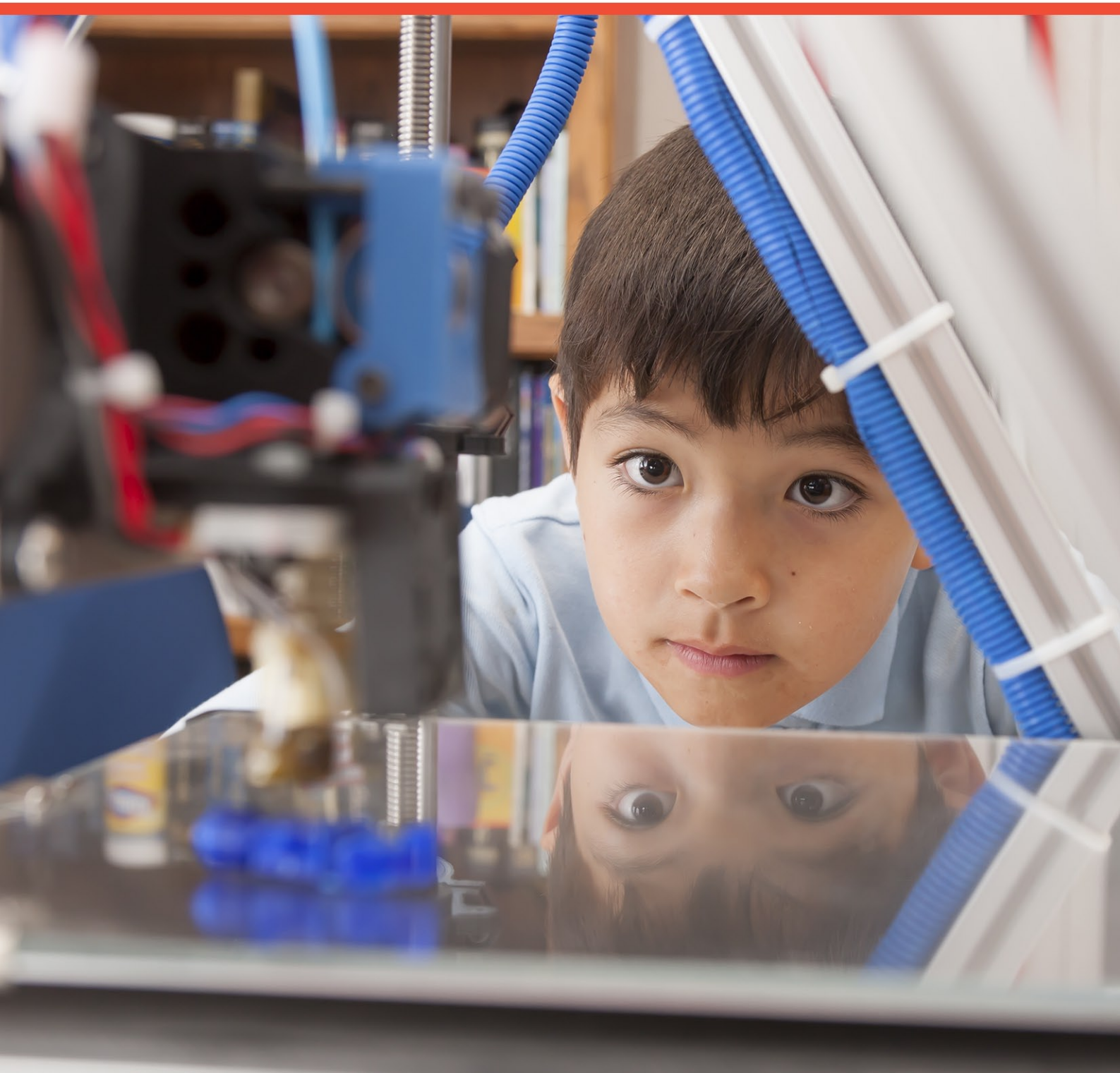
NMC Horizon Project

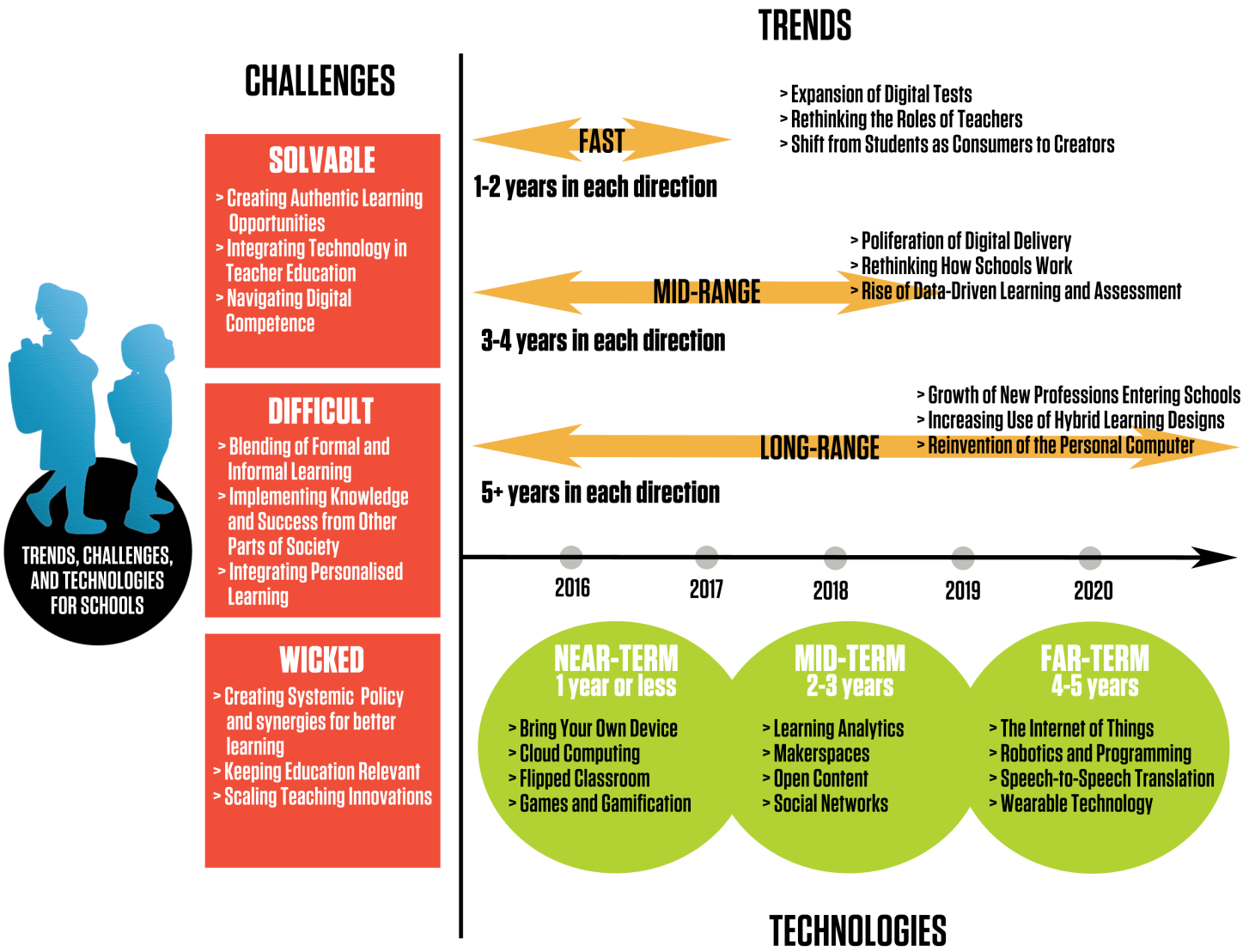
2015 NMC Technology Outlook

Scandinavian Schools

A Horizon Project Regional Report



The 2015 NMC Technology Outlook > Scandinavian Schools examines trends, challenges, and technologies for their potential impact on and use in teaching, learning, and creative inquiry.



