress with students and parents, and organize their schedules from a central dashboard, with Google App integration.

Murdock Middle School's Multimedia Research Model
go.nmc.org/ujjtt
Murdock Middle School is using MobileMe as a platform for a multimedia research model for students in their district to learn better research skills. Their site contains demos, resources, and tools to aid students as they develop research projects from start to finish.

Partnership Focuses on App Solutions for K-12 Students
go.nmc.org/aqzct
Through the partnership of the New York Institute of Technology and the New York State Teacher Centers and associated Boards of Cooperative Educational Services, the state has committed to provide Google App support to 697 public schools across the state, as well as non-public and charter schools.

Primary Access
go.nmc.org/zrzcp
Primary Access offers students and teachers frictionless access to a suite of online tools, including digital movies and storyboards. With this cloud-based program, students can create digital narratives, with text, audio, and film footage, without installing any software.

Teachers of the Future
go.nmc.org/wgmdi
A sixth grade class at Yokohama International School in Japan is using Google Apps to complete all of their assignments, including the creation of tutorials designed in Presentation and surveys created in Forms. Each student's work is then published to the web and shared through ePortfolios.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about cloud computing.

Cloud Migrations Trigger Organizational Challenges
go.nmc.org/fuwzr
(Vanessa Alvarez, InformationWeek.com, 9 February 2010.) This article discusses how cloud computing can work if organizations are well structured in advance to take advantage of its affordances.

Google Goes to the Cloud for New Idea in PC System
go.nmc.org/awciy
(Walter S. Mossberg, *The Wall Street Journal*, 15 December 2010.) Technology writer Walter Mossberg presents his thoughts on the new cloud-based Google OS Chrome and how it will be used with Google's experimental laptop, the Cr-48.

Jolicloud Becomes Joli OS, Announces Cross-Platform Apps
go.nmc.org/zsxqg
(Sarah Perez, ReadWriteWeb.com. 8 March 2011.) Joli OS is a web based operating system that enables slower machines to have fast access to files and services in the cloud. This OS allows for older, legacy computers to take advantage of modern cloud computing. The company also provides Jolicloud, an interface for accessing many different web services through a personal cloud desktop interface.

Personal Cloud Will Replace Traditional Operating Systems
go.nmc.org/cqwml
(Cliff Saran, Computer Weekly.com, 17 May 2010.) This writer discusses the view of Forrester Research analyst Frank Gillett who believes the traditional OS will eventually disappear and be replaced by an increasingly sophisticated personal cloud.

Strike Up the Band: Over 10 Million Have Gone Google with Apps for Education
go.nmc.org/pheol
(Miriam Schneider, Official Google Enterprise Blog, 14 October 2010.) In the four years since Google Apps for Education was launched, over 10 million students now use the cloud-based productivity suite. Now, K-12 schools are incorporating the software into their curriculum for students to use.

Thought Leaders in Cloud Computing
go.nmc.org/lxqur
(Sramana Mitra and Siddharth Garg, SramanaMitra.com, 12 April 2011.) Mark Egan, CIO of VMware, explores all the components that must be considered in a cloud computing solution, including the infrastructure level, the applications, and the end-user level.

Mobiles

Time-to-Adoption Horizon: One Year or Less

Mobiles as a category have proven more interesting and more capable with each passing year, and continue to surprise both researchers and consumers. According to a report from mobile manufacturer Ericsson, studies show that soon 80% of people accessing the Internet will be doing so from a mobile device. At the 2011 Mobile World Congress, Google CEO Eric Schmidt reaffirmed the prediction by revealing that for every baby born, 30 Android phones are activated. It is no arbitrary decision that the statistical point of comparison is between new lives and mobiles; the next generation of students will inevitably be armed with smarter mobiles at younger ages. Perhaps even more important for education is that Gartner Research projects Internet-capable mobile devices will outnumber PCs by 2013. In Japan, over 75% of Internet users already use a mobile as their first choice for access. This shift in the means of connecting to the Internet is being enabled by the convergence of three trends: the growing number of Internet-capable mobile devices, increasingly flexible web content, and continued development of the networks that support connectivity.

Overview

Mobiles are increasingly "always-connected" devices — and not just to text messages and phone conversations, but also doorways to the content and social tapestries of the Internet. The devices available today are extremely multi-functional and robust, and grow more so with each passing year. *The NMC Horizon Report: 2010 K-12 Edition* placed mobiles on the mid-term horizon, due to the growing role of cellular-based Internet services.

This year, mobiles have moved to the near-term horizon because of the rise of a new class of devices, led by the category-defining blockbuster that is the Apple iPad. Competing models, including the HP TouchPad — slated to launch in the summer of 2011 — and Motorola's Xoom and Samsung's Galaxy Tab, have not yet enjoyed the success of the iPad, but together, these companies have solidified tablets as the new family of mobiles to watch. Immensely portable, tablets serve as e-readers, video repositories, and web-browsing devices with instant access to thousands of apps — all in one package that easily fits in a book bag, and even replaces the need for the physical books therein.

In developed countries, it is quite common for young people to carry their own personal mobile devices. In the upper grades, it is not at all unusual to find schools in which virtually every student carries a mobile, even if they are not allowed to use them during class. The unprecedented pace of evolution of these devices continues to generate great interest, and their increasing capabilities make them more useful with each new product generation. The ability to run third-party applications represents a fundamental change in the way we regard mobiles and opens the door to myriad uses for education, entertainment, productivity, and social interaction.

The available choices for accessing the Internet and running applications are many — smartphones, laptops and tablet PCs; the newest class of devices, tablets such as the iPad, blends the functions of all of them. It has become common practice to develop web content that seamlessly adjusts for optimal display on whichever of these devices is used to access it, increasing the proportion of Internet applications and information that is accessible to mobile users. The release of HTML5, for example, has generated excitement with this sort of device flexibility in mind. Mobile and wireless data networks continue to evolve, supporting faster

connections and higher bandwidth throughput, as evidenced by the rapid adoption of 4G devices.

As more people choose to reach for a mobile rather than sitting at a desk to access the Internet, our views and behaviors about that access are shifting. Specialized applications allow seamless access to financial information, social networking sites, email, media, and more. Tasks that once were gathered into a single piece of software — the web browser — are now distributed among many applications specifically optimized for the mobile environment.

Easy mobile access also means that the full range of networked information and applications accompany us wherever we go. The Internet is no longer something that is piped into homes and offices via a cable anchored to the wall; it is a pervasive, ever-present entity, accessible from anywhere there is a cell signal.

Relevance for Teaching, Learning, or Creative Expression

The age at which students in the developed world acquire their first mobile device is dropping, and as we noted previously, by secondary school, nearly every student has one. With always-on Internet, mobiles embody the convergence of several technologies that lend themselves to educational use, including electronic book readers, annotation tools, applications for creation and composition, and social networking tools. GPS and compasses allow sophisticated location and positioning, accelerometers and motion sensors enable the device to be used for gesture-based computing, digital capture and editing bring rich tools for video, audio, and imaging — more and more, mobiles encompass it all, and innovation in mobile device development continues at an unprecedented pace.

