TECHNOLOGIES IN HIGHER EDUCATION: MAPPING THE TERRAIN

Over a period of four years from 2010 to 2014, the UNESCO Institute for Information Technologies in Education (UNESCO IITE) has commissioned from international experts a series of policy briefs that — taken together — provide a comprehensive map of the terrain of Information and Communication Technologies (ICT) in education. Covering topics ranging widely from the role of ICT in globalization to ICT use for administration in education, these briefs, 28 in total, are an information-rich resource that can guide policy-makers, educational leaders, and educational practitioners to make more effective use of ICT. Though it is impossible to do justice to the wealth of information they provide, this Summary Brief provides an overview of the scope of coverage of the Briefs and highlights a few of the key policy issues they raise.

ICT AND CHANGING CURRICULUM IMPERATIVES

ICT are now vital to support the business of educational institutions, and support the full academic lifecycle, in terms of learning and teaching, from initial student enquiries through to accreditation and graduation and in terms of research from initial bid writing through to project delivery and dissemination. ICT systems include six main areas: payroll and financial accounting, administration of student data, inventory management, personnel records maintenance, library systems, and learning management systems.

Core ICT services provide support for the student journey, from an initial enquiry through to graduation. This includes managing a student's initial enquiry about courses, application, module selection, monitoring and support for the delivery of a course, assignment handling, examinations and graduation. Courses are delivered and supported through an institutional Virtual Learning Environment (VLE) or Learning Management System (LMS). Most institutions have one centrally supported system, but in some instances there may be local or bespoke systems. The library provides access to learning resources (both paper-based and digital), these can include learning materials and set texts for course, research journals and multimedia resources. Research activities are supported through systems for managing and monitoring research applications, research grants and contracts, research finance, publications recording, as well as patents and intellectual property recording.

Beyond this, though, the development of ICT in society is leading to the emergence of new jobs and changes in existing jobs, which calls for new curricula at all levels of education. Knowledge for the digital age cannot comprise just a traditional curriculum consisting simply of a list of content to be learned. Knowledge today is more complex, more transverse, and evolves very rapidly. The educator no longer has a monopoly over knowledge delivery, since accessing and acquiring knowledge has changed so significantly. The Internet provides access to a huge amount of information, which has to be processed, according to the context and according to the learner, in order to lead to the construction of knowledge. Information has to be classified, sorted out, checked, and organized.

Creating and communicating information are skills of growing importance as digital tools develop and make high-quality creative experiences available for increasingly broader user groups. Collaborative applications increase the importance of social skills in the learning process at all levels. In the new digital literacy framework of the 21st century, communication and creation in the digital media will take centre stage. In parallel, the demand for Technical and Vocational Education and Training (TVET) is

increasing, and teaching and learning are adopting new forms. The challenges of vocational education are quite similar in countries that vary widely in their current economic level of development. Entrepreneurship, which is closely connected with ICT, is a very important factor in both global and local economies.

Because of these changes, it is necessary for students to master digital literacy to become fully-fledged members of society. Digital literacy has, however, become much more than the ability to handle computers — just like traditional literacy and numeracy, it comprises a set of basic skills which include the use and production of digital media, information processing and retrieval, participation in social networks for creation and sharing of knowledge, and a wide range of professional computing skills. Digital literacy improves employability because it is a gate skill, demanded by many employers when they first evaluate a job application. It also works as a catalyst because it enables the acquisition of other important life skills. The challenge that education systems face today is to embed digital literacy in all levels of the system, as well as in the professional development of educators. However, while the potential of ICT as a medium for teaching and learning is recognized by many, its implementation is often problematic, with the result that relatively few students worldwide are offered an opportunity to learn with the help of ICT.

As educators and educational planners have learned more about the potential roles of ICT in education, it has become clear that ICT is both a driver and a facilitator of the increasing globalization of education. It is a driver because educators realize that the combination of digitally-based ICT creates more powerful possibilities for extending and improving teaching and learning than all previous educational technologies from the blackboard to television. It is a facilitator because the Internet is an extraordinary means for the wide, low-cost distribution of educational material. As the Internet has also become a vehicle for interaction, its potential for teaching and learning has become even more significant.

