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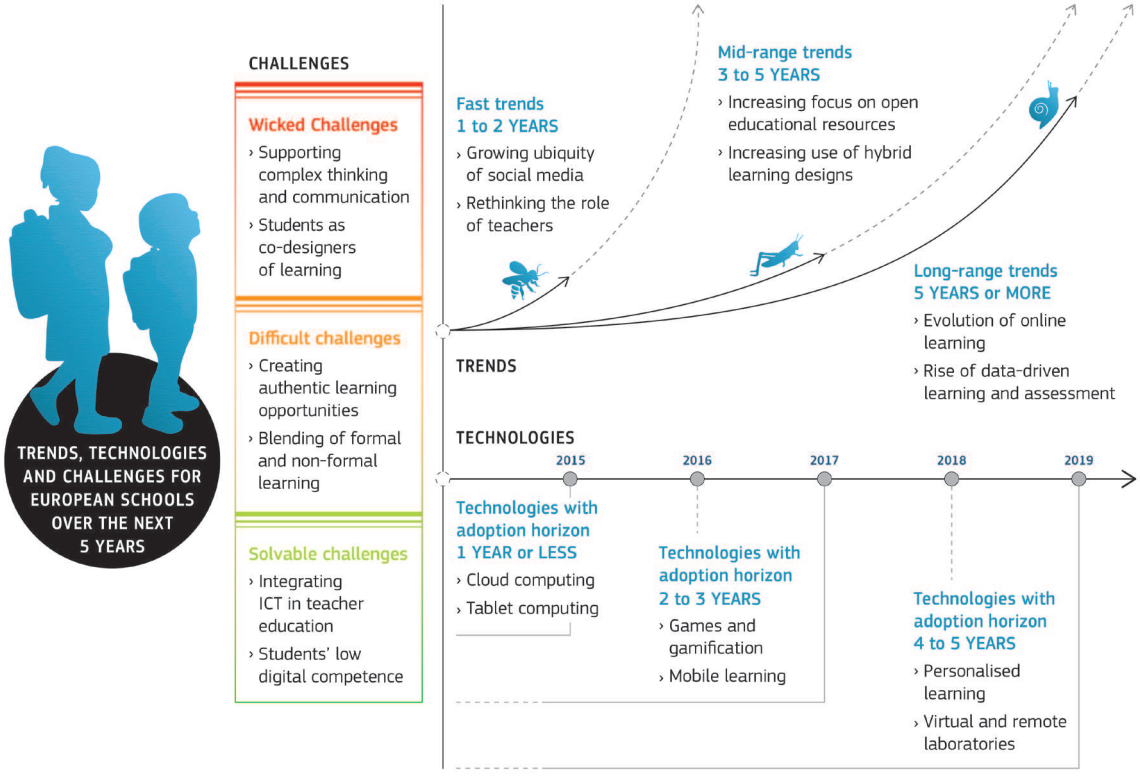
The *Horizon Report Europe: 2014 Schools Edition* examines trends, challenges, and technologies for their potential impact on and use in teaching, learning, and creative inquiry.



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European Commission
Directorate General for Education and Culture
A3 - Skills and Qualifications Strategies; Multilingualism policy

Contact information
Address: 70, Rue Joseph II – 03/125
B-1049 Bruxelles, Belgique
Email: EAC-UNITE-A3@ec.europa.eu
Tel.: +32 229 62 631
Fax: +32 229 987 151

http://ec.europa.eu/dgs/education_culture/

European Commission
Joint Research Centre – Institute for Prospective Technological Studies

Contact information
Address: Edificio Expo. c/ Inca Garcilaso, 3. E-41092 Seville (Spain)
Email: jrc-ipts-secretariat@ec.europa.eu
Tel.: +34 954488318
Fax: +34 954488300

https://ec.europa.eu/jrc

The New Media Consortium
Sparking innovation, learning and creativity

Contact information
1250 Capital of Texas Hwy South
Building 3, Suite 400
Austin, TX 78746
Email: communications@nmc.org
Tel.: 512 445-4200
Fax: 512 445-4205

www.nmc.org

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Executive Summary

What is on the five-year horizon for European schools? Which trends and technologies will drive educational change? What are the challenges that we consider as solvable or difficult to overcome, and how can we strategize effective solutions? These questions and similar inquiries regarding technology adoption and educational change steered the collaborative research and discussions of a body of 53 European experts to produce the first-ever *Horizon Report Europe: 2014 Schools Edition*, co-authored by the European Commission and the New Media Consortium (NMC). The *NMC Horizon Report* series charts the five-year horizon for the impact of emerging technologies in school communities across the globe. With more than 12 years of research and publications, it can be regarded as the world's longest-running exploration of emerging technology trends and uptake in education.

Experts agreed on two major imminent trends: the changing role of schoolteachers as a result of ICT influence, and the impact of social media platforms, such as Facebook and Twitter, which are already finding their way into classrooms. These are just two of the 18 topics analysed in the *Horizon Report Europe: 2014 Schools Edition*, indicating the key trends, significant challenges, and important technological developments that are very likely to impact changes in the 28 Member States' primary and secondary schools over the next five years.

Looking in the mid-term period, two to three years away, an increasing focus on open educational resources (OER) and on the use of both traditional and virtual learning methods are expected to have a strong impact in Europe. These trends are also identified at the global level for having the potential to stimulate new models of teaching and learning by tapping the wealth of content accessible through the Internet.

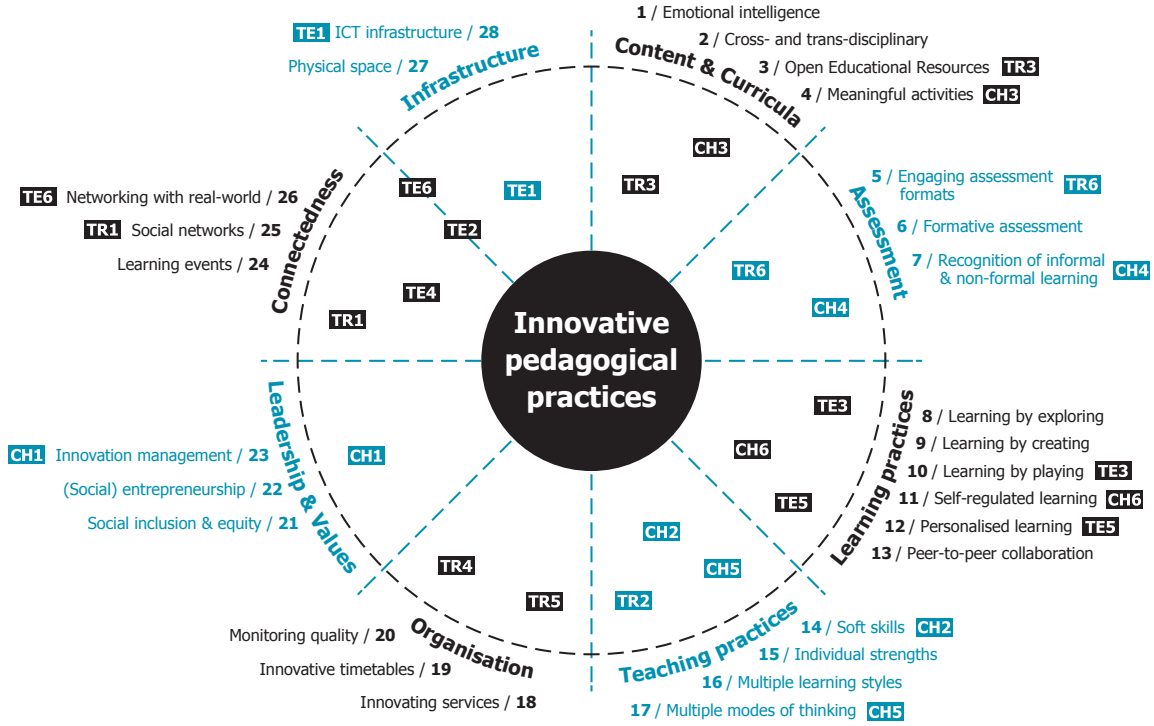
Regarding the challenges in European schools, students' low digital competence is considered one of the solvable challenges. It is already being addressed by ongoing actions of stakeholders and policy makers across the continent, as seen in the Digital Competence framework which has been recently endorsed by EU Member States representatives in the Education and Training Programme Thematic Working Group on ICT and Education. On the other hand, having students actively participating in the design of learning activities is considered to be a more difficult challenge and it lacks a clear strategy to solve it.

In view of the trends and challenges observed, the panel also signalled the technological developments that could support these drivers of innovation and change. Cloud computing and tablet computing are expected to be increasingly adopted by schools in one year's time or less to make use of services such as Google Apps for Education, Skype, and Dropbox. The time-to-adoption for educational games is estimated within two to three years, while personalised learning and virtual and remote laboratories are expected to be mainstream in schools within four to five years.

To better understand the likely impact of these 18 topics on the core missions of European schools, further analysis was conducted using a JRC-IPTS developed framework for mainstreaming ICT-enabled innovation for learning. This helped link the analysis to essential questions of relevance, policy, leadership, and practice that are needed to scale up innovative pedagogical practices in ICT-enabled learning settings (see Chart on page 2). While all of the topics can be described relating in some way to each of the eight elements of the framework, in Chart 1 they are mapped to demonstrate the element they impact the most. The framework, which was produced on behalf of the EC DG EAC in the "Up-Scaling Creative Classrooms in Europe" project (go.nmc.org/scaleccr[1]), sees learning environments, wherever they may be found, as "live ecosystems" that evolve over time, changing in tune with the context and culture in which they reside.

Elements of the Creative Classroom Framework

Mapping the Horizon Report Europe topics to the CCR Framework



Legend of Linkages to Horizon Report Europe Topics

TRENDS

TR1: Growing Ubiquity of Social Media
TR2: Rethinking the Role of Teachers
TR3: Increasing Focus on Open Educational Resources
TR4: Increasing Use of Hybrid Learning Designs
TR5: Evolution of Online Learning
TR6: Rise of Data-Driven Learning and Assessment

CHALLENGES

CH1: Integrating ICT in Teacher Education
CH2: Students' Low Digital Competence
CH3: Authentic Learning
CH4: Blending of Formal and Non-Formal Learning
CH5: Complex Thinking and Communication
CH6: Students as Co-Designers of Learning
TE1: Cloud Computing

TECHNOLOGIES

TE2: Tablet Computing
TE3: Games and Gamification
TE4: Mobile Learning
TE5: Personalised Learning
TE6: Virtual and Remote Laboratories

Introduction

In the pages that follow, 18 topics carefully selected by the Horizon Project Europe Expert Panel related to the educational applications of technology are examined, all of them areas very likely to impact technology planning and decision-making over the next five years (2014-2018). Six key trends, six significant challenges, and six important developments in educational technology are placed directly in the context of their likely impact on the core missions of European schools, and detailed in succinct, non-technical, and unbiased presentations. Each has been tied to a framework that links to essential questions of relevance, policy, leadership, and practice.

The *Horizon Report Europe: 2014 Schools Edition* was produced by the New Media Consortium (NMC) in collaboration with the European Commission's Directorate General for Education and Culture (EC DG EAC), the Joint Research Centre - Institute for Prospective Technological Studies (JRC-IPTS), Inholland University, QIN AS, and CellCove Ltd. The internationally recognised *NMC Horizon Report* series and regional *NMC Technology Outlooks* are part of the NMC Horizon Project, a comprehensive effort established in 2002 by the NMC that identifies and describes emerging technologies likely to have a large impact over the coming five years in education around the globe.

The partnership's goal for this major multi-organisational collaboration is that the key trends, challenges, and technological developments detailed here directly inform policy, leadership, and practice at all levels impacting European schools. This report aims to help ministers, governing boards, and school leaders to strategically approach the further evolution of teaching, learning, and creative inquiry. Each topic has been carefully researched and framed in the context of its potential impact on the 28 European Union Member States' primary and secondary schools. Moreover, throughout the report, references and links are made to more than 150 European publications (reports, articles, policy documents, blog posts etc.), projects (both EU-funded and national initiatives) and various policy initiatives from all over Europe.

The report's first two sections focus on an analysis of trends driving technology decision-making and planning, and the challenges likely to impede the adoption of new technologies, respectively. Each includes an explicit discussion of the trend or challenge's implications for policy, leadership, and practice in European schools, along with examples and relevant readings.

The third section, in which six important developments in educational technology are described, is ultimately framed by these trends and challenges. The adoption or abandonment of these technologies by European schools will be very much determined by the responses taken across the continent to these drivers of and obstacles to innovation and change.

This report aims to help ministers, governing boards, and school leaders to strategically approach the further evolution of teaching, learning, and creative inquiry.

Findings in the Global Context

The choices of the European experts overlap in interesting ways with those who contributed to the globally focused *NMC Horizon Report: 2014 K-12 Edition*, a sector analysis exploring technology adoption across primary and secondary education worldwide (Table 1). The choices also share similarities with the *NMC Horizon Report: 2014 Higher Education Edition*, which looked at technology uptake across higher education institutions, also from an international perspective. These comparisons illuminate key themes not only in European schools, but those whose impact is being felt globally.

The global Horizon Project K-12 and the Horizon Project Europe experts share a common vision that the role of schoolteachers will significantly evolve in the next couple of years, largely due to new developments in ICT and their effect on shifting pedagogies. Many schools in Europe are already reimagining teaching approaches to support more creative technology integration as well as more collaboration and hands-on learning among

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

NMC Horizon Report 2014 Global K-12 Edition	Horizon Report Europe 2014 Schools Edition	NMC Horizon Report 2014 Global Higher Ed Edition
Fast Trends		
Rethinking the Role of Teachers Shift to Deeper Learning	Growing Ubiquity of Social Media Rethinking the Role of Teachers	Growing Ubiquity of Social Media Integration of Hybrid Learning
Mid-Range Trends		
Increasing Focus on OER Integration of Hybrid Learning	Increasing Focus on OER Integration of Hybrid Learning	Rise of Data-Driven Learning Shift to Students as Creators
Long-Range Trends		
Acceleration of Intuitive Tech Rethinking of the School Day	Evolution of Online Learning Rise of Data-Driven Learning	Agile Approaches to Change Evolution of Online Learning

students. Both groups also recognise the potential influence of open educational resources (OER) and hybrid learning designs to stimulate new models of learning that leverage the rich tapestry of content accessible through the Internet.

There are also overlaps in the viewpoints of the Horizon Project Europe experts, mostly focused on schools and school issues, and the global Horizon Project Higher Education panel, which as the name suggests, focused on universities and other tertiary institutions. Both groups are seeing the proliferation of social media, and its impact on teaching and learning. Social media platforms, such as Facebook and Twitter, are finding their ways into classrooms at every level of education.

As online learning continues to grow in reach and quality, both schools and higher education are quickly adding hybrid and other web-based elements to their courses. These groups also see constraints, and while the challenges are distinct in the two sectors, both Expert Panels recognise that policy and practice need to be updated to maximise the effectiveness of online learning. Additionally, the global Horizon Project Higher Education panel and the European Schools panel agree that data-driven learning and assessment are on the rise, with emerging areas such as learning analytics and adaptive learning showcasing the potential to track student behaviours to better tailor their education pathways to their needs.

Several of the top-ranked challenges identified by the Horizon Project Europe Expert Panel were unique to Europe, and solidly based in local realities (Table 2). Concerns about student competency in the digital arena surfaced as a solvable challenge in Europe, largely due to ongoing actions of stakeholders and policymakers across the continent. The Digital Competence framework is a good illustration. It has been developed by JRC-IPTS on behalf of EC DG EAC and recently endorsed by EU Member States representatives in the Education and Training Programme (of ET 2020)

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

NMC Horizon Report 2014 Global K-12 Edition	Horizon Report Europe 2014 Schools Edition	NMC Horizon Report 2014 Global Higher Ed Edition
Solvable Challenges		
Authentic Learning Personalising Learning	Integrating ICT in Teacher Ed Students Low Digital Competence	Lack of Rewards for Teaching Low Digital Fluency of Faculty
Difficult Challenges		
Complex Thinking and Communication Increased Concern about Privacy	Authentic Learning Blending of Formal/Non-Formal	Competition from New Models Scaling Teaching Innovations
Wicked Challenges		
Competition from New Models Keeping Education Relevant	Complex Thinking and Communication Students as Co-Designers	Expanding Access to Education Keeping Education Relevant

Thematic Working Group on ICT and Education. Several Member States are already trying out the framework as a comprehensive approach to identify, describe, and assess digital competence. The *DIGCOMP* report[2] illuminates the issues and identifies potential solutions — some of which are already underway. Another distinctly European challenge is the blending of formal and non-formal learning, which conveys the consensus from the Expert Panel that the kinds of learning that take place at home and elsewhere should be better integrated into classrooms.

Additionally, the Horizon Project Europe Expert Panel saw authentic learning and complex thinking and communication as needing more time and concerted efforts to flourish than indicated by the global Horizon Project K-12 group. Both of these topics have unique definitions and contexts in Europe as compared to other parts of the world, justifying distinctive analyses and different kinds of project examples. In the United States, for example, some Horizon Project Higher Education panellists see makerspaces as a fundamental incarnation of authentic learning; while there are makerspaces in Europe, other activities, including vocational education training programmes and citizen science initiatives are at the forefront of the European panel discussions.

All three of these projects' panels share some visions for the use of educational technology in schools, as evidenced by several overlapping topics (Table 3). Games and gamification, for example, are perceived to be important developments that are two to three years away from widespread use. The three panels also recognise the potential impact of learning analytics and personalised learning, though the global Horizon Project Higher Education group sees this collection of technologies as more near-term than do schools in general.

Both the Horizon Project Europe and the global Horizon Project K-12 groups believe cloud computing is already in the agenda of schools, and will be more so over the next year. The many concrete project examples of schools using cloud-based services such as Google Apps for Education, Skype, Dropbox, and others show a movement toward leveraging this technology to bolster collaboration, digital competence, and productivity.

The Horizon Project Europe panel saw recurring need to increase students' access to high-calibre lab equipment, allowing students to conduct experiments from wherever they are, and exposing them to real data used by major research and science organisations. This choice underscores European school leaders' focus on designing more authentic and frequent learning opportunities for students.

Table 3: Comparison of Technologies Across Three NMC Horizon Projects

NMC Horizon Report 2014 Global K-12 Edition	Horizon Report Europe 2014 Schools Edition	NMC Horizon Report 2014 Global Higher Ed Edition
Time-to-Adoption Horizon: One Year or Less		
Bring Your Own Device (BYOD) Cloud Computing	Cloud Computing Tablet Computing	Flipped Classroom Learning Analytics
Time-to-Adoption Horizon: Two to Three Years		
Games and Gamification Learning Analytics	Games and Gamification Mobile Learning	3D Printing Games and Gamification
Time-to-Adoption Horizon: Four to Five Years		
The Internet of Things Wearable Technology	Personalised Learning Virtual and Remote Laboratories	Quantified Self Virtual Assistants

These points and comparisons provide an important context for the main body of the report that follows this summary. Its three major sections each highlight six rich technology-related topics, providing carefully curated examples and additional readings.

Methodology

To create the *Horizon Report Europe: 2014 Schools Edition*, a body of 53 experts in European education, technology, and other fields was convened in order to make the difficult decisions on which of those topics merited inclusion in the 2014 report, as well as determining if any key areas had been omitted.

The 2014 Horizon Project Europe Expert Panel represented 22 European countries, as well as several notable international organisations, including the

European Commission, OECD, and UNESCO, and European networks such as European Schoolnet.[3] The names and affiliations of the members are listed at the end of this report. Despite their diversity of backgrounds and experience, the panel agreed that each of the key trends profiled here will impact strategic technology planning for schools in Europe; that each of the significant challenges are impeding technology adoption in European schools; and that each of the six profiled technologies will influence the practice of primary and secondary education in Europe over the next five years.