The portability of mobile devices and their ability to connect to the Internet almost anywhere makes them ideal as a store of reference materials and learning experiences, as well as general-use tools for fieldwork, where they can be used to record observations via voice, text, or multimedia, and access reference sources in real time. Despite policies that ban mobile devices in most schools, the iPad is changing the conversations on campuses. K-12 schools are increasingly seeing the potential of mobile devices — and noting that not only are the devices themselves less expensive than most laptops, they need less infrastructure to support them. All of these changes have moved mobiles to the forefront of technology planning for many school districts. The Burrell School District in Pennsylvania, for instance, now allows cell phones in classrooms — expressly for assignments related to instructional lessons. Other institutions are gradually following suit.

Mobiles as a category have proven more interesting and more capable with each passing year.

However, with the emergence of iPads and other tablets, schools have begun to look at these devices as good candidates for a one-to-one solution. There is an inherent difference in the way educators view tablets vs. smartphones. While the idea of cell phones in the classroom too often conjures up images of disruption, tablets are a game-changer; they encompass many of the tools smartphones offer while presenting an ever-expanding collection of tools for learning.

Students at Scofield Magnet Middle School in Stamford, Connecticut, as part of the HP Catalyst Initiative, are using tablets for a project where they track and analyze data on the impact of water quality on urban development. These devices afford students the flexibility to work outside the classroom while encouraging student collaboration.

Inside the classroom, tablets are transforming traditional lessons. The iPad edition of *The Elements* (go.nmc.org/slgzt), for example, depicts the periodic table in an interactive, three-dimensional way that could not be replicated by any iteration of the physical book. Elements such as Bismuth crystals rotate on the screen so that classes can view and control them at every angle, as if they were holding the crystals. The idea of taking something that normally appears flat and bringing it to

life in a device you can hold in your hand creates some very interesting opportunities for deeper engagement among students.

An increasingly compelling function of the new mobiles is the ability to store and display dozens of full-length books. Literature, textbooks, children's books, novels, articles, and journals all fit easily in a pocket or purse. Students can use virtual bookmarks to mark important pages, highlight and annotate passages, look up words, and perform other common study tasks right on the mobile device. It is also important to note that eReaders alone are not making the transition into schools. It is the collection of features — applications, the Internet, media capture and playback — and books — that are making tablets interesting to schools.

K-12 schools are increasingly seeing the potential of mobile devices — and noting that not only are the devices themselves less expensive than most laptops, they need less infrastructure to support them.

New features are being added to what mobiles can do almost continuously, and the unprecedented evolution of these do-it-all devices itself is drawing a great deal of interest. Their ever-increasing capabilities are enhanced by the circumstance that schools do not have to buy or maintain them. In the coming months, the vast potential of these devices for learning will begin to outweigh concerns about misuse that currently dominate most conversations about their use in school settings. It is the sheer power of these devices that make them interesting, and that power lies in their ubiquity, their portability, the wide range of things that can be done with them, and their ability to access the Internet nearly anywhere through the growing cellular network.

A sampling of applications of mobiles across the curriculum includes the following:

> **Art.** Freshmen and juniors at Marymount School in New York are using Sketchbook Pro on iPads to produce self-portraits along with sketches at a Metropolitan Museum of Art exhibit. The artwork was assembled into an ebook, turning the students into published artists. The entire journey of integrating iPads into the curriculum is chronicled on the school's site (go.nmc.org/wvdrf).

> **Science.** Using iPhones, fifth through twelfth grade students are gathering and tracking GPS-tagged bird sightings as part of the WildLab program. The results of students' findings aid the Cornell Lab of Ornithology in their scientific research (go.nmc.org/vatpv).

> **Social Studies.** In partnership with Reach the World, classes at the Rafael Hernandez Dual Language School in New York City are completing digital mapping exercises on tablets. The maps they create using the technology on the devices highlight global geographic issues (go.nmc.org/myctp).

Mobiles in Practice

The following links provide examples of how mobiles are being used in schools.

City Experience
go.nmc.org/myhup
Students at MCL School in Sydney, Australia are using mobiles to explore various areas of the city and produce content documenting their experiences, including videos, photos, and presentations.

The Mobile Learning Experience
go.nmc.org/fizng
The Mobile Learning Experience is a yearly event in Phoenix, Arizona where educators interested in incorporating mobiles into their classrooms can congregate, share ideas, and learn about the latest mobile applications and initiatives.

Mobile Maths
go.nmc.org/bnucq
Nokia is delivering interactive study packages to students' phones in South Africa. The content pulls directly from the school curriculum and includes tutoring, peer-to-peer support, and other helpful exercises.

OurPlayground
go.nmc.org/tkkgf
In development at the University of Chicago, OurPlayground is an online environment that allows students of all ages to design their own data collection projects based on questions they create. The data is collected through mobile devices and incorporates information acquired through social networks.

PollEverywhere
go.nmc.org/qnwch
PollEverywhere is an online polling system that is used in conjunction with mobile phones. It is free for educators and the ease of use has made it attractive for classroom exercises. Millard North High School in Omaha, Nebraska is one example of a school using this.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about mobiles.

Acceptable Use Policies in Web 2.0 & Mobile Era
go.nmc.org/chbhj
(Consortium for School Networks, www.cosn.org, accessed 3 March 2011.) This website gives an overview of the guidelines and polices for mobile use in schools around the United States. It addresses issues such as cyber-bullying and Internet filtering.

Information Security in Education/Security Policies for Mobile Devices
go.nmc.org/jbdfw
(WikiBooks, wikibooks.org, last modified 30 April 2010.) This wikibook entry details considerations for cell phone use in K-12 schools. It outlines what to consider when you are writing a plan for a school and offers links to various policies as examples. The site also discusses the pros and cons of allowing students to use their cellular and smartphones in class.

Learning in the 21st Century: Taking It Mobile!
go.nmc.org/qoshl
(Project Tomorrow, www.tomorrow.org, 29 October 2010.) Project Tomorrow and Blackboard partnered on a series of reports documenting how K-12 students use mobile technology and blend it with traditional learning. The reports provide a guide to educators on trends and developments related to mobile technology in the classroom.

In the coming months, the vast potential of these devices for learning will begin to outweigh concerns about misuse that currently dominate most conversations about their use in school settings.

M-Learning: Promises, Perils, and Challenges for K-12 Education
go.nmc.org/zhwhb
(Patricia Wallace, Ph.D., Johns Hopkins University School of Education New Horizons Learning Journal, Winter 2011.) This article details issues and considerations when integrating mobiles in K-12 classrooms.

Mobile Subscriptions Hit 5 Billion Mark
go.nmc.org.ejmsy
(Ericsson, Ericsson.com, 9 July 2010). The mobile equipment and service provider released information on global mobile adoption, citing that over five billion people now have mobile phone subscriptions, underscoring the ubiquitous global penetration of this technology.