Within this changing global context, one can identify the following core reasons for introducing ICT into education:

- Social rationale: the need to teach basic ICT skills to prepare students for their place in society.
- Vocational rationale: the importance of ICT in giving students appropriate skills for future jobs.
- Pedagogical rationale: the enhancement of teaching and learning with the help of ICT.
- Catalytic rationale: the role that ICT may play in realizing educational change.
- Information technology industry rationale: the promotion of the ICT industry in education.
- Cost-effectiveness rationale: the expectation that ICT will reduce costs of education.

Importantly, a core goal for the application of ICT in education must be to raise the quality, efficiency and accessibility of teaching and learning. Integration of ICT in education offers possibilities to develop curricula that align with the challenges of the knowledge society. However, national curriculum policies often do not support and facilitate such use of ICT.

KEY FRAMING QUESTIONS

Consideration of the possible integration of ICT into education should be guided by five key questions:

1) *Why introduce ICT?* There must be clarity about what aims are being pursued through the introduction of ICT into education systems.
2) *Into what system is ICT being introduced?* To be effective, technology must be part of a system. Key elements of education and training systems already in place are the curricula, the teachers, the organization of the system and its supporting infrastructure. The insertion of ICT into these established systems requires careful and sensitive planning.
3) *Is ICT meant to improve learning outcomes?* A key question is whether ICT will be used to carry the existing curriculum or whether its introduction will be accompanied by curriculum reform that takes advantage of the benefits of ICT.
4) *Is ICT intended to improve cost-effectiveness?* Also critical is whether ICT is intended to make the education system more cost-effective. Such an aim will require careful planning to ensure that there is some substitution of capital for labour. Without such substitution, overall system costs will increase because the investment in ICT will simply be an add-on cost.

5) *Is there an exit strategy?* Education systems will last longer than any particular type of network or computing device. While technology or vendor lock-in may become less of a problem as systems become increasingly interoperable, good plans should include exit strategies.

ICT, PERSONALIZED LEARNING, AND CHANGING APPROACHES TO ASSESSMENT

Most contemporary public education systems are still based on the 'one-size-fits-all', full-time classroom-based model. This was believed to effectively serve all learners, or at least to provide them with the best education our society is able to offer in current economic and social circumstances. However, this single-model approach does not allow many students to achieve their best possible learning results. This can be dramatically improved by transition to a new education paradigm characterized by greater flexibility and options for individual students. So, the idea of personalization in education in general is very simple: to enable educators to match what is taught and how it is taught with the needs of each individual student.

If implemented within a context of accompanying curriculum and systemic reform, ICT can play a significant role in supporting a drive towards this 'personalized' learning experience. If implemented thoughtfully, ICT can:

- Present content in an engaging and attractive form;
- Help educators to record and constantly monitor the progress of each student;
- Allow customized delivery of relevant education material to individual learners;
- Build virtual social communities among different educational institutions, teams of students, or educators;
- Facilitate 'learning-to-learn' skills;
- Allow implementation of continuous learning processes in different learning contexts and provide on-demand support to students.

New educational technologies stimulate the development of creative components of pedagogical activity and transformation of the role of an educator provided full-scale and highly efficient active self-study under student-centred approach. New educational tools create virtual laboratories and workrooms. They encourage collective educational activity of a distributed group of students, which broadens the educational space of a college or university. ICT can also facilitate assessment in the context of innovative learning environments with new possibilities ranging from simple web-based tests for self-assessment to group work assessment to recent developments in semantic analysis for automatic diagnosis. Examples of these new possibilities are:

- New approaches (peer assessment, self-assessment, and so on), methodologies and tools to evaluate learning processes based on participation, collaboration, and production.
- Assessment within communities of practice that provide feedback and shared meanings essential to membership.
- More sophisticated assessment methods and tools that involve new types of questions and adaptive delivery procedures.
- Assessment of high-level skills and competences by means of Web 2.0 tools.