Over the course of several months during late 2013 and early 2014, the European Expert Panel discussed and narrowed down the topics that would appear here in the *Horizon Report Europe: 2014 Schools Edition*. The examples and readings under each topic are meant to provide practical models as well as access to more detailed information.

The process used to research and create the *Horizon Report Europe: 2014 Schools Edition* is rooted in the methods used across all the investigations conducted under the banner of the NMC Horizon Project. Dozens of meaningful trends, critical challenges, and emerging technologies are examined for possible inclusion in the report for each edition before the list is winnowed down to the topics presented in the ultimate report.

To make those choices, every report draws on the considerable expertise of a panel that first considers a broad set of important trends, challenges, and emerging technologies, adds those they feel are missing, and then examines each of them in progressively more detail, reducing the set until the final listing of trends, challenges, and technologies is selected. This process takes place online, where it is captured in the NMC Horizon Project wiki. The wiki is intended to be a completely transparent window into the work of the project, one that not only provides a real-time view of the work as it happens, but also contains the entire record of the research for each of the various editions published since 2006. The wiki used for the *Horizon Report Europe: 2014 Schools Edition* can be found at europe.wiki.nmc.org.

The procedure for selecting the topics in the report is based on a modified Delphi process refined over the now 12 years of producing the *NMC Horizon Report* series. In late 2013, the Horizon Project Europe began with the assembly of a distinguished panel of experts, as in every Horizon Project cycle. The 2014 Horizon Project Europe Expert Panel represented a wide range of backgrounds, disciplines, and interests, and as noted previously, 22 European countries.

The panel's work began with a systematic review of current literature — press clippings, reports, essays, and other materials from the past year, or at most two years — that pertained to a variety of aspects of emerging technology. Panel members were provided with an extensive set of carefully curated materials when the project began to ensure that each worked from a common baseline of knowledge about important developments in technology within the past two years. Panel members then commented on the timely research, identified selections that seemed especially germane, and added to the set. Using the Horizon Project framework, any topics with potential relevance to teaching, learning, and creative inquiry in European schools were open for discussion. A carefully selected set of RSS feeds from hundreds of relevant publications ensured that the library of background resources stayed current throughout their work.

Following this in-depth pass through the most up-to-date resources available, the expert panel turned to the questions that are at the core of every NMC Horizon Project study. These questions were designed to elicit a comprehensive dialogue around interesting trends, significant challenges, and emerging technologies from the panel:

1 What trends do you expect to have a significant impact on the ways in which European schools approach the core missions of teaching, learning, or creative inquiry and how will they impact policy, leadership, and practice?

2 What do you see as the key challenges related to teaching, learning, or creative inquiry that European schools will face during the next five years, and how will they impact policy, leadership, and practice?

3 Which technologies will be most important to teaching, learning, or creative inquiry in European schools within the next five years?

4 What technologies might we be missing? Consider these related questions:

- **What would you list among the established technologies that some European schools are using today that arguably *all* European schools should be using broadly to support or enhance teaching, learning, or creative inquiry?**
- **What technologies that have a solid user base in consumer, entertainment, or other industries should European schools be actively looking for ways to apply?**

> What other technologies, from any economic sector, do you see developing to the point that European schools should begin to take notice of them during the next four to five years?

After approximately two weeks of online discussions, the responses to these questions were moved into a special voting tool where they were systematically ranked and placed into adoption horizons by each expert panel member using a multi-vote system that allowed members to weight their selections. Each member was asked to also place their selections into one of three categories based on, in the case of trends, speed of the trend; for challenges, their relative difficulty; and for technologies, when they might be likely to enter mainstream use.[4] Some 90 potential emerging technology topics were on the table at the beginning of the process, each accompanied by a raft of related readings, news, research, and reports.

From the comprehensive list of trends, challenges, and technologies originally considered, the 36 that emerged at the top of the initial ranking process — four per subcategory — were further researched and expanded. With the interim results identified, the panel explored a number of implications. For trends and challenges, the lens was policy, leadership, and practice. For the technologies, the criterion was adoption horizon. A significant amount of time was devoted to formalising these implications in the format of the *NMC Horizon Report*. With that work informing the final voting, the interim results were then ranked yet again. The topics at the top of that ranking (six in each of the three parts of the report) are those detailed here in the *Horizon Report Europe: 2014 Schools Edition*.

Trends Accelerating Educational Technology Adoption in European Schools

The six trends described in the following pages were selected by the project's expert panel in a series of Delphi-based voting cycles, each accompanied by rounds of desktop research, discussions, and further refinements of the topics. These trends, which the members of the expert 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-moving trends that will realise their impact in the next one to two years, and two categories of slower trends that will realise their impact within three to five or more years. All of the trends listed here were explored for their implications for European schools in a series of online discussions that can be viewed at europe.wiki.nmc.org/Trends.

The framework of the "Up-Scaling Creative Classrooms in Europe" (CCR) project, developed by the JRC-ITPS on behalf of EC DG EAC and illustrated in the executive summary, was used to map implications for policy, leadership, and practice that are related to each of the six trends discussed in this section. The CCR Framework places learning environments, wherever they may occur, as part of an ecosystem that evolves over time, and that is very responsive to the context and culture in which they reside. The eight-dimensional framework is systemic by nature, and encourages the design of multi-dimensional approaches when scaling up innovative pedagogical practices, especially in ICT-enabled learning settings.[5]

The NMC Horizon Project model derived three meta-dimensions from the CCR framework that were used to focus the discussions of each trend and challenge: policy, leadership, and practice. Policy, in this context, refers to the formal laws, regulations, rules, and guidelines that govern schools; leadership is the product of experts' visions of the future of learning, based on research and deep consideration; and practice is where new ideas and pedagogies take action, in schools, classrooms, and related settings.

Policy. While all of the identified trends had policy implications, two trends in particular are expected to have a strong impact on policy decisions over the next five years. As social media have pervaded many aspects of our informal lives, numerous applications for teaching and learning have been developed. Current initiatives across Europe seek to formalise the relationship between social media platforms and classroom activities, and it begins with designing effective policies. One goal of the "EU Kids Online," for instance, is to create guidelines for safe and effective use of these sites.[6]

While the panel experts also believe that open educational resources will reach their maximum impact in European schools within three to five years, policy makers are already taking actions to make quality resources available to teachers, including the Flemish Ministry of Education's KlasCement website, which showcases best practice examples of OER in use.[7]

The CCR Framework places learning environments, wherever they may occur, as part of an ecosystem that evolves over time, and that is very responsive to the context and culture in which they reside.

Leadership. Although there are leadership implications highlighted for all the identified trends as well, two trends, specifically in the realm of online learning, stand out as unique opportunities for vision and leadership. First, the rise of digital learning has called into question traditional education paradigms where learning almost exclusively takes place face-to-face. The integration of hybrid learning designs — a combination of both the traditional and virtual — into education is expected to be commonplace in the next two to three years, and is already apparent in non-formal learning communities for teachers. After researchers at the Eindhoven University of Technology in the Netherlands analysed 26 online professional development communities, they concluded that both virtual learning and face-to-face learning are most effective when used together. The study they published

provides recommendations for scaling these kinds of hybrid experiences.[8]

Positioned as a long-range trend, online learning practices are evolving to incorporate more emerging ICT and authentic, interactive learning experiences. There is room for leadership in terms of establishing best practices and preparing online content. The EU-funded "Teachers' Aids on Creating Content for Learning Environments 2" (TACCLE2) offers practical guidance for teachers using online environments for their classes, as well as discipline-specific content.[9]

Practice. Each of the six trends identified by the expert panel has numerous implications for teaching and learning practice, and in many cases, current examples are easy to find. It is widely agreed that expectations for teachers are evolving rapidly, especially as models such as student-centred learning and hands-on learning are increasingly emphasised by ministries of education and school administrations. The panel of experts believes there will be a major transformation in the role of teachers within the next two years, and there is already evidence of this in the way technologies are being used during class. A European consortium called Innovative Technology for Collaborative Learning and Knowledge Building, for example, created MapTool, an interactive display with which students are collaborating on mind maps to help them sort through complex subject matter.[10]

Finally, the panel perceives the rise of data-driven learning and assessment for European schools is at least five years away from large-scale use. A number of schools are integrating learning analytics in order to get an accurate sense of how — and how well — students are grasping the subject matter. Flint High School in the UK, for example, uses the online "Itslearning" platform so that teachers and students can access real-time assessments of their knowledge acquisition through activities both inside and outside of the classroom.[11]

The following pages provide a discussion of each of the trends highlighted by this year's expert panel that includes an overview of the trend, its implications, and curated recommendations for further reading on the topic.

Growing Ubiquity of Social Media

Fast Trend: Driving Ed Tech adoption in European schools over the next one to two years

Social media are changing the way people interact, present ideas and information, and judge the quality of content and contributions. More than 1.2 billion people use Facebook regularly according to numbers released in October 2013;[12] the top 10 social media platforms worldwide reach more than 2.1 billion people, according to eBiz MBA.[13] A recent report by the firm eMarketer reported social networks reach nearly one in four people around the world — almost 25% of the world population.[14] As of February 2014, the agency We are Social shared that there were around 300 million active social media users in Europe, accounting for 40% of the continent's population.[15] Teachers and students routinely use social media to communicate with each other and keep up to date on assignments.[16] As social networks continue to flourish in Europe, educators are also using them as professional communities of practice, as learning communities, and as a platform to share interesting stories about topics students are studying in class.

CCR Framework Element: ***Connectedness***

Overview

In many ways, the increasing use of social media in schools is being fuelled by its common use in everyday life across Europe. A recent study by Internet World Stats revealed that 63% of Europe's Internet-connected population uses Facebook, compared to just over 30% for the rest of the world.[17] Many of these subscribers (some 175 million people) log on daily to catch up on news and share content. Millions more use Twitter, which has become a major news source with more and more journalists and media outlets breaking news stories there. Social media have now proliferated to the point where they span all ages and demographics. According to the Office for National Statistics and Eurostat, the largest groups, primarily 6-24 year-old users, are concentrated in the UK, the Netherlands, and Sweden.[18]

Early use of social networks established them as a place to share pictures, video, and stories, but as social media have evolved, their long term value has coalesced around the ways these platforms make it easy to connect to family, friends, and especially for education, people of similar interests. 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 organisations are doing and who is talking about what.[19] For schools, social media provides a way to encourage feedback and suggestions, even as it enables two-way dialogues between students, parents, teachers, and the institution that are less formal than other means. Parents, for example, use groups in WhatsApp to connect with each other and stay informed about school happenings.[20]

School-age students commonly use social media to connect with their peers for all sorts of reasons, and understanding how social media can be leveraged for social learning — and how to avoid common missteps — has come to be a key skill for teachers. Initial teacher education and continuing professional development (CPD) programmes are increasingly expected to include these topics. Ann Michaelsen, a teacher and administrator in Norway, recently showed BETT Conference participants in London how to use Skype, YouTube, blogs, and Twitter to forge connections between students and experts,[21] but educators can also access professional forms of social media as well. Teachers across Europe are creating and participating in communities of practice via LinkedIn groups — "Prime Teachers Network"[22] and "Teaching English in Europe"[23] are two example groups in a growing set. Schools are using LinkedIn to announce open teaching positions and evaluate potential candidates.

Implications for Policy, Leadership, or Practice

With social media use rapidly growing across Europe, there is a need for schools to develop policies and guidelines so that students can better and more safely leverage these platforms and tools for learning. In the Netherlands, the Kennisnet Foundation launched the "Social Media in Education" project to provide example applications and protocols. They published Social Media in School, which explores tips for teachers that include integrating Facebook into homework assignments, creating photography lessons around Instagram, and using Twitter for regular communications with students.[24] Several related publications detail guidelines for preventing misuse of social media, especially cyberbullying. EU Kids Online aims to make social media

use by students safer and more productive, especially for the many 9-12 year-olds who use social networks underage.[25]

The Staff Working Document of the EC's "Opening Up Education" explores the benefits of integrating social media into education, including ways that social media can be used to make learning environments more dynamic, flexible, and open, while extending learning beyond the school day and in the home.[26] Also addressed in the document are potential challenges; in the EU, 75% of teachers have been using computers and the Internet at school for at least four years, but this usage has centred around creating lessons. Many teachers have not demonstrated expertise in weaving social media into their pedagogies, and as a result, the document calls for more education programmes and development opportunities.

For schools, social media provides a way to encourage feedback and suggestions, even as it enables two-way dialogues between students, parents, teachers, and the institution that are less formal than other means.

There remains considerable room for leadership, especially in documenting creative social media projects that demonstrate the benefits of social media for education, but many schools are making progress, and there are some notable successes. In Romania, the "eSafety4eTwinners" project at Caransebes School aims to decrease dropouts by encouraging students to demonstrate knowledge acquisition through social media, while also documenting the process on a wiki for other teachers looking to implement similar activities.[27] Caransebes students are using Glogster to view and create interactive presentations, as well as a Facebook Group for easy and private sharing. Learn2Teach convened students from vocational training colleges in six EU countries to present outcomes of their ICT-based social media studies. The presentations demonstrated how social media are transforming the way students communicate and influencing deeper learning in the classroom.[28]

For Further Reading

The following resources are recommended for those who wish to learn more about the growing ubiquity of social media:

Media Education in Four EU Countries (PDF)
go.nmc.org/mediafour
(Kennisnet Foundation, October 2013.) This report explores social media policies in Finland, Sweden, the UK, and the Netherlands as it relates to the rise in digital competency and safe web usage. > *Policy*

3 Reasons Why the School Principal Needs to Tweet
go.nmc.org/need
(Mark W. Guay, *The Huffington Post*, 6 December 2013.) Social media such as Twitter are part of the landscape in which the important skills of research, content creation, and networking are applied, and principals can be role models in demonstrating how to navigate social networks. > *Leadership*

The Facebook Guide for Educators
go.nmc.org/eduk
(*The Facebook Guide for Educators*, The Education Foundation, 2013.) The Education Foundation, along with Wellington College and London Nautical School, developed a social media guide that illustrates how to support teaching across multiple subjects. > *Leadership*

How Social Media Helps Bridge the Gap Between Home and School
go.nmc.org/home
(Rebecca Ratcliffe, *Guardian Professional*, 18 September 2013.) To keep parents involved, UK teachers at Mereside School blog and tweet about what their children do in class, using tools like Evernote to share students' portfolios. > *Practice*

Social Media Transforms the Textbook Lesson
go.nmc.org/soctran
(Carolyn Rice, *BBC News*, 30 January 2014.) Students at Sandvika High School in Norway use Quadblogging software, which allows four schools to meet online to read and exchange information with students in other countries. > *Practice*

Why Learning Through Social Networks Is the Future
go.nmc.org/plns
(Paul Moss, *TechThought*, 26 November 2013.) Social networks are important for both teachers and students, and the author argues that they must become a feature of school curriculum. > *Practice*

Rethinking the Role of Teachers

Fast Trend: Driving Ed Tech adoption in European schools over the next one to two years

Teachers are increasingly expected to be adept at a variety of ICT-based and other approaches for content delivery, learner support, and assessment; to collaborate with other teachers both inside and outside their schools; to routinely use digital strategies in their work with students and act as guides and mentors; and to organise their own work and comply with administrative documentation and reporting requirements. Students, along with their families, add to these expectations through their own use of ICT to socialise, organise, and informally learn on a daily basis, and many education thought leaders argue that schools should be providing ways for students to continue to engage in learning activities, formal and non-formal, beyond the traditional school day. As this trend gathers steam, many schools across Europe are rethinking the primary responsibilities of teachers. Related to these evolving expectations are changes in the ways teachers engage in their own continuing professional development, much of which involves social media and online tools and resources. While fully online schoolwork is still relatively rare on the continent, an increasing number of teachers are using more hybrid and experiential learning scenarios, and experimenting with social media and other ways of building learning communities.

CCR Framework Element: ***Teaching Practices***

Overview

As schools make the shift to more student-centred learning, they are also faced, as a matter of course, with rethinking the functions of teachers. In ideal scenarios, the teacher's role is becoming that of a mentor, visiting with groups and individual learners during class to help guide them, while allowing them to have more of a say in their own learning. This trend has led to a number of Europe-wide efforts to aggregate best practices and create new resources for the 21st century teacher. For example, eTwinning is an online community and collaboration space for schools across Europe.[29] Primary and secondary students are able to write and share ideas, and collaborate on school projects with other students through the use of ICT, social media, and more. Increasing pressure is being placed on teachers not only to understand how to use these types of tools, but also to integrate them in ways that foster more authentic learning.

Greater accessibility to the Internet also continues to spark profound changes in traditional paradigms. Teachers are no longer the primary sources of information and knowledge for students when a quick web search is at their fingertips. Instead it is up to teachers to reinforce the habits and discipline that shape life-long learners — to ultimately foster the kind of curiosity that would compel their students to continue beyond an Internet search and dig deeper into the subject matter. In order to be prepared to guide learners in this manner, teachers are increasingly expected to be knowledgeable on the practices, skills, and resources that will be useful to students as they continue their education and seek gainful employment.

One visible example of the transformation of teaching is the Education & Training for Entrepreneurship initiative, which aims to make youth more employable through the inclusion of creativity, business thinking, and training in the standard school curriculum.[30] As part of this effort, the European Commission published *Entrepreneurship Education: A Guide for Educators*, which refers to the teacher as a coach, as someone who listens to students, helps them harness ideas, incites collaboration and interaction, and introduces practical knowledge and experience of the working world.[31] Integrating entrepreneurship in education has provided the foundation for the kind of training and professional development that will be necessary for teachers as technology brings new forms of education to the forefront and highlights the importance of developing life-long learning strategies in the global economy.

Implications for Policy, Leadership, or Practice

Key to nurturing the new role of teachers is providing them with plentiful opportunities for professional development. In 2013, the European Commission published the report *Key Data on Teachers and School Leaders*,[32] which calls for continuous learning opportunities for teachers in order for them to adapt to the 21st century pedagogies. According to the publication, CPD is now mandatory for career advancement in some Member States, including

Romania, Slovenia, and Croatia. Another key European Commission document, the *Strategic Framework for Education and Training*,[33] hopes to incite forward-thinking policy-making, which includes considering alternative means of gaining teaching qualifications, reassessing the support available to teachers, and awarding additional monetary allowances. Several EU Member States are already revising their initial teacher education and continuing professional development programmes in order to prepare them for their new roles. Towards this direction, the EC's *Supporting the Teaching Professions for Better Learning Outcomes* reports on the essential steps, for example, emphasising the critical need for induction support for new teachers and CPD for in-service teachers.[34] The publication outlines ten key actions to support improved teaching, including redefining the qualities required for the position.

Part of finding success in this changing landscape is determining the right balance in how class time is used, which is one of the underlying notions of a teaching model that is gaining momentum in Europe — the flipped classroom. In this model, rather than the teacher using class time to instruct and dispense information, that work is done by each student before or after class, and could take the form of collaborating with their peers in online communities, curating online content, watching video lectures, listening to podcasts, and more. In 2013, the EU-funded project Creative Classrooms Lab held a design and implementation workshop that resulted in a report called *Policy Maker Scenario: Flipped Classroom*. It promotes a shift in practice to more student-controlled learning, which teachers can foster through the use of technologies, such as tablets and apps for note-taking and content creation, along with the use of virtual learning environments.[35]

Policy makers at the workshop mentioned above envisioned the teacher's role as discussing with students how to take notes properly by sharing successful examples, equipping them with presentation skills, and assessing their learning through the content they have created. Across Norway, several successful flipped classroom models are already underway, including those at Sandgotna Secondary School,[36] Hundsund Lower Secondary School,[37] and Sandvika High School,[38] where teachers are assigning video lectures for homework and reserve class time for in-depth discussions and active problem-solving.

