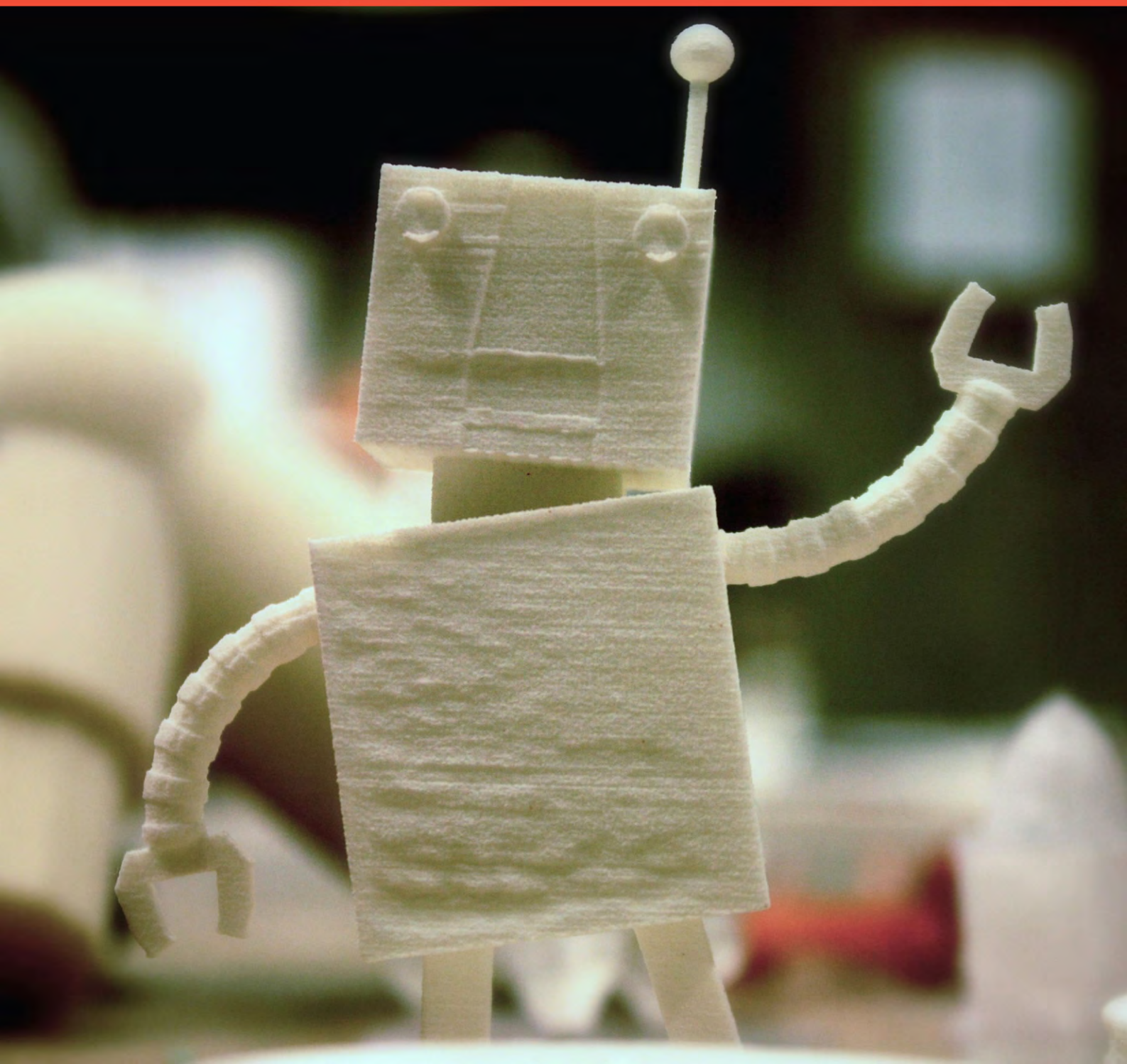
NMC Horizon Project

# Technology Outlook

## Norwegian Schools 2013-2018

An NMC Horizon Project Regional Analysis




THE NORWEGIAN CENTRE FOR ICT IN EDUCATION

# The *Technology Outlook for Norwegian Schools 2013-2018*
## *An NMC Horizon Project Regional Analysis*

is a collaboration between

The New Media Consortium

and

The Norwegian Centre for ICT in Education



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## Executive Summary

The *Technology Outlook for Norwegian Schools 2013-2018: An NMC Horizon Project Regional Analysis* reflects a collaborative research effort between the New Media Consortium (NMC) and the Norwegian Centre for ICT in Education to inform education leaders about significant developments in technologies supporting teaching, learning, and creative inquiry at Norwegian schools.

All of the research underpinning the report makes use of the NMC's Delphi-based process for bringing groups of experts to a consensus viewpoint, in this case around the impact of emerging technologies on Norwegian school education over the next five years. The same process underlies the *NMC Horizon Report* series, the most visible product of an ongoing research effort begun in 2002 to systematically identify and describe emerging technologies likely to have a large impact on education around the globe.

The *Technology Outlook for Norwegian Schools 2013-2018* was produced to explore emerging technologies and forecast their potential impact expressly in a Norwegian context. In the effort that ran from September through October 2013, the carefully selected group of 38 experts who contributed to this report considered hundreds of relevant articles, news, blog posts, research, and project examples as part of the preparation that ultimately pinpointed the most notable emerging technology topics, trends, and challenges for Norwegian schools over the next five years.

Collectively the 2013 Horizon Project Norway Advisory Board represents a range of diverse perspectives across the country's learning sector. The project has been conducted under an open data philosophy, and all the interim projects, secondary research, discussions, and ranking instrumentation can be viewed at norway.wiki.nmc.org. The precise research methodology employed in the work is detailed in a special section found at the end of this report.

**Table 1: Comparison of "Final 12" Topics Across Three NMC Horizon Research Projects**

| NMC Horizon Report 2013 K-12 Edition | Technology Outlook for Norwegian Schools 2013-2018 | Technology Outlook for STEM+ Education 2013-2018 |
|---|---|---|
| **Time-to-Adoption Horizon: One Year or Less** | | |
| BYOD<br>Cloud Computing<br>Mobile Learning<br>Online Learning | BYOD<br>Cloud Computing<br>Flipped Classroom<br>Social Media | Learning Analytics<br>Mobile Learning<br>Online Learning<br>Virtual and Remote Laboratories |
| **Time-to-Adoption Horizon: Two to Three Years** | | |
| Electronic Publishing<br>Learning Analytics<br>Open Content<br>Personalized Learning | Games and Gamification<br>Mobile Learning<br>Online Learning<br>Open Content | 3D Printing<br>Games and Gamification<br>Immersive Learning Environments<br>Wearable Technology |
| **Time-to-Adoption Horizon: Four to Five Years** | | |
| 3D Printing<br>Augmented Reality<br>Virtual and Remote Laboratories<br>Wearable Technology | Learning Analytics<br>Natural User Interfaces<br>Real-Time Machine Translation<br>Wearable Technology | Flexible Displays<br>The Internet of Things<br>Machine Learning<br>Virtual Assistants |

The 12 "technologies to watch" presented in the body of this report reflect our experts' opinions as to which of the more than 40 technologies considered will be most important to Norwegian school education over the five years following the publication of the report. As Table 1 above illustrates, the choices of our experts overlap in interesting ways with those who contributed to the *Technology Outlook for STEM+ Education 2013-2018*, a global sector analysis exploring technology adoption across science, technology, engineering, and mathematics, as well as the

*NMC Horizon Report > 2013 K-12 Edition,* which looked at technology uptake across schools from a global perspective.