Personalization in education can be achieved through: continuous assessment that seeks to diagnose every student's learning needs and abilities; teaching and learning strategies that build on individual aptitudes and demands; engaging learning pathways customized for each learner; and a radical approach to institutional organization. Likewise, digital literacy may best be evaluated through digital assessment tools, such as electronic portfolios. An electronic portfolio, also known as an e-portfolio or digital portfolio, is a collection of electronic evidence assembled and managed by a user, usually on the Web. Such electronic evidence may include inputted text, electronic files, images, multimedia, blog entries, and hyperlinks. E-portfolios are both demonstrations of the user's abilities and platforms for self-expression, and, if they are online, can be maintained dynamically over time.

Given these kinds of possibilities, discussions of assessment in education using ICT often concentrate on increasing the precision of assessments for evaluating individuals. This is because test makers are concerned about issues of reliability (consistency) and validity (are they measuring what they intend) of online assessments, and also about how to prevent cheating.

A key reason for improving the precision of measuring individual learning using ICT is that it enables adaptive learning systems. Adaptive learning systems ensure ongoing assessments of a learner's knowledge state, so they can tailor problems and instruction appropriately. However, if the goal of assessment is to improve instruction, then the measures also need to yield actionable information at the level of the learning environment.

For example, designers can embed learning assessments within the learning experience and analyse process data in log files that capture every click and key stroke. The emerging performance data can be used to draw inferences about the user's knowledge state and learning. This kind of assessment can reduce test anxiety, because the lines between learning and assessment are blurred; the assessment is integrated with the learning process. Importantly, embedded ICT assessments do not need to be hidden assessments. In fact, there are examples where providing students with the results of embedded assessments can drive greater learning and engagement.

In addition to reconsidering when and where assessment can happen using ICT, it is also possible to rethink what is being assessed. While codified knowledge is important, equally crucial for 21st century job success is the ability to adapt and learn. Using the concept of preparation for future learning assessments, rather than only measuring the student's codified knowledge, students are provided learning resources during the assessment. Assessment then measures how prepared students are to learn from those resources. For iterative design of ICT-based educational environments, the question becomes whether one experience prepares students to learn new, related content better than another. These kinds of assessment measures are more similar to what students will experience outside of formal learning and can show differences between learning experiences where traditional measures of codified knowledge do not. In these kinds of ways, technology can allow researchers and designers to collect data on students' choices about learning, which creates an interactive preparation for future learning assessment.

Assessments have many different uses, from ranking nations to characterizing a student to evaluate a learning experience. Different uses require different kinds of assessment. Particularly, formative assessment can be an important tool for making instructional decisions. Formative assessment is considered assessment 'for learning', where the primary goal is to inform the learning process. Formative assessment can be used at an individual level to decide what information or problems to present to students given their current level of understanding. It can also be used at the level of ICT development to determine which design choices are most effective for learning in a virtuous cycle of testing and improvement. There is, however, a great inertia within educational systems when it comes to shifting the focus from a transmissive paradigm to an active one. Traditional assessment generally encourages superficial and rote learning focused on evaluating whether what has been taught has been understood, remembered, and practised.

New prospects justify the efforts invested in the development of new methods and new educational technologies which should consider the following issues:

- Drastic rise in the significance of the self-study through expanded functions and increased efficiency while using active and student-centred forms of education;
- Shift of non-interactive components of classroom activities lessons to individual out-of-class activity;
- Increase in time to communicate with learners, transition from lecturing to discussion, collective analysis and research;
- New level of interaction among participants of the educational process due to the full-range computer support of the closed educational cycle and distance collective educational activity.

ICT AND OPEN LEARNING

Open learning uses ICT to provide formal education for learners who are separated from their educators and other learners in time and place. The value of open learning that uses ICT is its potential for scale (its ability to handle very large numbers of students) and reach (its ability to provide access to education at any place at any time). Why should ICT-based open learning produce an improved cost-benefit analysis in comparison with conventional open learning or campus-based methods? To put it most simply, the reasons are found in the capability of the technology to improve costs by operating at scale, and to improve benefits by supporting independent active learning.

Open learning achieves improved cost-benefits partly by transferring activities from variable costs to fixed costs, and achieving economies of scale through larger student numbers. ICT can support high student numbers because online delivery and communication is possible without large-scale and costly estates and buildings. This means it should be possible to achieve economies of scale, where the costs of provision are amortized over larger student numbers.