For Further Reading

The following resources are recommended for those who wish to learn more about rethinking the role of teachers:

Supporting Teacher Competence Development for Better Learning Outcomes
go.nmc.org/support
(European Commission, July 2013.) The recommendations in this report are the result of a peer-learning process between experts on teacher education nominated by 26 countries and by European bodies of stakeholders that drew shared conclusions about how to implement effective policies. > *Policy*

Is the Traditional Role of a Teacher Outdated? (Video)
go.nmc.org/isthe
(Skoll World Forum, 11 April 2014.) In this video from the Skoll World Forum, education leaders discuss how recent innovations, technological advances, and resource scarcity all affect the way students learn, challenging the definition of a teacher. > *Leadership*

Towards Teacher-Led Design Inquiry of Learning
go.nmc.org/inqui
(Valerie Emin-Martinez et al., The Open University, 2014.) This paper proposes teacher-led design inquiry of learning as a new model of educational practice and professional development that integrates teacher inquiry into student learning, learning design, and learning analytics. > *Leadership*

How a Radical New Teaching Method Could Unleash a Generation of Geniuses
go.nmc.org/radical
(Joshua Davis, *WIRED*, 15 October 2013.) The author explores how a primary school teacher in a rural town was able to improve student performance by implementing inquiry-based instruction techniques learned through videos on the Internet. > *Practice*

Moving Education into the Digital Age: the Contribution of Teachers' Professional Development
go.nmc.org/moving
(P. Twining et al., *Journal of Computer Assisted Learning*, 5 August 2013.) Research indicates that effective models of teacher education require changes at several levels of educational systems, and that ICT presents an opportunity to introduce new structures and roles that support these changes. > *Practice*

The Uncomfortable Truth about Personalised Learning
go.nmc.org/plearn
(Stephen Laster, *Gigaom*, 2 September 2013.) The Chief Digital Officer at McGraw Hill-Education lists the three skills modern teachers should have in order to take advantage of personalised learning. > *Practice*

Increasing Focus on Open Educational Resources

Mid-Range Trend: Driving Ed Tech adoption in European schools within three to five years

Open educational resources (OER) are growing in breadth and quality, as is the use of these materials in classrooms, networks, and school communities. The use and adoption of OER materials is increasingly a matter of policy in schools, especially in the many disciplines in which high quality educational content is more abundant than ever. Understanding that the term "open" is a multifaceted concept is essential to following this trend; often mistaken to simply mean "free of charge," advocates of OER have worked towards a common vision that defines it more broadly — not just free in economic terms, but also in terms of ownership and usage rights. The goal is that OER materials are freely copiable, freely remixable, culturally sensitive, and free of barriers to access, sharing, and educational use. The 2012 UNESCO Paris OER Declaration has been a crucial document for defining open as it relates to the creation, circulation, and standardisation of educational resources.[39]

CCR Framework Element: ***Content & Curricula***

Overview

In 2013, the EU identified the development of OER as one of three actions of the "Opening Up Education" initiative proposed to bring the digital revolution to schools and universities.[40] As part of this initiative, a web portal called "Open Education Europa" was launched.[41] The portal is an expansion of an existing community that has been serving teachers since 2002. Today, it enables teachers, students, policy makers, and stakeholders to access existing European OER, MOOCs, the eLearning Papers journal, transnational projects, and forums where members exchange their experiences and ideas on the use of OER.

Together, these multinational efforts are an important precursor to the widespread adoption of OER for teaching and learning, and reflect a shift in the way European leaders are conceptualising education. The focus is increasingly moving to the process of learning than on the body of information conveyed. Information, in this view, is everywhere; the challenge is to make effective use of it. OER is seen as a way to do that. New licensing and IP schemes, led by efforts such as the Creative Commons, encourage not only the easy sharing and adaptation of educational materials, but also the exchange of pedagogies and instruction techniques. Part of the appeal of OER is that they are a response to both the rising costs of traditionally published resources and the related lack of educational resources in some regions. Actively in development in both the private and public sectors are business models to ensure that OER can be sustainable, credible, and up-to-date resources for teaching and learning.[42]

As a result, development of OER policy and distribution methods has advanced rapidly in Europe, supported by a number of high-profile projects dedicated to solving the remaining challenges so that the use of OER can realistically become widespread. The EU-funded project "Policies for OER Uptake" (POERUP) is a collaborative effort by institutions in Europe and Canada to compile research about existing OER policies throughout the world to support policy development.[43] In the *Report on Comparative Analysis of Transversal OER Initiatives*, it was noted that of the 120 notable initiatives studied throughout North America, Europe, and the Gulf States, nearly half are related to digital assets, while 20% are for open textbooks, and 29% are open courses.

The goal is that OER materials are freely copiable, freely remixable, culturally sensitive, and free of barriers to access, sharing, and educational use.

Implications for Policy, Leadership, or Practice

A major consideration of OER initiatives lies in resolving intellectual property issues to ensure that the resources shared are free and adaptable for anyone and for any purpose. To this aim, there has been significant progress; led by a founding member of the Polish Coalition for Open Education, the "Open Educational Resources Policy Project in Europe" is an effort by the Creative Commons and its European affiliates to ensure that all

educational content that is produced in Europe through public funding is licensed for free use.[44] The initiative's three main activities are focused on coordinating a community of Creative Commons affiliates and OER activists, developing a policy position with supporting research along with the publication of an informative manual about the benefits of open education, and conducting meetings with key decision making bodies and other stakeholders.

While there are focused efforts to publicly finance the development of streamlined platforms to create and distribute open content, much work is yet to be done to ensure the quality and completeness of OER. There are three ways in which OER quality is commonly verified: by the users and/or community; by a peer review process; or by adherence to an established quality assurance criterion. The Norwegian National Digital Learning Arena employs a top-down model using criteria developed by Norway's Centre for ICT to ensure that published OER fall within their standards. On the other side of the spectrum, a bottom-up approach is used to ensure the quality of open textbooks for "Book in Progress," a web resource for Italian secondary schools in which a subject teacher works with a subject coordinator to validate the text.[45]

To aid teachers with integrating OER into their classroom practices, the "OER Commons" is an online hub for content curation and training that was developed by the Institute for the Study of Knowledge Management in Education.[46] The "OER Commons" provides teacher education on the use and creation of learning materials with Open Author, a three-step online publisher that licences and shares the content with the "OER Commons" community. In addition to offering face-to-face training sessions with the "Teachers as Makers Academy,"[47] the project also provides a year-long mentorship programme and webinar trainings as part of the "OER Fellowship Programme."[48] Other forms of professional development for European teachers in the use of OER exists, but is typically limited to the OER community within the teacher's home country; "OER Commons" is a model for teacher education that transcends national boundaries and provides a variety of training options to teachers everywhere.

For Further Reading

The following resources are recommended for those who wish to learn more about the increasing focus on open educational resources:

The Cyfrowa Szkoła Programme in Poland
go.nmc.org/cyfrow
(Cyfrowa Szkoła, accessed 17 February 2014.) The Cyfrowa Szkoła is a government programme in Poland that is implementing technical training and OER provisioning pilots to determine the best selection of ICT equipment and methods for raising teachers' technical competences in teaching. > *Policy*

eQNet Travel Well Criteria
go.nmc.org/eqn
(Learning Resources Exchange for Schools, accessed 6 February 2014.) "eQNet" is a three-year project coordinated by European Schoolnet that involves nine ministries of education. This EU-funded project has published a set of "Travel Well" criteria that any teacher, repository owner, publisher, or vendor can use to identify and flag digital learning content with high potential for re-use. > *Leadership*

Open Education Europa
go.nmc.org/openup
(European Commission, accessed 16 February 2014.) The EC launched "Opening Up Education" to increase the use of publicly funded OER in schools and universities and promote the acquisition of digital skills. This web portal contains regularly updated information about the OER and free learning opportunities. > *Leadership*

Open Educational Resources InfoKit
go.nmc.org/infokit
(JISC, accessed 16 February 2014.) As part of the JISC "Open Educational Resources Programme," a kit of resources was compiled to help educators understand OER and how they can be integrated into learning activities. > *Leadership*

KlasCement
go.nmc.org/klasce
(KlasCement, accessed, 14 February 2014.) "KlasCement" started in 1998 as a resource website for primary and secondary teachers in Belgium to share teacher-generated content. As of 2014, it is part of the Ministry of Education. The site now includes OER suitable for cross-border usage and examples of best practices. > *Practice*

The Potential of Open Educational Resources (PDF)
go.nmc.org/pote
(JRC-IPTS, January 2013.) This presentation highlights the major current OER initiatives in Europe and how they are affecting educational practices. > *Practice*

Increasing Use of Hybrid Learning Designs

Mid-Range Trend: Driving Ed Tech adoption in European schools within three to five years

As teachers and students alike become more familiar with and adept at using the Internet, traditional classroom pedagogies increasingly include online learning components, hybrid learning strategies, and increased focus on collaboration within the classroom. 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 engage students in a broader variety of ways, and even extend the learning day. Hybrid models, when designed and implemented effectively, enable students to use the school day for group work and project-based activities, while using the network to access readings, videos, and other learning materials on their own time, leveraging the best of both environments.

CCR Framework Element: ***Organisation***

Overview

A renewed interest in online learning has taken place over the past few years, fuelled in large part by press attention to massive open online courses (MOOCs), but also by increased access to the Internet and broadband services, and a growing recognition that online learning can indeed add value to almost any learning environment. Hybrid learning models, which blend the best of classroom instruction with the best of web-based delivery, place a strong emphasis on using school time for peer-to-peer collaboration and teacher-student interaction, and placing independent learning into online environments.[49] The flipped classroom is one pedagogical example of hybrid learning that requires students to engage with web-based content at home, usually video lessons, while class time is repurposed as an opportunity for teachers to mentor individuals and groups, and for students to problem solve and work together with classmates. The distinction is in the degree to which the Internet components are woven into the curricular design.

The International Association for K-12 Online Learning's (iNACOL) latest survey of global online and blended learning initiatives shows that while online learning options are commonly available to students in the EU, only a handful of countries, such as Denmark, Finland, and Romania, have made it part of their national agendas to fund hybrid learning initiatives for primary and secondary students.[50] While not part of national agendas yet, other countries are encouraging schools to experiment with hybrid models. In the Steve Jobs Schools in the Netherlands, for example, students use their personal tablet devices to access educational resources both inside and outside of school. A host of innovative resources have been developed to facilitate this blended experience including a virtual campus called "sCoolSpace," which allows children and their teachers to meet offsite.[51]

In a recent *Talking Futures* interview, online learning experts and authors Gavin Dudeney and Nicky Hockly described their vision of European education in 2050 as one where hybrid and flipped learning models would become more common as collaboration replaces lecture as the cornerstone of learning, both in the virtual and physical realm. They emphasised the need for policy-makers and educators to work together in addressing the changing role of teachers and the impact of ubiquitous technology in the classroom. While both agree that physical learning environments are necessary for socialisation and will likely still exist in 2050, they believe hybrid learning models will become the mainstream for secondary education as digital communication tools become more sophisticated.[52]

Implications for Policy, Leadership, or Practice

Ministries of education across Europe are examining the implications of hybrid learning for policy and practice. The "Creative Classrooms Lab" project, for example, is designing policies and developing capacity in support of hybrid-based teaching and learning for nine ministries of education, and plans to implement their ideas in 45 classrooms. The *Policymaker Scenario: Flipped Classroom* envisions a classroom where teachers are expected to guide students to resources, lead discussions, and coordinate activities, while students are responsible for using ICT tools to seek, organise, and prepare information they can share with their peers during class. After compiling observations from the pilot and making plans for further capacity development, the project will begin its second round of school pilots in October 2014.[53]

In many ways, hybrid learning strategies reflect how learning takes place in the modern workplace, and EU-funded research teams are conceiving of new designs for classrooms that reflect this reality. An initiative by European Schoolnet has formalised its visions for learning spaces in *Future Classroom Lab Learning Zones*, which are designed to optimise physical space, leverage ICT resources, and take into account the transformation of the student-teacher role and dynamic as well as the different learning strategies of students.[54] The "Develop" scheme is the most informal layout provided, and it is based on the idea that independent learning is expected to take place at home, while the classroom is used for project work and collaborative activities. The new classroom environment is informal and relaxed, a place where learners can use their personal devices to access online resources and virtual learning environments in study corners and comfortable places, while tables and other common areas encourage face-to-face collaboration.

Hybrid learning models, which blend the best of classroom instruction with the best of web-based delivery, place a strong emphasis on using school time for peer-to-peer collaboration and teacher-student interaction.

Hybrid learning is not unique to schools, but appears to have more of a social component among adult learners. A recent study published at the Eindhoven University of Technology in the Netherlands analysed 26 informal online communities for professional development to find out if hybrid forms of teacher education provided more practical benefits to teachers than other models. Among the initial findings was that the nature of blended learning is different with teachers than it is with students — while students are obliged to participate more in the virtual space, teachers tend to leverage the blended platform to establish offline connections with other teachers outside of their learning communities.[55]

For Further Reading

The following resources are recommended for those who wish to learn more about the increasing use of hybrid learning and related instructional designs:

Online and Blended Learning (PDF)
go.nmc.org/obl
(iNACOL, October 2013.) This publication explores online learning policy examples from schools around the world, sharing major trends, issues, and challenges. Several Ministries of Education in Europe are developing programmes to implement blended learning at scale.
> *Policy*

A Framework for Adopting Blended Learning in Traditional School Based Learning
go.nmc.org/frame
(Othman et. al., *International Journal of Digital Information and Wireless Communications*, 2013.) Researchers from the University of Huddersfield in the UK explain how the ubiquity of technology is advancing a method of learning that combines e-learning with practical, laboratory-based learning to compose a pedagogy that prepares learners for today's workplace. > *Leadership*

Semi-Autonomous Blended Learning for Intercultural Communication in the Euregio Meuse-Rhine
go.nmc.org/interc
(M. Verjans and A. Gelan, European Universities' Network on Multilingualism, accessed 6 February 2014.) Project "INTERcCOM" seeks to simplify studying and working in the Euregio Meuse-Rhine. E-learning modules are being developed based on research results from studying young Polish and Turkish natives and their language habits to be used in either an independent learning setting or a blended semi-autonomous setting.
> *Leadership*

Blended Learning in Theory and Practice: Finland
go.nmc.org/theo
(Teemu Leinonen, Media Lab Helsinki, 14 December 2013.) Elaborating on a digital first strategy, this researcher highlights the importance of making all aspects of a course accessible from anywhere and from any device, so that the classroom can be repurposed as a laboratory, studio, or workshop. > *Practice*

Hybrid Personal Learning Environments
go.nmc.org/bilandzic
(Mark Bilandzic, Kavasmlikon, 20 October 2013.) A researcher and developer of user-centred methodologies and digital media demonstrates what a personalised, hybrid ecosystem of learning is through the perspective of designer and architect. > *Practice*

Evolution of Online Learning

Long-Range Trend: Driving Ed Tech adoption in European schools in five or more years

The nature of online learning has enjoyed a renaissance over the last two years as MOOCs have largely silenced questions about the relevance of online learning and sparked an explosion of development, new ideas, and experimentation. The design of these online experiences has become the central focus of most discussions, and new pedagogical models and new tools are proliferating all over the world; in Europe, several new initiatives have been put into place to stimulate development, notably the European Commission's "Opening Up Education."[56] New distance learning offerings across the board feature more rich media, more interactive features, better-defined objectives and outcomes, and more polished content than their earlier prototypes. Modernising online learning strategies calls for the consideration of how both students and teachers are impacted. Students can benefit from supplemental and alternative learning experiences and teachers from online professional development and communities of practice.

CCR Framework Element: ***Organisation***

Overview

While the previous topic and this one are clearly related, the ways in which online learning is evolving are much broader than the already well-established notion of hybridisation. This trend is expected to remain important for some time in Europe, as the ability for schools to support fully online learning varies considerably across the continent. The European Commission recently reported that 63% of the population's nine year-olds and 50% of 16 year-olds attend schools that are missing important digital equipment. Twenty percent of secondary school students have never — or almost never — used a computer in class. Access to online resources is especially limited in EU countries such as Croatia and Greece, where less than half of schools provide Internet connectivity for students.[57]

Based on these gaps, the EC is working to support and create projects that improve and expand online learning opportunities through "Opening Up Education" and other initiatives. This trend reflects a growing awareness that for online learning to be a realistic option, all aspects of school life and the school ecosystem need to be considered. Moreover, many see online learning as a vehicle for social equality, reaching disadvantaged students as well as those in rural areas. The "Bednet" in Belgium, for example, is an organisation that serves children who are suffering from long-term and/or chronic illness.[58] Similarly, the Wereldschool in the Netherlands provides online, alternative education for students with special needs that may not be accommodated by the traditional school system.[59]

While there have been major developments in online learning, much work remains to be done on assessment strategies, identity management, ensuring quality, promoting deeper student engagement, and managing online learning at scale. The EU-funded VISCED project has developed an online inventory of 81 virtual schools in Europe that are promoting the use of online learning to supplement and even replace face-to-face schooling.[60] VISCED provides case studies that analyse the effectiveness of eight virtual schools in the EU, detailing existing models that can be emulated, and highlighting further work that can be done to maximise online learning.[61]

These, and many related developments underway in this arena, present schools and students with a significantly broader range of choices for instructional delivery and learning than has been available in the past. Several online schools are already aimed at specific groups of students, such as "NotSchool" in the UK, which uses personalised learning techniques to address individual needs.[62]

Implications for Policy, Leadership, or Practice

While there are an increasing number of online schools and hybrid learning experiences for students, teachers can also benefit from online continuing professional development. Several new online initiatives expressly target teacher education. In Spain, the Ministry of Education developed the initiative "Formación en Red" in order to provide teachers there with online training in critical areas, such as open educational resources.[63] The recent launch of the European Schoolnet Academy aims to provide better professional development for primary and secondary school teachers, and piloted its first courses in early 2014. These free, online courses include

topics such as "Innovative Practices for Engaging STEM Teaching" and "Future Classroom Scenarios."[64]

In addition to the growing array of pan-European efforts, individual countries have assumed leadership roles in advancing the state of online learning by producing high-quality online methodologies and resources. For example, the Education Development Centre in Lithuania launched the "Development of the Key Competencies in Basic School" project, which entailed the designing of new online teaching approaches and materials that can be used for language, literature, and science curriculum for pupils in years five through eight.[65] Similar efforts are underway through the EU-funded project "Teachers' Aids on Creating Content for Learning Environments 2" (TACCLE2), which provides teachers with step-by-step guides for integrating more emerging technologies into their online learning environments for a wide range of subjects including math, science, arts and culture, and humanities.[66] TACCLE2 also provides ideas that are customised for specific ages.

While initiatives such as the ones mentioned above convey a focus on expanding and improving online learning offerings across the EU, the trend is still perceived by many as long-range. Researchers provided a review of online learning policy as it pertains to European schools in an article entitled "E-learning Policy and the 'Transformation' of Schooling: a UK Case Study," published in the *European Journal of Open, Distance and E-Learning*.[67] The article explored reasons why current online education policies have not yet led to peak effectiveness and cited difficulties encountered by more rural countries in the EU, including lack of computer access and insufficient ICT training for both teachers and students necessary for the creation of and participation in online classes.

Many see online learning as a vehicle for social equality, reaching disadvantaged students as well as those in rural areas.