All three of these projects' advisory boards — a group of 132 acknowledged experts — share some visions for the use of educational technology in schools. There are several overlapping topics between the Norway report and the global K-12 report, while it is clear that STEM disciplines are seeing a different timeline and mix in the technologies they feel will be important. Compared to both of the other advisory boards, the Norway experts saw mobile learning, online learning, and learning analytics as further away from widespread use in the Norwegian school context.

Both the global K-12 and the 2013 Horizon Project Norway groups viewed BYOD as poised for imminent adoption, largely based on the rise of tablet and smartphone usage. Mobiles have proven benefits for teaching and learning, and now schools in Norway and across the globe are starting to relax their policies to allow students to use their own devices in the classroom. Both panels also saw cloud computing as rapidly moving into widespread use. Google Apps, Skype, and other cloud-based resources are increasingly being used as collaborative tools that can be conveniently accessed from anywhere, making learning more ubiquitous.

Additionally, the Horizon Project Norway and global K-12 groups saw open content positioned on the mid-term horizon; in Norway, organizations such as the National Digital Learning Arena (NDLA) are catalysing important discussions around open educational resources. There was also agreement about the placement of wearable technology on the far-term horizon; much of the work being done in this field across education institutions is experimental, with companies in the consumer sector leading advancements in the field.

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

| NMC Horizon Report 2013 K-12 Edition | Technology Outlook for Norwegian Schools 2013-2018 | Technology Outlook for STEM+ Education 2013-2018 |
|---|---|---|
| Education paradigms are shifting to include online learning, hybrid learning, and collaborative models. | Social media is changing the way people interact, present ideas and information, and communicate. | Education paradigms are shifting to include online learning, hybrid learning, and collaborative models. |
| Social media is changing the way people interact, present ideas and information, and communicate. | Education paradigms are shifting to include online learning, hybrid learning, and collaborative models. | Citizen science projects increasingly provide formal students and lifelong learners the opportunity to participate and learn in real STEM projects. |
| Openness — concepts like open content, open data, and open resources, along with notions of transparency and easy access to data and information — is becoming a value. | People expect to be able to work, learn, and study whenever and wherever they want. | The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators. |

The Horizon.STEM and the Norway experts share a common vision that games and gamification are still two to three years away for most educators, even though research indicates that, especially for complex subjects, connecting lessons to the real world — whether through simulations or online games — engages learners and helps them better grasp the material.

Several unique choices distinguished the viewpoints expressed by the Horizon Project Norway Advisory Board from their counterparts. While previous K-12 and STEM advisory boards have

tracked social media use through all three horizons into mainstream use, Norwegian educators still see it as much as a year away from broad use. With Norway ranking third highest among European nations for posting to social media platforms, schools there can be expected to increasingly leverage social media and networks to amplify communication and collaboration among teachers and students. Similarly, the group also saw the flipped classroom as some months away, placing it in the near term horizon. As Norway educators focus on implementing 21st century pedagogies, it is likely that the pattern seen in other Horizon studies around the utility of the flipped classroom concept will find broad traction in Norway as well.

Real-time machine translation, an obviously useful technology in Europe, was seen as coming, although still some five years out. This is the first Horizon Project advisory board to vote this topic into a report, although given the pace of development with the technology, it will undoubtedly be featured in other reports as the technology becomes more well established. Advancements in computing systems are facilitating the automatic analysis of speech, physical gesture, and other nuanced human actions. There are vast implications for teaching, learning, and productivity as the relationship between people and machines becomes more natural and intuitive, and the Horizon Project Norway Advisory Board agreed, placing natural user interfaces (NUIs) on the far-term horizon. Touchscreens, haptic interfaces, voice, facial, and emotional recognition will enable students to interact with devices much more seamlessly.

While there are obvious overlaps with other Horizon Project studies, the nuances of the technologies and their associated adoption horizons featured in this report are specific to Norwegian schools. Likewise, the key trends (Table 2 and pages 17-18) and significant challenges (Table 3 and pages 19-20) selected by the 2013 Horizon Project Norway Advisory Board distinctly reflect the current drivers and obstacles facing Norwegian schools over the coming five years.

**Table 3: Top-Ranked Challenges Across Three NMC Horizon Research Projects**

| NMC Horizon Report 2013 K-12 Edition | Technology Outlook for Norwegian Schools 2013-2018 | Technology Outlook for STEM+ Education 2013-2018 |
|---|---|---|
| Ongoing professional development needs to be valued and integrated into the culture of the schools. | Current approaches to initial teacher training and in-service training in digital tools and pedagogies are insufficient for the need. | The demand for personalized learning is not adequately supported by current technology or practices. |
| Too often it is education's own processes and practices that limit broader uptake of new technologies. | Teachers and schools remain dependent on physical textbooks. | Appropriate metrics of evaluation lag the emergence of new scholarly forms of authoring, publishing, and researching. |
| New models of education are bringing unprecedented competition to the traditional models of education. | Digital skills and the use of ICT for learning do not appear to be embedded in reform efforts, measurement strategies, prioritized areas, and national programmes to any appreciable extent. | Most academics are not using new and compelling technologies for learning and teaching, nor for organizing their own research. |

The experts spent a fair amount of time researching and discussing relevant trends and challenges in the context of teaching, learning, and creative inquiry in Norwegian schools. Horizon Project advisory boards in general have agreed that trends like these are important drivers of technology adoption; the 2013 Horizon Project Norway group especially saw such a linkage. At the same time,

these panels of experts also usually find that technology adoption is often hindered by both local and systemic challenges. Many challenges impacting technology uptake are grounded in everyday realities that often make it difficult to learn about, much less adopt, new tools and approaches.

All three advisory boards in our comparison agree on the notion that education paradigms are transitioning to encompass more online, hybrid, and collaborative learning models. This trend is further underscored by the Horizon Project Norway panel's placement of the flipped classroom as a technology topic on the near-term, and online learning on the mid-term horizon. Schools are taking a cue from the online offerings across higher education and emphasizing digital learning. Social media rose to the top of the trends for the Horizon Project Norway Advisory Board, echoing their placement of the topic on the Technologies to Watch list. The group agreed that the emergence of Facebook, Twitter, and other platforms is changing the way people communicate. This decision resonates with the global K-12 group, who ranked it as the second most key trend.

The Horizon Project Norway panel also highlighted one trend that has appeared in other Horizon Project studies, but that has especially important implications here. Norwegians expect to work, learn, and study wherever and whenever they want. Primary and secondary students in Norway have never known a world without Internet access. Using desktops, laptops, and mobile devices, they are able to connect to a limitless network that contains learning opportunities around every corner. The emergence of smartphones and tablets has further enabled students and teachers alike to discover new information and share ideas at home, on the road, or wherever they may be.

The top three challenges identified by the Horizon Project Norway Advisory Board were completely unique to Norway, and solidly based in local realities. Concerns about initial teacher training in the digital arena surfaced as the most highly ranked challenge. While there is an emphasis being placed on digital competence for students through the national curriculum, there is a concern that many pre-service teachers are not receiving a sufficiently rigorous foundation.