The societal benefits of social mobility and an educated workforce that Education for All aims to achieve can only be made possible through the logistical benefits of widening access to education. ICT in open learning contributes to this by providing the flexibility and local access that makes it possible for people to study alongside work and family commitments, i.e. at low opportunity cost to the student. However, this is critically dependent on the provision of equipment and connectivity at low cost to those potential students, often the responsibility of government agencies.

It is the capability of ICT to enable the teacher to represent their teaching without their personal physical presence that makes it viable to transfer teaching from variable-cost activities (such as lectures, labs, tutorials) to fixed-cost activities (such as multimodal web resources, simulations, peer support activities), and still maintain, or even improve the quality of learning experience. The fixed cost of designing and producing the tools, environments, or activities can be high, but they can be rich enough to provide many learners with many hours of productive learning activity that does not involve the teacher, and yet has high value for the learner because of the adaptive feedback and/or their interaction with other learners. If these benefits are achieved, and if student numbers are high, then per capita costs can be low enough to achieve an improved cost-benefit analysis.

Understanding the importance of these benefits will help to avoid the bad ways of reducing the costs of teaching. The largest cost is tutoring and marking time, and if this were to be reduced by offering a 'less constructivist environment', such as converting open-ended examination questions, or group projects, into computer-marked multiple choice questions, this would seriously under-exploit the capabilities of ICT, and undermine the value of the teaching. The cost would be lower, but the benefits would also be much lower, yielding a poorer cost-benefit analysis.

Achieving the benefits of ICT in open learning requires focus on the following key actions:

1) Manage the digital infrastructure to reduce students' ICT access costs;
2) Invest in and manage teaching development and teacher training to ensure ICT increases active and personalized learning;
3) Increase and carefully design peer support activities to reduce costs and increase social and collaborative learning;
4) Increase group sizes to reduce variable costs, while maintaining the quality of the learning experience through more social and collaborative learning;
5) Convert all student services to online to reduce variable costs;
6) Increase student numbers and retention to reduce per capita costs;
7) Convert all resources to digital to reduce fixed costs;
8) Promote reuse and sharing of resources among teachers to reduce fixed costs;
9) Establish a more direct link between teaching activity cost and return within institutional budgeting to encourage collaboration.

ICT FOR INCLUSION

ICT can enable people with disabilities to receive an equitable education and facilitate them to reach their full potential as productive and integrated members within society. Achieving this can be done through the use of:

- Mainstream technologies (such as computers) that contain in-built accessibility features;
- Accessible formats, also known as alternate formats, such as accessible HTML (Hypertext Markup Language) and DAISY (Digital Accessible Information System) books, as well as 'low-tech' formats, such as Braille;
- Assistive technologies[1] (ATs), such as hearing aids, screen readers, adaptive keyboards, and so on.

[1] An Assistive Technology (AT) can be defined as a 'piece of equipment, product system, hardware, software or service that is used to increase, maintain or improve functional capabilities of individuals with disabilities'.

The high-tech ATs that have emerged over the last two decades have had a particularly dramatic impact on access to education. Other ICT for learning include educational software and Virtual Learning Environments (VLEs). These have a broader application to all students. It is therefore imperative that educational authorities ensure that these technologies are universally designed in accordance with requirements under the UN Convention on the Rights of People with Disabilities.

From the perspective of ICT for inclusion, common challenges that all countries continue to grapple with include the following:

- The high cost and/or availability of suitable ICT, in particular the availability of affordable high-tech assistive technologies such as screen readers in the language of the student.
- Levels of AT abandonment are high. Reasons for this include poor needs assessment, provision of unsuitable technology, and poor training and follow up support.
- Attitudes of educators towards the perceived value and potential of ICT use by people with disabilities.
- Poor support for educators and students for ICT to be implemented as a pedagogical tool rather than as an add-on to traditional teaching methods.

Given these challenges, it is important to ensure that ICT for inclusion receives the necessary policy attention. For example, national agencies for special education and/or ICT in education are in existence in many countries. While these vary in form and function, all should have a clear statement of intent and help to coordinate policy development and implementation of a national infrastructure for ICT in education for people with disabilities. Likewise, a key area for policy development should be the instruction of educators during initial and in-service training on use of ICT in teaching students with disabilities.