For Further Reading

The following resources are recommended for those who wish to learn more about the evolution of online learning:

EU Says School Children Lack e-Learning Facilities
go.nmc.org/eulack
(*Phys Org*, 25 September 2013.) Under the "Opening Up Education" initiative, the European Commission announced plans to fund projects that will improve online learning in order to help learners develop more advanced digital skills. > *Policy*

We Need to Close the Gap that is Swallowing Up 700,000 Kids
go.nmc.org/close
(Holly Seddon, *The Huffington Post*, 22 January 2014.) There are still many students in Europe without Internet access at home — sometimes not even in school. "Mind the Gap" is a national programme in the UK to get every school-age child access to online learning from home. > *Policy*

How Has the Internet Changed Education?
go.nmc.org/howhas
(Sahiba Pahwa, *EdTech Review*, 29 May 2013.) The author explores how the Internet has impacted education, providing a sense of where we have been as a precursor to how we can move forward. > *Leadership*

eLearning: It's Time for a Reboot
go.nmc.org/reboo
(Carol Leaman, *WIRED*, 24 June 2013.) By combining the latest technology with research on how the brain works to improve memory and cognition, e-learning can be modified to deliver better results. Some of these modifications include breaking learning into bite-sized segments and providing ongoing reinforcement of critical points through spaced repetition. > *Practice*

The Impact of Technology on Curiosity
go.nmc.org/curi
(Terry Heick, *TeachThought*, 16 August 2013.) The Internet has introduced an environment where students can have an infinite number of social groups and access large amounts of data, which has changed their expectations for online learning experiences. > *Practice*

A New Pedagogy is Emerging…And Online Learning is a Key Contributing Factor
go.nmc.org/pedag
(*Contact North*, accessed 6 January 2014.) This article describes how technology and student expectations are driving changes in pedagogy that favour knowledge management through digital fluency and lifelong learning skills. > *Practice*

Rise of Data-Driven Learning and Assessment

Long-Range Trend: Driving Ed Tech adoption in European schools in five or more years

There is an increasing interest in using new sources of data for personalising the learning experience, for ongoing formative assessment of learning, and for performance measurement; this interest is spurring the development of a relatively new field — data-driven learning and assessment. Learning analytics is one manifestation of it. 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. Data-driven learning and assessment will build on those early efforts.

CCR Framework Element: ***Assessment***

Overview

Data are routinely collected, measured, and analysed in the consumer sector to inform companies about nearly every aspect of customer behaviour and preferences. A number of researchers and companies are working to design similar analytics that can reveal patterns in learning-related data that could be used to improve learning both for individual students, and across institutions and systems. Before entering European schools, many challenges will need to be addressed by researchers and companies providing such services. Researchers and practitioners are just beginning to understand which data is useful for advancing learning, as well as the scope of privacy and ethics issues. The potential of using data to improve services, retention, and student success is already becoming evident.

The Fischer Trust's independent report[68] on the online platform "SAM Learning"[69] details the potential of integrating analytics in learning environments. The site monitors student progress so that teachers can identify and assist those having difficulty with certain materials. The Fischer Trust's report revealed a positive relationship between the use of the SAM Learning platform and academic progress in General Certificate of Secondary Education (GCSE) exams; students who used the tool for ten hours improved their scores by one GCSE grade. Data-driven learning can also affect the way learning is organised in a classroom. In the Finnish upper secondary school Martinlaakson Lukio, students participate in a math course autonomously. Using paper materials and formative assessment tools embedded in a learning management system, they pace their own learning. As a result, teachers have more time to concentrate on students' individual needs. This implementation of data-driven learning not only assures that students are learning the required content, but also teaches them self-evaluation skills.

As the body of knowledge around learning analytics from projects and studies continues to grow over the next few years, school and government leaders will be much more informed about performance measurement statistics and how to use them to guide learning outcomes and educational policy. Toward this end, the EC has funded a number of research and development projects on data-driven learning and assessment, and adaptive learning in general. One project in this space is "Learning Analytics Community Exchange" (LACE), a collaborative project involving European partners who are passionate about the opportunities afforded by learning analytics and educational data mining.[70] The promise of data-driven learning and assessment is such that work in this area will continue until there are easy and efficient ways to generate and capture real-time learning data in classrooms and schools.

Implications for Policy, Leadership, or Practice

In online environments especially, students and teachers are already generating a large amount of learning-related data from their interactions with websites, learning software, and communication and sharing tools that could be used to inform the learning process. A growing number of initiatives aim to formalise policies regarding the appropriate gathering and use

of student data. The EU-funded "Learning Analytics Community Exchange" seeks to reduce risk and increase benefit through unity of research, policy, and practice. "Opening Up Education," an initiative by the European Commission, is another effort that will test the impact of this technology on business models, and encourage the exchange of best practices for learning analytics and adaptive learning technologies through the Erasmus+[71] and Horizon 2020[72] programmes, as well as through the European Social Fund.[73]

A region-wide report by OECD, titled *Synergies for Better Learning: An International Perspective on Evaluation and Assessment*, suggests that data-driven evaluation and assessment is expanding and will require more technological sophistication at all levels of the education system.[74] To support this long-range trend, OECD concluded that school leaders must build the capacity of teachers to experiment with curriculum development, improve data collection skills, and understand computer-facilitated approaches to assessment through teacher education programmes. Additionally, OECD suggests the formation of consortia and partnerships at the national level, by providing important leadership in modelling and disseminating best practices. To advance the use of data-driven learning and assessment, European school leaders can actively encourage teachers to try new methods of assessment and find ways to generate real-time data from classroom activities.

European schools have already started piloting online assessment tools in hybrid classes, where teachers are gaining experience using new forms of data. Hybrid classes, which blend online with traditional face-to-face class activities, present the opportunity for automated data collection and instructional customisation. By combining computer-based instruction with data analysis features, teachers can track students' progress in the curriculum and determine how best to meet their individual needs. Hundreds of primary and secondary schools in Norway, the UK, and the Netherlands are currently using the LMS, "Itslearning,"[75] to facilitate this digital strategy. The "Itslearning" platform, for example, provides Flint High School in the UK with course dashboards that enable both teachers and students to get quick assessments of learning inside and outside of the classroom.[76] As more schools experiment with online assessment tools, leaders and policy makers will have more findings to inform the guidelines for the effective adoption of these tools.

For Further Reading

The following resources are recommended for those who wish to learn more about data-driven learning and assessment:

The Use of ICT for the Assessment of Key Competences (PDF)
go.nmc.org/ictkey
(JRC-IPTS, 2013.) The report illuminates how ICT can enable assessment formats that capture students' competencies and proposes measures needed to encourage the development and large-scale implementation of innovative assessments in schools. > *Policy*

Learning Analytics Context
go.nmc.org/lace
(LACE Project, accessed 6 February 2014.) LACE is a collaborative project involving European partners who are passionate about the opportunities afforded by learning analytics and educational data mining.
> *Leadership*

The Potential of Learning Analytics and Big Data
go.nmc.org/poten
(Patricia Charlton et al., *Ariadne*, 8 July 2013.) The UK authors believe that gaining access to data is not the problem; instead, determining which data are significant and why is the challenge. > *Leadership*

Assessment Strategy at Martinlaakson Lukio
go.nmc.org/marti
(Pekka Peura, *Matematiikan Opetuksen Tulevaisuss*, 12 February 2014.) At Finnish upper secondary school Martinlaakson Lukio, students use their own learning data to self-assess in order to advance through the course. The method is based on Bloom's mastery learning model and it bypasses the need for final exams.
> *Practice*

Formative Assessment and Learning Analytics (PDF)
go.nmc.org/format
(Dirk T. Tempelaar et al., Universiteit van Amsterdam, April 2013.) This paper from researchers in the Netherlands examines what individualised information feedback can look like in a blended learning environment. > *Practice*

Khan Academy's Use of Data to Assess Learning (Video)
go.nmc.org/assess
(Geddes Munson, YouTube, 25 March 2013.) This video entails a description of what comprises Khan Academy's analytics model: thoughtful measurement of learning, user goals, game mechanics, and machine learning with the support of researchers. > *Practice*

Challenges Impeding Educational Technology Adoption in European Schools

The six challenges described on the following pages were selected by the project's expert panel in a series of Delphi-based cycles of discussion, refinement, and voting; the expert panel was in consensus that each is very likely to impede the adoption of one or more new technologies if unresolved. A complete record of the discussions and related materials were captured in the online work site used by the expert panel and archived at europe.wiki.nmc.org/Challenges.

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 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; and 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. Once the list of challenges was identified, the "Upscaling Creative Classrooms in Europe" (CCR) framework, detailed in the Executive Summary, served as a lens to identify implications for policy, leadership, and practice.

The CCR Framework places learning environments, wherever they may occur, as part of an ecosystem that evolves over time, and that is very responsive to the context and culture in which they reside. The eight-dimensional framework is systemic by nature, and encourages the design of multi-dimensional approaches when scaling up innovative pedagogical practices, especially in ICT-enabled learning settings.[77] The NMC Horizon Project model derived three meta-dimensions from the CCR framework that were used to focus the discussions of each trend and challenge: policy, leadership, and practice. Policy, in this context, refers to the formal laws, regulations, rules, and guidelines that govern schools; leadership is the product of experts' visions of the future of learning, based on research and deep consideration; and practice is where new ideas and pedagogies take action, in schools, classrooms, and related settings.

Policy. While all of the identified challenges have important policy implications, two specific challenges are driving policy decisions in European schools at the moment. The easiest of these to address is the development of and adoption of policies related to enhancing the digital competence of students. The work to frame such policies is already well underway in the European Commission, which published a recent report with a digital competence framework that can serve as a meta-framework for current frameworks, initiatives, curricula and certifications.[78] The framework has been endorsed by EU Member State representatives in the Education and Training Programme (of ET 2020) Thematic Working Group on ICT and Education. Several Member States are already trying out the framework as a comprehensive approach to identify, describe and assess digital competence.

Because not all challenges are of the same scope, the discussions here are sorted into three categories defined by the nature of the challenge.

Still a few years away from being solved is the challenge of blending non-formal and formal learning approaches into a comprehensive model of learning. Policymakers have been relatively quiet in terms of developing guidelines that connect this kind of learning with formal curriculum, but the Slovenian government has been developing standards and criteria. As part of their Vocational Education and Training programme, they aim to better define informal experiences so they may be included as part of special vocational pathways.[79]

Leadership. Leadership implications are common to all the challenges described in this section, but two will require visionary leadership. The first is considered by the expert panel as an urgent need to address the lack of ICT education for teachers. Fifteen ministries of education in Europe have formally recognised this challenge and are partnering with European Schoolnet

on their "iTEC: Designing the Future Classroom" project. Through this initiative, more in-service and pre-service teachers are learning how to effectively apply ICT in their classrooms from pedagogical and technical trainers.[80]

The second opportunity for extraordinary leadership was deemed a wicked challenge by the expert panel. Schools are trying to understand how to include students in the design of learning experiences, even as personalised learning, the flipped classroom, and other forward-thinking approaches are already shifting more control over learning to students. The inability to define this challenge combined with a lack of clear strategies to solve it is what makes it wicked.

Practice. Each of the six challenges identified by the expert panel presents numerous impediments for advancing teaching and learning, and two are viewed as particularly daunting to solve. Incorporating more authentic learning in curricula is classified as a difficult challenge, but it is already a priority for many schools in Europe, including the Marina Laroverket School in Sweden. In their immersive learning model, they invite students to study aboard a sailboat over the course of a month and immerse themselves in practical applications of astronomy and marine biology in the field.[81]

Many educational leaders and theoreticians feel that the research required to understand complex thinking and communication is just beginning to produce new insights — making it a wicked challenge. Until that happens, it will be all but impossible to deploy new models that will integrate these skills into classroom activities. Nonetheless, the expert panel felt that these skills are critical if we are to develop the scientists, engineers, and leaders that are needed to address the global challenges students will face.

The following pages provide a discussion of each of the challenges highlighted by the expert panel that includes an overview of the challenge, its implications, and curated recommendations for further reading on the topic.

Integrating ICT in Teacher Education

Solvable Challenge: Those that we understand and know how to solve

The Survey of Schools: ICT in Education report[82] found that ICT is not being used to its full capacity across the European Union. While the majority of schools are connected and equipped with technology, many teachers lack the skills or formal education they need to empower learners to pursue their own interests and free class time for more experiential forms of learning. There is a need for teacher education programmes that integrate digital pedagogies and learning in a way that is not merely superficial, but founded on the meaningful research that shows how students best learn with digital tools and methods. Many of these emergent methods support environments where the Internet and web-based applications offer a way for learners to explore, create, and share knowledge with each other.

CCR Framework Element: ***Leadership & Values***

Overview

The lack of adequate teacher education relating to digital learning and digital pedagogies is a challenge that is widely acknowledged and documented throughout Europe. A number of countries are working to update their teacher education programmes to include techniques and strategies for digital learning, but there is still much to be done.[83] ICT training comprises a component of initial teacher education in just over half of EU countries, but implementation varies by institution and country. The challenge for pre-service teachers is that although ICT is deemed important, it is not a compulsory component for all initial teacher education programmes. A majority of the training currently available to in-service teachers focuses primarily on learning software, and much less on integrating ICT into instruction in ways that add real value to learning.

The *Survey of Schools: ICT in Education* identified several obstacles that are all too often present when implementing ICT in the classroom, ranging from insufficient ICT equipment for digital learning, lack of competence and pedagogical models, unclear goals for using ICT or lack of consensus about what the goals are, and the lack of mandatory teacher training in ICT.[84] Additionally, the study revealed that although there are many online opportunities for teachers, they look for professional development online only a minority of the time. A recent TALIS survey by OECD supports these findings; the research shows that on average, 65% of TALIS teachers reported that their ICT training used traditional forms of expert-led workshops or seminar-style classes.[85] The TALIS study also illuminated impediments such as conflicts with teachers' work schedules and a general feeling that there was no suitable professional development available. Professional learning communities could be the key to addressing many of these obstacles by providing school-wide, ongoing support for teacher ICT education.

Technology already permeates almost every dimension of students' and teachers' lives outside of school, and both students and their parents expect schools to help them to become fully competent digitally. A wide range of pedagogies and strategies exist for instilling fluency in technology; many are even mapped for use in a range of specific disciplines. Further demonstrating the need for this dimension of teacher preparation to be enhanced, the Norwegian SMILE report[86] and *Survey of Schools: ICT in Education* found that the uneven pedagogical use of technology in the classroom revolves around a number of factors, but the most important finding is that the level of a teacher's digital competence directly correlates with students' learning outcomes when technology is used.

Implications for Policy, Leadership, or Practice

One of the reasons this challenge is perceived as solvable is that the challenge is well understood, and solutions are available. As *Survey of Schools: ICT in Education* documented, for example, teachers are not taking advantage of formal teacher training opportunities that exist, and are using ICT primarily to prepare their teaching instead of having students use technology in their work. The report recommends the creation of policies to boost the development of digitally supportive schools and teachers by promoting the use and integration of ICT in the classroom and investing in capacity building for in-service teacher education. Many education leaders agree — to ensure schools and teachers are able to deliver on the expectations of parents, employers, and society, digital learning should permeate teacher education at all levels.

University pre-service programs are also beginning to see the importance of their leadership and willingness to innovate if this challenge is to be met, and some are stepping up with new programs aimed directly at the issue. The Universidad Pablo de Olavide in Spain, for example, has developed the "New Information Technologies and Communication" module for teachers of secondary education students.[87] Among the objectives of this training module are to promote the active and independent role of students in the process of knowledge construction and design, to develop interactive concept maps about the strengths and weakness of ICT in educational contexts, and to encourage multimodal learning. The module is organised in several thematic clusters: society, education, and ICT; students and teachers of the new millennium; social software and example of good practice with ICT; and the study of educational platforms and evaluation of multimedia network materials.

In-service teachers looking to learn more about effective use of ICT in the classroom can turn to the growing array of resources across Europe aimed precisely at this need. "Edukata," for example, enables Finnish in-service teachers to turn their innovative ideas into actual classroom practice.[88] They do so by investigating digital scenarios such as BYOD, the flipped classroom, or online learning, and creating future classroom learning activities that reflect key aspects of the personal interests and needs of their students. Similarly, European Schoolnet's Academy provides free online teacher training in key ICT concepts and ideas and enables practicing teachers to share their experiences with their colleagues across Europe. Two pilot courses include "Future Classroom Scenarios" and "Innovative Practices for Engaging STEM Teaching."[89]

In-service teachers looking to learn more about effective use of ICT in the classroom can turn to the growing array of resources across Europe aimed precisely at this need.

For Further Reading

The following resources are recommended for those who wish to learn more about integrating ICT in teacher education:

The 'Teacher Effect' on the Use of ICT
go.nmc.org/schoolnet
(European Commission, April 2013.) The *Survey of Schools: ICT in Education* found that about half of European students are taught by teachers that are confident with using ICT in the classroom, but only a fraction of those teachers have access to technology in their schools and ICT training. > *Policy*

Teachers Need Confidence to Teach Coding Properly
go.nmc.org/conf
(Andrew Manches, *The Conversation*, 24 January 2014.) The author argues that there is insufficient research into what makes good coding pedagogy and digital literacy because it is often not incorporated in teacher training. > *Policy*

Eduvista
go.nmc.org/eduvista
(Eduvista, accessed 6 February 2014.) The "Eduvista" toolkit helps teachers organise their educational visions through change management and helping stakeholders and ICT experts better understand schools' needs. > *Leadership*

Hands-On ICT: Learn, Practice, Teach Creativity and ICT
go.nmc.org/handson
(*Hands-On ICT*, 25 March 2013.) The "Hands-On ICT" project, funded by the Lifelong Learning Programme of the EC, facilitates the integration of ICT tools in education by employing a learn-by-doing model in which teachers learn on their own with the support of mentors. > *Leadership*

Adopting Digital Skills in an International Project in Teacher Education
go.nmc.org/nordseth
(Hugo Nordseth, *International Journal of Media, Technology, and Lifelong Learning*, 2012.) An associate professor describes a project to train teachers using ICT tools and video-based learning resources, as well as to coordinate collaborative work. > *Practice*

Education Researcher to Teachers: Use Available Technology to Improve Student Achievement
go.nmc.org/learnblend
(Mark Macdonald, *Itslearning*, 17 September 2013.) The head of Digital Learning Communities at the University of Bergen in Norway believes teachers need to adopt ICT tools because they offer learners different ways to demonstrate content mastery. > *Practice*

Students' Low Digital Competence

Solvable Challenge: Those that we understand and know how to solve

Despite a range of national and pan-European digital competence initiatives, research from sources such as the "EU Kids Online"[90] project shows that the levels of digital competence in children and teenagers remain inadequate, especially on the dimensions of critical and participatory literacy, where students do not just read content, but also engage with it and actively create their own responses to it. In an age when news often spreads virally through social media, most experts feel it is critical that young people learn how to analyse and evaluate the authenticity of the myriad of messages they encounter everyday.

CCR Framework Element: ***Teaching Practices***

Overview

The EU has defined digital competence to be the confident, critical, and creative use of ICT to achieve goals related to work, employability, learning, leisure, inclusion and/or participation in society. All EU Member States agree that digital competence education is a means for learners to hone their skills for productivity and the creation and understanding of media.[91] While many European countries have established digital competence programmes for students in the past decade, there is a continuing need to update learning outcomes and objectives to adapt to the current technological terrain. Education policy is continuously challenged to stay abreast of the evolution of media and the devices used to access it, and increasingly, digital competence of students is not just the focus of educators, but also policymakers and regulatory bodies, as well as media-oriented NGOs and citizen initiatives.

Since 2006, the "EU Kids Online" project has been actively monitoring research about the benefits and risks that youth may encounter while engaging in online activities.[92] They have charted the understanding of how children use online technologies and have identified several significant gaps in research around online activity. These include uneven coverage by age, an overwhelming focus on the fixed Internet (to the neglect of mobile, convergent, and emerging technologies), the roles of parents and teachers, and safety mediation.