Another significant challenge noted was the dependence Norwegian schools have on printed textbooks. The national curriculum relies on them to dispense mandated subject matter. Although there is more attention being paid to open educational resources, publishers have not yet embraced open learning concepts, and it is unclear what their role will be in producing this type of content. The advisory board also agreed that digital skills and the use of ICT are not prevalent enough across the education system — from reform to assessment. While technology use is rising across the country, it is simply not embedded frequently or deeply enough in schools

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

Those key sections, and this report in general, constitute a reference and straightforward technology-planning guide for educators, researchers, administrators, policymakers, and technologists. It is our hope that this research will help to inform the choices that institutions are making about technology to improve, support, or extend teaching, learning, and creative inquiry across Norwegian schools. Educators and administrators worldwide look to the NMC Horizon Project and both its global and regional reports as key strategic technology planning references, and it is for that purpose that the *Technology Outlook for Norwegian Schools 2013-2018* is presented.

**Time-to-Adoption: One Year or Less**

## BYOD

The term BYOD, which stands for "Bring Your Own Device," refers to the practice of students bringing their own laptops, tablets, smartphones, or other mobile devices with them to class. Intel coined the term in 2009, when the company observed that an increasing number of its employees were using their own devices and connecting them to the corporate network. Since then, this type of activity has become commonplace in workplaces all over the globe. The BYOD movement in education institutions is being driven by a major challenge that many institutions face — a lack of funds to support one-to-one learning, which is a systemic solution in which every student is provided a laptop or mobile device that can be used to support learning in and outside of the classroom. BYOD makes one-to-one easier by simply leveraging the devices that students already have, or those their parents could buy for them. In practice, it has proven important to provide funds to support families in financial need, and to standardize on a small set of devices and software packages. Often the school will negotiate advantageous pricing for families to reduce their costs. In early studies, the act of a student using his or her own device for learning has proven to increase productivity and engagement. BYOD has gained momentum in upper secondary education in Norway, and tablet computing has accelerated the pace of BYOD, especially in schools, where these smaller, less-expensive devices are seen as a better option than traditional laptops. With their ever-growing capabilities, tablets, (which now include an expanding set of choices, such as the iPad, Galaxy, Nexus, and Surface) are well positioned for BYOD environments.

### Relevance for Teaching, Learning, or Creative Inquiry

- Because BYOD allows students access to the same devices at school and at home, it can extend learning opportunities to times and places outside of the classroom.
- BYOD policies allow students to work with technology with which they are already comfortable and familiar.
- BYOD programs eliminate the support and other burdens from schools that go along with paying for and maintaining institution-provided devices.

### BYOD in Practice

- Falmouth Public Schools launched a BYOD pilot program in which all teachers can integrate personal mobile devices into their classroom activities: go.nmc.org/falmouth.
- In the ITEC Project at Odda Ungdomsskole, eighth grade students brought their iPhones to math class to download the GPS-enabled app MotionxHD, so they could measure and calculate angles of triangles and rectangles in the schoolyard: go.nmc.org/ite.
- This year, three counties in Norway will implement BYOD in their schools, adding on to two counties that have already developed policies encouraging students to use their own devices during class: go.nmc.org/byodnor.

### For Further Reading

*20 BYOD Resources For The 21st Century School*
go.nmc.org/bres

(Terry Heick, *TeachThought*, 2 April 2013.) BYOD policies encourage a student-centred learning approach, and this list of resources covers many BYOD-related issues, such as establishing successful guidelines and other important considerations.

*Mapping of Schools Relative to Bring Your Own Device*
go.nmc.org/kart

(Norwegian Centre for ICT in Education, 1 March 2013.) This report outlines key issues relating to BYOD from Norwegian counties´ perspectives and discusses how schools can implement it.

**Time-to-Adoption: One Year or Less**

## Cloud Computing

Cloud computing refers to expandable, on-demand services and tools that are served to the user via the Internet from a specialized data centre and do not live on a user's device. Cloud computing resources support collaboration, file storage, virtualization, and access to computing cycles, and the number of available applications that rely on cloud technologies has grown to the point that few institutions do not make some use of the cloud, whether as a matter of policy or not. Cloud computing is often used as a synonym for grid computing, in which unused processing cycles of all computers in a single network are leveraged to troubleshoot issues that cannot be resolved by a single machine. The primary distinction is how the host computers are accessed. Clouds, especially those supported by dedicated data centres, can be public, private, secure, or a hybrid of any or all of these. Many businesses, organizations, and institutions use storage, software (SaaS), and API services to reduce IT overhead costs. Google Apps, a SaaS provider, for example, has become a popular choice for education institutions and many have moved their email infrastructure to Gmail and adopted Google Docs for document sharing and collaboration, but such services do not meet the high security needs of many corporations or government agencies. Private cloud computing solves these issues by providing common cloud solutions in secure environments. Hybrid clouds provide the benefits of both types. Whether connecting at home, work, school, on the road, or in social spaces, nearly everyone who uses the network relies on cloud computing to access or share their information and applications.

### Relevance for Teaching, Learning, or Creative Inquiry

- The adoption of cloud-based platforms and services provides a more flexible means of adjusting a school's infrastructure and technology portfolio to the needs of the moment.
- Cloud resources are often free and very simple to use, making access to storage, tools, media, and educational materials much more accessible than ever before.
- Online access to documents and applications facilitates greater flexibility, enabling students and teachers to create and edit their own materials and to consult and review information wherever and whenever they need it.

### Cloud Computing in Practice

- The NANSen project, run by the Norwegian research and education network UNINETT, is establishing a sector-specific set of common cloud services: go.nmc.org/uninett.
- Sandvika High School students used Microsoft OneNote, Skydrive, and Google Docs to collaborate in writing and publishing a book on connected learning: go.nmc.org/conne.
- WeVideo is a Norwegian cloud-based video creation tool that includes editing software and a central hub for user collaboration and management, making it especially useful in classroom settings: go.nmc.org/wev.

### For Further Reading

*Cloud Jargon Unwound: Distinguishing SaaS, IaaS and PaaS*
go.nmc.org/expla

(Fredric Paul, *Read Write Web*, 8 May 2013.) This infographic explains the differences between IaaS, SaaS, PaaS and other potentially confusing cloud-related acronyms.

*Protecting Vulnerable Data Subjects: Findings from a Survey of EU Data Protection Officials on the Use of Cloud Services in Organisations*
go.nmc.org/safe

(Jeff Gould, SafeGov.org, 23 September 2013.) This report recommends establishing codes of conduct for schools and cloud providers that include a binding pledge to ban the processing and secondary use of students' personal information for advertising purposes.

**Time-to-Adoption: One Year or Less**

## Flipped Classroom

The flipped classroom refers to a model of learning that rearranges how time is spent both in and out of class to shift the ownership of learning from the educators to the students. After class, students manage the content they use, the pace and style of learning, and the ways in which they demonstrate their knowledge, and the teacher becomes the guide, adapting instructional approaches to suit their learning needs and supporting their personal learning journeys. Rather than the teacher using class time to lecture to students and dispense information, that work is done by each student after class, and could take the form of watching video lectures, listening to podcasts, perusing enhanced e-book content, collaborating with their peers in online communities, and more. Students can access this wide variety of resources any time they need them. In the flipped classroom model, valuable class time can be devoted to more active, project-based learning where students work together to solve local or global challenges — or other real-world applications — to gain a deeper understanding of the subject. Teachers can also devote more time interacting with each individual. The goal is for students to learn more authentically by doing, with the teacher guiding the way; the lecture is no longer the expected driver of concept mastery. The flipped classroom model is part of a larger pedagogical movement that overlaps with blended learning, inquiry-based learning, and other instructional approaches and tools that are meant to be flexible, active, and more engaging for students. It has the potential to better enable educators to design unique and quality learning opportunities, curriculum, and assessments that are more personal and relevant to students' lives.