Another policy measure that will improve access to curriculum for students with disabilities using ICT is a requirement for educational resources to be made available in accessible formats. Similarly national policies and initiatives that require publicly funded websites to be accessible will help improve access to educational resources published online. From this perspective, a key development in curriculum design is universal design for learning (UDL). UDL is an emerging and transformative idea which has, at its core the development of curriculum that is designed for the outset to meet the greatest number of users, reducing the need for costly and time-consuming retrofitting.

TECHNOLOGY PLATFORMS, SOCIAL MEDIA, AND MOBILE LEARNING

A goal of many educational organizations is to provide seamless learning experiences through diverse learning platforms and tools via the Internet. Proliferation of web-based applications of all kinds has led to much more distributed learning resources. There has also been expansion of various types of learning applications and platforms, including social networking services (SNS), wikis, blogs, user created content (UCC), personal communication devices, repositories, and assessment systems, amongst others. Increasingly, learning platforms can be connected to diverse and independent web-based applications, such as Web 2.0 tools, assessment tools, simulation tools, and specialized tutoring tools. This does not mean, however, that all the connections need be provided by a single learning platform. Therefore, learning platforms need to have open architecture which can contain and/or be easily connected to web resources. Open learning platforms can gather various functions and resources on the wider web due to their open architecture, and are capable to provide personalized learning interfaces through mash-ups.

Thus, key features of effective learning platforms increasingly include the following:

- Creation, aggregation and exchange of information among educators, learners, administrators, and parents;
- Functions for delivery of self-directed learning content and support for instructor-led learning activities;
- Incorporation of distributed learning services and tools, as well as the capability to allow users to design their own interface;
- Support for collaboration and interaction between educators and learners, as the opportunities to collaborate and work on shared resources and ideas can help learners and/or educators to work together to solve problems.

Selection of the right set of interoperability points from a huge pool of standards has become an important issue. For flexible learning content, connection with distributed web services and tools, and convergence between e-textbook and learning services, learning technologists need now more than ever before make the standards more focused.

As has been noted, operating in parallel with learning platforms are social media. Social media allow for a better, faster and more constant social interaction among learners. However, social media are often used in a very inflexible way: students develop one-sided manners to communicate on the web, and are not effective or efficient in the long run. In other words, systematic instruction is needed to make youngsters more sophisticated in their use of social media. Moreover, social media typically deal with the personal situation and lifestyle of the student. Very few social media have been configured to consider the group of students as a class. The dominant belief is still that learning and social networking are antithetical. Despite this, social media raise our awareness that human intellect is not only an individual asset, and they highlight the importance of crowd-sourcing and distributed cognition.

Social media have entered education because of students' need to keep in contact with their peer group, and not necessarily only with their classmates. The challenge for the future is to open the didactic arena and see how this stage of transformation for students can be used for intellectual learning. The first step needed is to let educators explore the potentials of social media and gradually test-drive some of their benefits in classroom exercises.

Another emerging technology trend is the growth of mobile learning. The key to mobile learning lies in taking advantage of the learning opportunities offered by mobile technologies, which typically happens when learners are not at a fixed, predetermined location, so that they are able to engage in situated learning and make use of context-specific resources. Devices used in mobile learning are commonly: mobile phones (cellular phones); personal listening devices such as mp3/mp4 players; and lightweight, portable computers such as slates, tablets, netbooks, and small laptops. Mobile learning is often 'content-light', and is used as a tool that helps learners to access audio materials, receive and send text messages, respond to quizzes, participate in instant chat, make brief notes, or reflect on their learning.

Mobile learning does carry some attendant educational risks. With excessive use of mobile technologies, human relationships can become compromised and stress levels, or feelings of overload, can rise. Pervasive use of mobile devices may entail loss of privacy and attacks on personal security. Mobile learning requires financial investment and educator training. From a pedagogical perspective, education can become trivialized if it is reduced to learning nuggets and a 'grazing' ethos whereby real depth of understanding is no longer valued.

Given these developments in different kinds of learning platforms and delivery options, there has been growing interest in the concept of Cloud Computing, which has the following key characteristics:

- Cloud services are delivered via the Internet from high-specification data centres in locations remote from end users and their institutions.
- Resources such as data storage, processing, memory and bandwidth are shared between multiple customers and can be allocated dynamically depending on demand.
- Rapid elasticity, allowing for sudden peaks in demand and giving the customer the impression that the services are infinitely scalable.
- Customers pay for the services they use while providers bear the costs of hardware and software provision.