Improving the abilities of students to interpret and create digital media is a problem that is understandable and solvable; much is known about the topic, both at the policy and practice levels. Teacher education will be at the centre of successful solutions. To prepare European students for the skills and capacities for 21st century citizenship — global awareness, creativity, collaborative problem-solving, and self-directed learning — it is clear that the core practice of teaching and learning must include the tools and resources used commonly by most of the population.

Implications for Policy, Leadership, or Practice

The *DIGCOMP* project, released in 2013 by the European Commission, was part of a multi-year policy effort initiated by DG EAC and executed by JRC-IPTS to define digital competence in order to establish an umbrella for frameworks, curricula, and certifications in this area.[93] The project identified the key components of digital competence in terms of knowledge, skills, and attitudes; developed descriptors to inform a conceptual framework and/or guidelines; and proposed a roadmap for a digital competence framework. The authors defined digital competence needs as including the following areas: information, communication, content-creation, safety, and problem solving. Each of these areas was placed in a matrix and included a general description of the competence; descriptors on three proficiency levels; examples of knowledge, attitudes, and skills; and examples of applicability for different purposes. The framework has been endorsed by EU Member States representatives in the Education and Training Programme (of ET 2020) Thematic Working Group on ICT and Education and several Member States are already using it.

The European Commission's "Opening Up Education" initiative includes a comprehensive effort to solve identified deficiencies in digital competence and provide schools with the framework and tools necessary to prepare students for jobs in the growing European digital economy.[94] Indeed, the EC has projected that by 2020, 90% of European jobs will require digital skills. Three key initiatives have been identified as strategies to improve digital competence: encourage teachers and educational institutions to test innovative digital approaches; ensure open access to educational materials; and improve the digital infrastructures of

schools. Support for these initiatives will come from the new programmes Erasmus+[95] and Horizon 2020,[96] as well as through the European Social Fund.[97]

The EU-funded project iTEC investigates how established and emerging technologies can be used effectively in classrooms over the next several years.[98] As part of the initiative, the ORT School in Milan will implement iTEC's "Design of the Future Classroom" model.[99] In this comprehensive digital competence project, a class of 15 year-old students will utilise collaborative video-making, a flipped classroom methodology, and Edmodo social media technology to develop video math tutorials for younger students. Findings from the first three years of the iTEC project have revealed a positive impact on students' knowledge, skills, and learning practices as well as improving teachers' technology-supported pedagogy, digital competence, and motivation.

While many European countries have established digital competence programmes for students in the past decade, there is a continuing need to update learning outcomes and objectives to adapt to the current technological terrain.

For Further Reading

The following resources are recommended for those who wish to learn more about students' low digital competence:

DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe (PDF)
go.nmc.org/digc
(JRC-IPTS, 2013.) This report details the various aspects of digital competence by listing 21 competences and describing them in terms of knowledge, skills, and attitudes. It then proposes a framework for digital competence. > *Policy*

DIYLab Do It Yourself in Education: Expanding Digital Competence to Foster Student Agency And Collaborative Learning
go.nmc.org/diyl
(European Commission, Education, Audiovisual and Culture Executive Agency, 6 March 2014.) A 3-year project called DIYLab, coordinated by the University of Barcelona, Charles University in Prague, Escola Virolai, and ZŠ Korunovační, explores the educational intersection of technology, digital media, and the creative DIY culture. > *Leadership*

EU Kids Online III: A Thematic Network to Stimulate and Coordinate Investigation into the Use of New Media by Children (PDF)
go.nmc.org/euk
(The London School of Economics and Political Science, 31 October 2013.) The "EU Kids Online" network provides findings and critical analyses of new media applications and associated risks among children across Europe in an effort to sustain an active dialogue with stakeholders about priority areas of concern for child online safety.
> *Leadership*

Vassiliou Calls for More Focus on Media Literacy
go.nmc.org/vassiliou
(European Commission, 18 October 2013.) The European Commissioner for Education, Culture, Multilingualism, and Youth acknowledges the need for children to begin studying media and communication, as it is considered an essential competence in the European economy.
> *Leadership*

A Journey to Media Literacy (Video)
go.nmc.org/eavi
(EAVI, 29 January 2013.) This animation from the European Association for Viewers Interests provides an explanation of media literacy and why it is important for youth to be able to evaluate, understand, and produce audio-visual media and communications. > *Practice*

Learning to Be: Developing and Understanding Digital Competence (PDF)
go.nmc.org/devel
(Morten Søby, idunn.no, 2013.) The author argues that schools must equip youth with the necessary digital skills that will allow them to cope with the challenges that fostering connectedness poses, and therefore students need digitally competent teachers as role models. > *Practice*

Blending of Formal and Non-Formal Learning

Difficult Challenge: Those that we understand but for which solutions are elusive

There is increased focus on the kinds of self-directed, curiosity-based learning that can happen in non-traditional, non-formal educational environments, especially as access to ICT tools expands throughout Europe. Museums, libraries, and science centres have historically been hubs for non-formal learning, and now commonly incorporate digital resources into their programming and encourage visitors to delve deeper into subject matter via their mobile devices. As more Europeans are able to connect to the Internet and pursue inquiries at their leisure from wherever they choose, there is a burgeoning discussion about formalising these types of educational experiences. While some EU Member States have made significant progress on qualifying non-formal learning for adults through VET programs, there is mounting effort to recognise the value of non-formal and informal learning for European youth as well. Many experts believe that the promise of blending outside learning experiences into formal education will create a dynamic environment that fosters experimentation, curiosity, and creativity and, perhaps most importantly, a propensity for learning that will endure throughout a student's lifetime.

CCR Framework Element: ***Assessment***

Overview

The blending of non-formal learning into formal education is an intriguing notion, but hampered by the lack of ways to acknowledge and qualify learning that happens beyond the classroom. Adding complexity to the matter is a lack of clear ways to quantify the kinds of informal learning experiences in which youth engage. Some argue that in order to integrate non-formal education into the formal system, skills that have tangible, transferable value in the real world must be identified and promoted as key competences. Much work has been done to define and explore those aspects of non-formal learning, but the larger frame of possible learning — now generally understood as the kinds of acquisition of knowledge that occur in everyday life but are not usually formally evaluated — is not so well understood.

In 2010, OECD worked with representatives from 22 countries to compile their experiences in a report entitled *Recognising Non-Formal and Informal Learning*, which provides a foundation for countries to begin defining learning and skills that are gained outside of formal institutions.[111] The overall goal of this work is a massive undertaking — to be able to accurately assess human capital within a nation with the aim of strengthening all economies involved. At a time when many EU Member States are faced with high levels of youth unemployment, the need to continue this effort for young people has become a high priority.[112] As access to ICT tools and the Internet steadily increase, there are more opportunities for European youth to have profound learning experiences in informal environments and to pursue employable skills on their own.

As other non-formal learning institutions such as museums, libraries, and science centres are exploring the potential of ICT to engage their patrons, activities offered to the public are growing more sophisticated, providing opportunities for people to gain real-world skills. A recent EU-funded initiative offers European youth authentic STEM experiences through "SciCamp," a network of European institutions and organisations that provide programming for students to explore science and technology using inquiry-based learning and ICT.[113] "SciCamp" connects learners with role models in the field by establishing relationships for students with local companies and laboratories, as well as regional universities, technical universities, and other STEM-focused institutions. In a similar vein, the London Science Museum's "Robot Safari" exhibition featured 13 biomimetic robots along with their makers who explained how they were used to study plant and animal behaviours. As part of the three-day exhibition, participants learned to program, build, and race their own simple robots through a series of interactive workshops.[114]

Implications for Policy, Leadership, or Practice

Work is well underway across Europe to develop policies to guide the validation of non-formal and informal learning. The Council of the European Union recently released their official recommendation that by 2018, Member States should have arrangements to validate this type of learning through the processes of identification, documentation, assessment and certification.[115] Since

2004, the European Commission has been consulting stakeholders, teachers, students, and human resource managers for the European Inventory Project, a compilation of best practices and relevant legislation from over 30 Member States that is updated constantly. Slated to release in late 2014, the latest edition of the European Inventory Project will inform policymakers of systems that have already proven effective as they work toward achieving this benchmark.[116]

EU-funded initiatives in the museum sector are highlighting the array of quality educational experiences offered by cultural institutions across the EU with the aim of legitimising informal learning. The Learning Museum, for example, is a network of 23 partners from Europe and the United States that are working on how museums can and should play an active role in support of lifelong learning. The organisation's website provides a place where museum stakeholders can contribute to discussion on the recognition of skills and qualifications of learners and workers, as well as share descriptions of summer schools, camps, free online courses, and other activities that promote non-formal and informal learning activities for children and adults.[117]

Building frameworks for assessment is a key piece of the solution, as schools and teachers will need criteria to measure non-formal experiences in ways that are transparent and transferable across borders. The Youth on the Move programme, Youth Pass, for example, legitimises learning outcomes for youth that participate in voluntary service, training courses, or work exchanges, and awards certificates that list the key competences acquired by the participant. While Youth Pass is not integrated in the formal education system, it is a method that has successfully promoted key Lifelong Learning competences, and can serve as one model for assessing non-formal experiences for youth.[118]

For Further Reading

The following resources are recommended for those who wish to learn more about the blending of formal and non-formal learning:

Council Recommendation on the Validation of Non-formal and Informal Learning (PDF)
go.nmc.org/valid
(The Council of the European Union, *Official Journal of the European Union*, 20 December 2012.) As a response to a proposal from the European Commission, the Council of the EU makes recommendations on how to proceed with the integration of non-formal learning into formal learning scenarios. > *Policy*

Potential and Perspective of Non-Formal Education for the Future of the Younger Generation
go.nmc.org/potential
(Justina Vitkauskaite Bernard, *The Baltic Times*, 28 November 2013.) A Lithuanian member of the European Parliament describes an innovative approach that encourages youth to be lifelong learners who use technology to learn non-formally, with the aim of gaining the competences and skills they need for employment.
> *Policy*

Informal Learning: Facing the Inevitable and Seizing the Advantage
go.nmc.org/inevitable
(Terry Heick, *Edutopia*, 7 March 2014.) The author makes the case that educators can no longer afford to resist the cultural and technological trends that have already disrupted how people access information, connect with one another, and publish the events of their lives.
> *Leadership*

Designing Blended Learning Space to the Student Experience
go.nmc.org/space
(Andrew J. Milne, EDUCAUSE, accessed 1 April 2014.) The authors highlight a shift in learning to more social, non-formal, and less structured activity. He visualises classrooms designed as meeting spaces that facilitate interaction and collaboration. > *Practice*

Learning Why Ships Float at the Lithuanian Sea Museum
go.nmc.org/ships
(Creative Classes Laboratory, 13 December 2013.) Year seven students visited the Lithuanian Sea Museum to get hands-on experience with buoyancy by performing their own experiments to learn how vessels float.
> *Practice*

Opportunities via Extended Networks for Teens' Informal Learning (PDF)
go.nmc.org/exte
(Peyina Lin and Shelly D. Farnham, ACM 2013.) Interviews with secondary school students explore their non-formal learning activities, what contributes to their initiation and continuation, and the role of technologies for their non-formal learning. > *Practice*

Creating Authentic Learning Opportunities

Difficult Challenge: Those that we understand but for which solutions are elusive

Authentic learning, especially that which brings real life experiences into the classroom, is still all too uncommon in European schools. Authentic learning is seen as an important pedagogical strategy, with great potential to increase the engagement of students who are seeking some connection between the world as they know it exists outside of school, and their experiences in school that are meant to prepare them for that world. Use of learning scenarios that incorporate real life experiences, technology, and tools that are already familiar to students, and interactions from community members are examples of approaches that can bring authentic learning into the classroom. Practices such as these may help retain students in school and prepare them for further education, careers, and citizenship in a way that traditional practices are too often failing to do.

CCR Framework Element: ***Content & Curricula***

Overview

Authentic learning, as defined by the EDUCAUSE Learning Initiative, typically focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice. EDUCAUSE's report *Authentic Learning for the 21st Century: An Overview* suggests that authentic learning prepares students for the skills and knowledge demanded by universities and the workplace.[100] Experiential and hands-on learning curricula represent early efforts, but much remains to be done, including the design of methods to assess these activities. Establishing mutually beneficial relationships with businesses, organisations, and public entities in the community is seen as a promising avenue for development, but effective models are rare. Very few schools have forged these kinds of relationships. Fewer still are teachers who are adept in the design and delivery of authentic learning approaches.

While the concepts inherent in authentic learning are appropriate for many disciplines, the need for authenticity is expressed most often in science, technology, and mathematics education. Across Europe, there has been a marked decrease in students pursuing science degrees in college, a trend that is already creating a shortage of qualified workers for the science and technology industries. As a result, there is a growing focus on the need for students to experience what the work of real scientists is like. Authentic learning focuses on involving students in citizen science projects and other activities that can bring science to life. Online citizen science projects such as "Zooniverse,"[101] "CamClickr,"[102] and "Evolution MegaLab"[103] allow students to participate in authentic scientific discovery. In each of these examples, students can contribute real data and observations about their surroundings to a growing database. "Evolution MegaLab," for instance, encourages students to study the evolution of the banded snail by recording observations of snails in their community as part of a massive project to understand the evolution of snail shell colouring.

"Virtual Enterprises International" is an example of how authentic learning experiences can connect students with the world of business and entrepreneurship, preparing them for continuing their education and entering the workforce.[104] This in-school, global business simulation offers students project-based and collaborative learning, along with the development of 21st century skills in areas including problem-solving, communication, personal finance, and technology. Inspired by the Austrian model of apprenticeships, this experiential learning model engages students by replicating all the functions of real business in both structure and practice. Teacher-facilitators and business mentors guide students as they create and manage all facets of their virtual business from product development to marketing in a range of firms.

Implications for Policy, Leadership, or Practice

While many educators are embracing the concept of authentic learning, there is a need for concrete policies that will stimulate the interest of schools and help guide them throughout the process — from standards for defining and evaluating authentic learning to establishing safety protocol for offsite learning experiences. Many current examples of authentic learning in practice involve initial vocational education, in which upper secondary students are undertaking apprenticeships and shadowing professionals at local

enterprises. The European Commission's report, *Work-Based Learning in Europe*, assesses the state of these programmes and makes education and labour market policy recommendations to maximise their safety and effectiveness.[105] Among other suggestions, the report calls for investing in other types of work-based learning, including the development of onsite labs and workshops in schools that link back to the offsite vocational training.

In order to facilitate authentic learning in their classrooms, teachers will need adequate support to update their pedagogies and teaching materials. ESTABLISH ("European Science and Technology in Action Building Links with Industry, Schools, and Home") is an EU-funded project in which policymakers, parent groups, and others are coming together to develop authentic learning experiences for secondary students, while providing education programmes for teachers to help them incorporate this new curriculum in their classrooms.[106] Similarly, the "Developing Real World Authentic Learning" project, co-funded by the Republic of Cyprus and the European Regional Development Fund, developed its own model of authentic learning, based on real-world problem-solving through collaborations between schools and enterprises.[107] The project includes training programmes for teachers as well as online instructional materials that support staff capacity-building. Standards of assessing authentic learning experiences are not yet readily available.

While projects such as ESTABLISH convey an active interest from EU leaders to implement authentic learning in STEM areas, more leadership is needed by EU Member States and the local educational authorities across all primary and secondary school disciplines. 3D printing is being viewed as a way to achieve more hands-on learning in the humanities, allowing students to explore cultural history through replicas of real-world artefacts. Greek company Museotechniki recently won an award from the EU @Diversity Ideas Competition for their 3D printing project "Museofabber."[108] The project aims to open up access to museums' digital collections, so that schools can print historical objects for teaching and learning. Increasingly, leaders are looking to facilitate similar activities on school grounds in the form of makerspaces. These designated spaces enable students to tinker, experiment, and build with tools such as 3D printers, laser cutters, and microcontrollers. Most schools in Europe do not yet have onsite makerspaces, but there is an opportunity for leaders to partner with organisations like MakerFaire Rome[109] or Barcelona's MADE Makerspace,[110] and strategise ways to develop them in schools and school libraries.

For Further Reading

The following resources are recommended for those who wish to learn more about authentic learning:

Germany's Unique Key to Success
go.nmc.org/unique
(Stefan von Borstel, *Press Europ*, 8 May 2013.) Germany's dual vocational training system has enabled more real-world learning, decreased their unemployment rate dramatically, and now supply outweighs demand. > *Policy*

The inGenious Code: School - Industry Collaboration
go.nmc.org/inge
(Jean-Noel Colin et al., European Schoolnet, June 2013.) Collaboration between school and industry is becoming more common in Europe to help students gain real-life perspectives, especially on how STEM subjects are applied in research and business. The inGenious code of conduct is Europe's first attempt to guide both schools and businesses in forming alliances. > *Policy*

Robotics Lessons in New Curriculum
go.nmc.org/robot
(Graeme Paton, *Education News*, 7 July 2013.) Children as young as five years-old will be learning about robots, programming, 3D printers, and laser cutters after the UK government mandated that the national design and technology syllabus be revised to teach more engineering-related skills. > *Policy*

A Hands-On Approach to Physics in the Classroom
go.nmc.org/phot
(European Commission: Horizon 2020, 13 December 2013.) A team of photonics researchers, teachers, and experts in pedagogy from 11 EU countries has created a new educational kit with equipment for fun classroom experiments to be distributed free to schools across Europe. > *Leadership*

Is it Project-Based Learning, Maker Education or Just Projects?
go.nmc.org/pbledu
(Jackie Gerstein, *User Generated Education*, 22 October 2013.) The author believes that many attempts to implement authentic learning experiences fail because teachers lack a solid foundation in the concept. She shares a list of guiding questions for educators. > *Practice*

Why Academic Teaching Doesn't Help Kids Excel in Life
go.nmc.org/excel
(Shelley Wright, *Mindshift*, 14 November 2013.) An educator describes how she transformed her instruction to move away from its traditional academic focus and into a project-based, technology-enhanced pedagogy that mimics real world scenarios. > *Practice*

Complex Thinking and Communication

Wicked Challenge: Those that are complex to even define, much less address

It is essential for schoolchildren both to understand the networked world in which they are growing up and also — through computational thinking — to understand the difference between human and artificial intelligence, learn how to use abstraction and decomposition when tackling complex tasks, and deploy heuristic reasoning to complex problems.[119] The semantic web, big data, modelling technologies, and other innovations make new approaches to training learners in complex and systems thinking possible. Yet, mastering modes of complex thinking does not make an impact in isolation; communication skills must also be mastered for complex thinking to be applied in profound ways. Indeed, the most effective leaders are outstanding communicators with a high level of social intelligence; their capacity to connect people with other people, using technologies to collaborate and leveraging data to support their ideas, requires an ability to understand the bigger picture and to make appeals that are based on logic, data, and instinct.

CCR Framework Element: ***Teaching Practices***

Overview

While some aspects of this topic could be framed as similar to or overlapping with what several authors have described as "design thinking," for the purposes of this report, the two are considered as distinct concepts. The term "complex thinking" refers in this report to the ability to understand complexity, a skill that is needed to understand how systems work in order to solve problems.[120] Complex thinking could be described as an application of systems thinking, as the ability to decipher how individual components work together as part of a whole, dynamic unit that creates patterns over time is very much a part of this idea.[121]

Computational thinking, too, relates to the notion of complex thinking. Computational thinking entails logical analysis and organisation of data; modelling, abstractions, and simulations; and identifying, testing, and implementing possible solutions.[122] Emphasis on these approaches in education helps learners understand how the world works and equips them with skills deemed essential in solving complex problems. The third leg of the stool is the ability to make complex ideas understandable, using data visualisation, new forms of imagery, succinct narrative, and other communications tools. In today's world, it is not enough to be able to conceptualise difficult challenges — one must also be able to make those ideas easy to grasp, easy to share, and easy to support.