Game-Based Learning

Time-to-Adoption Horizon: Two to Three Years

Game-based learning has gained considerable traction since 2003, when James Gee began to describe the impact of game play on cognitive development. Since then, research and interest in the potential of gaming on learning has exploded, as has the diversity of games themselves, with the emergence of serious games as a genre, the proliferation of gaming platforms, and the evolution of games on mobile devices. Developers and researchers are working in every area of game-based learning, including games that are goal-oriented; social game environments; non-digital games that are easy to construct and play; games developed expressly for education; and commercial games that lend themselves to refining team and group skills. Role-playing, collaborative problem solving, and other forms of simulated experiences are recognized for having broad applicability across a wide range of disciplines.

Overview

The first digital games appeared with the first home computers in the early 1980s. Ten years later, the web was born, and games began to be delivered over the Internet. In 2003, the first full Internet service for mobile phones arrived in the US, bringing games to mobile devices. The three most recent cohorts of children — those born in the early 1980s, the early 1990s, and the early 2000s — have grown up in a world where digital games have always been an important part of their lives. Those born since the early 1990s have never lived in a world without a global network. The most recent kids to enter schools, those born since the early 2000s, have never known a world in which that global network was not accessible from the palm of your hand. According to a recent study from the Entertainment Software Association, 64% of parents believe games are a positive force in their children's lives. There are now active gamers in every generation; the average age of gamers in the US is 35 years old, a figure not far off from the median age of 36.8 for all US residents.

Beyond the generation-specific appreciation for gaming, advocates point to collaboration, problem solving, and communication as the main benefits of game-based learning. In the National Education Technology Plan, U.S. Secretary of Education Anne Duncan named gaming as an ideal method of assessing student knowledge comprehension, citing the ability of games to provide immediate performance feedback to the players. Students are engaged because they are motivated to do better, get to the next level, and succeed. Proponents also underscore the productive role of play, which allows for experimentation, the exploration of identities, and even failure.

Early studies of consumer games helped to identify the aspects of games that make them especially engaging and appealing to players of various ages and of both genders: the feeling of working toward a goal; the possibility of attaining spectacular successes; the ability to problem-solve, collaborate with others, and socialize; an interesting story line; and other characteristics. These qualities are replicable for educational content, though they can be difficult to design well. This challenge is why game-based learning continues to be placed on the mid-term horizon.

One way to engage students with educational gaming is to give them a hand in designing games. The National STEM Video Game Challenge (go.nmc.org/zsyof) recently selected winners for the Youth Prize, announced by the United States Chief Technology Officer, Aneesh Chopra, which targeted middle school students to create their own games playable on open or free gaming platforms. The idea behind the challenge was that it would build

both critical-thinking and creative design skills. The contest showed that not only do students have an interest in designing games; it revealed that the academy itself has taken major strides in accepting — and promoting — gaming as an important learning vehicle.

Another area of gaming that is increasingly interesting to schools is simulation-based games. Militaries worldwide have adopted games and simulations across the entire range of skills training they provide, and the game-design insights from that tremendous body of work are beginning to inform simulations designed for school children. A good example is EVOKE, an educational game with real-world applications, developed by the World Bank Institute and the World Bank Group and directed by game master Jane McGonigal. For an intense ten-week period, players ages 13 and up were faced with challenges to invent and implement creative solutions to pressing social issues, including food security, disaster relief, and human rights. When game design is of sufficiently high quality, it is increasingly clear that these approaches can deeply engage students in learning.

Relevance for Teaching, Learning, or Creative Expression

Digital educational games have been in common use for a long time, both in classrooms and at home. The earliest forms were single-player drill and practice games such as *Reader Rabbit* or *Math Blaster*. Now, we're beginning to see more examples — and a much more dedicated following — at the university level. While games and game-based learning continue to generate interest and relevancy in the K-12 sector, the scarcity of quality educational games is impeding more rapid adoption. The production requirements seen in popular consumer games thus far have exceeded education providers' abilities to build them. In *The NMC Horizon Report: 2010 K-12 Edition* game-based learning was also positioned on the mid-term horizon, and that remains the case today, although it does seem to be gaining acceptance.

Nonetheless, digital subject mastery games are continuing to gain momentum in K-12 classes. A good example is *Immune Attack* (go.nmc.org/jgsgz), developed by the Federation of American Scientists, which integrates key biology concepts about connective tissue and red and white blood cells into the plot. On the surface, what makes games like this more engaging to students is that the end goal of learning is packaged

The productive role of play allows for experimentation, the exploration of identities, and even failure.

in the form of an exciting, alternate reality, or, in the case of *Immune Attack*, an alien world. These types of games make successful learning aids because students are willing to play them more frequently and for longer periods of time than they would otherwise study the material in question.

This year, there has also been a great deal of traction surrounding online games and game apps for mobile devices. Schools are beginning the transition from blocking web-based games to integrating them into their classrooms and curriculum. There are many free games designed for K-12 students, such as *The Hexagon Story* (go.nmc.org/aneal), an award-winning alternate reality game (ARG) in which students must solve a mystery by answering initiation questions across multiple disciplines and following clues sent to them via email, text messages, etc. from fictitious characters. Games in the form of apps have increased with the explosion of smartphones and tablets. *Mind Snacks* is a popular app in the iTunes store that boosts students' foreign language skills and fluency. *PopMath Basic Math* is another well-received iPad game app that turns the notion of flashcards into a timed or untimed game filled with colorful bubbles to sharpen arithmetic skills.

A digital counterpart to these activities is the Global Kids Gaming Initiative, which uses online games to promote digital literacy skills, global awareness, and citizenship among young people. Urban youth taking part in Global Kids' Playing 4 Keeps program create and play games about social issues of global significance. Designing and developing games is another way to bring games into

the curriculum. Good game design involves research, creative thinking, the ability to envision both problems and solutions, and many other learning skills. This year, Global Kids embarked in training for the Serious Games Leadership Program; participating children designed games around real world issues, such as hydration and poverty, acquiring creative design and collaboration skills, as well as a better knowledge of global problems.

As gaming and the science of engagement become better understood, we are likely to see significant investment in large-scale educational games. The compelling nature of Massively Multiplayer Online (MMO) games in particular is attracting researchers and educators who appreciate the revolutionary power of including games in the curriculum. *World of Warcraft* continues to be a popular game that is integrated into schools and a standard by which to measure other MMO games. The role of these sorts of games in K-12 education is to foster collaboration and digital literacy. In playing them, students must learn how to reach a goal together where the obstacles are often other people. They provide lessons in both academics and real life.

Research and experience are starting to show that games can clearly be applied very effectively in many learning contexts. Games can engage learners in ways other tools and approaches cannot, and their value for learning has been established through research. We know more about how games work and how to apply them to teaching and learning than we ever have, and that understanding is increasing. Education in general is still a few years away from embracing games as mainstream practice, but given the exciting results coming from game-based research, they are clearly a space to watch.

A sampling of applications of game-based learning across the curriculum includes the following:

> **Language Arts.** In Florida, Palm Beach Gardens High School is integrating young adult novels into a language arts social network using Community of Reading Engagement, a web-based game show format methodology based on higher order thinking skills (go.nmc.org/ujriu).