The economies of scale and other features of cloud computing are likely to mean an increasing shift away from institutionally-hosted services. These services are increasingly provided using Internet technologies to staff and students and accessed from web browsers. The services are offered cheaply or freely to education, often with much higher availability than can be provided by the educational institution. It can be argued that computing services are becoming commoditized, and are handled better by organizations with specific expertise and economies of scale. Increased use of lower-level cloud services in education, such as for data storage, seems inevitable, particularly for services where security is less of an issue, such as for repositories of learning content. However, there is a risk that institutions will become 'locked-in' to the products of a particular provider. There are significant costs in migrating from any widely-used system. While some providers make claims about the interoperability of their products, it is rarely easy to transfer content from one system to another.

OPEN EDUCATIONAL RESOURCES (OER)

OER refers to any educational resources (including curriculum maps, course materials, textbooks, streaming videos, multimedia applications, podcasts, and any other materials that have been designed for use in teaching and learning) that are openly available for use by educators and students, without an accompanying need to pay royalties or licence fees. OER can exist as smaller, stand-alone resources (reusable learning objects), that can be mixed and combined to form larger pieces of content or as larger course modules or full courses. OER can also include simulations, labs, collections, journals, and tools. These materials are considered open if they are released under an open licence such as a Creative Commons licence.

For individuals, the greater availability and accessibility of resources created by OER has been found to help them to:

- Learn new things or enrich other studies;
- Share and discuss topics asynchronously or synchronously with other learners;
- Assess whether they wish to participate in (further) formal education;
- Decide which institution they want to study at;
- Improve their work performance;
- Create or revise OER themselves.

For educators, individually and collectively, OER can be of use to:

- Create courses more efficiently and/or effectively, particularly using rich media resources;
- Investigate the ways in which others have taught their subject;
- Create resources or courses in collaboration with others rather than doing it all themselves;
- Join in communities of practice which help improve their teaching practices through the use of new open tools and technologies;
- Customize and adapt resources by translating or localizing them.

For educational institutions, OER offers opportunities to:

- Showcase their teaching and research programmes to wider audiences;
- Widen the pool of applicants for their courses and programmes;
- Lower the life time costs of developing educational resources;
- Collaborate with public and commercial organizations in new ways, including educational publishers;
- Extend their outreach activities.

For governments and national agencies OER offer scope to:

- Showcase their country's educational systems;
- Attract international students (to higher education at least);
- Help drive changes in educational practices;
- Develop educational resources in 'minority' languages that commercial publishers are reluctant to create;
- Develop educational resources that reflect local cultures and priorities;
- Cooperate internationally on common resources to meet common needs.

A major value of OER is the way that they can facilitate changes in educational policies and practices to the benefit of learners, teachers and institutions. Key issues being investigated include:

- Who should have responsibility for checking intellectual property rights and publishing the OER — the creator or a dedicated support team?
- How might the quality of an OER be determined?
- How should courses be designed for e-learning using OER?
- What are the incentives, either rewards or recognition, for academic staff in developing OER?
- Which media are best used for which teaching or learning purposes?
- What partnership models are best for developing collaborative, collective and common resources?

While OER activity is global, the largest and best funded initiatives have mostly been in developed countries from North America and Europe, and have mostly been in English. Although interest is widespread, significant implementation and use is patchy but growing. The initial major force driving OER is the unlocking or opening up of knowledge to as many people as possible in as many countries as possible. Nevertheless, dedicated funding from Foundations

and government departments or agencies has been necessary to kick start most developments or fund investigations into how best to sustain OER activities.

Consequently, key considerations to stimulate the growth of OER and open educational practices include the following:

1) For those involved in providing content, decide that taking part in a more open approach is worthwhile and accept that this can have some risks and unforeseen consequences (but in practice these are rarely bad consequences).
2) For users of content, become a user of open content, starting by looking at how content is made available and checking if permissions are given and if they are clear (which both helps with retrieval of high quality content and can lead to steps towards working with others.
3) Look to the Creative Commons as a model for how to think about release of rights and if possible adopt the licences to help promote a consistent approach.