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2015 NMC Technology Outlook for Scandinavian Schools

A Horizon Project Regional Report

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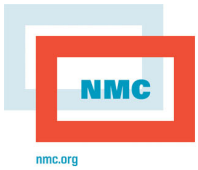

THE NORWEGIAN CENTRE FOR ICT IN EDUCATION

Skolverket
Swedish National Agency for Education

DANISH MINISTRY OF EDUCATION
NATIONAL AGENCY FOR IT AND LEARNING

2015 NMC Technology Outlook for Scandinavian Schools

A Horizon Project Regional Report

is a collaboration between

The New Media Consortium,

Norwegian Centre for ICT in Education, The Swedish National Agency for Education (Skolverket), and the Danish National Agency for IT and Learning (Styrelsen for It og Læring)

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Executive Summary

The *2015 NMC Technology Outlook for Scandinavian Schools: A Horizon Project Regional Report* reflects a collaborative research effort between the New Media Consortium (NMC), the Norwegian Centre for ICT in Education, The Swedish National Agency for Education (Skolverket), and the National Agency for IT and Learning in Denmark (Styrelsen for It og Læring) to inform Scandinavian school leaders and decision-makers about significant developments in technologies supporting teaching, learning, and creative inquiry in primary and secondary education across Denmark, Norway, and Sweden.

All of the research underpinning the report makes use of the NMC's Delphi-based process for bringing groups of experts to a consensus viewpoint, in this case around the impact of emerging technologies on teaching, learning, or creative inquiry in Scandinavian schools over the next five years. The same process underlies the well-known *NMC Horizon Report* series, which is the most visible product of an on-going research effort begun more than 13 years ago to systematically identify and describe emerging technologies likely to have a large impact on education around the globe.

The *2015 NMC Technology Outlook for Scandinavian Schools* was produced to explore emerging technologies and forecast their potential impact expressly in a Scandinavian school context. In the effort that took place from October through December 2014, a carefully selected panel of experts was asked to consider hundreds of relevant articles, news, blog posts, research, and project examples as part of the preparation that ultimately pinpointed the most notable emerging technology topics, trends, and challenges for Scandinavian schools over the next five years.

Known as the 2015 Horizon Project Scandinavia Expert Panel, that group of thought leaders consists of notably knowledgeable individuals, all highly regarded in their fields. Collectively the panel represents a range of diverse perspectives across the primary and secondary education sector. The project has been conducted under an open data philosophy, and all the interim projects, secondary research, discussions, and ranking instrumentation can be viewed at scandinavia.wiki.nmc.org. The precise research methodology employed in producing the report is detailed in a special section found at the end of this report.

The expert panel identified nine key trends, nine significant challenges, and 12 technologies to watch. Each of the 12 key technologies are profiled, each on a single page that describes and defines a technology ranked as very important for Scandinavian schools over the next year, two to three years, and four to five years. Every page opens with a carefully crafted definition of the highlighted technology, outlines its educational relevance, points to several real life examples of its current use, and ends with a short list of additional readings for those who wish to learn more. Following those discussions are sections that detail the expert panel's top ranked trends and challenges, and frame them into categories that illuminate why they are seen as highly influential factors in the adoption of technology in Scandinavian schools over the next five years.

The three key sections of this report constitute a reference and straightforward technology-planning guide for educators, school leaders, administrators, policy-makers, and technologists. It is our hope that this research will help to inform the choices that institutions are making about technology to improve, support, or extend teaching, learning, and creative inquiry in Scandinavian primary and secondary education. Educators and administrators worldwide look to the NMC Horizon Project and both its global and regional reports as key strategic technology planning references, and it is for that purpose that the *2015 NMC Technology Outlook for Scandinavian Schools* is presented.

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Introduction

The NMC Horizon Project and the 2015 Horizon Project Scandinavia Expert Panel recognise that technology adoption in schools is accelerated by trends in policy, leadership, and practice. Therefore, key trends frame the discussion of technology use in Scandinavian schools. Similarly, a number of challenges are impeding the proliferation of digital tools, and the panel has identified a set of significant challenges that expert panel distinctly reflects the current drivers and obstacles facing schools in Denmark, Norway, and Sweden over the coming five years. The top three trends and challenges from those longer lists are included in the related tables in this summary, and are organised by categories described in the next sections of this report.

As Table 1 below illustrates, the choices of the Scandinavian experts overlap in interesting ways with those who contributed to the *NMC Horizon Report > 2014 K-12 Edition,* which looked at technology uptake from a global perspective, and the *NMC Horizon Report Europe > 2014 Schools Edition*, which provides perspective on technology, trends, and challenges across the European Union — altogether a group of 159 acknowledged experts.

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

NMC Horizon Report 2014 K-12 Edition	2015 Technology Outlook for Scandinavian Schools	NMC Horizon Report 2014 European Schools Edition
Fast Trend		
Rethinking the Roles of Teachers	Expansion of Digital Tests	Rethinking the Roles of Teachers
Mid-Range Trend		
Increasing Focus on Hybrid Learning Designs	Rise of Data-Driven Learning and Assessment	Increasing Focus on Hybrid Learning Designs
Long-Range Trend		
Rethinking How Schools Work	Growth of New Professions Entering Schools	Rise of Data-Driven Learning and Assessment

The Scandinavian panel proposed a trend that is new to the NMC Horizon Project — the expansion of digital tests. Denmark and Norway have been among the progressive countries that have already implemented online exams for national summative assessments, and in Sweden this is also prospect, being aided by two government agencies. As more learning resources are made available online, it is a natural next step for the testing to become increasingly virtual. Both the Scandinavian and European panels are observing the rise of data-driven learning and assessment, which is evidenced by the inclusion of learning analytics as a technology to watch in both reports.

Unique to Scandinavia panel discussions was the attractive prospect of incorporating more professionals from other, non-academic backgrounds into school systems. For example, schools have been inviting people with business degrees to help design more entrepreneurial and real-world training experiences for both faculty and students, while IT experts have been called in to enhance online learning initiatives and technology programmes.