> **Mathematics.** Students across the country, including Fox Run Elementary School in San Antonio, Texas, are using the BrainPop website and app — a bestseller in the iTunes store — to watch short, animated movies on topics, such as price comparison. The students then take interactive quizzes to demonstrate the knowledge they have gained (go.nmc.org/hrllk).

> **Media Literacy.** The *World of Warcraft* (WoW) in School Project engages at-risk students at Suffern Middle School in New York and Cape Fear Middle School in North Carolina in an afterschool program that teaches skills in communication, digital literacy, online safety, mathematics, and leadership through game play (go.nmc.org/ldffz).

Game-Based Learning in Practice

The following links provide examples of how educational games are being used in schools.

A Crash Course in Saving the World
go.nmc.org/tjwmt
EVOKE developed a free and open social networking game that simulates real global issues to empower people to find new and innovative solutions.

Finding Identity
go.nmc.org/zjjig
Finding Identity is a social science game that teaches K-12 students about history, culture, and life values using a 21st century approach to storytelling and collaborative puzzle solving.

Ghosts of a Chance
go.nmc.org/rrbbw
Ghosts of a Chance allows visitors to the Smithsonian American Art Museum a chance to decipher codes, follow treasure maps, send text messages, and uncover hidden objects in this multimedia scavenger hunt.

Quest Atlantis
go.nmc.org/hisxo
Designed for students, ages 9-16, *Quest Atlantis* is a simulated, 3D learning environment that combines strategies from commercial gaming with educational research on what motivates children to learn. Students

participating in this game learn and apply skills in multiple disciplines, including mathematics and environmental sciences.

Quest to Learn
go.nmc.org/gdayk
Quest to Learn is an entire public school in New York City founded in 2009 devoted to teaching children through game play. Among other key features, the school is focused on rigorous college preparation and inquiry-based learning.

World Without Oil
go.nmc.org/shzdy
World without Oil was a collaborative and social imagining of the first 32 weeks of a global oil crisis. The simulation was designed for participants to gain a better understanding of disaster response.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about game-based learning.

By 2015, More Than 50 Percent of Organizations That Manage Innovation Processes will Gamify those Processes
go.nmc.org/tvsop
(Gartner Newsroom, Gartner.com, 12 April 2011.) Analysts at the 2011 Gartner Enterprise Architecture Summit are exploring the employment of game mechanics across various sectors of the workplace, including training, innovation, and marketing.

Gaming Education
go.nmc.org/levhm
(Elizabeth Corcoran, O'Reilly Radar, 27 October 2010.) This insightful post discusses the three predominate types of gaming in education: classic edu-tech games, build-your-own games, and the gamification approach to teaching in general. The author looks at these approaches and how they all differ in the integration of gaming into the K-12 learning experience.

How Social Gaming is Improving Schools
go.nmc.org/wypau
(Greg Ferenstein, Mashable.com, 7 February 2010.) This article points to collaborative, digital games that address real world problems as a means to make education more exciting to students than the standard textbook methods.

How Video Games Are Infiltrating — and Improving — Every Part of Our Lives
go.nmc.org/vmnqz
(Adam L. Penenberg, Fast Company, 13 December 2010.) This article discusses how gaming culture is becoming part of everyday culture and will only grow in importance in the future. Carnegie Mellon professor Jesse Schell and Institute for the Future researcher Jane McGonigal are profiled as some of the leading thinkers in this area.

The New Games People Play: How Game Mechanics Have Changed In The Age Of Social Media
go.nmc.org/uhppm
(Alexia Tsotsis, TechCrunch, 1 August 2010.) This post presents how gaming has changed in the age of social media and online communication. Issues around what makes games addictive and how they are integrated into the real world are addressed in addition to how game mechanics may change in the future as a result of social media.

Reality is Broken, Game Designers Can Fix It
go.nmc.org/egymq
(Jane McGonigal, Institute for the Future, 2010.) This TED talk advocates incorporating principles of game design into the real world to effect social change. She points to games as ways to learn how to combat hunger, poverty, and climate change and attain the "epic win."

Open Content

Time-to-Adoption Horizon: Two to Three Years

The movement toward open content reflects a growing shift in the way academics in many parts of the world are conceptualizing education to a view that is more about the process of learning than the information conveyed in their courses. Information is everywhere; the challenge is to make effective use of it. Open content embraces not only the sharing of information, but the sharing of instructional practice and experiences as well. Part of the appeal of open content is that it is also a response to both the rising costs of traditionally published resources and the lack of educational resources in some regions. It presents a cost-effective alternative to textbooks and other materials. As customizable educational content — and insights about how to teach and learn with it — is increasingly made available for free over the Internet, students are learning not only the material, but also skills related to finding, evaluating, interpreting, and repurposing the resources they are studying in partnership with their teachers.

Overview

Open content, as described here, has its roots in a number of seminal efforts, including the Open Content Project, MIT's Open Courseware Initiative (OCW), the Open Knowledge Foundation, and work by the William and Flora Hewlett Foundation and others. Many of these projects focused on creating collections of sharable resources and on devising licenses and metadata schemata. The groundswell of interest in open content described here is differentiated from early work by its primary focus on the use of open content and its place in the curriculum. The role of open content producers has evolved as well, away from the idea of authoritative repositories of content and towards the broader notion of content being both free and ubiquitous. While universities ultimately paved the way for open content as an instrumental classroom tool, its recent entrance in the K-12 sector is partly rooted in the financial benefits. For example, launched in South Africa, Free High School Science Textbooks serves disadvantaged schools by providing royalty-free, open source books written by volunteer experts.

This philosophy of open content and open education acknowledges that information is not the only useful and distributable commodity among educators. Understanding, insight, and experience can also be collected and shared. An outgrowth of that perspective is the emergence of open-content textbooks that can be "remixed" — that is, customized, modified, or combined with other materials — and the resulting new combinations shared in turn. A number of publishers are finding ways to support authors and consumers of such materials. The publishing company Flat World Knowledge provides access to textbooks authored for open use, making it very easy for faculty to individually tailor a text for use in their own class and then share that custom text with the larger community. Flat World Knowledge operates as any publisher does, reviewing book submissions and using a traditional editing process before release; however, electronic copies of the textbooks are free. Students only pay for print copies if desired, and authors receive royalties for these purchases whether the book has been customized or not.

At the center of many discussions of open content are the challenges of sharing, repurposing, and reusing scholarly works; related to those discussions are concerns about intellectual property, copyright, and student-to-student collaboration. Groups such as Creative Commons, Creative Commons Australia, the Academic Commons, Science Commons, and others have done solid work in this area to address these concerns. Many believe that reward structures that support the sharing of work in progress, ongoing research, and highly collaborative projects,

along with a broad view of what constitutes scholarly publication, are key challenges that institutions need to solve. Additionally, more research and work need to be devoted to reputation systems, peer review processes, and models for citation of the new forms of content that are likely outgrowths of open content initiatives.