### Relevance for Teaching, Learning, or Creative Inquiry

- Flipped classroom concepts and the idea of providing the student with a more diverse set of learning resources can support self-directed learning.
- More active learning is an important component of the flipped classroom: lectures can be watched with ensuing online discussions unfolding at home, and teachers can use class time for hands-on activities or trips outside of the building.

### Flipped Classroom in Practice

- Eighth grade grammar students at Sandgotna Secondary School in Bergen are watching video lectures and completing online surveys to demonstrate subject comprehension in a flipped learning model: go.nmc.org/flipgram.
- Hundsund Lower Secondary School uses a flipped classroom for all subjects, assigning students brief video lectures to watch at home so that when they come to class the next day, they can discuss the material and receive personalized support: go.nmc.org/hugsno.
- Videos by a mathematics educator at Sandvika High School explain concepts to students at home, and class time is reserved for active problem solving: go.nmc.org/anneflip.

### For Further Reading

*5 Flipped Classroom Issues (And Solutions) For Teachers*
*go.nmc.org/flipsol*

(Beth Holland and Samantha Morra, *Edudemic*, 12 August 2013.) Teachers make five suggestions about how to implement the flipped classroom model effectively and include an infographic and presentation to support educators who share similar goals.

*Flipped Classroom 2.0: Competency Learning With Videos*
go.nmc.org/samsflip

(Katrina Schwartz, *MindShift*, 21 May 2013.) A pioneer of the flipped classroom, Aaron Sams, describes the transition of the pedagogical model from video-centric learning to a strategy that focuses on helping students find resources for self-directed learning.

**Time-to-Adoption: One Year or Less**

## Social Media

Today's web users are prolific creators of content, and they upload photographs, audio, and video to cloud-based social media sites, such as Facebook, Pinterest, Twitter, YouTube, Flickr, and many others, by the billions. While the initial emphasis of social networks was placed on producing and uploading media to these popular sharing sites, as the notion of social media has evolved it has ultimately become more about the conversations started and relationships formed via this media. When users log in to Facebook and Twitter, two of the sites that have the most subscribers and daily traffic, they are there to see what their family, friends, and favourite brands and organizations are doing and who is talking about what. For educational institutions, social media enables two-way dialogues between students, prospective students, educators, and the institution that are less formal than with other media. New tools, such as Facebook's social search engine, promise to mine these interactions using a concept known as the social graph. A person's social graph represents the sum of all of a person's online social connections (who he or she is friends with, who likes the things she or her friends are interested in, who among those connections is where, etc.) and provides a means to search and navigate those connections. Social graphs can be visualized in a variety of interesting ways, but far more interesting is the information embedded within the social graph and what it can tell us.

### Relevance for Teaching, Learning, or Creative Inquiry

- Engagement in social media either as producers of content, or consumers, or aggregators of user-generated content will allow faculty to more deeply connect with each other.
- Social media outlets enable students to create powerful personal learning networks to direct and focus their own learning.
- Video platforms including YouTube and Vimeo enable educators to upload and share instructional videos that students can watch anywhere. Similarly, Google Hangouts allow them to connect with students outside of the classroom.

### Social Media in Practice

- At the Bjørgvin Secondary School, tools such as YouTube and Twitter are being used to teach mathematics: go.nmc.org/flippmath.
- Researchers from Stord/Haugesund University College are investigating the role of social media in education to address ethical considerations and the relationship fostered between educators and students: go.nmc.org/hsh.
- Students at Kastellet School in Oslo made learning resources including podcasts and screencasts on subjects ranging from religion to social science and mathematics by collaborating on Facebook, as well as sharing their final products: go.nmc.org/kast.

### For Further Reading

*Challenges and Opportunities for Schools and Teachers in a Digital World*
go.nmc.org/smil

(European Schoolnet, April 2013.) This report describes the work and the outcomes of the Social Media in Learning and Education (SMILE) Action Research Project, in which a group of European teachers collaborated to improve the understanding of the challenges and opportunities encompassed by social media for teachers and schools.

*From Twitter to Edmodo: Schools Collaborate With Social Media*
go.nmc.org/socme

(David Raths, *THE Journal*, 5 February 2013.) Several innovative instructional technology leaders discuss why social media is a valuable learning tool, allowing schools to model digital citizenship behaviours and enabling students to reach both peers and field experts.

**Time-to-Adoption: Two to Three Years**

## Games and Gamification

The games culture has grown to include a substantial proportion of the world's population, with the age of the average gamer increasing with each passing year. As tablets and smartphones have proliferated, desktop and laptop computers, television sets, and gaming consoles are no longer the only way to connect with other players online, making game-play a portable activity that can happen in a diverse array of settings. Gameplay has long since moved on from solely being recreational and has found considerable traction in the worlds of commerce, productivity, and education as a useful training and motivation tool. While a growing number of educational institutions and programs are experimenting with game-play, there has also been increased attention surrounding gamification — the integration of gaming elements, mechanics, and frameworks into non-game situations and scenarios. Businesses have embraced gamification as a way to design incentive programs that engage employees through rewards, leader boards, and badges, often with a mobile component. Although more nascent than in military or industry settings, the gamification of education is gaining support among educators who recognize that it is well established that effectively designed games can stimulate large gains in productivity and creativity among learners.

### Relevance for Teaching, Learning, or Creative Inquiry

- Educational games offer opportunities for both discovery-based and goal-oriented learning, and can be very effective ways to develop teambuilding skills.
- Simulations and role-playing games allow students to re-enact difficult situations to try new responses or pose creative solutions.
- When used to teach cross-curricular concepts, games can help further engage students to grasp complex subjects.

### Games and Gamification in Practice

- Dragonbox is a Norwegian-developed app for learning algebra that initially uses pictures rather than numbers or variables to demonstrate the 'game'-like qualities inherent in algebra: go.nmc.org/dragon.
- Eleventh grade students at Nordahl Grieg Upper Secondary School play Civilization IV, an online multi-player strategy game in which they face scenarios that require students to take leadership roles and make diplomatic decisions, as part of the social studies curriculum: go.nmc.org/civsoc.
- Students at Ringstadbekk Lower Secondary School choose an already-existing, well-known building to build in Minecraft for a cross-curricular project that combines the study of both Norwegian and architecture: go.nmc.org/ringst.

### For Further Reading

*Learning World: The Serious Side of Playing Games (Video)*
go.nmc.org/euronews

(Maha Barada, *Euronews*, 3 May 2013.) In a short documentary, the potential for game and game design to teach complex concepts is explained through interviews with researchers and developers from MIT's Game Lab and The Consolarium in Scotland.

*Peace, Innovation and Gamification: Can Games Help Resolve Social Conflict?*
go.nmc.org/peace

(Nilgun Arif and Alexis Franke, *Voices from Eurasia*, 27 August 2013.) The United Nations Development Programme has become keenly aware of how gaming can serve purposes such as peace-building, disaster response, engagement of youth with mental health disabilities, and farming and economic development.