Horizon Project panels in general have agreed that trends like these are clear drivers of technology adoption; the 2015 Scandinavian panel especially saw such a linkage. At the same time, these panels of experts also agree that technology adoption is often hindered by both local and systemic challenges, which are grounded in everyday realities that make it difficult to learn about, much less adopt, new tools and approaches.

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

NMC Horizon Report 2014 K-12 Edition	2015 Technology Outlook for Scandinavian Schools	NMC Horizon Report 2014 European Schools Edition
Solvable Challenge		
Integrating Personalised Learning	Integrating Technology in Teacher Education	Integrating Technology in Teacher Education
Difficult Challenge		
Safety of Student Data	Implementing Knowledge and Success from other Parts of Society	Shift to Deeper Learning Approaches
Wicked Challenge		
Keeping Formal Education Relevant	Creating Systemic Policy and Synergies for Better Learning	Students as Co-Designers of Learning

A noted in Table 2, above, Both the Scandinavian and European panels agreed that the digital fluency of teachers is a great challenge, and will rely on better integration of ICT in initial teacher education programmes and professional development. In order for emerging technologies to be creatively leveraged by students in classrooms across Scandinavia, teachers need to be confident and effective in applying them. Adequate ongoing training is one key component, but more important is that school leaders set expectations for the basic skills of teachers.

New this year to the NMC Horizon Project and to the list of top challenges facing Scandinavian education is the focus on how schools can learn from the successes and mistakes of other industries. Expert panellists specifically pointed to the music industry as a potential model for schools to emulate; what once was a business that relied on the physical distribution of albums has now turned into a largely virtual space. Schools are facing a similar shift to the digital arena and must adapt quickly to remain accessible and relevant.

Creating systemic policy and synergies for better learning is defined as a wicked challenge — one that is difficult if not impossible to define, let alone address — articulating that it is a complicated endeavour. This challenge encompasses the lack of coherence between digital competence policies and gaps in digital competence implementation, which have ultimately caused a lack of technology savvy among teachers and students. There is concern that existing initiatives, such as the Norwegian Knowledge Promotion Reform, have not been effectively coordinated throughout the country's education programmes.

Fuelled by the key trends and impeded by significant challenges selected by the panel, the 12 "technologies to watch" presented in the body of this report reflect our experts' opinions as to which of the nearly 60 technologies considered will be most important to Scandinavian schools over the five years following the publication of the report. All three of these projects' expert panels strongly agree that cloud computing and mobile learning, in some form, will likely tip into mainstream use within the next year — a trend that spans education across the world.

There are also several other overlaps, indicating Scandinavia's close alignment with prevalent European and global trends. The three panels believe that learning analytics will be in widespread practice in two to three years, as governments and school leaders recognise the potential of data to inform teachers about student progress on a deeper level. Some Scandinavian schools are currently piloting programmes and services that track and reveal patterns in the data in real-time.

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

NMC Horizon Report 2014 K-12 Edition	2015 Technology Outlook for Scandinavian Schools	NMC Horizon Report 2014 European Schools Edition
Time-to-Adoption Horizon: One Year or Less		
Bring Your Own Device Cloud Computing Mobile Apps Tablet Computing	Bring Your Own Device Cloud Computing Flipped Classroom Games and Gamification	Cloud Computing Flipped Classroom Mobile Apps Tablet Computing
Time-to-Adoption Horizon: Two to Three Years		
3D Printing Games and Gamification Learning Analytics Makerspaces	Learning Analytics Makerspaces Open Content Social Networks	Games and Gamification Learning Analytics Massive Open Online Courses Mobile Learning
Time-to-Adoption Horizon: Four to Five Years		
Flexible Displays The Internet of Things Virtual and Remote Laboratories Wearable Technology	The Internet of Things Robotics and Programming Speech-to-Speech Translation Wearable Technology	Personal Learning Environments Virtual Assistants Virtual and Remote Laboratories Visual Data Analysis

Both the Scandinavian panel and the 2014 global panel deemed "Bring Your Own Device" (BYOD) as a critical digital strategy that will be accelerated over the next year. The goal is that providing students with the freedom to use their own devices for learning will help extend the school day and enable them to use the tools with which they are already familiar during class.

A related digital strategy, emphasised by the Scandinavian and European panels, is the flipped classroom, which focuses on using technology outside of the classroom to provide students with ubiquitous access to learning materials. Many teachers are placing video lectures, podcasts, quizzes, and more online — activities that students would normally engage in during class are available to them at home. This is allowing teachers to rearrange how class time is spent, making more room for deep discussions and collaborative, hands-on projects. Swedish school Årstaskolan even developed their own online platform, "Kunskapshubben," to create and host their videos.

There are also some differences between perceived time-to-adoption horizons. For example, the Scandinavia panel sees games and gamification as a near-term horizon topic, while the other two panels believe it is at least two to three years away from mainstream adoption. Throughout the discussions between panellists on the wiki as well as the research process, it was evident that more and more Scandinavian schools are emphasising the idea of play in the classroom as a means of learning and increasing student engagement.

A number of unique choices distinguished the perspectives expressed by the Scandinavian panel from their counterparts. Open content is a major topic of conversation in Scandinavia, especially in Norway, where 18 of 19 county councils have joined forces in the consortium for open educational resources known as NDLA (National Digital Learning Arena). The Danish Ministry of Education also launched EMU.dk, a portal for educational open content.

The panel also proposed a far-term topic that is brand new to the Horizon Project — robotics and programming. The student- and creation-centric culture of learning in Scandinavia lends itself to building more opportunities for students to learn how to code and at a younger age, and is seen not only as a key component of computer science education but also as an activity that stimulates critical thinking and analysis.

These points and comparisons provide an important context for the main body of the report that follows.

Key Trends Accelerating Technology Adoption

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

These nine trends, which the panel agreed are very likely to drive technology planning and decision-making over the next five years, are sorted into three time-related categories: fast trends that will last for the next one to two years and are bound to become pervasive in schools, and two categories of slower trends that will grow more incrementally in Scandinavian schools.

Fast Trends

Driving Ed Tech adoption in Scandinavian schools for the next one to two years

Expansion of Digital Tests. As teachers and schools are increasingly making learning activities available online, it is a natural next step for more formal assessments to be digitised. In Denmark and Norway, national summative exams are now taking place online and the government has plans to expand these efforts to other types of tests. The Norwegian Directorate for Education and Training provides the virtual testing environment in Norway, but the use of learning management systems for other types of assessment varies. Sweden is not as far along yet, but there are currently two groups investigating how to digitise national tests in Sweden — the Ministry of Education and the National Agency for Education.

Rethinking the Roles of Teachers. Teachers are now expected to be adept at a variety of technology-based and other approaches for content delivery, learner support, and assessment and to act as guides and mentors to promote student-centred learning. As this trend gathers steam, many schools across the world are rethinking the primary responsibilities of teachers. In Scandinavia, the flipped classroom has largely been a response to this trend, rearranging what can be done at home and how class time is spent.