Companies like Amazon, Google, and Facebook have been built on the insights of complex thinkers and communicators, who have popularised the use of big data to capture user-derived data in real-time, redefined the way we conceptualise consumer behaviour, and have built entirely new businesses based on this work. These skills can be applied across virtually any industry, but schools are not yet adept at encouraging greater development of complex thinking and communication. According to the European Commission's report, *Big Data: Analytics & Decision Making*, the market demand for big data is currently estimated at over €56 billion, and it is growing by 10% every year.[123] A recent report by business analytics provider, SAS, found that demand for data specialists is expected to rise by 243% over the next five years in the UK alone.[124] If data science is expected to become a major standard for decision-making, schools will be expected to shape learners who have complex thinking skills, and can use data and visualisations to support their reasoning.

Implications for Policy, Leadership, or Practice

Policy makers in the EU are aware that big data is rapidly becoming the model for productivity and have included it in the Digital Agenda of the Europe 2020 Initiative. EURYDICE conducted the latest comprehensive survey of European national policies, research, and practices in science education in 2011.[125] Their findings noted that although there were many countries with individual programmes to promote data science education, few operated under the guidance of well-defined national strategies. While countries such as Germany, Spain, Ireland, the Netherlands, the United Kingdom, and Norway have STEM education plans in place, initiatives that focus on introducing data science and other 21st skills to young learners are rare. This is changing, however, as countries such as the UK and Estonia have made computer programming part of their national curricula.[126]

Leaders seeking to foster complex communication skills in schools can refer to programmes that have already been scaled and proven effective. A good example is the EU-funded "Promoting Social Skills amongst Students" (PSS) project.[127] This initiative brought together institutions from five European countries — Bulgaria, Denmark, Italy, Poland, and the UK — with the intention of producing educational materials that promote effective communication skills such as understanding social cues, listening to the thoughts and feelings of others, and negotiating with others who have differing viewpoints. PSS created a guide with 60 lesson plans that reinforce social intelligence through games, discussion, and group tasks targeted at students ages 14 and up.

Practitioners can include more problem-solving and collaborative work at the classroom level. In a recent study of a post-primary mathematics class in Ireland, teacher Caitriona Rooney describes her success with inquiry-based learning (IBL) as a catalyst for complex thinking.[128] Rooney concluded that not only does IBL foster higher-order thinking, but the model also encouraged her students to take responsibility and accountability for their work. Rooney's experience was not without its challenges; however, she noted that implementing IBL required time and diligent preparation. New models like IBL require an investment in teacher education and continued professional support.

It is not enough to be able to conceptualise difficult challenges — one must also be able to make those ideas easy to grasp, easy to share, and easy to support.

For Further Reading

The following resources are recommended for those who wish to learn more about complex thinking and communication:

New National Curriculum to Teach Five Year Olds Computer Programming
go.nmc.org/gove
(Steve McCaskill, *Tech Week Europe*, 8 July 2013.) England's Secretary of State for Education has overhauled the curriculum to focus on teaching kids to create and debug simple programs with the aim of encouraging logical thinking, creativity, and interest in STEM. > *Policy*

Teaching Kids to Think Like Engineers
go.nmc.org/engi
(Breanna Draxler, *Discover Magazine*, December 2013.) A new suite of open-ended standards has been developed that seeks to give students experience with engineering and technology by working together to solve problems. > *Leadership*

How Computer Science Can Solve Problems in Biology
go.nmc.org/welsh
(Julia McWatt, *Wales Online*, 3 March 2014.) A bioinformatics professor explains how learning computer science enables children to make discoveries in other scientific fields. Computer science is integral to store and manage data, leverage data mining algorithms to find informative patterns, and to produce statistics to interpret results. > *Practice*

How Technology Has Changed Our Idea of 'Knowledge,' and What This Means for Schools
go.nmc.org/knowle
(Dennis Pierce, *eSchool News*, 30 July 2013.) The concept of knowledge has changed due to Internet innovations. The author discusses how organically growing online communities such as Reddit have proven that knowledge is no longer fixed, but constantly evolving. Students must now communicate and network as an integral part of the learning process. > *Practice*

Systems Thinking
go.nmc.org/systems
(Centre for Ecoliteracy, 2013.) This essay emphasises the need for children to consider themselves part of a larger system and to think in terms of relationships, connectedness, and context. > *Practice*

Students as Co-Designers of Learning

Wicked Challenge: Those that are complex to even define, much less address

The notion that students could be designers and architects of their learning environments is inherently disruptive, even if the idea is to work in collaboration with classmates and teachers to co-construct learning. Nonetheless, there is considerable evidence substantiating that when students are given the tools and responsibility to design their own learning environments, they become more curious and more engaged. With the resources available to the modern learner on the Internet, the role of the teacher is shifting to being more of a mentor and advisor in the learning journey. The challenge is determining how the co-design process is developed. Many are concerned that students — especially those in primary school — do not have the insight necessary to see the larger picture of their long-term learning, which is a combination of personal goals and the school and administration's goals.

CCR Framework Element: ***Learning Practices***

Overview

While the expert panel strongly supported the notion of co-designed learning, there is little consensus on what that actually means in broad practice. The European Democratic Education Community states that educational science data has proven the benefits of the related concept of self-directed learning, citing an increase in motivated, innovative, and lifelong learners. Their mission is to promote "self-determined" learning across European schools and universities in which students choose how to spend their time in school and pursue their curiosities. They believe integrating more independent study, Internet research, games, and project-based learning can engage students in meaningful ways.[129]

Aspects of this challenge fall in the policy arena, others in leadership, and some in the very definition of what it means to be a teacher. Actually moving to a model where a large number of schools routinely involve students in the design of their own learning will be complex. A concerted effort by political leaders, policy makers, schools as well as labour, and local stakeholder groups is needed to even begin to understand the scope of this undertaking. Health studies, such as the one conducted by JAMA Pediatrics, have cited how making student-centred changes to the traditional school day can impact student response and engagement. The study suggests that beginning the school day later can impact the sleep, mood, and behaviour of adolescents, which ultimately relates to how students learn and how well they perform in school.[130] This finding offers some basis for incorporating student needs in the learning process.

There are few models that focus on how to include students in the design of learning. Researchers in several universities are exploring this challenge, but most of the published work is still quite preliminary. Some of the notable current work is that of individual teachers who are informally documenting ideas and making the case for greater use of multimedia, writing, and other sorts of products that can become part of the curriculum, assignments, and lectures. For example, Elizabeth Allen, the Director of Online Communications at the American School in London maintains a blog in which one of the main categories is encouraging student-generated content. She provides several examples of how students can contribute useful materials to the education ecosystem, including a book written by a team of students on how to navigate career options post graduation as well as student produced videos that showcase their perspectives on pressing environmental issues.[131] While there needs to be an ongoing dialogue among European education leaders to truly define what is meant by student-designed learning, this kind of early evidence indicates that students are more engaged when they are involved in the development process.

Implications for Policy, Leadership, or Practice

Part of making sense of this challenge is understanding the implications of a shift toward students being the creators of resources that can become part of the learning ecosystem. In this shift, there are inherent opportunities for leaders and policy makers to help define what constitutes quality student-produced content, as the worry for many is that the quality of content could suffer from too much learner input. Currently much of this exploration is taking place in research efforts within the tertiary education sector. The Open University of Catalonia, for example published an article in the *European Journal of Open, Distance,*

and E-Learning that explored quality aspects of student content creation for use in online environments.[132] They used three categories to organise the criteria — content, format, and process — and each included focal points. For example, the content category emphasises the importance of consistency across language and imagery, the format category encompasses creative and accessible design, and the process category includes the use of emerging technologies.

At the Hellerup School in Denmark, students share responsibility with teachers for planning their work. The school contains several different physical spaces that enable children to engage with subject matter as they choose, from private and quiet areas for deep and critical thinking to playful areas that encourage them to act out scenarios and do group work. Students there are also constantly challenged to take responsibility for their own learning progress; innovative timetables allow them to start sorting through material together and then work alone, according to their needs.[133]

While strategies like the one underway at Hellerup show potential for primary and secondary schools, the benefits and challenges of incorporating students in the learning design process are still being examined through research efforts at the tertiary education level. For example, in the UK, Durham University's Institute of Physics is exploring the use of student-generated content to enhance teaching practices.[134] The goal of the study is to identify ways to engage students more deeply in the learning process by treating them as knowledge creators. Approaching students as partners in learning design is thought to make complex subjects more approachable, and present a pathway to more student-centred learning. Furthermore, the skills necessary to develop high-quality content are those that have been demonstrated to increase employability and success in the workforce. In one of Durham University's examples, students helped develop interactive screen experiments in physics courses. The study revealed that students' knowledge acquisition was tremendously enriched when they had more control over the design process, and it is feasible that this approach could have similar effects for primary and secondary students.

For Further Reading

The following resources are recommended for those who wish to learn more about students as co-designers of learning:

When Kids Craft BYOD Policies
go.nmc.org/kidscraft
(John Spencer, *Education Rethink*, 5 March 2013.) A teacher discusses how his sixth grade students created their own BYOD policy. He found that his students had very mature perspectives about mobile devices, equity, and responsibility. > *Policy*

Students' Voices
go.nmc.org/voices
(Stephen Heppell, Heppell.net, accessed 31 January 2014.) At the annual BETT Show in 2014, students from Norway, Sweden, and Denmark assembled in a Scandinavian colloquium where they presented and discussed a new learning evolution in which teachers are now co-constructing learning with their students.
> *Leadership*

3 Reasons to Encourage Student-Generated Content
go.nmc.org/three
(Paul Moss, *eLearning Industry*, 30 October 2013.) Student-generated content is an outcome of the organic interaction and research that students participate in daily online. The authors believe that teachers who understand this concept can harness its power, teach students to act responsibly with it, and help shape a new learning culture. > *Practice*

Denmark to Open World's First Lego School
go.nmc.org/lego
(Helen Russell, *The Guardian*, 22 April 2013.) The first ever Lego school will be centred around inquiry-based learning, a pedagogy that is planned to allow time for creativity, play, and getting into a "state of flow" for students. > *Practice*

The Future of Learning Environments
go.nmc.org/futurele
(Moa Dickmark, *Core 77*, 10 February 2014.) An architect explains how workshops in which students explore and question existing spaces at their school and homes can better incorporate student feedback when designing their learning spaces and schools. > *Practice*

Student Created Content Is an Exciting and Inspiring Learning Tool that Teaches Many Skills
go.nmc.org/studen
(K. Walsh, *Emerging Ed Tech*, 19 November 2013.) When students create content, they are developing literacy skills, communication skills, presentation skills, and the confidence to take control of their learning and harness their creativity. > *Practice*

Important Developments in Educational Technology for European Schools

Each of the six developments in educational technology detailed in this section were selected by the project's expert panel, using the Horizon Project's Delphi-based process of iterative rounds of study, discussion, and voting. In the NMC Horizon Project, educational technology is defined in a broad sense as tools and resources that are used to improve teaching, learning, and creative inquiry. While many of the technologies considered were not developed for the sole purpose of education, they have clear applications in the field.

The technologies, which the members of the expert panel agreed are very likely to drive technology planning and decision-making over the next five years, are sorted into three time-related categories — near-term technologies that are expected to achieve adoption in one year or less; mid-term technologies that will take two to three years; and far-term technologies, which are forecasted to enter the mainstream of education within four to five years. Each technology topic opens with an overview of the topic and relates to areas of the CCR Framework as pictured in the chart in the Executive Summary.

The initial list of topics considered by the expert panel was arranged into categories that were based on the primary origin and use of the technology. The potential applications of the technologies featured, specifically in the context of European schools, were considered in a series of online discussions that can be viewed at europe.wiki.nmc.org/Horizon+Topics.

The expert panel was provided with an extensive set of background materials when the project began that identified and documented a range of existing technologies used in both education and beyond. The panel was also encouraged to consider emerging technologies whose applications for schools may still be distant. A key criterion for the inclusion of a new technology in this edition was its potential relevance to teaching, learning, and creative inquiry in European schools.

In the first round of voting, the expert group reduced the master list of topics to 12 technologies that were researched in-depth by the NMC staff. Each was then written up in the format of the *Horizon Report* and used to inform the final round of voting. Technologies that do not make the interim results or the final report are often thoroughly discussed on the project wiki at europe.wiki.nmc.org. Sometimes a candidate technology does not get voted in because the expert panel believes it is already in widespread use in schools, or, in other cases, they believe the technology is more than five years away from widespread adoption. Some technologies, while intriguing, do not have enough credible project examples to substantiate them.

There are currently seven categories of technologies, tools, and strategies for their use that the NMC monitors continuously. These are not a closed set, but rather are intended to provide a way to illustrate and organise emerging technologies into pathways of development that are or may be relevant to learning and creative inquiry. New technologies are added to this list in almost every research cycle; others are merged or updated. Collectively, the categories serve as lenses for thinking about innovation; each is defined below.

> **Consumer technologies** are tools created for recreational and professional purposes and were not designed, at least initially, for educational use — though they may serve well as learning aids and be quite adaptable for use in schools. These technologies find their ways into schools because people are using them.

> **Digital strategies** are not so much technologies as they are ways of using devices and software to enrich teaching and learning, whether inside or outside of the classroom. Effective digital strategies can be used in both formal and informal learning; what makes them interesting is that they transcend conventional ideas and learning activities to create something that is new, meaningful, and 21st century.

> **Enabling technologies** are those technologies that have the potential to transform what we expect of our devices and tools. The link to learning in this category is less easy to make, but this group of technologies is where substantive technological innovation begins to be visible. Enabling technologies expand the reach of our tools, make them more capable and useful, and often easier to use as well.

> **Internet technologies** include techniques and essential infrastructure that help to make the technologies underlying how we interact with the network more transparent, less obtrusive, and easier to use.

> **Learning technologies** include both tools and resources developed expressly for the education sector, as well as pathways of development that may include tools adapted from other purposes that are matched with strategies to make them useful for learning. These include technologies that are changing the landscape of learning, whether formal or informal, by making it more accessible and personalised.

> **Social media technologies** could have been subsumed under the consumer technology category, but they have become so ever-present and so widely used in every part of society that they have been elevated to their own category. As well established as social media are, they continue to evolve at a rapid pace, with new ideas, tools, and developments coming online constantly.

> **Visualisation technologies** run the gamut from simple infographics to complex forms of visual data analysis. What they have in common is that they tap the brain's inherent ability to rapidly process visual information, identify patterns, and sense order in complex situations. These technologies are a growing cluster of tools and processes for mining large data sets, exploring dynamic processes, and generally making the complex simple.

The following pages provide a discussion of the six technologies highlighted by the 2014 Horizon Project Europe Expert Panel, who agree that they have the potential to foster real changes in education, particularly in the development of progressive pedagogies and learning strategies; the organisation of teachers' work; and the arrangement and delivery of content. As such, each section includes an overview of the technology; a discussion of its relevance to teaching, learning, or creative inquiry; and curated project examples and recommendations for further reading.

Consumer Technologies
> 3D Video
> Electronic Publishing
> Mobile Apps
> Quantified Self
> Tablet Computing
> Telepresence
> Wearable Technology

Digital Strategies
> Bring Your Own Device (BYOD)
> Flipped Classroom
> Games and Gamification
> Location Intelligence
> Makerspaces
> Preservation/Conservation Technologies

Internet Technologies
> Cloud Computing
> The Internet of Things
> Real-Time Translation
> Semantic Applications
> Single Sign-On
> Syndication Tools

Learning Technologies
> Badges/Microcredit
> Learning Analytics
> Massive Open Online Courses
> Mobile Learning
> Online Learning
> Open Content
> Open Licencing
> Virtual and Remote Laboratories

Social Media Technologies
> Collaborative Environments
> Collective Intelligence
> Crowdfunding
> Crowdsourcing
> Digital Identity
> Social Networks
> Tacit Intelligence

Visualisation Technologies
> 3D Printing/Rapid Prototyping
> Augmented Reality
> Information Visualisation
> Visual Data Analysis
> Volumetric and Holographic Displays

Enabling Technologies
> Affective Computing
> Cellular Networks
> Electrovibration
> Flexible Displays
> Geolocation
> Location-Based Services
> Machine Learning
> Mobile Broadband
> Natural User Interfaces
> Near Field Communication
> Next-Generation Batteries
> Open Hardware
> Speech-to-Speech Translation
> Statistical Machine Translation
> Virtual Assistants
> Wireless Power

Cloud Computing

Time-to-Adoption Horizon: One Year or Less

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. According to the 2013 MATEL report, enabling technologies such as cloud computing are among the key technologies for primary and secondary education.[135] Cloud computing resources support collaboration, file storage, virtualisation, and access to computing cycles, and the number of available applications that rely on cloud technologies have 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 established as an efficient way for European businesses to protect data, develop applications, deliver software and online platforms, and to collaborate, and the Digital Agenda for Europe is instrumental in supporting similar cloud-based strategies in schools to boost collaboration, productivity, and mobility in teaching and learning.

CCR Framework Element: ***Infrastructure***

Overview

Clouds, especially those supported by dedicated data centres, can be public, private, or a hybrid of these. Many businesses use software as a service (SAAS), and API services in the cloud to reduce IT overhead costs. Google Apps, for example, has become a popular choice for schools, and many have moved their email infrastructure to Gmail and adopted Google Drive for document sharing and collaboration. Whether learning takes place at home, work, school, on the road, or in social spaces, nearly every student who uses the network relies in some fashion on cloud computing to access or share their information and applications. Some are concerned, however, that many public cloud services may not meet national privacy and data protection standards and requirements for schools and students. Private cloud computing solves these issues by providing common cloud solutions in secure environments, and hybrid clouds provide the benefits of both types.

As part of the official Digital Agenda for Europe, the European Commission is currently devising a cloud computing strategy for better standards, safer contracts, and more overall usage in both the private and public sectors.[136] There is a consensus that cloud-based services provide a range of solutions related to infrastructure, software, and security. By means of virtualisation, cloud computing providers can deliver fully-enabled virtual computing environments of almost any scale that can be accessed from any connected device, seamlessly and on demand. Cloud services have also proven to cut the cost and time required for server maintenance, and offer support for new tools that foster best computing practices for easy sharing and mobility. They can negate the need for specialised IT staff that can be expensive and difficult to retain. Additionally, as the mobile Internet has expanded, an increasing number of tablets and other devices that are designed expressly to operate in the cloud have entered the market. These devices have price points that make them competitive for 1:1 computing and BYOD deployments, which refer to the practice of students receiving their own school provided tablet or computer, and bringing their own laptops, tablets, smartphones, or other mobile devices with them to class, respectively.

According to the Horizon Europe Panel, the rapid integration of cloud computing into our everyday routines — from technology infrastructure to communication exchanges to the many apps and resources used for informal learning — has accelerated the interest of European schools in cloud computing. As more individuals use cloud-based sharing services such as Dropbox and Google Drive in their personal lives, cloud computing has become widely recognised as a means of improving productivity and expanding collaboration in education. In early 2014, Ministries of Education in

Cloud computing has become widely recognised as a means of improving productivity and expanding collaboration in education.

Finland and Estonia convened to plan a collaboration to develop cloud services that will leverage digital learning materials and applications to significantly boost the use of the cloud in education in both countries.[137]

Relevance for Teaching, Learning, or Creative Inquiry

A recent SafeGov.org and Ponemon Institute study of UK schools revealed that the use of cloud services has grown rapidly over the past five years, making digital strategies such as BYOD, the flipped classroom, and personalised and collaborative learning environments fairly straightforward technologically.[138] The Sotogrande International School in Spain, for example, is using Google Apps for Education to promote communication, creativity, collaboration, and productivity among teachers and students.[139]

King Solomon Academy is using Chromebooks, inexpensive laptops that rely on ubiquitous connectivity and cloud-based software and storage, for experiments with blended learning in a seventh grade math classroom.[140] The teacher has implemented both a flipped classroom model where the core content is delivered via videos as homework, as well as a flex model where the content is primarily delivered online. Chromebooks enable these learning models because of constant Internet connectivity to access different types of educational resources.