**Time-to-Adoption: Two to Three Years**

## Mobile Learning

We are in the midst of a complete shift in the devices we use. As smartphones and tablets become more and more capable and user interfaces more and more natural, old methods of computing seem place-bound and much less intuitive. People increasingly expect to be connected to the Internet and the rich tapestry of knowledge it contains wherever they go, and the majority of them use a mobile device to do so. According to the 2013 "ICT Facts and Figures" report from the ITU Telecommunication Development Bureau, the mobile market consists of over 6.8 billion subscribers, with a majority living in developing countries. The unprecedented evolution of these devices and the apps that run on them has opened the door to myriad uses for education. Learning institutions all over the world are adopting apps into their curricula and modifying websites, educational materials, resources, and tools so they are optimized for mobile devices. The significance for teaching and learning is that these devices have the potential to facilitate almost any educational experience, allowing learners to organize virtual video meetings with peers all over the world, use specialized software and tools, and collaborate on shared documents or projects in the cloud, among many other things. Although there are still likely many uses that have not been realized yet, over the past several years mobile learning has moved quickly from concept to reality.

### Relevance for Teaching, Learning, or Creative Inquiry

- As a one-to-one solution, mobile learning presents an economic, flexible alternative to laptops and desktops due to the devices' lower cost, greater portability, and apps access.
- Mobile apps with built-in social features enable learners to share their questions or findings with each other in real-time. For example, productivity apps such as Evernote and Edmodo make it possible to exchange notes, assignments, drawings, videos, and more.
- Students can leverage the cameras, microphones, and other tools inherent in mobiles to do field work or create rich media. This is especially convenient for work done outside of the classroom as students can record interviews, collect data for experiments, and more.

### Mobile Learning in Practice

- At Nidarvoll School, mobile apps such as Book Creator, Pages, and Puppet Pals are being integrated into the curriculum to facilitate English language learning and the creation of multimedia content: go.nmc.org/nidarvoll.
- Gjennestad Upper Secondary School has a one-to-one tablets program in which the devices are used for electronic textbooks, along with numerous documentation and learning activities: go.nmc.org/gjenn.
- The municipality of Fredrikstad launched a pilot to implement mobile learning projects that range from global collaboration to paperless productivity at four schools: go.nmc.org/fredrikstad.

### For Further Reading

*Apps in Science*
go.nmc.org/insc

(naturfag.no, accessed 15 October 2013.) The Norwegian Centre for Science in Education compiled this list of apps for smartphones and tablets to aid in school science instruction.

*Building Classroom Community Amongst the Machines*
go.nmc.org/buildi

(Andrew Marcinek, *Edutopia*, 19 August 2013.) Mobile devices have become community hubs, where people go for information and to socialize. Teachers must now build classroom communities based on meaningful relationships that can coexist with a device.

**Time-to-Adoption: Two to Three Years**

## Online Learning

Online learning is not new; the category encompasses any learning that takes place through web-based platforms, whether formal or informal. The learning can be structured as in traditional courses or entirely self-paced. What has made the topic new is the recent and unprecedented focus on providing learning via the Internet that has been stimulated by the tremendous interest in massive open online courses (MOOCs). What is new in this space is that online learning has "come of age;" the design of online learning is (more and more) specifically intended to encompass the latest research, the most promising developments, and new emerging business models in the online learning environment. At many institutions, online learning is an area newly ripe for experimentation — some would argue it is undergoing a sea change, with every dimension of the process open for reconceptualization. On campuses around the globe, virtually every aspect of how students connect with institutions and each other to learn online is being reworked, rethought, and redone — but it will be some time yet before ideas coalesce enough to be validated by research and implemented broadly.

### Relevance for Teaching, Learning, or Creative Inquiry

- As new pedagogies emphasize personalized learning, there is a growing demand for learner-centered online opportunities. Online learning environments, when designed effectively, have the potential to scale globally.
- Online learning environments can make creative use of several educational technologies and emerging instructional approaches, including blended learning, video lectures, and badges.
- When placed online, a diverse set of learning resources is easily accessible to students and can support self-directed learning.

### Online Learning in Practice

- Flexible Education Norway is a national member-based organization for institutions involved in distance learning programs, and their role is to advance the development of online learning: go.nmc.org/fun.
- Min Stemme is a learning website that includes texts, videos, photos, podcasts, exercises, and user-generated content that is all geared toward increasing democratic participation and awareness in primary and secondary education: go.nmc.org/min.
- The Norwegian Centre for ICT in Education has been commissioned by the Ministry of Education to test a virtual mathematics school that offers a training program to personalize learning content for two groups of high school students: high-performing students who need more challenging work and at-risk students who need extra support and motivation: go.nmc.org/dvm.

### For Further Reading

*How Online Learning is Saving and Improving Rural High Schools*
go.nmc.org/rural

(Tom Vander Ark, *Getting Smart*, 26 January 2013.) Rural high schools face immense challenges, including federal and state education funding inequities, which causes many schools to close down every year. Online schools even the playing field.

*Sebastian Thrun on the Future of Learning*
go.nmc.org/sebas

(Rachel Metz, *Technology Review*, 19 July 2013.) The founder of Udacity discusses the evolution of MOOCs, and how in the future artificial intelligence will play a role in personalizing online learning experiences based on each student's learning profile.

**Time-to-Adoption: Two to Three Years**

## Open Content

The movement toward open content reflects a growing shift in the way scholars in many parts of the world are conceptualizing education to a view that is more about the process of learning than the information conveyed. Information is everywhere; the challenge is to make effective use of it. Open content uses open licensing schemes, like those of Creative Commons, to encourage not only the sharing of information, but the sharing of pedagogies and experiences as well. Part of the appeal of open content is that it is a response to both the rising costs of traditionally published resources and the lack of educational resources in some regions. As this open, customizable content — and insights about how to teach and learn with it — is increasingly made available for free over the Internet, people are learning not only the material, but also the skills related to finding, evaluating, interpreting, and repurposing the resources. Recent data from Edcetera indicate that open educational resources (OERs) make up three quarters of the content in most MOOCs; paid content, such as required textbooks, is less than 10%. These data reflect a notable transformation in the culture surrounding open content that will continue to impact how we think about content production, sharing, and learning.

### Relevance for Teaching, Learning, or Creative Inquiry

- Open, sharable materials reduce teacher workloads; open educational resources do not need to be created from scratch.
- Most of the world's top institutions are providers of open content and have created a wealth of materials now available on demand to anyone.
- 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.

### Open Content in Practice

- As an organization supported by the Norwegian Ministry of Education and Research, the International Council for Open and Distance Education joined the Nordic OER Network in an effort to promote open education and collaboration among stakeholders across educational sectors: go.nmc.org/nordnet.
- The Nordic Open Education Alliance is a network of Nordic and European stakeholders that supports the uptake, adoption, and collaboration around open education with the aim of informing educators how to access and use OERs: go.nmc.org/nordicoer.
- The Norwegian National Digital Learning Arena is an initiative that allocates funds across counties to ensure Norwegian students have free access to textbooks and provides incentives for the development of digital resources that are shared on an open source platform under a Creative Commons Attribution ShareAlike license: go.nmc.org/nndla.

### For Further Reading

*Open Education Europa*
go.nmc.org/openup

(European Commission accessed 21 October 2013.) The European Commission launched "Opening up Education" to increase the use of publicly funded open educational resources in schools and universities and promote the acquisition of digital skills. This website contains regularly updated information about the OERs and free learning opportunities.

*Open Educational Resources InfoKit*
go.nmc.org/infokit

(JISC, accessed 16 October 2013.) As part of the JISC Open Educational Resources programme, a kit of resources was compiled to help educators understand OERs and how they can be integrated into learning activities.