While a number of highly structured projects exist to provide access to open content, in general, the open content community is diffused and distributed. Learning to find useful resources within a given discipline, to assess the quality of content available, and to repurpose them in support of a learning or research objective are valuable skills for any emerging scholar. Many adherents of open content list that aspect among the reasons they support the use of shareable materials. Nonetheless, broad use of open learning materials, specifically in K-12 schools, remains at least two years away, and the larger promise of open content — in which teaching and learning experiences and insights are shared as easily as information — will take even longer to realize. For the present, the creation of learning materials is still more a process of design driven by individual tastes and opinions than a collaborative process involving the contributions and views of many.

Relevance for Teaching, Learning, or Creative Expression

Sharable materials reduce teacher workloads as they do not need to be recreated from scratch. The same set of materials, once placed online and made sharable via the appropriate licensing, can also inform a wide variety of learning modalities, not the least of which is learning for the sheer joy of discovery. Additionally, the use of open content promotes a set of skills that are critical in maintaining currency in any area of study — the ability to find, evaluate, and put new information to use. The same cannot be said for many textbooks, which can be cumbersome, unchanging, and particularly costly for K-12 schools. Not-for-profit providers Curriki and Wikibooks are building ever-growing platforms filled with free, open source textbooks that are easy to find.

As more faculty and administrators become aware of and experience open content, its comparative benefits and challenges vis-à-vis traditional learning resources are becoming better understood. Open resources are generally, though not always, electronic. They are easier to update than print materials. Because they are digital in nature, open learning materials can incorporate activities to support multiple modes of study — reading, listening, interacting — though they can be challenging to create as a result. As new courses are developed, faculty have a responsibility to carefully consider the best supporting materials and activities to offer to students, and a thorough understanding of what is available through open channels will assist with this.

The role of open content producers has evolved as well, away from the idea of authoritative repositories of content and towards the broader notion of content being both free and ubiquitous.

Because open content is more widespread, schools are beginning to feel a social responsibility to create and share their content. Utilizing and developing content is no longer about being experimental; it has become the mark of a world-class institution. Taking this notion even further, some universities, including Universitat Oberta de Catalunya, have built their entire curriculum around open source materials. A handful of K-12 schools are beginning to follow suit. The Open High School of Utah reflects the recent embracement of open content in the K-12 space. This online school manages to conduct one-on-one tutoring with every student across all disciplines with a focus on fostering personal responsibility — perhaps one of the most important values of open content. The Bering Strait School District in Alaska launched an open content initiative that includes mathematics and social studies curriculum as a supplement to traditional classes. While K-12 examples of this caliber are rare, those that do exist are being followed with a great deal of interest.

Open content continues to influence course development and planning on several levels. Few teachers will reuse material as-is; most will customize the open content they find to suit their local context. In many cases, the benefits of adapting open materials obviously outweigh the cost of creating new ones, but this is not the only factor under consideration; there is a strong impulse to design from scratch or rely on familiar resources. The typical process of course development does not always lend itself to the use of open content.

Schools are beginning to feel a social responsibility to create and share their content. Utilizing and developing content is no longer about being experimental; it has become the mark of a world-class institution.

A sampling of applications for open content across the curriculum includes the following:

> **History.** Using the presentation feature of neoK12, a resource of free videos, quizzes, and more, students select Creative Commons photos of the American Civil War from Flickr to build highly visual slides for class presentations. The presentation can be created, edited, and saved in a web browser (go.nmc.org/wkfeu).

> **Science.** The K-12 wiki project Curriki is an example of extensive open content that has been provided through a network of education partners for use by educators and students. Educators across the world have contributed K-12 science exercises, including National Geographic's Water Footprint Calculator, which teaches students the importance of water conservation (go.nmc.org/gmgvm).

> **STEM Education.** CK-12 is a non-profit organization, striving to provide a robust selection of textbooks at significantly lower costs. With CK-12 Flexbooks, students and teachers choose from a wide range of open content textbooks, specific to science, technology, engineering, and mathematics (go.nmc.org/lajit).

Open Content in Practice

The following links provide examples of how open content is being used in schools.

K12EdCom — An Educational Commons
go.nmc.org/njtrx
K12EdCom — An Educational Commons is a project designed to promote and publish OpenCourseWare content for K-12 schools.

Open High School, Utah
go.nmc.org/wesdn
The Open High School of Utah is an online charter high school that leverages next-generation learning technology and strategic one-on-one tutoring to provide students with significantly better learning experiences.

Open Resources
go.nmc.org/heziv
In South Africa, Free High School Science Texts created a program where math and science textbooks are openly licensed and royalty-free.

Thinkfinity
go.nmc.org/zdxch
Thinkfinity is a project by the Verizon Foundation to put many K-12 education resources online for free access by students and teachers. It is an aggregation of content that reflects discplines from art to mathematics.

Wikibooks
go.nmc.org/abqyz
These open content books take textbook annotations to the next level — students can edit the content and share their contributions with each other in real-time. The site offers a plethora of textbooks across most disciplines.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about open content.

Curriki's Christine Mytko: Open Education and Policy
go.nmc.org/xextv
(Jane Park, CreativeCommons.org, 5 August 2010.) Cristine Mytko, lead science reviewer with the open source wiki project Curriki, discusses the role of Curriki and open content policy in K-12 education.

How To Get Started with Open Source in K-12
go.nmc.org/hvnpf
(Natasha Wanchek, thejournal.com, 15 July 2010.) This article explores how K-12 schools can integrate and use open content. A number of experts in the area give examples of ways that schools can embrace this form of content.

A K12 Educator's Guide to Open Source Software
go.nmc.org/nuntd
(Máirín Duffy, Máirín Duffy Blog, 31 March 2010.) User interface designer and researcher for Red Hat systems, Máirín Duffy has compiled a good list of open source resources for K-12 educators. Her knowledge of the open source community helps make this reference a good one for educators.

Managing and Learning in Massive(ly) Open Online Courses
go.nmc.org/lyhsy
(George Siemens, eLearnspace, 21 October 2010.) This slide deck from educator George Siemens provides a good overview of how open content can be successfully used and implemented in coursework. While focused on higher education, the material here is good background for K-12 educators.

An Open Source Platform for Internet-based Assessment
go.nmc.org/knqxz
(Grunwald Associates, LLC., 2010.) This report extensively covers the use of open source platforms as a cost-effective and efficient way to conduct assessment. The study also includes results from numerous interviews and sampling efforts.

Information is everywhere; the challenge is to make effective use of it.

Learning Analytics

Time-to-Adoption Horizon: Four to Five Years

Learning analytics refers to the interpretation of a wide range of data produced by and gathered on behalf of students in order 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 directly assessed as part of the student's educational progress. 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 modeling to improve understandings of teaching and learning, and to tailor education to individual students more effectively. Still in its early stages, learning analytics responds to calls for accountability on campuses across the country and leverages the vast amount of data produced by students in day-to-day academic activities.

Overview

At its heart, learning analytics is about analyzing a wealth of information about students in a way that allows schools to respond in real time. This information can include student profiles within an institution's database, as well as the interactions of students within course management systems. A long absence from a course's online activities, for example, can trigger faculty intervention. At its best, however, learning analytics goes much further than this, marrying information from disparate sources to create a far more robust and nuanced profile of students, in turn offering faculty members a great deal more insight.