Shift from Students as Consumers to Students as Creators. A shift has long been taking place in the focus of pedagogical practice in schools across Scandinavia as students in a wide variety of disciplines are learning by creating rather than consuming content. Creativity, as illustrated by the growth of user-generated videos, maker communities, and apps in the past couple years, is increasingly the means for active, hands-on learning. In Sweden, students are engaging in creation-oriented activities such as building e-books through BOOKIS, while FabLabs have emerged in Denmark to bring maker culture to Danish schools.

Mid-Range Trends

Driving Ed Tech adoption in Scandinavian schools for the next three to five years

Proliferation of Digital Delivery. The open-source movement has yielded thousands of online educational resources and services. Scandinavian schools continue to experience a paradigm shift in which online learning represents the intersection of formal and informal learning. More and more, teachers are interacting with students through online discussion forums and by sharing video and audio recordings. While 18 of 19 counties in Norway are already funding free online content, many school leaders are still weighing the benefits of open content versus licensed content by publishers. Textbook culture is still prevalent across Scandinavia.

Rethinking How Schools Work. There is a focused movement to reinvent the traditional classroom paradigm and rearrange the entire school experience. Methods such as project- and challenge-based learning call for school structures that enable students to move from one learning activity to another more organically. Moreover, these novel arrangements encourage renovation of classroom layouts. Century-old practices in which students learn subject by subject while uniformly facing the front of the classroom are perceived by many as an antiquated approach. However, changing the paradigm often calls for new schools to be built as it is difficult to revise existing architecture. At Denmark's Hellerup School there are no classrooms; students are encouraged to collaborate in common areas or be introspective in more private corners, based on their own preferences.

Rise of Data-Driven Learning and Assessment. There is a growing interest in Scandinavia in using new sources of data for personalising the learning experience and for performance measurement. As learners participate in online activities, they leave a clear trail of data that can be mined for insights. Learning analytics experiments and demonstration projects are currently examining ways to use that data to modify learning processes. As the field of learning analytics matures, the hope is that this information will enable continual improvement of learning outcomes. In Norway, the need for more pervasive data analysis tools was formally acknowledged with 5 million NOK allocated in the 2015 government budget to set up a national centre for learning analytics.

Long-Range Trends

Driving Ed Tech adoption in Scandinavian schools for five or more years

Growth of New Professions Entering Schools. Now that Scandinavian schools are more focused on integrating technologies and online learning into curriculum design, they are calling upon IT and business experts to help design and implement effective virtual environments and technology infrastructure. Furthermore, the expanded use of digital tools in schools has fostered more real-world and entrepreneurial experiences for students, and bringing in experts from industry can help better prepare them for university and work settings. In Norway, the Lektor 2 program allows teachers to cooperate with professionals from the world of work to bring authentic learning opportunities into the classroom.

Increasing Use of Hybrid Learning Designs. According to a 2014 research report from the University of Oslo, students' digital skills are not yet being fully leveraged at school as many schools still prohibit the use of tools such as mobile devices and social media. There is a need for teachers to make use of students' existing digital knowledge and integrate it into learning activities. Schools that are making use of hybrid learning models are finding that using both the physical and the virtual learning environments to their highest potentials allows teachers to further personalise the learning experience and engage students in a broader variety of ways. Hybrid models, when designed and implemented effectively, enable students to use the school day for group work and project-based activities, while accessing readings, videos, and other learning materials online, on their own time.

Reinvention of the Personal Computer. Computers as we know them are in the process of a massive reinvention. The computer is smaller, lighter, and better connected than ever before, without the need for wires or bulky peripherals. In many cases, smartphones and other mobile devices are sufficient for basic computing needs, and only specialised tasks require a keyboard, large monitor, and a mouse. Mobiles are connected to an ecosystem of apps supported by cloud computing technologies that can be downloaded and used instantly, for pennies. As the capabilities and interfaces of small computing devices improve, our ideas about when — or whether — a traditional computer is necessary are changing as well.

Significant Challenges Impeding Technology Adoption

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

Solvable Challenges

Those which we both understand and know how to solve

Creating Authentic Learning Opportunities. Authentic learning, especially that which brings real life experiences into the classroom, is still all too uncommon in schools, but has great potential to increase the engagement of students who are seeking some connection between the world as they know it exists outside of school, and their experiences in school that are meant to prepare them for that world. This challenge is becoming increasingly solvable as schools are beginning to facilitate more authentic projects for students. High school students in Norway, for example, have already written and published a book, *Connected Learners*, which is sold through Amazon and is in use by many teachers. Similarly, Swedish students are using Wikiversity to create their own OER to contribute to the learning ecosystem.

Integrating Technology in Teacher Education. Despite the widespread agreement on the importance of digital competence, training in the supporting skills and techniques is rare in teacher education and non-existent in the preparation of teachers. As teachers begin to realise that they are limiting their students by not helping them to develop and use digital competence 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 competence as a norm. Furthermore, although Danish teachers are performing exceptionally well with IT integration in student activities, the technologies are still widely used for outdated modes of traditional type of teaching.

Navigating Digital Competence. The challenge is that learning digital competence is different from applying digital tools in specific subjects, such as language and science, in the same manner that learning to read is different from using text to explain mathematics. However, in many discussions, these topics are often confused. Some Scandinavian thought leaders believe teacher education should involve them learning how to teach digital competence to their students, while others believe the primary lesson should be in using the technologies themselves in the disciplines they are teaching. The confusion between the two ideas often hinders the creation of cohesive policy and teacher education curriculum.

Difficult Challenges

Those we understand but for which solutions are elusive

Blending Formal and Informal Learning. Traditional learning approaches are still very common in many Scandinavian schools, and often stifle learning as much as they foster it. As the Internet has brought the ability to learn something about almost anything to the palm of one's hand, there is an increasing interest in the kinds of self-directed, curiosity-based learning that has long been common in museums and science centres. These and other more serendipitous forms of learning fall under the banner of Informal learning, and serve to

enhance student engagement by encouraging them to follow their own learning pathways and interests. This challenge is exacerbated by one-size-fits-all purchased learning management systems and other tools, which could prevent the spread of blended learning.

Implementing Knowledge and Success from Other Parts of Society. Schools in Scandinavia do not look to practices from other parts of society and industry as often as they should. Modernising education will require school leaders to analyse how other sectors have adapted to remain relevant, and also to learn from their mistakes. For example, the music industry underwent a complete overhaul when applications like iTunes U and Spotify emerged. Scandinavian schools have an opportunity to refine their organisational models to remain more agile. In the business of education, the consumers are the students, and there is a need to better cater to them as their expectations and behaviours evolve.

Integrating Personalised Learning. Personalised learning includes a wide variety of approaches to support self-directed learning designed around each learner's goals. Solving this challenge means incorporating into Scandinavian school activities concepts such as personalised learning environments and adaptive learning tools. There are two paths of development: the first is organised by and for the learner, which includes apps and social media. School goals and interests are driving the other path, primarily in the form of adaptive learning programmes, which interpret data about how a student is learning and responds by changing the learning environment based on their needs.