MASSIVE OPEN ONLINE COURSES (MOOCS)

A MOOC is a model of educational delivery that is, to varying degrees: massive, with theoretically no limit to enrolment; open, allowing anyone to participate, usually at no cost; online, with learning activities typically taking place over the web; and a course, structured around a set of learning goals in a defined area of study.

Definitions of MOOCs tend to emphasize openness in relation to the ability of learners to be able to access content through web based platforms, openness in terms of cost, openness in terms of the use of open courseware, or openness with respect to learner collaboration. However, there are two distinct types of MOOCs when compared in terms of their underpinning theory, format and structure, namely cMOOCs (or connectivist MOOCs) and xMOOCs (the 'x' is adapted from MITx and edX). Whilst the two types of courses have some common features, they clearly differ with regards to their learning theory and pedagogical model — in particular, the different way in which social interactions happen during the courses. The concept of openness in cMOOCs and xMOOCs also has different meanings, with learner autonomy, peer-to-peer learning and social networking being emphasized in cMOOCs, whilst xMOOCs are based on a tutor-centric model that establishes a one-to-many relationship to reach massive numbers. In xMOOCs, 'open' does not necessarily refer to open content or even open access, but may only equate to 'no charge' (with the option of a fee for certification).

At this stage in their development, it is not clear whether MOOCs are a disruptive technology which will alter the face of higher education, or an overhyped and/or transient phase in educational learning and delivery. Key policy considerations therefore include the following:

- Mission: what role can MOOCs play in communicating knowledge and expertise, and raising the profile of an institution and its departments around the world?
- Recruitment: what role can MOOCs play in diversifying recruitment pathways (if that is an institutional aim)?
- Innovation: what role can online models of delivery play in improving the quality and value of online and traditional courses for students, employers, and society?
- Sustainability: what are the costs of developing and running MOOCs and what are the wider implications of a shift towards free course content for existing business and pedagogical models?
- Pedagogy: how can an institution add value to the educational experience of students beyond the standard MOOC platform experience, and facilitate access to a variety of social and professional networks?

THE CENTRAL ROLE OF EDUCATORS

Educators at all levels of education systems are key to the integration of ICT in education. The way that they use ICT is affected by will (attitudes toward IT), skills (ICT competencies), and access to ICT tools. In this regard, ICT competency is not limited to basic ICT knowledge and skills, because meaningful use of ICT requires educators to develop knowledge and skills that enable them to integrate ICT with a suitable pedagogical approach for teaching specific subject matter in a certain context.

High-quality professional development for educators is critical, yet often lacking in education reform efforts. This lack of effective professional development for educators is often considered a root cause of the divide between what learners could potentially achieve and the reality they

actually face in classrooms throughout the world. The UNESCO ICT-Competency Framework for Teachers (ICT-CFT) was developed in 2008 to improve teacher practice in a way that contributes to a better- informed citizenry and higher quality workforce that will ultimately impact a country's economic and social development.

The objectives of the UNESCO ICT-CFT project are to:

- Constitute a common core syllabus (defining various ICT competency skills for educators) that professional development providers can use to develop learning materials sharable at a global level;
- Provide a basic set of qualifications that allows educators to integrate ICT into their teaching;
- Extend professional development of educators, advancing their skills in pedagogy, collaboration, and innovation using ICT;
- Harmonize different views and vocabulary regarding the uses of ICT in teacher education.

Various factors have been associated with successful professional development. These include:

- The duration of the activity (both time per session and number of sessions). Findings indicate that longer is better.
- Collective participation of groups of educators from the same institution or department have been found to be more effective than individual participation.
- Active learning opportunities are associated with effective professional development.
- Content focus has been deemed more effective than generic teaching strategies not tied to particular content areas.
- Coherence is the degree to which the activity is tied to institutional goals, policies, standards, and so on. The greater the coherence for educators, the more effective the professional development.