**Time-to-Adoption: Four to Five Years**

## Learning Analytics

Learning analytics is an educational application of "big data," a science that was originally leveraged by businesses to analyse commercial activities, identify spending trends, and predict consumer behaviour. The rise of the Internet drove research into big data and metrics as well as the proliferation of web tracking tools, enabling companies to build vast reserves of information they could study and use to personalize their marketing campaigns. Education is embarking on a similar pursuit into data science with the aim of improving student retention and providing a high quality, personalized experience for learners. Learning analytics research uses data analysis to inform decisions made on every tier of the educational system. Whereas analysts in business use consumer data to target potential customers and personalize advertising, learning analytics harnesses student data to build better pedagogies, target at-risk student populations, and assess whether programs designed to improve retention have been effective and should be sustained — outcomes for legislators and administrators that have profound impact. For educators and researchers, learning analytics has been crucial to gaining insights about student interaction with online texts and courseware. Students are beginning to experience the benefits of learning analytics as they engage with mobile and online platforms that track data to create responsive, personalized learning experiences.

### Relevance for Teaching, Learning, or Creative Inquiry

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

### Learning Analytics in Practice

- At the University of Agder in Norway, engineering students are learning advanced math with MyMathLab, an adaptive platform for formative and summative assessment that provides real-time feedback: go.nmc.org/agder.
- Data collected from a survey of physics students in upper secondary and first-year tertiary institutions is being used to classify learners based on their motivations in an effort to improve STEM pedagogies in Norwegian schools: go.nmc.org/norstem.
- The Society for Learning Analytics Research developed a massive open online course to provide educators with a non-technical introduction to learning analytics, along with context on how they are being implemented across education sectors: go.nmc.org/solana.

### For Further Reading

*Education Researcher to Teachers: Use Available Technology to Improve Student Achievement*
go.nmc.org/learnblend

(Mark Macdonald, itslearning, 17 September 2013.) A case study of a Swedish physics educator's experience is used to show how a blended learning platform offers an effective method for formative assessment in the classroom.

*The Role of Learning Analytics in Improving Teaching and Learning (Video)*
go.nmc.org/lerana

(George Siemens, Teaching and Learning with Technology Symposium, 16 March 2013.) In this keynote, Siemens gives a thorough explanation of how companies are using analytics to understand consumers and reviews a number of case studies to show that when applied to education, these practices can improve teaching and learning in the digital age.

**Time-to-Adoption: Four to Five Years**

## Natural User Interfaces

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

### Relevance for Teaching, Learning, or Creative Inquiry

- As the ability of NUIs to read subtle changes in facial expressions and user reactions improves, software will be able to "sense" when a student is struggling or frustrated with material.
- NUIs make devices seem easier to use and more accessible; interactions are far more intuitive, which promotes exploration and engagement.
- Students with disabilities, including the visually impaired, increasingly rely on natural user interfaces to communicate and interpret information through touch.

### Natural User Interfaces in Practice

- Haptix is a sensor that enables any surface, such as a table or wall, to become a multi-touch control system for a television or computer so that users can scroll, swipe, and zoom, as well as select items by tapping on the converted surface: go.nmc.org/hap.
- In partnership with WNET, researchers at Teachers College are testing how using NUIs to manipulate images and information on computer screens can help students ages 8 to 11 learn fractions: http://go.nmc.org/fra.
- The University of Minnesota's Institute of Child Development is exploring how Microsoft's Kinect gaming sensor, when combined with computer-vision algorithms, can be trained to detect behavioural abnormalities like autism in children: go.nmc.org/kinau.

### For Further Reading

*Beyond the GUI: It's Time for a Conversational User Interface*
go.nmc.org/cuiwi

(Ron Kaplan, *WIRED*, 21 March 2013.) Ron Kaplan — a linguist, mathematician, and technologist — predicts the imminent emergence of the conversational user interface, which is based on voice-recognition and machine learning technologies.

*Phones, Tablets To Get Touchless Gesture Technology By 2014*
go.nmc.org/touc

(Ryan W. Neal, *International Business Times*, 13 May 2013.) Norway's Elliptic Labs developed a technology that will allow users to control devices through gesture, rather than touch. It uses small speakers to transmit ultrasonic waves and record the echoes when they bounce off various parts of the hand.

**Time-to-Adoption: Four to Five Years**

## Real-Time Machine Translation

Real-time machine translation refers to the process of a computer producing real-time translation between human languages at a rate and quality level that would allow it to be used for speech-to-speech, speech-to-text, text-to-speech, or text-to-text applications. Two early examples of where this technology is heading can be found in Siri, Apple's personal assistant, which listens to, transcribes, and acts upon speech, and Google Translate, which rapidly translates to a reasonable standard between over 50 languages. While some may argue that these examples are evidence that computers have not yet mastered this activity, recent developments in real-time machine translation are bringing us closer to smarter, faster, more accurate, and more culturally aware systems for communicating across language barriers. Systems that can listen to student speech, then coach (or rate) it for pacing, tone, dialect, and accuracy of pronunciation have been in production for some time. In the next generation of machine translation, these sorts of technologies will merge to provide tools that can deliver more accurate real-time translations, and render them into speech that includes fine-grained nuances of pronunciation, tone, and more. Ray Kurzweil, a major thought leader in the area of machine translation, believes that before 2030, machines will reach a sufficient level of understanding of human written and spoken communications to allow for routine, everyday, seamless and highly accurate translation. Many believe the technology will enter specialized uses much sooner, with a great many applications in learning, teaching, and global communications.

### Relevance for Teaching, Learning, or Creative Inquiry

- Real-time machine translation can potentially sort through learner-contributed observations and create visualizations that identify crucial patterns.
- Software that employs real-time translation to detect patterns in written work, speech, and other actions could better adapt to students' learning styles and needs.
- Ultimately, real-time machine translation promises to enable teachers and students to communicate more authentically with their devices — even in improvised ways, just as a colleague or friend would.

### Real-Time Machine Translation in Practice

- The Natural Language Computing Group and Speech Group at Microsoft Research Asia demoed a tool that translates speech to other languages in real-time: go.nmc.org/speech.
- NTT Docomo, the biggest mobile network operator in Japan, recently revealed glasses that can provide nearly instant translation of written texts by projecting an image of the translated text over the unfamiliar characters: go.nmc.org/doco.
- Translate Your World and ReadSpeaker are collaborating on software that converts speech for 23 languages to instantly translate speakers during Skype calls: go.nmc.org/tyw.

### For Further Reading

*10 Breakthrough Technologies 2013: Deep Learning*
go.nmc.org/rev

(Robert D. Hof, *MIT Technology Review*, 23 April 2013.) Machines can now sift through massive amounts of data, recognizing objects and translating speech by learning in the same way our brains interpret patterns in digital representations of sounds and images.

*Translate This: Google's Quest to End the Language Barrier*
go.nmc.org/trans

(Thomas Schulz, *Spiege*l, 13 September 2013.) This article highlights an app from Google that allows users to simply speak a sentence into their smartphone so that a translation is repeated from the smartphone in the chosen language.

**Time-to-Adoption: Four to Five Years**

## Wearable Technology

Wearable technology refers to devices that can be worn by users, taking the form of an accessory such as jewellery, sunglasses, a backpack, or even actual items of clothing such as shoes or a jacket. The benefit of wearable technology is that it can conveniently integrate tools that track sleep, movement, location, social media, and even new classes of devices that are seamlessly integrated with a user's everyday life and movements. Google's "Project Glass" is one of the most talked about current examples — the device resembles a pair of glasses, but with a single lens. A user can see information about their surroundings displayed in front of them, such as the names of friends who are in close proximity, or nearby places to access data that would be relevant to a research project. Another is the Jawbone UP bracelet that tracks how you eat, sleep, and move. Other wearable technology already in the market includes clothing that can keep a mobile device charged via solar cells, allow interactions with a user's devices via sewn-in controls or touch pads, or collect data on a person's movements.