While numerous cloud computing projects are currently underway in Europe, including examples such as Project Schools in the Cloud in Spain,[141] Killingworth School in the Cloud in the UK,[142] and the Ballerup municipality cloud project in Denmark,[143] security and privacy concerns have surfaced as key issues impeding more widespread implementation. The SafeGov.org report, *Protecting Vulnerable Data Subjects*, offers a list of recommendations to European data protection officials, schools and school authorities, parent associations, and cloud providers for establishing codes of conduct. The aim is for these policies to ensure safe and effective use of cloud computing in European schools.[144]

Cloud Computing in Practice

The following links provide examples of cloud computing in use that have direct implications for European schools:

Galicia Use of the Open-Source Cloud
go.nmc.org/gali
Spain's province of Galicia is piloting open-source cloud solutions to provide students, teachers, and administrators with cost-effective access to learning materials while also encouraging collaboration between teachers across Europe. > *Policy*

The School on the Cloud
go.nmc.org/eusoc
The School on the Cloud partnership is an ICT network funded by the European Commission that works to evaluate future resources and scenarios for education in a cloud environment, then disseminate and expand best practices. It currently includes 18 countries. > *Leadership*

Flat Connections
go.nmc.org/flat
Flat Connections is a series of independent collaborative projects in which classrooms leverage cloud platforms to connect with, mentor, and collaborate with other classrooms across the globe. > *Practice*

For Further Reading

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

The Benefits of Cloud Computing in Education Are Huge!
go.nmc.org/huge
(Gail Staines, *Aspect Blogs*, 27 June 2013.) Advantages of using cloud services for schools include less in-house maintenance such as storing and keeping up servers, software, and external hard drives. > *Leadership*

What is the Future of Technology in Education?
go.nmc.org/whatis
(Matt Britland, *The Guardian*, 19 June 2013.) The author argues that the future of technology in education relies on access to learning resources and collaboration tools by leveraging cloud platforms and services. Investments in fast and robust Internet infrastructure are currently of paramount importance to schools. > *Leadership*

Education in the Cloud
go.nmc.org/inth
(Przemyslaw Fuks, *isgtw*, 20 November 2013.) This article describes how students can freely access lessons, courses, and research regardless of geographic restraints. The cost of hardware necessary to create IT infrastructure and software licences is no longer a barrier. > *Practice*

Tablet Computing

Time-to-Adoption Horizon: One Year or Less

Computers as we know them are undergoing a complete transformation. Laptops and desktop computers are being replaced by devices that offer the latest in natural user interfaces. For children especially, touchscreens are quickly becoming the most familiar way of interacting with information. Indeed the Internet is full of videos of toddlers effortlessly navigating their way around on tablets, or even swiping the pages of print publications, bewildered by their analogue nature. Currently, the market for tablet computers is booming; in 2014, tablets will make up fully half of the PCs sold worldwide, according to the research firm Canalys.[145] The category is led by the incredible success of the iPad, which at the time of publication had sold more than 170 million units, a number expected to rise to over 366 million units by 2016, as predicted by GigaOM.[146] In the same timeframe, Samsung, Google, and Amazon, as well as traditional PC vendors like HP and Microsoft, are rapidly growing their share of this market. Increased choice and competition will continue to drive down retail prices. Tablets' consumer-friendly reputations have led to their integration into educational environments. Visually compelling and highly portable, they are ideal tools for browsing the Internet, viewing presentations and videos, and accessing apps, giving school leaders reason to position tablets at the centre of teaching and learning.

CCR Framework Element: ***Connectedness and Infrastructure***

Overview

As 1:1 initiatives (programs where every student is provided with a personal device to use throughout the school day, and often at home) and BYOD initiatives (where students bring their own devices) become more commonplace in schools, leaders in the technology industry have started designing and marketing tablets specifically for educational purposes. This new angle has led to developments in interface, feature sets, and connectivity that are making tablets uniquely suited for teaching and learning. Tablets have proven to be an affordable 1:1 solution, but the affordances of these mobile devices are not quite as complete in a school setting. While it is quite easy to consume and interact with information on a tablet, activities that engage students in the co-creation and co-construction of knowledge are limited by a design that discourages typing.

With the advent of competition in this market, many tablet manufacturers are hoping to help place large-scale 1:1 initiatives in schools, and offer a range of products and programmes to especially encourage the educational use of tablets. Apple's focus has been on content production and dissemination with platforms such as iTunesU, iBooks Textbooks, iBook Author, and the Education Collections section in its app store.[147] Samsung has stakes in the educational market as well; the Samsung Smart Schools initiative employs Android-based interactive whiteboards and smart TVs with screen sharing capabilities to support collaborative learning in the classroom. Now partnered with major educational content publisher Houghton Mifflin Harcourt, Samsung is working on software and educational materials to create a tablet-computing ecosystem that consists of hardware, software, and content. With successful pilots already completed in South Korea, Australia, and the United States, the Smart School solution is currently underway in two schools in the UK.[148]

One of the most useful features of tablets is the breadth of apps available for free or for small fees. With over 115,000 educational apps offered, iPad apps can be purchased in bulk via the Volume Purchase Programme.[149] Google Play for Education is not far behind, with over 77,000 educational apps at the time of publication, in addition to a growing list of hardware options that are designed with education in mind.[150] Samsung's new Galaxy Tab, released in April 2014, is the latest addition to the Google Play for Education programme. The new educational tablet features near field communication technologies that are intended to give administrators an easy way to coordinate an entire classroom of devices.

Relevance for Teaching, Learning, or Creative Inquiry

Findings from the latest *Survey of Schools: ICT in Education* report indicate a trend toward 1:1 initiatives in European schools; at grade 8 (i.e. around 13.5 years old) more students are in 1:1 classes than in other grades, and most of these students are found in Spain, Norway

and Sweden.[151] This trend demonstrates the growing interest in understanding how tablets can support learning inside and outside of school. A 2013 meta-study on European educational pilots surveyed 31 recent 1:1 initiatives across 47,000 schools and 17,500,000 students in primary and/or secondary education across 19 European countries.[152] The report found that national and/or regional authorities are often the main initiators of pilots, and are also often involved in the implementation process. Supporting such experimentation in actual educational settings provides guidance to students and parents, logistical support, and teacher training, especially at the school level.

Indeed, many schools leaders are intrigued by the potential of tablets, but to realise this opportunity, teachers must know how to use tablets in activity-based and project-based learning, according to research on 1:1 initiatives mentioned above. Ongoing school-based support and training is essential to helping practitioners use tablets in the classroom; moreover, the study team has recommended further investigation into the use of hybrid learning models for teacher training; these hybrid approaches leverage online components and communities of practice reinforce the integration of technology into instruction.

As tablets become more accessible and capable, an increasing number of countries are identifying tablet computing as a focal point of their national strategies for education. Turkey's FATIH project has plans to introduce over ten million tablets into its public education system. Its goals are to achieve ICT ubiquity in Turkish classrooms, and to reinforce formal and informal learning with mobile technology.[153] Similarly, Belgium has set forth a plan to create a network of innovative schools to be test beds for three novel, tech-based approaches to teaching and learning; with ten schools in each test bed, the first group will explore 1:1 computing and tablets.[154] National directives and policies are also encouraging schools in France to experiment with tablets in the classroom; Académie Nantes, for example, has integrated tablets into its schools and reported their experiences on the affordances of tablets for learning, providing detailed notes on user production, ease of mobility, document management solutions, and volume purchasing programmes among other considerations.[155]

Tablet Computing in Practice

The following links provide examples of tablet computing in use that have direct implications for European schools:

The Creative Classrooms Lab
go.nmc.org/cclp
The "Creative Classrooms Lab" is a network of 30 Ministries of Education in Europe that is conducting policy experimentations to collect evidence on the implementation, impact, and up-scaling of 1:1 pedagogical approaches with tablets. > *Policy*

Boosting Learning through Tablets
go.nmc.org/boost
As part of a £3.5m strategy by the Education Endowment Foundation, Rosendale Primary in South London is using tablets to photograph and tag their work with notes about how well they learned so they can analyse their learning strategies. > *Practice*

French Students Ditch Books for Tablets (Video)
go.nmc.org/fran
Students in North Central France who are each given a tablet at the age of seven appreciate the organisational aspect of tracking their projects and studies without needing multiple books and papers. > *Practice*

For Further Reading

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

Who Owns the Laptops and Tablets Used by Students and Teachers, and How Does This Affect Their Use?
go.nmc.org/own
(Michael Trucano, *World Bank Blogs*, 25 November 2013.) This article discusses some of the different ownership models in relation to a device's usefulness being a function of how people are permitted to use it. > *Policy*

iPad Research in Schools
go.nmc.org/hull
(University of Hull, accessed 28 March 2014.) Based on eight schools in Scotland, this study discusses management and leadership issues associated with tablet deployment and how parental engagement with learning is affected by personal devices. > *Leadership*

iPads Bring Students with Disabilities New Ways to Participate, Excel in Education
go.nmc.org/concord
(Kathleen Ronayne, *Concord Monitor*, 14 August 2013.) Using iPads, blind students can now translate written words to audio with one touch; students with dyslexia or other reading disorders can complete work using only their voice; and students with autism can find alternative ways to express their ideas. > *Practice*

Games and Gamification

Time-to-Adoption Horizon: Two to Three Years

The culture around digital games is growing, with the age of the average gamer increasing every year. The gaming industry is producing a steady stream of games that continue to expand 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. Now that tablets and smartphones are commonplace, game play is a portable activity. Once considered purely as entertainment, scientific studies are revealing the impact games can have on human behaviour, leading to their uptake in the worlds of commerce, the military, and education, among other areas. Similarly, there has been increased attention surrounding gamification — the integration of gaming elements, mechanics, and frameworks into non-game situations and scenarios for training and motivational purposes. Businesses especially have embraced gamification as a way to design programmes that incentivise productivity through rewards, leader boards, and badges — elements that are often integrated into mobile platforms. 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.

CCR Framework Element: ***Learning Practices***

Overview

Aligned with findings of the 2013 MATEL report, games and gamification are positioned as key technologies for primary and secondary education.[156] The roots of game-based learning can be traced back to 2003, when a burgeoning body of research began exploring the impact of game play on cognitive development. Since then, games and simulations, digital and otherwise, have been developed to help learners build social and intellectual skills with greater goals in mind. A recent report, *The Potential of Digital Games for Empowerment and Social Inclusion of Groups at Risk of Social and Economic Exclusion*, concluded that online and other digital games can positively impact employment, economic growth, and innovation by increasing socio-economic inclusion of at-risk populations, including youth who may be struggling academically. The report also recommends that serious games and gamification be integrated across industry, research, and learning sectors.

When the gaming industry began to incorporate network connectivity into game design, they revolutionised game-play by creating vast virtual arenas where participants from all over the world could connect, interact, and compete. The Internet offers gamers the opportunity to join massively multiplayer online (MMO) role-playing environments and to build online reputations based on their skills, accomplishments, and abilities. In the last five years, games have converged with natural user interfaces to create an experience for players that more closely mimics real life, engaging users with touch screens and gesture-sensing technologies.

Gamification applies gaming mechanics to routine activities, often with the express purpose of engaging and supporting people as they learn new skills. Simple.com, for example, is a gamified banking service that helps users master their finances. Similar game-like environments can transform assignments into exciting challenges, reward students for dedication and efficiency, and offer a space for leaders to naturally emerge. Badges are being increasingly used as a rewards system for learners, allowing them, in many cases, to publicly display their progress and skill mastery in online profiles. In their report, *Social Inclusion of Youth with Mental Health Conditions*, the United Nations also suggests that games and gamification may enable students with mental disabilities to better grasp learning materials and exhibit improved behaviour.[159]

Relevance for Teaching, Learning, or Creative Inquiry

Educational games promote social skills that youth need to understand and confront complex social dilemmas with diplomacy and mutual understanding. The EU-funded SIREN project, for instance, aims to design games to nurture children's abilities to identify and diffuse conflicts in a culturally sensitive manner, with the overarching goal of creating a more harmonious European society. In a case study published in 2013, SIREN researchers tested the game on a group of 67 children, ages 9 to 12 years old.[160] As the participants

experimented with their resolution skills in simulated scenarios, the study team found the approach effective in helping students accurately perceive varying degrees of conflicts.

Games that have gained mainstream popularity outside of school are often viewed in a new light when they are placed in an educational context. The best-selling MMO game, Minecraft, is a good example: the premise is equally appealing to children and adults, there are no prescribed goals, and players are free to explore a seemingly infinite virtual space and construct or deconstruct their surroundings with blocks of various materials.[161] With thousands of children playing in their free time, and learning math and design skills along the way, school leaders are taking increasing note of Minecraft's potential for learning. BBC Radio 5 identified at least 150 schools in the United Kingdom that already use Minecraft to reinforce collaboration. The game was highlighted as a potential gateway to computer science, as players often are required to use programming skills to overcome challenges within the virtual world.[162]

Researchers at the University of Warwick found that gamified learning in online environments motivates students to engage in higher order thinking. The scientists established a framework to measure the quality of a contribution in an online environment. They observed that when students were obligated to participate in the gamified discussion forum, contributions increased, yet not a single person achieved the highest level of thinking. On the other hand, discussions that took place when students were encouraged, rather than forced, to contribute in the gamified platform were more productive, and resulted in more learners reaching higher levels of thinking. The study ultimately acknowledges that the success of a gamified learning environment relies on achieving a fair balance of external pressure and encouragement to participate.[163]

Games and Gamification in Practice

The following links provide examples of games and gamification in use that have direct implications for European schools:

MAGICAL
go.nmc.org/magicaleu
This EU-funded project is exploring collaborative design of educational games by primary and lower secondary students. MAGICAL investigates the impact collaborative design of educational games can have on learning, and especially on support for key transversal skills, such as strategic thinking and creativity. > *Leadership*

Minecraft at Viktor Rydberg School
go.nmc.org/minecr
At the Viktor Rydberg School in Sweden, secondary students take a mandatory course on Minecraft in which they learn about city planning and environmental issues through gameplay. > *Practice*

The Research Game
go.nmc.org/eurg
This EU-funded Research Game project aims to inspire and teach students the value and methodology of scientific research. > *Practice*

For Further Reading

The following articles and resources are recommended for those who wish to learn more about games and gamification:

The Potential of Digital Games for Empowerment and Social Inclusion of Groups at Risk of Social and Economic Exclusion: Evidence and Opportunity for Policy (PDF)
go.nmc.org/soci
(JRC-IPTS, September 2013.) This report includes case studies that identify both the opportunities and challenges in deploying digital games and gaming in education, especially for those experiencing social exclusion, by developing systems thinking, creativity, and other 21st century skills. > *Policy*

Peace, Innovation, and Gamification: Can Games Help Resolve Social Conflict?
go.nmc.org/peac
(Nilgun Arif and Alexis Franke, *Voices from Eurasia*, 27 August 2013.) The United Nations Development Programme believes gaming can serve purposes such as peace-building, disaster response, engagement of youth with mental health disabilities, and farming and economic development. > *Leadership*

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. > *Practice*

Mobile Learning

Time-to-Adoption Horizon: Two to Three Years

UNESCO describes mobile learning as "learning that occurs in or outside of a classroom or formal education setting, is not fixed to a particular time or place, and is supported by the use of a mobile device."[164] The latest crop of mobile devices ranges from tablets to smartphones to e-book readers, and other portable electronics. As these devices grow more capable and user interfaces more natural, combined with their constant Internet connectivity, they are becoming increasingly useful tools for learning. The unprecedented evolution of these devices and the applications that run on them has illuminated their vast potential for educational use. Learning institutions all over the world are not simply adopting apps into their curricula, but developing mobile strategies that consider the modification of learning arrangements in schools. Many schools across Europe are taking advantage of these opportunities in the form of 1:1 initiatives — programmes where every student is provided with a personal device to use throughout the school day, and often at home.

CCR Framework Element: ***Connectedness***

Overview

Mobile learning has profound implications for primary and secondary education, where it is seen as facilitating both non-formal and self-directed learning. The portability of mobile devices, coupled with increasingly fast cellular-based broadband connectivity, lead naturally to envisioning the devices as a very enticing learning tool. Ultimately, one of the biggest appeals of mobile learning is that the devices themselves naturally encourage exploration — a notion that is easily demonstrated by placing a device in the hands of a small child. Whether it is connecting with new people via social media or discovering local resources recommended by an app, mobiles make it easy for people of all ages to act upon their curiosities and expand their knowledge. In many ways, mobile devices reflect a user's personal learning environment, encompassing their own collection of apps and productivity features.

Additionally, the use of mobile devices can have a transformative effect in the organisation of learning within schools if students are allowed to use their own devices in the classroom, personalise their use of ICT, and granted more flexibility and choice. A 2013 report, *Overview and Analysis of 1:1 Learning Initiatives in Europe*, analysed a number of 1:1 initiatives and found that the mobile learning movement has created a new set of tasks for school leaders, including the provision of Internet access; organising learning platforms and resources; and training and supporting teachers.[165] The report calls for mobile learning and 1:1 initiatives that are underpinned by evolved teaching approaches — the technology must be supported by effective pedagogy, cultivated through a flexible framework of clear objectives, guidelines, and tools. According to the report, up-scaling these programs will require evidence and widespread sharing of best practices. Successful implementations will involve a diverse network of stakeholders, including teachers, administrators, parents, commercial suppliers, and local sponsors.

Relevance for Teaching, Learning, or Creative Inquiry

Because of their portability, flexibility, and continuously improving interfaces, mobile devices are especially enticing to schools, and in many regions of the world, students are already accustomed to using mobile devices in their daily lives. Research conducted in the EU has shown that young people own and use mobiles more than ever. In the 2013 *Net Children Go Mobile* study, researchers surveyed youth ages nine to 16 across six different countries in the EU — Denmark, Italy, Romania, the UK, Ireland, and Portugal.[166] The study revealed a clear trend that young people are using mobile devices to access the Internet in diverse environments. It is becoming increasingly clear to schools that mobility is a key feature of the digital age, and one that will shape the future of education.

As mobile devices have become commonplace, a number of European countries are looking for ways for children to use their personal devices to access learning-related content. Denmark's national ICT strategy, for example, allocates money specifically for developing digital education resources and building streamlined online and mobile platforms to distribute them. Their goal is to achieve an "app store feel" for educational content that allows teachers and students to download material related to specific subject areas and learning goals. By 2014, all students in Danish public schools

are expected to have a mobile computing device and access to wireless Internet. In order to meet this goal, the majority of students are expected to bring their own device, while schools will fill in the gaps for students whose families lack the economic means to purchase the devices on their own.[167]

While widespread use of mobile learning by most schools is still two to three years away, there are a number of EU Member States that are adopting mobile-friendly policies and directives. For instance, the Austrian Mobile Learning Companions project, which encompasses 27 schools and 50 classrooms, encourages schools to conduct classroom activities on tablets, smartphones, and other portable devices.[168] In Sweden, Vittra Education has implemented a BYOD approach across its 27 international private schools, in addition to other measures to modernise education such as creating personalised curricula for individual students and eliminating classrooms.[169]

The use of mobile devices can have a transformative effect in the organisation of learning within schools if students are allowed to use their own devices in the classroom, personalise their use of ICT, and granted more flexibility and choice.