Wicked Challenges

Those that are complex to even define, much less address

Creating Systemic Policy and Synergies for Better Learning. Technologies are not yet fully exploited in education across Scandinavia. Triggering large-scale sustainable changes requires shared efforts and focused actions, involving and engaging all stakeholders, policy-makers, local communities, school leaders, teachers, and learners. All Scandinavian countries have the digital skills integrated in their curriculum, but only Norway has a digital dimension that applies to all objectives in the curriculum. With some exceptions, panellists believe that many critical digital skills have not been made explicit in the competence objectives. Additionally, forms of assessment rarely include digital tools, and many pedagogies are only relatively adapted to the use of ICT. So even though digital competence is present in many of the countries initiatives, they have been insufficiently coordinated.

Keeping Education Relevant. As online learning and free educational content become more pervasive, stakeholders and administrators must seriously consider what schools can provide that cannot be replicated by other sources. There are valuable skills and attitudes that can only be acquired in school settings. Soft skills, such as face-to-face communication and collaboration, for instance, are essential practices for solving problems in a world that is increasingly interconnected. The 2014 Danish report "Use of Digital Learning" reveals that the use of technology can help motivate the students and improve their work ethic, and vary learning environments — as is characteristic of workplaces.

Scaling Teaching Innovations. Scandinavian schools are not yet adept at moving teaching innovations into mainstream practice. Innovation springs from the freedom to connect ideas in new ways, but schools generally allow teachers to connect ideas only in prescribed ways that lead to rote learning. In Sweden, cities and regions across the country are launching websites, such as Omvärldsbloggen, that are aimed at school leaders, teachers, and librarians that describe local innovations in teaching practice and collaborative professional development. These websites have recently started to collaborate to share the insights.

Time-to-Adoption: One Year or Less

Bring Your Own Device

Bring Your Own Device (BYOD) refers to the digital strategy 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 Scandinavian schools 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. In early studies, the act of a student using his or her own device for learning has proven to increase productivity and engagement. 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. In Sweden, school education is free for all, and schools must be careful about requiring families to purchase devices for their children. Therefore in practice, many schools have provided devices to students for free, including access to the school network.

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 programmes eliminate the support and other demands placed on schools that accompany paying for and maintaining institution-provided devices.

BYOD in Practice

- As a mandate from the County Council in Norway, all Rogaland secondary schools in Norway have developed BYOD programmes with an emphasis on personal laptop computers: go.nmc.org/roga.
- In Denmark, Vejle schools recently won a digitisation prize for their BYOD initiative, which has led to new forms of teaching and collaboration: go.nmc.org/vejle.
- Teachers in Odda, Norway sent students outside the classroom with their personal iPhones to measure distance and angles and leveraged GPS tracking: go.nmc.org/odda.

For Further Reading

Commentary on a Nordic Perspective on ICT in Teaching and Learning
go.nmc.org/nordict

(Ola Berge, *Nordic Journal of Digital Literacy*, 2014.) As a digitally connected, relatively affluent country, Norway is well positioned to overcome social and technical obstacles presented by BYOD policies.

Leveraging ICT for a World-Class Education System (PDF)
go.nmc.org/ictedu

(Anders Johansson et al., Arthur D. Little, May 2014.) This report on ICT in schools addresses the need to combine technology with new pedagogical strategies, and includes a case study of schools in the city of Stockholm as they move toward a one-to-one policy.

Time-to-Adoption: One Year or Less

Cloud Computing

Cloud computing refers to expandable, on-demand services and tools that are served to the user via the Internet from specialised data centres and consume almost no local processing or storage resources. Cloud computing resources support collaboration, file storage, virtualisation, and access to computing cycles, and the number of available applications that rely on cloud technologies has grown to the point that few education institutions do not make some use of the cloud, whether as a matter of policy or not. Over the past few years, cloud computing has been firmly established as an efficient way for businesses to protect data, develop applications, deliver software and online platforms, and to collaborate. Education institutions are deploying similar cloud-based strategies to boost collaboration, productivity, and mobility in teaching and learning.

Relevance for Teaching, Learning, or Creative Inquiry

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

Cloud Computing in Practice

- At Vittra Telefonplan, a school in Stockholm, students receive assignments via a cloud-based portal and have access to a full digital suite of creative tools to produce films, music, and animations: go.nmc.org/digitool.
- Copenhagen's Oerestad Gymnasium is an all-digital school where textbooks have been eliminated and teachers are required to produce and share interactive materials for lessons through online cloud services: go.nmc.org/oerestad.
- Norwegian company Kahoot has produced a cloud-based, device-neutral platform for posting interactive quizzes that engage and excite students, with real-time results allowing teachers to adjust the lesson plan based on the students' knowledge levels: go.nmc.org/interact.

For Further Reading

Driving Future Developments With Students – Interview with Aelsa Carroll
go.nmc.org/stfintan

(Elina Jokisalo, European Schoolnet, 11 March 2014.) A teacher in Dublin, Ireland details her experiences integrating Google Apps into her classroom and school as part of the European Commission's Living Schools Lab project.

Facilitating Student Reflection Through Digital Technologies in the iTEC Project: Pedagogically-Led Change in the Classroom
go.nmc.org/reflect

(Sarah McNicol et al., HCI International Proceedings, 2014.) This paper explores the use of digital tools for students to engage in reflection and monitor learning progress.

The Future is Now
go.nmc.org/hustvedt

(Mark Macdonald, Itslearning, 13 November 2013.) A Norwegian teacher has embraced cloud-based learning tools to forge a learning environment that mirrors everyday technology use, so students stay engaged and reach their full potential.

Time-to-Adoption: One Year or Less

Flipped Classroom

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

Relevance for Teaching, Learning, or Creative Inquiry

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

Flipped Classroom in Practice

- Kunskapshubben, a publishing platform built and hosted by Swedish school Årstaskolan, allows teachers to post instructional videos and students to upload completed assignments: go.nmc.org/swedepub.
- A Swedish woodworking teacher posts videos on YouTube to accommodate the range of skills present in his classroom and allows time for more hands-on work with students during class: go.nmc.org/blomqvist.
- To make better use of class time to teach music theory and notation, a music teacher in Norway created instructional videos on how to use GarageBand: go.nmc.org/garage.

For Further Reading

A Flipped Classroom? Or Should It Be Sideways?
go.nmc.org/sideways

(Emily Ko, *Edudemic*, 1 September 2014.) For teachers lacking resources or support to fully flip their classrooms, integrating digital technologies can improve job satisfaction and learning accessibility for students.

The Flipped Museum (PDF)
go.nmc.org/flipmuse

(Cecelia von Heijne, *ICOMON* e-Proceedings, 2014.) The Royal Coin Cabinet, National Museum of Economy in Sweden, introduced a flipped museum project where online introductory films and quizzes supplant the traditional museum tour and students arrive at the museum knowledgeable and ready to interact with the exhibits.