While learning analytics is already being used in admissions and fund-raising efforts on several campuses, "academic analytics" is just beginning to take shape. Learning analytics need not simply focus on student performance, but can also be used to assess curricula, programs, and institutions. It could contribute to existing assessment efforts on a campus, helping provide a deeper analysis, or it may be used to transform pedagogy in a more radical manner. It could also be used by students themselves, creating opportunities for holistic synthesis across both formal and informal learning activities.

Learning analytics is distinct from high stakes testing, but is often misrepresented as such. In contrast to standardized testing, learning analytics encompasses each student's learning goals, paces, and needs, extracting information from the flow of learning activities. Teachers use that information to intervene and make pedagogical modifications in the moment, which make learning analytics specifically relevant to the K-12 arena. It is not just students' understanding of a lesson that is evaluated, but also teachers' approaches and styles. What makes learning analytics a 21st century model is that dynamic data mining helps both learners and educators improve their behaviors and techniques in real-time.

Far from the prescriptive approach of individual learning plans, learning analytics offers a more organic, diagnostic approach that does not assume that students comprehend a concept. If a student lacks the prerequisite knowledge necessary to fully absorb a lesson, learning analytics present opportunities for students to learn essential background knowledge "just in time." To accomplish this, the link to data mining is imperative; in order to identify what information a student is lacking, learning patterns must be located across large sets of data that on the surface may not reveal anything obvious.

In 2011, the Gates Foundation's Next Generation Learning initiative (go.nmc.org/tqyfc) announced the award of $20 million in grants to institutions adopting technology-enabled solutions to learning challenges. One of the five key categories for development in their first wave of funding is learning analytics. While the grant recipients will be from the higher education sector, the learning analytic research that the schools have committed to, in many instances, is intended to effect change at the K-12 level.

In light of the recent attention it has been given, learning analytics still faces some challenges, which is why it remains poised on the far-term horizon. It requires combining data from disparate sources, often in different formats. It also carries with it concerns about student privacy and profiling, as well as the sense that students are being reduced to information and numbers. Indeed, learning analytics to date generally falls within the purview of IT departments. For the information and its use to be more productive within curricula and pedagogy, faculty will need both to understand its technical potential, as well its pedagogical usefulness. These challenges will need to be addressed as the work moves forward. The potential for learning is clear, but the technology to deliver that potential is still very young.

Relevance for Teaching, Learning, or Creative Expression

Currently, most of the research into learning analytics has taken place in the higher education sector. While it has centered primarily on identifying at-risk students who can then receive attention to avoid failure in a particular course, it is increasingly being utilized to determine the most effective pedagogical approaches for specific learning styles, which makes the topic very interesting to K-12 stakeholders. The growing interest in learning analytics goes beyond the data mining technology itself; the potential applications of the information the analytics provide are now being explored in different capacities, from the impact on vocabulary acquisition to career readiness.

The largest promise of learning analytics is that when correctly applied and interpreted, it will enable faculty to more precisely identify student-learning needs and immediately tailor instruction appropriately in the K-12 classroom setting to better prepare students for university entry. This has implications not simply for individual student performance, but also in how educators perceive teaching, learning, and assessment. Suddenly, models of curriculum are more fluid and open to change.

Currently in the midst of its first full year of implementation, the School of One (go.nmc.org/zzevx) is an exemplary illustration of learning analytics in practice, and one that has already been incorporated into the mathematics curriculum of several New York City public schools. The School of One's learning algorithm pairs teachers with students in ways that take into account their individual learning styles and paces. Learning analytic tools provide up-to-date data on students to create a unique schedule for each student every day so that students move on to the next lesson only when they have mastered the previous. The Michigan Regional Data Initiatives, funded by the American Recovery and Reinvestment Act, aim to provide educators across the state with real-time access to data about student learning comprehension and aid in professional development for faculties utilizing the assessments.

Learning analytics promises to harness the power of advances in data mining, interpretation, and modeling to improve understandings of teaching and learning, and to tailor education to individual students more effectively.

There are currently several kinds of tools for learning analytics. Commercial applications include Mixpanel analytics, which offers real-time data visualization documenting how users are engaging with material

on a website. Similarly, Userfly, designed for usability testing, provides the ability to record the behavior of visitors to websites, and then play it back for analysis. Gephi is a free, open source interactive visualization and exploration platform described as "Photoshop but for data" that allows researchers to mine data for patterns visually. While these sorts of tools have applications for learning analytics, they are not specifically designed for that purpose.

Among the tools developed specifically for learning analytics is Socrato, an online learning analytics service that generates diagnostic and performance reports. SNAPP (Social Networks Adapting Pedagogical Practice), developed by the University of Wollongong in Australia, is a tool designed to expand on the basic information gathered within learning management systems, which often tends to center on how often and for how long students interact with posted material. SNAPP instead visualizes how students interact with discussion forum posts, giving significance to the socio-constructivist activities of students. The Santa Ana Unified School District in California launched Arrow-Data Analytics in Support of Graduation, College and Career Readiness to develop a data warehouse system that strategically predicts and improves student success in terms of high school graduation and college readiness.

In contrast to standardized testing, learning analytics encompasses each student's learning goals, paces, and needs, extracting information from the flow of learning activities.

The explosion of data and information presents a challenge for educational institutions. Learning analytics offers one direction through the morass, with considerable potential to enhance teaching, learning, and assessment if used with sophistication and in tandem with productive theories of contemporary learning practices.

A sampling of applications of learning analytics across the curriculum includes the following:

> **Instructional Technology.** Instructional technologists can use learning analytics to help educators design systems and approaches to better measure student outcomes and faculty development. These approaches can lead to new ways of thinking and new technologies to better track, visualize, and mine data for application in learning analytics.

> **Math.** Early alert systems aimed at students studying essential early math concepts such as fractions can identify which students might learn best via an alternative strategy, such as manipulatives, or a visual approach. Teachers can respond to students' specific needs in real-time by accessing up-to-date data. Across a district or several schools, such data could be used to inform changes in the core curriculum.

> **Writing.** The Visualizing Collaboration Knowledge Work project at Ball State University is designed to visualize collaborative writing processes in order to support stronger formative evaluation and empower student communities of practice. Using software that accesses the history of the collaboration will provide the insights needed for immediate classroom intervention (go.nmc.org/umqcm).

Learning Analytics in Practice

The following links provide examples of current projects that demonstrate the potential of learning analytics.

Academic Early Alert and Retention System
go.nmc.org/bfunr
Northern Arizona University uses a guidance system for students aimed at improving student academic success and retention. The system provides feedback to students in four areas (attendance, grade, academics, and positive feedback). Depending on the feedback given, students are given options and pointed to resources to help them improve.

Arrow-Data Analytics in Support of Graduation, College and Career Readiness
go.nmc.org/zayvu
Santa Ana Unified School District is building a data warehouse system that promotes the acquisition, maintenance, and use of data to improve college and career readiness and to improve the high school graduation rate.