### Relevance for Teaching, Learning, or Creative Inquiry

- Google Glass is enhanced with augmented reality, which is intended to provide learners with information about objects and locations they encounter as they move through their daily lives.
- Wearable cameras such as Memoto, which is designed to take photos every 30 seconds, will allow science students to easily document an experiment, traditional observations, or setting.
- Wearable technology such as the UP wristband monitors users' everyday behaviors, including movement and sleep. In time, these data will comprise an enormous quantity of information for studies of behavior, motivation, and physical health and well being.

### Wearable Technology in Practice

- Norwegian scientists at SINTEF developed a line of smart clothing called ColdWear to monitor the body temperature of those who live or work in harsh environments: go.nmc.org/sint.
- Project 2x1 is a documentary shot with Google Glass that explores cultures of the Hasidic and West Indian communities of Crown Heights from multiple community members' perspectives in ways that traditional film crews could not capture: go.nmc.org/twoxone.
- Students at Oslo and Akershus University College of Applied Science are creating smart textiles for purposes ranging from monitoring health and vital signs to creating sounds and special effects for theatre costumes: go.nmc.org/osl.

### For Further Reading

*8 Brilliant Concepts for the Future of Wearable Tech*
go.nmc.org/frog

(Mark Wilson, *Fast Company*, 20 February 2013.) The international design studio Frog conceptualizes the future of wearable technology in which wearable objects have a very small screen or no screen at all.

*Here's Proof That Wearable Tech Is The Next Big Thing*
go.nmc.org/nex

(Megan Rose Dickey, *Business Insider*, 5 Jan 2013.) In the consumer market, wearable technology has already taken off in the form of electronic drum machine t-shirts, accessories that absorb sunlight to charge electronics, and much more.

## Top Ten Trends Impacting Technology Decisions

The technologies featured in the NMC Horizon Project research are embedded within a contemporary context that reflects the realities of its time, both in the sphere of education and in the world at large. The following ten trends have been identified as key drivers of technology adoptions in Norwegian schools for the period of 2013 through 2018; they are listed here in the order they were ranked by the 2013 Horizon Project Norway Advisory Board.

**1) Social media is changing the way people interact, present ideas and information, and communicate.** According to the EU Digital Agenda Scoreboard, 2012, Norway ranks high with regard to Facebook use, as close to 60% of the population uses Facebook, and the country ranks third in Europe with regard to posting messages to social media sites. Educators, students, and even the general public routinely use social media to share current events, opinions, and articles of interest. The impact of these changes in scholarly communication and on the credibility of information remains to be seen, but it is clear that social media has found significant traction in almost every education sector. Teachers are beginning to educate their students on how to use social media responsibly as an objective for basic digital skills across Norwegian curriculum.

**2) Education paradigms are shifting to include online learning, hybrid learning, and collaborative models.** Online learning environments have distinct advantages over physical campuses, including opportunities for greater collaboration while equipping students with stronger digital skills. They have gained policy relevance through a dedicated MOOC Task Force appointed by the former Norwegian Minister of Education and Research. Hybrid models, when designed and implemented successfully, enable students to travel to campus for some activities, while using the network for others, taking advantage of the best of both environments. The wide variety of online courses encompass as many possibilities for Norwegian schools in the form of flipped classroom models where students have access to a vast array of digital tools after class.

**3) People expect to be able to work, learn, and study whenever and wherever they want.** Euromonitor International predicts that annual sales of mobile phones in Norway will reach nearly 2.5 million units by 2016 — in a country in which the mobile penetration rate was already 114% of its 5.1 million population in March 2013. Today's school-age children are in a state of constant connection to their peers, social groups, and family through mobiles. While some decry the constant flow of information as a distraction, others see the opportunity to "flip" expectations about what is homework and what is schoolwork by taking advantage of those devices for learning. The implications are profound, as flipping frees up valuable teacher classroom time, extends the learning day, and fundamentally changes the teacher-student relationship.

**4) As the cost of technology drops and school districts revise and open up their access policies, it is becoming more common for students to bring their own mobile devices**. A number of Norwegian county councils responsible for upper secondary education are now shifting to or considering various BYOD models; several governments are mandating that soon all classrooms must have wireless networks so that students can leverage their personal devices. The relative new interest in BYOD programs has been accompanied by an attitude shift as schoolteachers and staff better understand the capabilities of smartphones and other devices that, unfortunately, still remain banned on many school campuses.

**5) Openness — concepts like open content, open data, and open resources, along with notions of transparency and easy access to data and information — is becoming a value.** As authoritative sources lose their importance, there is a need for more curation and other forms of validation to generate meaning in information and media. "Open" has become a term often applied in very different contexts. Often mistaken to mean "free," open education advocates are working towards a common vision that defines "open" more broadly — not just free in economic terms, but educational materials that are freely copiable, freely remixable, and devoid of barriers to

access and sharing and educational use. In Norway, NDLA (National Digital Learning Arena) is catalysing more discussions around openness, though it has not yet become a high priority agenda item among national authorities. Still, the potential of open materials to help teachers and students create their own learning paths has been a compelling development. The recent EU initiative "Opening up Education" further adds to the policy relevance of this trend.

**6) The abundance of resources and relationships made easily accessible via the Internet is challenging us to revisit our roles as educators.** Norwegian administrators and policymakers must consider the unique value that schools add to a world in which information is everywhere, and generally free. 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 and work is again at the forefront. Schools have always been seen as critical paths to educational credentialing, but challenges from competing sources are redefining what these paths can look like. A new form of digital divide is occurring between students who have teachers that are experts in finding and making sense of the information on the network, and those who do not. As teachers and school leaders adjust to new roles, the conversations are naturally extending to include the effect of changes in teacher and student roles on exams and competency goals in Norway.

**7) New opportunities, like learning analytics, are driving deployment of interoperability standards for learning technologies.** Teachers, school administrators, and researchers are expecting to be able to harvest the rich data provided by various systems used in our schools for learning analytics and accountability issues. Students expect the ability to use a wide range of devices, and their data to flow seamlessly through all their applications. Systems implementing specifications that facilitate interoperability will be in higher demand, and as such, purchasing staffs are increasingly cautious of vendor lock-in. The hope in Norway is that the resulting data will empower students and facilitate formative assessment while avoiding serious privacy issues.

**8) There is a new emphasis in the classroom on more challenge based, active learning.** The evaluation of the Knowledge Promotion reform efforts in Norway highlights the need for more student-active forms of learning. Active learning approaches are thought to be decidedly more student-centred, allowing them to take control of how they engage with a subject and to brainstorm and implement solutions to pressing local and global problems. The hope is that if learners can connect the course material with their own lives and their surrounding communities, then they will become more excited to learn and immerse themselves in the subject matter. Providing a challenge to students is increasingly being seen as a way to give them a sense of mastery, which could deter dropouts.

**9) The world of work is increasingly collaborative, driving changes in the way student projects are structured.** The days of isolated desk jobs are disappearing, giving way to models in which teams work actively together to address issues too far-reaching or complex for one person to resolve. Recently, a raft of new (and often free) tools has made collaboration much easier. The International Society of the Learning Sciences' efforts in Computer-Supported Collaborative Learning, along with that of other scholarly groups, have been instrumental in encouraging the understanding and use of technology to mediate and support group interactions.