Time-to-Adoption: One Year or Less

Games and Gamification

The culture around digital games is growing to encompass a substantial proportion of the world's population, with the age of the average gamer increasing every year. The gaming industry is producing a steady stream of games that continue to expand in their nature and impact — they can be artistic, social, and collaborative, with many allowing massive numbers of people from all over the world to participate simultaneously. A 2013 study by the American Psychological Association highlights the cognitive, motivational, emotional, and social impact video games have on human behaviour; this significant body of research underlines the overwhelming potential of games to teach new forms of thought and behaviour. Studies like these are encouraging the uptake of games into the worlds of commerce, the military, and education, among others. Gamification — the integration of gaming elements, mechanics, and frameworks into non-game situations and scenarios for training and motivational purposes — has added another level of complexity to discussions surrounding the potential of games to transform teaching and learning. Although still in its nascent stages in education, the gamification of learning environments is gaining support among educators who recognise that effectively designed games can stimulate large gains in engagement, productivity, creativity, and authentic learning.

Relevance for Teaching, Learning, or Creative Inquiry

- Discovery-based and goal-oriented learning is often inherent in educational games, fostering opportunities for the development of essential social skills such as collaboration and teamwork.
- Gamified learning environments help students keep track of new skills as they gain them and motivate learners to pursue the next level of mastery.
- Simulations and role-playing games allow students to experience real world challenges with room to try new, creative solutions and to learn from failures.

Games and Gamification in Practice

- Nordahl Grieg Upper Secondary in Norway gives its teachers free rein to incorporate popular commercial video games into their pedagogy and curriculum design: go.nmc.org/bergen.
- Over 2,100 classrooms worldwide are using MinecraftEdu, a version of Minecraft developed by Finnish company TeacherGaming that features tools for educators to create and incorporate their own curriculum content into the game: go.nmc.org/minecraftedu.
- SmartFeet, a Finnish learning game platform, is completely customisable; teachers program tasks and rewards into the interactive online interface, and students form teams to solve problems using tablets or mobile devices: go.nmc.org/smartfeet.

For Further Reading

Apps Thrill Toddlers as Swedish Schools Go Digital
go.nmc.org/digiswede

(Tom Sullivan, *The Japan Times*, 10 March 2014.) Champions and critics discuss the digitisation of Swedish classrooms, from tablet use in preschools to the use of games to engage children with behavioural or mental challenges.

Using PhotoStory, MovieMaker and Voki to Motivate Danish Upper Secondary Students to Learn German Language and Culture (PDF)
go.nmc.org/learngerm

(Lisbet Pals Svendsen et al., *Læring og Medier (LOM)*, 2014.) Researchers found that use of fun, creative ICT tools in Danish schools resulted in increased student engagement and higher intrinsic motivation to learn the German language.

Time-to-Adoption: Two to Three Years

Learning Analytics

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

Relevance for Teaching, Learning, or Creative Inquiry

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

Learning Analytics in Practice

- ClassDojo, a free behaviour-tracking app, allows teachers to record student conduct and communicate directly with parents: go.nmc.org/dojo.
- Smart Øving is a forthcoming app for Norwegian students, intended to monitor progress, detect areas of struggle, and recommend further resources to improve learning outcomes: go.nmc.org/oving.
- Swedish school Årstaskolan is partnering with Vinnova to create Looper, a professional development platform for teachers that will use analytics to increase teacher efficiency, with the goal of ultimately improving student performance: go.nmc.org/looper.

For Further Reading

A Day in the Life of a Data Mined Kid
go.nmc.org/datakid

(Adriene Hill, *Marketplace*, 15 September 2014.) This article details the prevalence of student information collection and highlights the important role of teachers, parents, and schools in protecting students' digital data, particularly when existing laws may not cover information stored in the cloud.

Learning Analytics
go.nmc.org/soby

(Morten Søby, *Nordic Journal of Digital Literacy*, 2014.) The use of cloud computing resources and digital tools in the classroom provides valuable information to help teachers create a flexible, customisable learning environment to improve student motivation and retention.

Measuring and Understanding Learner Emotions: Evidence and Prospects
go.nmc.org/lar

(Bart Rienties et al., *Learning Analytics Review*, 10 December 2014.) This paper explores the gathering and interpretation of data depicting learners' emotional states.

Time-to-Adoption: Two to Three Years

Makerspaces

The turn of the 21st century has signalled a shift in what types of skillsets have real, applicable value in a rapidly advancing world. In this landscape, creativity, design, and engineering are making their way to the forefront of educational considerations as tools such as 3D printers, robotics, and 3D modelling web-based applications become accessible to more people. The question of how to renovate or repurpose classrooms to address the needs of the future is being answered through the concept of makerspaces, or workshops that offer tools and the learning experiences needed to help people carry out their ideas. Makerspaces are intended to appeal to people of all ages, and are founded on an openness to experiment, iterate, and create. The driving force behind makerspaces is rooted in the maker movement, a following comprised of artists, tech enthusiasts, engineers, builders, tinkerers, and anyone else who has a passion for making things. The formation of the movement stems from the success of the Maker Faire, a gathering that launched in 2006, and has since propagated itself into numerous community-driven events all over the world.

Relevance for Teaching, Learning, or Creative Inquiry

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

Makerspaces in Practice

- A library in Stockholm has opened a parent- and teacher-free space, Tio Tretton, where children aged 10-13 can explore technologies to create films, animations, or music: go.nmc.org/tretton.
- The Skaparbibblan ("Maker Library") aims to spark interest in science, technology, and entrepreneurship by offering programming workshops, a 3D printer, robot Legos, and traditional crafts: go.nmc.org/libspace.
- The Swedish Institute's Children Make project creates makerspaces where students have access to modern technologies and art supplies to learn, express creativity, and celebrate cultural values: go.nmc.org/kidsmake.

For Further Reading

The Environment and Tools of Great Educational Makerspaces (PDF)
go.nmc.org/eduspace

(R. Steven Kurti et al., *Teacher Librarian*, October 2014.) A makerspace will best achieve goals of fostering critical thinking, innovation, and creativity when it is carefully designed for maximum flexibility, technological tools are chosen to inspire, and students feel a sense of ownership within the space.

The Public Library as a Community Hub for Connected Learning (PDF)
go.nmc.org/libhub

(Åke Nygren, *IFLA World Library and Information Congress*, August 2014.) This paper explores the intersection of the changing role of libraries and the spread of the maker movement, describing library makerspace projects in Europe and America and offering best practice tips for libraries to meet the needs of learners in the digital age.

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 conceptualising 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, customisable 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.

Relevance for Teaching, Learning, or Creative Inquiry

- In many cases, open materials can be easily updated and reposted to reflect the latest knowledge and discoveries.
- Many of the top schools and learning-focused organisations in Scandinavia are proponents and users of open content and have made materials available on demand to anyone.
- The use of open content promotes a set of skills for teachers 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

- NDLA.no (National Learning Digital Arena), Norway's publicly funded portal, offers free digital learning resources for 40 upper secondary education subjects using an open licensing model: go.nmc.org/ndlano.
- A project of the Danish Ministry of Education, EMU.dk is Denmark's public portal for open content with an educational focus, offering resources, training manuals, and news: go.nmc.org/emu.
- Run by the National Library of Sweden and part of the EU project OpenAIRE, OpenAccess.se promotes free access to works by Swedish researchers, teachers, and students: go.nmc.org/opense.
- Spindeln is a search service for open educational resources for students and teachers in Sweden. Lärarspindeln ('teacher spider') is a new service that allows teachers to share their own Creative Commons-licensed digital learning resources: go.nmc.org/spider.