Learning Analytics at the University of British Columbia
go.nmc.org/hwnie
The University of British Columbia has implemented an analytics reporting tool, eLIP (eLearning Intelligence Platform), with assistance from AlmaLogic Solutions, Inc. (go.nmc.org/nrhrt) to allow the collection, analysis and use of large volumes of intelligent data and learner-produced data.

Signals — Stoplights to Student Success
go.nmc.org/topfp
The Signals system at Purdue University provides tools for faculty to identify and help students through analytical data mining. The tools pinpoint at-risk students in real-time and interventions begin as early as the second week of class.

Teachscape Classroom Walkthrough
go.nmc.org/farlo
Teachscape's Classroom Walkthrough program allows teachers to collect data and analysis on student knowledge comprehension via mobiles so that they can quickly adapt classroom practices to better suit learning needs.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about learning analytics.

7 Things You Should Know About Analytics
go.nmc.org/pmxfl
(*Educause*, April 2010.) This brief report explains how analytics is used for teaching, learning and assessing student progress.

The Case for Nudge Analytics
go.nmc.org/zfhlq
(Colleen Carmean and Philip Mizzi, *Educause Quarterly Review*, Volume 33, no.4, 2010.) Taking a cue from observations of consumer behavior, the authors suggest the nudge principle can be deployed in education to subtly influence learner behavior without taking away freedom of choice.

Evolving a Learning Analytics Platform
go.nmc.org/emhlu
(Ari Bader-Natal and Thomas Lotze, grockit.com, 27 February 2011.) This paper was presented at the first international annual Learning Analytics Conference, held in Banff, Canada. The paper discusses how learning analytics can evolve into robust data collecting systems that ultimately benefit both students and teachers.

Learning and Knowledge Analytics
go.nmc.org/igyjh
(George Siemens (TEKRI, Athabasca University), Jon Drown (SCIS, Athabasca University), Dave Cormier (University of Prince Edward Island), Tanya Elias (Athabasa University), and Sylvia Currie (BCcampus), www.learninganalytics.net/, January 2011.) This is a new blog built as an open course for educators to learn more abut learning analytics. It was launched in January 2011 by several prominent educators and researchers who are exploring this area in more depth.

What are Learning Analytics?
go.nmc.org/nqxvg
(George Siemens, *eLearnspace*, 25 August 2010.) This article presents an overview of learning analytics and discusses how it might be applied in learning institutions.

Personal Learning Environments

Time-to-Adoption Horizon: Four to Five Years

Personal learning environments (PLEs) are often described as systems for enabling self-directed and group-based learning, designed around each user's goals, with great capacity for flexibility and customization. PLEs are conceived as drawing on a variety of discrete tools, chosen by the learner, which can be connected or used in concert in a transparent way. While the concept of PLEs is still quite fluid, it does seem to be clear that a PLE is not simply a technology but an approach or process that is individualized by design, and thus different from person to person. It involves sociological and philosophical considerations and cannot be packaged, passed out, and handed around as a cell phone or tablet computer could. Widespread adoption of PLEs, once the tools and approaches are clearer, will almost certainly also require a shift in attitudes toward technology, teaching, and learning.

Overview

PLEs serve a dual purpose: They enable students to determine the style and pace at which they learn while exposing them to technologies that they may not otherwise encounter in traditional classroom settings that will help prepare them for university and the workforce. Though PLEs often emerge in the same conversations as learning management systems, there is a distinct and sometimes overlooked difference between the two. Learning management systems by nature are more about the ephemera of learning than the actual learning itself; it is the gathering of course calendars, assignments, and all other relevant content in a single place where both students and teachers can access everything. On the other hand, PLEs are described as more about personalizing the environment and experiences at an individual level.

A PLE is not simply a technology but an approach or process that is individualized by design, and thus different from person to person.

The underlying technologies needed to construct a personal learning environment are relatively straightforward and readily available now. Using a growing set of free and simple tools and applications, it is already quite easy to create customized, personal web-based environments, and craft them to explicitly support one's social, professional, learning and other activities. Online material, once found, can be saved, tagged, categorized, monitored via RSS, and repurposed without difficulty and without any special knowledge of how web pages are put together.

The promise of PLEs is that they would give students significant control over their education. The role of the teacher is seen primarily as a guide, helping students develop their learning plans and tools. A current example of how this might be done may be seen in Symbaloo (go.nmc.org/liqex), which has gained traction amongst instructors as a reputable resource for links to substantial content related to a range of specific disciplines and topics, such as algebra or Shakespeare. Diigo (go.nmc.org/ylhnd) is another tool quickly rising in use amongst schools looking for easy-to-use ways to collect, highlight, and store material for the development of personal learning environments.

There have been discussions among some thought leaders that are merging PLEs with digital portfolios to provide a record of their learning that students can

carry with them as they move through the various stages of their educational pursuits. This notion is completely compatible with the more strict visions of PLEs, but adds a distinct and new element to the topic as generally viewed.

Relevance for Teaching, Learning, or Creative Expression

In concept, personal learning environments would encourage students to approach learning in ways best suited to their individual needs. Visual learners, for example, might be able to obtain material from a different source than auditory learners. Students using PLEs may further benefit from the practice of keeping track of, and curating, their own resource collections. Personal learning environments are seen as a way to shift the control over learning — particularly its pace, style, and direction — to the learner.

Some writers have suggested that social networking tools such as tagging, blogs, iTunes, wikis, Delicious.com, and others should be part of a PLE. Early experiments are promising. High school students in Canton, Georgia have learned to use Netvibes (go.nmc.org/nlrof) as a tool to create personalized dashboards that reflect the curriculum in ways that appeal to each individual, even integrating the students' personal social media networks. The goal is to balance predetermined lessons with educational components chosen by the student, and reflective of their interests. The University of Florida College of Education's PLEK12 program is an example of a course designed to aid educators who are exploring PLEs within their professional development.

Despite the fact that there is a range of easy-to-use tools that could be used to construct personal learning environments, they have not yet garnered widespread adoption. The reason why PLEs are poised on the far-term horizon is because they are still in the conceptual phase, lacking robust documentation or relevant case studies. One of the preconditions for them to take hold in the long run is for students to have perpetual access to their own Internet-enabled devices. Ultimately, however, widespread adoption will hinge on a shift in attitude about the role of technology in learning that simply has not occurred yet.

A sampling of applications of personal learning environments across the curriculum includes the following:

> **Digital Literacy.** As part of a research project on the student construction of personal learning environment, one 7th grade student models how she built and organized her own PLE in her Life Sciences class. In this personal tour, she demonstrates how she added her social media networks and blogs to enhance her learning experience (go.nmc.org/oltyt).

Widespread adoption of PLEs, once the tools and approaches are clearer, will almost certainly also require a shift in attitudes toward technology, teaching, and learning.

> **English.** Students and teachers can customize their English curriculum by using dashboards that have aggregated curated content that can be customized to suit personal learning styles and interests. For example, if there is a William Shakespeare segment in the classroom, students can create environments that include text from his plays, plot summaries, bibliographies, and more.