Mobile Learning in Practice

The following links provide examples of mobile learning in use that have direct implications for European schools:

6,000 High School Students in Catalonia Begin Developing Apps in the Classroom
go.nmc.org/letsm
"Let's Mobilise Computer Technology" is part of the mSchools program backed by Mobile World Capital Barcelona, the Regional Government of Catalonia, the City of Barcelona, and GSMA Intelligence. It is an initiative to encourage Catalonia's high school students to create and use mobile solutions in the classrooms, and enhance their digital skills. > *Policy*

Innovative Pedagogy 1:1
go.nmc.org/slov
This national project in Slovenia provides students in multiple schools with mobile devices to help them integrate ICT into all subjects and allow their informal learning habits to better mesh with the formal classroom environment. > *Policy*

Mobile Learning in Fredrikstad
go.nmc.org/fredrikstad
The municipality of Fredrikstad in Norway launched mobile learning projects that range from cross-continent collaboration to paperless productivity to e-book pilots at four primary and secondary schools. > *Leadership*

For Further Reading

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

Policy Guidelines for Mobile Learning (PDF)
go.nmc.org/guidelines
(UNESCO, 2013.) This set of guidelines developed in consultation with experts in over twenty countries seeks to help policy-makers better understand what mobile learning is and how it can expand education access in a variety of settings. > *Policy*

Mobile Devices in Education: Part One
go.nmc.org/ptone
(Mark Pearce, *Business Review Europe*, 1 June 2013.) The author analyses the BYOD trend, citing specific lessons that education institutions can learn from businesses. He believes allowing students to use their own devices in class could give them a competitive edge. > *Leadership*

Turning on Mobile Learning in Europe (PDF)
go.nmc.org/nok
(Jan Hylén, UNESCO Working Paper Series on Mobile Learning, 2012). This paper identifies strategies, initiatives, and projects for mobile learning in formal education across Europe. > *Practice*

Personalised Learning

Time-to-Adoption Horizon: Four to Five Years

Personalised learning includes a wide variety of approaches to support self-directed and group-based learning that can be designed around each learner's goals. The idea includes concepts like personalised learning environments and networks, adaptive learning tools, and more. Using a growing set of free and simple resources, such as a collection of apps on a tablet, it is already quite easy to support one's on going social and professional learning and other activities with a collection of resources and tools that is always on hand. There are two paths of development for personalised learning: the first is organised by and for the learner, which includes apps, social media, and related software. School goals and interests are driving the other path, primarily in the form of adaptive learning. In this pathway, which envisions the development of tools and data streams that are still some time away from being seen in schools, adaptive learning is enabled by intervention-focused machine intelligence that interprets data about how a student is learning and responds by changing the learning environment based on their needs. While the concept of personalised learning is fairly fluid, it is becoming more and more clear that it is individualised by design, different from person to person, and built around a vision of life-long learning.

CCR Framework Element: ***Learning Practices***

Overview

The goal of personalised learning is to enable students to determine the strategy and pace at which they learn while allowing them to demonstrate their knowledge acquisition in a manner that is uniquely their own. Though effective personalised learning strategies focus on the learner and not the technology, personalised learning may significantly draw on enabling technologies and tools. Free or nearly free cloud computing tools, for example, allow users to easily store the content they want, share their content with others, gather new and relevant items, write personal commentary, complete assignments, and more. YouTube, iTunes U, Facebook, and other social media provide students with outlets to discover new content, disseminate their own, and develop digital portfolios they can carry with them and build upon throughout their schooling.

The underlying technologies needed to support personalised learning are relatively straightforward and readily available now. For example, a person's smartphone or tablet and the collection of apps they have chosen to download directly represents their assortment of interests. With hundreds of thousands of apps available in multiple marketplaces, it is easy to see how no two people are likely to share the exact same set. Everyone has distinctive preferences and approaches learning and exploration differently — the basic premise of personalised learning. The European Commission's "Opening Up Education" initiative, which explores this premise as part of its mission, is working to strategise best practices that incorporate the wide diversity of options available to today's students.[170]

Education researchers have emphasised the need for learning settings to be adaptable and flexible in order for personalised learning to take root. Students' preferences and needs must be understood accurately before designing or implementing personalised learning scenarios and activities. The goal is to give the student the flexibility to make their learning as effective and efficient as possible, but adequate mentorship, especially at the primary and secondary school level, is still a clear necessity. In this model, there is a need for teachers to adjust their roles in the classroom to focus less on dispensing information through lectures and more on being guides

Relevance for Teaching, Learning, or Creative Inquiry

Personalised learning is, at its core, a way to allow students to approach learning in ways best suited to their individual needs. Some students, for example, may benefit from the practice of keeping track of, and curating, their own resource collections. The EU-funded *Responsive Open Learning Environments* (ROLE) project took this approach in an effort to study the impact of student-created environments for personalised learning.[171] Resources like YouTube, Wikipedia, and Flickr were used to support teachers in developing personal learning environments for their students. Over the four years of the project, ROLE developed, tested, and deployed an operating learning environment and a collection of ROLE-designed widgets. However, despite the fact that there is a growing range of easy-to-use

tools that could be used to construct personal learning resources, the emerging focus on helping students assess and select tools is still somewhat nascent, justifying the placement of personalised learning on the far-term horizon.

Adaptive learning software in the form of online learning platforms is an emerging area within the personalised learning space, but one that shows the potential of guiding students' individual progress through a set of material via an analysis of their responses to mini-quizzes or prompts in real time. These tools are envisioned as providing students and educators with highly personalised information about how lessons are progressing, with adjustments made on the fly as needed. "Realize It" is an online learning platform developed in Ireland that uses such data to react and adapt to a student's behaviour and performance.[172] The software indicates the learner's progress in relation to learning objectives, outlines his or her state of knowledge at a granular level, and uses the gathered evidence to determine the most appropriate next step for the student.

This type of personalisation is seen as central in the evolution of learning, and while scalable methods and concepts will take some time to refine, there is considerable consensus among government, policymakers, and school leaders of the importance of this work. A partnership between eight European countries is currently developing an adaptive learning program called TERENCE, targeted to children age 7-11 who have demonstrated difficulty with text comprehension.[173] TERENCE aims to stimulate high-level cognitive text processing through tailored "smart games" that are designed to foster story-reasoning skills. Ultimately, teachers will be able to customise the types of stories and games for each student. TERENCE is envisioned as a cross-disciplinary effort, with future plans to build adaptive learning models for art and design, computers, engineering, and linguistics.

Personalised Learning in Practice

The following links provide examples of personalised learning in use that have direct implications for European schools:

WeSPOT
go.nmc.org/wespot
weSPOT is a research initiative that aims to strengthen scientific inquiry in classrooms and curricula in the EU by leveraging students' personal curiosity and experience to deepen their conceptual knowledge. > *Leadership*

Colegio Montserrat's Personalised Learning
go.nmc.org/cole
At Colegio Montserrat in Barcelona, Spain, every fourth-year student receives their own iPad or laptop, which they use with the school's Moodle learning management system. This allows them to choose their own pathways through a learning landscape while their progress is charted in their personal e-portfolios. > *Practice*

Collaboration and Personalisation in Riihimäki, Finland (PDF)
go.nmc.org/collabo
At Peltosaari School, a learning approach called "progressive inquiry" is used to personalise learning. Primary school students tackle challenging topics and present their own ideas and solutions in group settings. > *Practice*

For Further Reading

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

Future Learning Environments (Video)
go.nmc.org/wheeler
(Steve Wheeler, *Learning Technologies*, 29 January 2013.) A media specialist and educator from the UK explores ways in which emerging technologies can be used in a more participatory, personalised model for education. > *Leadership*

One Essential Resolution for Educators in 2013 — A Personal Learning Environment
go.nmc.org/insights
(Debbie Morrison, *Online Learning Insights*, 1 January 2013.) This perspective on PLEs includes formal and informal learning experiences and a variety of educational resources. > *Practice*

What Personalised Learning Really Means for Modern Teachers
go.nmc.org/means
(Jennifer Kelly, *Edudemic*, 4 August 2013.) Personalised learning is not about the technology, but technology does help scale the method by empowering a teacher to keep a larger number of students at different levels moving forward simultaneously. > *Practice*

Virtual and Remote Laboratories

Time-to-Adoption Horizon: Four to Five Years

Virtual and remote laboratories reflect a movement among many education institutions to make the equipment and elements of a working science laboratory more easily available to learners, via special software running on the Internet. Virtual laboratories are web applications that emulate the operation of physical laboratories and enable students to practice techniques or run common experiments in a "safe" environment either before using real instruments and equipment, or in place of them. Students can typically access virtual labs 24/7, from wherever they are, and run the same experiments over and over again, varying an array of factors and input values. Remote laboratories, on the other hand, provide a virtual interface to a real, physical laboratory. Institutions that do not have access to high-calibre lab equipment can run experiments and perform lab work online, accessing the tools from a central location. Users are able to manipulate the equipment and watch the activities unfold via a webcam on a computer or mobile device. This provides students with a realistic view of system behaviour and allows them access to professional laboratory tools from anywhere.

CCR Framework Element: ***Infrastructure and Connectedness***

Overview

Virtual and remote laboratories are not new technologies, though they have become the subject of many important discussions about improving STEM education — especially in schools that cannot afford expensive technology and equipment. The EU-funded project "UniSchooLabs" is one such project that addresses this gap of access.[174] By collaborating with several universities, primary and secondary schools across the continent can use high-quality tools through computers and other devices. "UniSchooLabs" leverages both virtual and remote labs, which, while often spoken of together, are different in significant ways.

Remote laboratories enable users to conduct experiments and participate in activities via the Internet using remotely controlled but real laboratory equipment. Virtual laboratories are interactive online environments for performing experiments with simulated equipment. Both, however, offer the promise of authentic laboratory experiences regardless of the locale of the user. In both cases, students are still accountable for data collection and analysis, though some virtual labs have built-in tools to aid the lab write-up process. Likewise, both approaches are designed to mimic the same interactions users experience in a traditional "hands-on" laboratory, where users manipulate materials, measure liquids, and press buttons. Online users are able to control these actions through an interface. The online environment allows users to see the consequences of their actions as they unfold, whether simulated in virtual labs or with real equipment in remote labs. If the user does not get the results they desire, there is flexibility to re-do the experiment.

There are several notable hybrid virtual/remote laboratories, including the HYPATIA project, which enables college students to work with their teachers to study the fundamental particles of matter and their interactions through the inspection of the graphic visualisation of the products of particle collisions. The work done by students and teachers through HYPATIA directly informs the ATLAS experiment at the world's most powerful particle accelerator, the LHC in the European Particle Research Centre (CERN) in Geneva.[175]

Relevance for Teaching, Learning, or Creative Inquiry

Virtual and remote laboratories are responses to an increasing emphasis in schools on creating more authentic learning experiences in online education. Though the technology is still at least four to five years away from mainstream use in European schools, its pedagogical benefits are clear. Virtual and remote labs offer flexibility, as students can run experiments both in and outside of school. Because these labs are designed to allow easy repetition of experiments, there is less pressure on students to execute perfectly the first time. After learning what did not work, they can easily make adjustments to their processes and get different results.

In the controlled environments of virtual and remote laboratories, students' safety can be ensured, even if they make an error. In school settings, this solves a number of issues involved with having children exposed to potentially dangerous materials and processes. It

is especially true in scenarios involving chemicals or radioactive experiments. Teachers hesitant to engage in certain types of inquiry can now engage students in significant laboratory work easily, at low cost, and from anywhere. Most remote and virtual labs are currently either the result of high profile, well-funded university-level collaborations or targeted government grants. The "UniSchoolLabs" project, mentioned earlier, is creating an infrastructure to enable primary and secondary schools to remotely access university science laboratories through Internet-based services and mobile learning devices. Educators have access to a catalogue of available online laboratories, an archive of activities created by other users, and a tool for creating new activities or reusing existing ones.

For students, one of the most compelling features of these online labs is that they can deliver realistic scientific experiences that a student may not find even in the physical labs at their schools. This is one of the goals of the "Go Lab" project, an EU initiative that provides a diverse set of online labs for learners.[176] Through the virtual "International Space Station (ISS) 3D Teaching Tool," for example, students role-play as astronauts, navigating a 3D replica of the ISS as it orbits earth.[177] Similarly, the "Discovery Space Portal" gives them remote access to six robotic telescopes so they can track real astronomy and astrophysics data.[178]

Virtual and remote laboratories are responses to an increasing emphasis in schools on creating more authentic learning experiences in online education.

Virtual and Remote Laboratories in Practice

The following links provide examples of virtual and remote laboratories in use that have direct implications for European schools:

LiLa
go.nmc.org/lila
The EU-funded Library of Labs project (LiLa) was an initiative of eight universities and three companies to exchange and provide access to remote experiments. It included a scheduling system, connection to library resources, a tutoring system, and a 3D environment for online collaboration. > *Leadership*

Labster
go.nmc.org/labst
Labster, a Denmark company, created a virtual lab where an interactive molecular 3D animation makes molecular processes visible that would normally be obscured behind the walls of physical machinery. > *Practice*

Real Science in Sweden
go.nmc.org/mar
In the Swedish town of Lysekil, secondary students used virtual tools to explore the marine environment of the Gullmar Fjord on the Swedish west coast, learning in the process how scientific knowledge is created. The students accessed a virtual ocean acidification laboratory to conduct studies on acidification of the marine environment. > *Practice*

Virtual Physics Lab
go.nmc.org/virphy
Kosovo schools are using an online virtual physics lab that simulates 30 experiments in which students can manipulate variables and observe outcomes. > *Practice*

For Further Reading

The following articles and resources are recommended for those who wish to learn more about virtual and remote laboratories:

UniSchooLabs Toolkit: Tools and Methodologies to Support the Adoption of Universities' Remote and Virtual Labs in Schools (PDF)
go.nmc.org/unischool
(A. Ceregini et al., Consiglio Nazionale delle Ricerche and Istituto per le Tecnologie Didattiche, July 2012.) This paper describes a project funded by the European Commission that aims to improve science education across the continent by promoting collaboration between universities and schools. > *Leadership*

Education Online: The Virtual Lab
go.nmc.org/eduon
(M. Mitchell Waldrop, Nature.com, 17 July 2013.) This article explores online environments that enable students to access real data from remotely controlled instruments, allow them to upload and organise their personal findings and data, and simulate laboratory experiences. > *Practice*

Flipping Lab Science with Remote Labs
go.nmc.org/fliplab
(Jim Vanides, *HP Blog Hub*, 18 June 2012.) The author explores the role of remote science labs in the flipped classroom model. Students have more time to explore the material and run more iterations of an experiment.
> *Practice*

The 2014 Horizon Project Europe Expert Panel

Larry Johnson
Co-Principal Investigator
Management/Editorial Board
New Media Consortium
International Organisation

Guus Wijngaards
Co-Principal Investigator
Management/Editorial Board
Inholland University of Applied Sciences
The Netherlands

Samantha Adams Becker
Horizon Project Director
Lead Writer
New Media Consortium
International Organisation

Marta Caceres Piñuel
Editorial Board
CSEV
Spain

Jim Devine
Research Team/ Editorial Board
DEVINE Policy | Projects | Innovation
Ireland

Gavin Dykes
Management/Editorial Board
Cellcove Ltd
United Kingdom

Øystein Johannessen
Management/Research Team/ Editorial Board
Qin AS
Norway

Panagiotis Kampylis
Management/Editorial Board
JRC-IPTS
International Organisation

Holly Ludgate
Editorial Board
New Media Consortium
International Organisation

Yves Punie
Management/Editorial Board
JRC-IPTS
International Organisation

Riina Vuorikari
Management/Editorial Board
JRC-IPTS
International Organisation

Michele Cummins
Research Manager
New Media Consortium
International Organisation

Stefania Aceto
MENON Network
International Organisation

Helga Bechmann
Multimedia Kontor Hamburg GmbH
Germany

Jean-Pierre Berthet
École Centrale de Lyon
France

Roger Blamire
European Schoolnet
International Organisation

Stefania Bocconi
Institute for Educational Technology of the National Research Council of Italy (ITD-CNR)
Italy

Charlotte Bosworth
OCR
United Kingdom

Jeroen Bottema
Inholland University of Applied Sciences
The Netherlands

Deirdre Butler
St. Patrick's College, Dublin
Ireland

Nuria De Salvador
Teacher/Researcher
Spain

Simon Drazic
Secondary School Teacher
Slovenia

Lucian Cornel Duma
Special School Caransebes
Romania

Jelmer Evers
UniC, Utrecht
The Netherlands

Elizabeth FitzGerald
Open University
United Kingdom

Mario Franco
Millennium.edu
Portugal

Claus Gregersen
Herning Gymnasium
Denmark

Dawn Hallybone
Oakdale Junior School
United Kingdom

Paul Hine
Hine Consultancy
United Kingdom

Anna Hoberg
Fraunhofer Institut IAO Fraunhofer Gesellschaft
Germany

Jan Hylén
Ivar H Konsult
Sweden

Neil Ingram
Bristol University
United Kingdom

Ivailo Ivanov
Lauder Jewish Elementary & High School
Bulgaria

William Jenkins
Tech Stories
United Kingdom

Kiira Kärkkäinen
FCG International Ltd
Finland

Vibeke Kløvstad
Norwegian Centre for ICT in Education
Norway

Ioanna Komninou
First Experimental Upper High School of Athens
Greece

Harald Kraemer
Zürcher Hochschule der Künste
Switzerland

Anne Looney
National Council for Curriculum and Assessment
Ireland

Ann Michaelsen
Sandvika Upper Secondary School
Norway

Tao Papaioannou
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Lithuania

Steven Ronsijn
Sint-Lievenscollege Gent
Belgium

Gabriel Rubio Navarro
Ministry of Education
Spain

Tiina Sarisalmi
City of Orivesi
Finland

Ursula Simmetsberger
Education Group
Austria

Magdalena Sverc
Martin Slomsek Institute, Innovative Classrooms Project
Slovenia

Pieter Swager
Inholland University of Applied Sciences
The Netherlands

Marta Turcsanyi-Szabo
Etvos University
Hungary

Michael van Wetering
Kennisnet
The Netherlands

Stephan Vincent-Lancrin
OECD
International Organisation

Steven Edwin Vosloo
UNESCO
International Organisation

Barbara Wasson
University of Bergen
Norway

Endnotes and Links

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2 http://ftp.jrc.es/EURdoc/JRC83167.pdf (PDF)
3 http://www.eun.org
4 Mainstream use is defined for the purpose of the project as when about 20% of institutions adopt the technology within the period discussed. This figure, based on the research of Geoffrey A. Moore, refers to the critical mass of adoptions needed for a technology to have a chance of entering broad use.
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Abstract
The NMC Horizon Project from the New Media Consortium is a long-term investigation launched in 2002 that identifies and describes emerging technologies likely to have a large impact over the coming five years in education around the globe. The *NMC Horizon Report Europe: 2014 Schools Edition*, the first of its kind for Europe, examines six key trends, six significant challenges and six important developments in educational technology that are very likely to impact educational change processes in European schools over the next five years (2014-2018). The topics within each section were carefully selected by the Horizon Project Europe Expert Panel, a body of 53 experts in European education, technology, and other fields. They come from 22 European countries, as well as international organisations and European networks. Throughout the report, references and links are made to more than 150 European publications (reports, articles, policy documents, blog posts etc.), projects (both EU-funded and national initiatives) and various policy initiatives from all over Europe. The Creative Classrooms multidimensional framework, developed by European Commission's JRC-IPTS on behalf of DG EAC, was used for analysing the trends, challenges and technologies impacting European schools over the next five years. The analysis reveals that a systemic approach is needed for integrating new technologies in European schools and impacting educational change over the next five years.

Interested in these topics? Learn more about them and other Horizon Project insights by "liking" the NMC on Facebook at facebook.com/newmediaconsortium and on Twitter at twitter.com/nmcorg. Access the European Commission on Facebook at facebook.com/EuropeanCommission and on Twitter at twitter.com/EU_Commission.

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