For Further Reading

Comparative Analysis of the Strengths and Weaknesses of Existing Open Access Strategies (PDF)
go.nmc.org/openstrat

(Julie Caruso et al., *Science-Metrix*, 22 October 2014.) This report reviews governmental and institutional strategies to promote open access resources, identifying best practices, successful collaborations, and barriers to growth.

Open Educational Resources (OER) in Less Used Languages: A State of the Art Report
go.nmc.org/langoer

(Linda Bradley et al., LangOER Consortium, 2014.) Ten percent of Europe's population speaks a regional or minority language, and the quality and availability of OER in these languages vary widely depending on policy commitments at the community, municipal, or national level.

Time-to-Adoption: Two to Three Years

Social Networks

Today's web users are prolific creators of content, and they upload photographs, audio, and video to cloud-based social networks 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 organisations 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 visualised in a variety of compelling 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 networks either as producers of content, or consumers, or aggregators of user-generated content allow school faculty to more deeply connect with each other.
- Social networks 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 Networks in Practice

- Bolstered by Sandvika High School's 1:1 policy, an English teacher created a digitally rich, textbook-free classroom using social media and blogging: go.nmc.org/sandvika.
- Following a classroom pen pal program, Swedish students and American students are using social media to expand their cultural horizons: go.nmc.org/penpal.
- Students from Norway and Sweden are participating in the entrepreneurial program Enterprise Without Borders and have used Skype and Facebook to collaborate on the creation of an international company, Happy Ear: go.nmc.org/ear.

For Further Reading

The Expanded Classroom – Spatial Relations in Classroom Practices Using ICT
go.nmc.org/expand

(Ola Erstad, *Nordic Journal of Digital Literacy*, 2014.) This article explores the effects of social media use on students' learning engagement and identity building.

YouTubing: Challenging Traditional Literacies and Encouraging Self Organisation and Connecting in a Connectivist Approach to Learning in the K-12 System
go.nmc.org/tubing

(Halvdan Haugsbakken et al., *Digital Education & Culture*, 11 August 2014.) After tracking YouTube usage by students in Trondheim, Norway in both informal and formal learning settings, researchers recommended that schools alter their pedagogy to develop connective skills, audio-visual literacy, and critical thinking.

Time-to-Adoption: Four to Five Years

The Internet of Things

The Internet of Things (IoT) conveys information communicated by network aware objects that connect the physical world with the world of information through the web. The advent of TCP/IP v6, launched in 2006, added enormous new addressing capabilities to the Internet, and enabled objects and the information they might carry in attached sensors or devices to be addressable and searchable across the web. This expanded address space is particularly useful for tracking objects that monitor sensitive equipment or materials, point-of-sale purchases, passport tracking, inventory management, identification, and similar applications. Embedded chips, sensors, or tiny processors attached to an object allow helpful information about the object, such as cost, age, temperature, colour, pressure, or humidity to be transmitted over the Internet. This simple connection allows remote management, status monitoring, tracking, and alerts if the objects they are attached to are in danger of being damaged or spoiled. Traditional web tools allow objects to be annotated with descriptions, photographs, and connections to other objects, and any other contextual information. The Internet of Things makes access to these data as easy as it is to use the web.

Relevance for Teaching, Learning, or Creative Inquiry

- Big data will play a big part of IoT in education, as information transmitted from students' mobile devices will lead to improved understanding of learner behaviours.
- Integration of IoT will raise concerns about privacy, resulting in research efforts to identify incentives that encourage schools, educators, students, and parents to share data openly.
- Networked sensors make it possible to study objects that cannot be reached or touched, such as living things like marine life and ancient artefacts.

The Internet of Things in Practice

- Muse, a neurosensor headband that detects brain activity, could add to a teacher's contextual understanding of student learning and identify patterns that lead to disciplinary problems: go.nmc.org/museband.
- Norwegian company ThinFilm uses printed electronics to bring intelligence to simple objects at low costs, without the need to redesign products to incorporate tracking sensors: go.nmc.org/thinfilm.
- Teddy the Guardian, a plush toy bear that measures the vital signs of the person holding it and wirelessly transmits the data to a paediatrician's device, offers comfort to children in medical settings with implications for early and special education students: go.nmc.org/teddy.

For Further Reading

Even Trees Can Talk: The Internet of Things in Education
go.nmc.org/iotedu

(Michelle Selinger, *Education Technology Solutions*, 13 October 2014.) As the Internet of Things expands, devices that perform measuring and recording functions will allow a shift in pedagogy toward critical thinking, problem solving, and data analysis.

The Internet of Things Will Thrive by 2025 (PDF)
go.nmc.org/pewiot

(Pew Research Center, 14 May 2014.) This report gathers expert opinions on the Internet of Things' expansion, projected technological advances, and the impact on personal privacy in the era of big data collection.

Time-to-Adoption: Four to Five Years

Robotics and Programming

Robotics refers to the design and application of robots — a form of artificial intelligence. This technology is not new, and the field is filled with examples of machines built for highly practical functions, such as lifting and moving heavy objects as well as for intellectual purposes, including assisting people with research and organisation. In both cases, the goal of robots is to streamline and automate processes to make them far more efficient than if conducted by people. While robotics is at least four years away from being in mainstream use across primary and secondary education, the potential applications are vast. In some examples, students with spectrum disorders are more comfortable working with robots to develop better social, verbal, and non-verbal skills. The use of robotics in education and its clear implications for improving workflows in the global economy also lends itself to the development of robotics. More and more, schools are teaching students the computer science and programming skills at a younger age as the next few generations of learners are responsible for advancing the field of robotics to aid with pressing local and global issues. In Scandinavia, Code Club World offers opportunities for children to learn coding after school.

Relevance for Teaching, Learning, or Creative Inquiry

- Early exposure to working with robotics can encourage students to take an interest in the fields of engineering and programming.
- In physical education classes and school sports, robots have the potential to perform tasks such as retrieving balls and provide feedback to students on how to better improve their stance and throwing techniques based on their programmed knowledge of physics.
- Research from leading world universities and organisations such as the Australian Council for Educational Leaders reveals that coding helps instil more critical thinking and creativity in students.

Robotics and Programming in Practice

- At Stockholm's KTH Royal Institute of Technology, researchers are programming teams of robots to become school assistants: go.nmc.org/helpbot.
- In Norway, the initiative Kidsakoder is helping teachers implement coding programmes such as Scratch and LegoNXT in their classrooms: go.nmc.org/kidsa.
- A robot at Birmingham's Topcliffe Primary School helps autistic children develop social interaction skills by emitting encouraging responses without the confusion of non-verbal cues: go.nmc.org/teachbot.
- Swedish extracurricular programmes are using Coder Dojo to teach young learners how to develop mobile apps and games: go.nmc.org/coder.