> **Math and Science.** With the SAMIAM project, short for Science and Math Initiative for Augmenting Memory, teachers created personal learning environments containing dynamic PowerPoint lessons incorporating graphics, videos, audio and Internet simulations. The participating teachers also helped students develop a learning portfolio by requiring a single-page document summarizing each unit (go.nmc.org/fpqkt).

Personal Learning Environments in Practice

The following links provide examples of current projects that demonstrate the potential of personal learning environments.

Capstone Project
go.nmc.org/tbqbs
Colorado Libraries has developed a series of lessons for information professionals, culminating in a capstone project to create an individual PLE. The lessons include a list of vital questions that educators should answer before introducing PLEs to their workflows.

The underlying technologies needed to construct a personal learning environment are relatively straightforward and readily available now.

Cengage Learning's MindTap
go.nmc.org/lndgr
MindTap is a new system designed to work as Personal Learning Experience, building on concepts used in PLEs. This system offers adaptable learning paths and activities that instructors can choose from, based on student needs.

Innovative Technologies for an Engaging Classroom
go.nmc.org/mjzzr
This pan-European project is committed to designing the future classroom. In doing so, it is bringing together policy-makers, researchers, technology suppliers, and teachers to develop scalable learning environments for students.

PLEK12
go.nmc.org/yzjtf
The University of Florida College of Education offers a free, open course for anyone who wants to explore how personal learning environments impact inquiry in K-12 education. It offers a repository of resources where teachers chronicle their classroom experiences in implementing PLEs.

Students Provide a Video Tour of Their Netvibes Learning Portals
go.nmc.org/tnhjp
Tenth grade Students at Creekview High School in Canton, Georgia learned how to use Netvibes as part of a PLE, configuring the tool to their needs. Links to student's Netvibes portals are provided.

Using Symbaloo as a Personal Learning Environment for Algebra
go.nmc.org/rwmiv
Symbaloo is a PLE tool designed for education and is now used by a large number of teachers and students in K-12. This link provides an example of how Symbaloo has been configured for teaching high school algebra by aggregating relevant sources into one place that can be further customized for use.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about personal learning environments.

5 Ways to Build Your 1.0 and 2.0 Personal Learning Network
go.nmc.org/mlllh
(Lisa Nielsen, The Innovative Educator Blog, 1 August 2010.) This post discusses how to build a personal learning network and how this has evolved as online communities and technologies have developed more robust ways to share information and collaborate. The author offers ways to create a PLE through some exercises and examples.

7 Things You Should Know About Personal Learning Environments
go.nmc.org/uqxzn
(Educause, www.educause.edu/eli, May 2009.) This summary from Educause gives a quick overview of Personal Learning Environments, what they are, how they are used and why they are becoming increasingly important.

Envisioning the Post-LMS Era: The Open Learning Network
go.nmc.org/vdxpd
(Jonathan Mott, *Educause Quarterly Review*, Volume 33, Number 1, 2010.) This article discusses the evolution of online learning environments beyond Learning Management Systems. The author looks at PLEs and compares them with an LMS. He also discusses how PLE's function together with Personal Learning Networks (PLN).

The Learning Experience in a Personal Learning Environment
go.nmc.org/ywgnu
(Rita Kop, National Research Council Canada, March 2010.) The National Research Council Canada has a current research project focused on PLEs. This paper by reseacher Rita Kop takes a look at two different approaches to PLEs and addresses the unique nature of PLEs that can be as unique as each individual user.

The PLN Matures. The Progression of the 21st Century Personal Learning Network
go.nmc.org/pskhi
(Lisa Nielsen. The Innovative Educator Blog, 18 August 2010.) Educator Lisa Nielsen discusses how PLEs have progressed into collaborative creation environments that are more interactive. She also mentions how PLEs are beginning to use social media such as Twitter to further grow and enrich personal learning networks.

Xplana.com: Is This a PLE?
go.nmc.org/jchsc
(Michael Feldstein, e-Literate.com, 13 August 2010.) This detailed post examines the social learning and distribution platform Xplana from the perspective of a PLE. The author, an education technologist formerly at Oracle and now at Cengage, points out the open-ended nature of PLEs and how the definition can be elusive but the concept can be effective.

PLEs are poised on the far-term horizon because they are still in the conceptual phase, lacking robust documentation or relevant case studies.

Methodology

The process used to research and create *The NMC Horizon Report: 2011 K-12 Edition* is very much rooted in the methods used throughout the NMC Horizon Project. All editions of *The NMC Horizon Report* 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 is intended to be a completely transparent window into 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 2011 K-12 Edition can be found at k12.wiki.nmc.org.

The procedure for selecting the topics that will be in the report incorporates a modified Delphi process now refined over years of producing *The NMC Horizon Report* Series, and it begins with the assembly of the advisory board. The board as a whole is intended to represent a wide range of backgrounds, nationalities, and interests, yet each member brings a particularly relevant expertise. To date, hundreds of internationally recognized 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, research, or creative expression. 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 engaged in the central focus of the research — the research questions that are at the core of the NMC Horizon Project. These questions were designed to elicit a comprehensive listing of interesting technologies, challenges, and trends from the advisory board:

1 Which of the key technologies catalogued in the NMC Horizon Project listing will be most important to teaching, learning, or creative expression in K-12 education within the next five years?

2 What key technologies are missing from our list? Consider these related questions:

> **What would you list among the established technologies that some educational institutions are using today that arguably ALL institutions should be using broadly to support or enhance teaching, learning, or creative inquiry?**

> **What technologies that have a solid user base in consumer, entertainment, or other industries should educational institutions be actively looking for ways to apply?**

> **What are the key emerging technologies you see developing to the point that learning-focused institutions should begin to take notice during the next four to five years?**

3 What do you see as the key challenges related to teaching, learning, or creative expression that educational institutions will face during the next five years?

4 What trends do you expect to have a significant impact on the ways in which educational institutions approach our core missions of teaching, research, and service?

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 the course of about ten 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.

From the comprehensive list of technologies originally considered for any report, the 12 that emerge at the top of the initial ranking process — four per adoption horizon — are further researched and expanded. Once this "short list" is identified, the group, working with both NMC staff and practitioners in the field, begins to explore the ways in which these twelve important technologies might be used for teaching, learning, research, and/or creative expression. A significant amount of time is spent researching real and potential applications for each of the areas that would be of interest to practitioners.

Much of the process takes place online, where it is captured and placed in The NMC Horizon Project wiki. This wiki is a completely transparent window into the work of the project.

For every edition, when that work is done, each of these twelve "short list" items is written up in the format of *The NMC Horizon Report*. With the benefit of the full picture of how the topic will look in the report, the "short list" is then ranked yet again, this time in reverse. The six technologies and applications that emerge are those detailed in *The NMC Horizon Report*.

For additional detail on the project methodology or to review the actual instrumentation, the ranking, and the interim products behind the report, please visit k12.wiki.nmc.org.

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The Internet is no longer something that is piped into homes and offices via a cable anchored to the wall; it is a pervasive, ever-present entity, accessible from anywhere there is a cell signal.

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