The UNESCO Framework also advocates embedding ICT work in larger efforts to transform content and curriculum. Notwithstanding the importance of educators, studies on implementation of educational change clearly show that educator change alone is not enough to make educational change happen. Educator change should be part of a systemic change effort. Factors that foster institution-wide integration of ICT include a strong connection between pedagogical aims and ICT, strong leadership, institution-wide adoption of ICT, a focus on the process of ICT implementation, collaboration with external partners (including those from the private sector) and with other institutions (to share ideas and approaches), and being able to cope with new trends.

LEARNING ANALYTICS

'Analytics' is a term used in business and science to refer to computational support for capturing digital data to help inform decision-making. Learning Analytics appropriates this concept for education: what should a digital nervous system look like when the focus is on learning outcomes, and to extend the metaphor, what kind of 'brain' or collective intelligence is needed to interpret the signals and adapt the system's behaviour accordingly?

Learning analytics covers the macro-, meso- and micro-levels. What is now taking place is the integration of, and mutual enrichment between, these layers. The aggregation of thousands of learners' interaction histories across cohorts, temporal periods, institutions, regions and countries creates meso- and macro-level analytics with an unprecedented level of fine-grained process data. One of the more advanced uses of analytics generating interest is the possibility that, from the pattern of learners' static data (for example, demographics; past attainment) and dynamic data (for example, pattern of online logins; quantity of discussion posts) one can classify the trajectory that they are on (for example, 'at risk'; 'high achiever'; 'social learner'), and hence make more timely interventions (for example, offering extra social and academic support; presenting more challenging tasks).

Likewise, adaptive learning platforms build a model of a learner's understanding of a specific topic, sometimes in the context of standardized tests which dictate the curriculum and modes of testing. This enables fine-grained feedback (for example, which concepts the student has grasped and at what level), and adaptive presentation of content (for example, not showing material that depends on having mastered concepts in which the learner has failed).

There are several potential impacts of learning analytics, which can be summarized as follows:

- Micro-level benefits:
  - Identify at-risk learners and provide interventions.
  - Provide learners with insight into their own learning habits and give recommendations for improvement.
- Meso-level benefits:
  - Improve administrative decision-making and organizational resource allocation.
  - More transparent data and analysis could create a shared understanding of the institution's successes and challenges.
  - Make better sense of complex topics through combinations of analytics (for example, from social, technical and information networks).
  - Support holistic decision-making through better understanding the impact of different variables.
  - Increase organizational productivity by providing up-to-date information and allowing rapid response to challenges.
  - Help leaders determine the hard (e.g. patents, research) and soft (e.g. reputation, profile, quality of teaching) value generated by faculty activity.
- Macro-level benefits:
  - Ultimately the above might transform the college/university system, as well as academic models and pedagogical approaches.

However, recent critique of the rhetoric around Big Data provides a reminder to enter this field with caution. In particular, it is important to remember that: automating research changes the definition of knowledge; claims to objectivity and accuracy are misleading; bigger data are not always better data; not all data are equivalent; just because data is accessible does not make it ethical; and limited access to big data creates new digital divides. Every step of the lifecycle — from data to analytics to insight to intervention — is infused with human judgment. Thus, it is as naïve to believe that 'data speaks for itself' as it is to believe that a text has a single, objectively discernible meaning for all contexts.

As importantly, the risk is that research and development focuses on the data which is simplest to log computationally, perpetuating the dominant pedagogies and learning outcomes from an industrial era, when most educational thought-leaders point to the additional dispositions and skills needed for lifelong, life wide learning, and the capacity to thrive in a very turbulent world. Consequently, it is important that institutions should:

1) Train staff and researchers in the design and evaluation of learning analytics — to ensure that there is the organizational capacity to deploy analytics with integrity, sustain quality dialogue about how they are used, ask the right questions of vendors, and to satisfy the societal demand for this workforce.
2) Invest in analytics infrastructures to optimise student success, and to enable their own researchers to ask foundational questions about learning and teaching in the 21st century.
3) Collaborate on establishing trusted partnerships and robust mechanisms to share student data, analytics techniques and information visualization tools.

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Author: Neil Butcher

Published by the UNESCO Institute
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8 Kedrova St., Bldg. 3
Moscow, 117292
Russian Federation
Tel: +7 (499) 129 29 90
Fax: +7 (499) 129 12 25
E-mail: Liste.info.iite@unesco.org
http://www. iite.unesco.org

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