For Further Reading

Kids Coding at School
go.nmc.org/kidsco

(Stuart Dredge, *The Guardian*, 22 September 2014.) This article provides perspective on teaching students how to code at a younger age and how it stimulates more critical thinking.

Robots in the Classroom: What Are They Good For?
go.nmc.org/robotool

(Katrina Schwartz, *MindShift*, 27 May 2014.) Schools view robots as teaching tools that will increase student engagement, develop children's computational thinking skills, assist teachers in presenting abstract concepts, and encourage learners to explore the field of programming.

Time-to-Adoption: Four to Five Years

Speech-to-Speech Translation

No longer in the realm of science fiction, the concept of a real-time universal translator is currently in the works as pioneering companies such as Microsoft, Google, and Facebook are acquiring and developing technologies that support speech recognition, language translation, and speech synthesis. In 2006, an advancement that led to the development and use of layered models of inputs, termed deep neural networks (DNN), brought speech recognition to its highest level of accuracy yet, clearing the way for speech-to-speech translation. As a result, today's consumers are habitually interacting with voice-activated virtual assistants on their mobile phones and even in their vehicles with greater ease and comfort. Researchers are now applying DNN to automatic translation engines in efforts to increase the semantic accuracy of interpreting the world's languages, and Microsoft engineers have already demoed software that can synthesise an individual's own voice in another language, from English to Mandarin. Progress in machine learning technologies is bringing the universal translator closer to the consumer's hand, and is poised to transform communication and collaboration at the global level.

Relevance for Teaching, Learning, or Creative Inquiry

- As speech-to-speech translation continues to advance, it is opening up a world of new learning resources as both teachers and students are able to access videos and podcasts in other languages that they previously would not have been able to comprehend.
- More sophisticated translation tools are improving virtual assistants, enabling voice-activated services like Cortana and Siri to be more effective in responding to teachers' and students' searches and requests.
- Speech-to-speech translation can be leveraged for cultural and foreign exchange programs, enabling Scandinavian students to more easily connect with pen pals from all over the world.

Speech-to-Speech Translation in Practice

- MIT researchers have developed the FingerReader, a camera-enabled reading device worn on the index finger that scans text and reads it aloud to blind and vision-impaired persons. There are inherent benefits for special education programs: go.nmc.org/mitscan.
- Poised to revolutionise worldwide communication, Microsoft has released a preview version of Skype Translator. The app will translate voice input in real-time and offers instant message translating in over 40 languages: go.nmc.org/realtime.
- A teacher with learning disabilities used Nuance's Dragon voice recognition software to prepare for class, communicate with students, and dictate a book he wrote about his challenges: go.nmc.org/natspeak.

For Further Reading

Deep Neural Networks Power Big Gains in Speech Recognition
go.nmc.org/dnn

(Alex Woodie, *Datanami*, 30 May 2014.) This article presents an evolution of research on natural language processing that led to advances in speech recognition, language translation, and Microsoft's development of Skype Translator.

Tech is Removing Language Barriers – But Will Jobs Be Lost in Translation?
go.nmc.org/appjobs

(Martin Williams, *The Guardian*, 19 September 2014.) Even as speech and translation technologies advance, human translators will still play a role in preserving nuance and bridging concepts across various cultural contexts.

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" was one of the earliest examples, and enables a user to see information about their surroundings displayed in front of them. Smart watches have also become commonplace, allowing users to check emails and perform other productive tasks through a tiny interface. Additionally, a rapidly growing category of wearable technology takes advantage of the burgeoning interest in the "quantified self." The Jawbone UP and Fitbit bracelets are two examples that track how you eat, sleep, and move. Empowered by these insights, many individuals now rely on these technologies to improve their lifestyle and health. Today's wearables not only track where a person goes, what they do, and how much time they spend doing it, but now what their aspirations are and when those can be accomplished.

Relevance for Teaching, Learning, or Creative Inquiry

- The next wave of wearable technology, implantable devices, can be embedded under a person's skin to detect and even dispense treatment for health issues.
- Students already spend time in formal classroom settings gathering data about themselves or research topics they have been assigned. Quantified self-enabled wearables tap into this interest to make the data collection process much easier.
- Wearable devices such as the Memoto, a camera worn around the neck that can capture an image every half minute, are enabling students to track their surroundings automatically — a particularly interesting dimension for student field trips.

Wearable Technology in Practice

- Scientists at Malmö University in Sweden are developing biofuel cells that will harvest and store energy from naturally occurring chemicals in the body, with future applications in wearable electronics such as pacemakers: go.nmc.org/malmo.
- A Swedish start-up company has unveiled Tinitell, a wearable phone and GPS-tracker for children that straps to a child's wrist and operates on voice recognition: go.nmc.org/tinitell.
- There are many potential educational uses for a wearable drone that unstraps itself from a user's wrist, shoots videos and photos, and wirelessly uploads images to a mobile device: go.nmc.org/wearit.

For Further Reading

Empathic Things: Intimate Computing from Wearables to Biohacking (PDF)
go.nmc.org/empath

(Sander Duivestein et al., VINTLabs Research, 12 March 2014.) This report identifies upcoming trends in wearable technology, and examines the rise of empathic devices that not only track data, but respond to conditions in real time.

Hearables: The Next Big Thing in Wearable Tech
go.nmc.org/heartech

(Nyshka Chandran, *CNBC*, 29 December 2014.) The next wave of wearables may be smart devices worn in the ear that wirelessly transmit information, because the ear offers a seat for technology that is discreet and does not interfere with face-to-face communications.

Methodology

The process used to research and create the *2015 NMC Technology Outlook for Scandinavian Schools: A Horizon Project Regional Report* is very much rooted in the methods used throughout the NMC Horizon Project. All publications of the NMC Horizon Project are produced using a carefully constructed process that is informed by both primary and secondary research. Dozens of technologies, meaningful trends, and critical challenges are examined for possible inclusion in the report for each edition. Every report draws on the considerable expertise of an internationally renowned panel of experts that first considers a broad set of important 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 *2015 NMC Technology Outlook for Scandinavian Schools* can be found at scandinavia.wiki.nmc.org.

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

Once the expert panel for a particular edition is constituted, their work begins with a systematic review of the literature — press clippings, reports, essays, and other materials — that pertains to emerging technology. Panel members are provided with an extensive set of background materials when the project begins, and are then asked to comment on them, identify those that seem especially worthwhile, and add to the set. The group discusses existing applications of emerging technology and brainstorms new ones. A key criterion for the inclusion of a topic is the potential relevance of the topic to teaching, learning, or creative inquiry. A 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 expert panel engages in the central focus of the research — the research questions that are at the core of the NMC Horizon Project. These questions are designed to elicit a comprehensive listing of interesting technologies, challenges, and trends from the panel:

1. *Which of these key technologies will be most important to Scandinavian 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 Scandinavian schools and programmes are using today that arguably ALL schools 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 Scandinavian schools and programmes be actively looking for ways to apply?*

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

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

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

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

2015 Horizon Project Scandinavia Expert Panel

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