**10) Technology continues to profoundly affect the way Norwegians work, collaborate, communicate, and succeed.** In 2000, the government implemented a national ICT policy called eNorway as a way for all citizens to participate in the global knowledge economy. Several subsequent related initiatives, including UP! and Green IT, have helped Norway continue to gain momentum as an innovation leader. Increasingly, technology skills are critical to success in almost every arena, and those who are more facile with technology advance more easily than those without access to or fluency in technology. 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.

## Top Ten Most Significant Challenges

Along with the trends discussed in the preceding section, the advisory board identified a number of important challenges common to most — if not all — Norwegian schools. Like the trends, the challenges described below were drawn from a careful analysis of current events, papers, articles, and similar sources, as well as from the personal experience of the advisory board members in their roles as leaders in education and technology. The ten challenges ranked as most significant in terms of their impact on teaching or learning in Norwegian schools in the coming five years are listed here, in the order of importance assigned them by the advisory board.

**1) Current approaches to initial teacher training and in-service training in digital tools and pedagogies are insufficient for the need.** According to the NIFU's "ICT in Teacher Education" report, teacher training at all levels in Norway may not be fully meeting its responsibility of producing teachers who are sufficiently digitally literate to help learners make the most of the tools at their disposal. While formal requirements for the use of ICT are mandated within the national curriculum for students, similar expectations for teacher training programs are missing at both the national and institutional level.

**2) Teachers and schools remain dependent on physical textbooks.** Norwegian teachers are grounded in a strong textbook culture. As textbook content has become so closely aligned with the curriculum, teachers naturally rely on them, especially for challenging concepts. While there has been a surge of new open content and educational resources in Norway, still to be determined is how traditional publishers will embrace the trend. Teachers will need help seeing the utility and efficacy of open educational resources in comparison to what they are more accustomed to using.

**3) Digital skills and the use of ICT for learning do not appear to be embedded in reform efforts, measurement strategies, prioritized areas, and national programmes to any appreciable extent.** Programmes that focus on assessment for learning, school and classroom leadership, and competence development for the lower secondary level are not necessarily grounded in the digital realities of school, where technology use is rising. Across all of education and the public sector, many Norwegian thought leaders believe insufficient attention has been paid to ICT; there is an increasing concern that e-government models for education, health services, and other major areas will fall behind in international rankings.

**4) 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, but there remains a gap between the vision and the tools needed to achieve it. In Norway, the desire for personalization is rooted in the idea that ICT has a huge unrealized potential for individualized learning. As long as teachers are working in an exam-based system, however, where everyone has to adapt to the same system and knowledge requirements, it will be difficult to change practise.

**5) Digital competence in the curriculum should be revised or embedded in new ways.** The current concept of digital competence was conceived ten years ago by what was then called the ITU. The concept was included in the report for the Quality Commission, and the subsequent 2004 White Paper on Primary and Secondary Education as well. The past ten years have seen tremendous changes in the everyday expectations for and use of ICT. There is a need for a new and system-wide discourse on the concept of digital competence and its role in Norway's educational system. A clear example is the emergence of visual literacy as a critical skill. The increased use of visual media is making it essential for teachers and students to both learn how to express themselves through imagery and rich media, to interpret and understand what they are seeing, and to assess the credibility of visual materials.

**6) New ways of learning challenge the way we measure and document the value of knowledge and skills.** There is an acknowledgement that schools are not using digital media for formative assessment the way they could and should. Over the last years Norway has seen a welcome rise in the use of formative assessment in educational practice. For example, a recent case study, "Assessment for Learning," documents a new educational programme that incorporates capacity-building and accountability into assessment, and is currently underway in 400 Norwegian schools. Nonetheless, despite changes in curricula and the incorporation of new skills, schools are not always able to also make appropriate adjustments in assessment practices needed as a consequence of these changes. Such adaptations need not be expensive or complex. Simple applications of digital media tools, like webcams that allow non-disruptive peer observation, can offer considerable promise in giving teachers timely feedback they can use.

**7) Learning that incorporates real life experiences happens infrequently and is undervalued when it does take place.** This challenge could also be described in terms of the disconnect between the world as students know it exists outside of school, and their experiences in school that are meant to prepare them for that world. Project-based learning is one method of incorporating real-life experiences in learning that has been shown to be effective if designed around relevant, realistic challenges. The use of technology and tools already familiar to students can be encouraged, as can mentoring from community members, both examples of good practices that can bring the real world into the classroom. Practices like these can help students who are not engaged with traditional approaches to see the value of their learning, and prepare them for further education, careers, and citizenship.

**8) Norway is a small market with five million inhabitants and is dependent upon resources developed in other languages with different pedagogies and traditions.** For digital competency and the use of new technologies in schools to be successful, there is a need for Norwegian resources that are adapted to national and cultural traditions. This is especially a challenge because the size of the market is relatively small in terms of the return on investment potential for localized educational resources. At the same time, investors too often fear the risks associated with being the first to the market with new technologies, which adds an additional damper to the development of truly Norwegian approaches.

**9) The success and dominance of the major learning platforms in Norway hinders educational innovation.** Nearly every school in Norway uses a learning platform of some kind — often one of the two dominant market players. Learning platforms have been instrumental in digitising Norwegian schools. However, from the content and service producers' point of views, this means they generally have to adapt their content and services to both platforms in order to make sales. As a result, schools that opt to use a different learning management system have to maintain a separate service, and developing content for it can become costly. In either scenario, schools have to adjust the learning and curriculum to fit the design of their platforms, making the learning itself feel secondary to the technology. Learning management systems are increasingly viewed as too rigid to help foster true innovation in teaching and learning.

**10) There is a systemic incoherence between curriculum, professional and leadership development, and assessment in the digital domain in Norwegian schools.** Building on the work of OECD in the publication *Inspired by Technology, Driven by Pedagogy: A Systemic Approach to Technology-Based School Innovations*, there is an imbalance between the requirements in Norway´s national curriculum on one hand, and professional development and the embedding of relevant assessments on the other hand. While administrations in Norway may be excelling at the use of ICT assessment, many strongly feel that it is not yet sufficiently integrated with the national curriculum itself.

## Methodology

The process used to research and create the *Technology Outlook for Norwegian Schools 2013-2018: An NMC Horizon Project Regional Analysis* is very much rooted in the methods used throughout the NMC Horizon Project. All publications of the NMC's Horizon Project are produced using a carefully constructed process that is informed by both primary and secondary research. Dozens of technologies, meaningful trends, and critical challenges are examined for possible inclusion in the report for each edition. Every report draws on the considerable expertise of an internationally renowned advisory board that first considers a broad set of important emerging technologies, challenges, and trends, and then examines each of them in progressively more detail, reducing the set until the final listing of technologies, trends, and challenges is selected.

Much of the process takes place online, where it is captured and placed in the NMC Horizon Project wiki. This wiki, which has grown into a resource of hundreds of pages, is intended to be a completely transparent window onto the work of the project, and contains the entire record of the research for each of the various editions. The section of the wiki used for the *Technology Outlook for Norwegian Schools 2013-2018* can be found at norway.wiki.nmc.org.

The procedure for selecting the topics that will be in the report includes 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 information management. A carefully selected set of RSS feeds from dozens of relevant publications ensures that background resources stay current as the project progresses. They are used to inform the thinking of the participants throughout the process.

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

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

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

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

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

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

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