eleed
e-learning
& education

Issue 10
2014

(Lifelong) learning in your pocket?

How technologies have changed teaching and learning in schools, universities and businesses, and what developments are still to come for all education providers

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urn:nbn:de:0009-5-40840

Zusammenfassung

Der Beitrag fokussiert die Entwicklung, den Einsatz und die Nutzung von innovativen Technologien zur Unterstützung von Bildungsszenarien in Schule, Hochschule und Weiterbildung. Ausgehend von den verschiedenen Phasen des Corporate Learning, Social Learning, Mobile Learning und Intelligent Learning wird in einem ersten Abschnitt das Nutzungsverhalten von Technologien durch Kinder, Jugendliche und (junge) Erwachsene in Schule, Studium und Lehre betrachtet. Es folgt die Darstellung technologischer Entwicklungen auf Basis des Technology Life Cycle und die Konsequenzen von unterschiedlichen Entwicklungszuständen und Reifegraden von Technologien wie Content Learning Management, sozialen Netzwerken, mobilen Endgeräten, multidimensionalen und -modalen Räumen bis hin zu Anwendungen augmentierter Realität und des Internets der Dinge, Dienste und Daten für den Einsatz und die Nutzung in Bildungsszenarien. Nach der Darstellung von Anforderungen an digitale Technologien hinsichtlich Inhalte, Didaktik und Methodik wie etwa hinsichtlich der Erstellung von Inhalten, deren Wiederverwendung, Digitalisierung und Auffindbarkeit sowie Standards werden methodische Hinweise zur Nutzung digitaler Technologien zur Interaktion von Lernenden, von Lehrenden, sozialer Interaktion, kollaborativem Autorieren, Kommentierung, Evaluation und Begutachtung gegeben. Abschließend werden - differenziert für Schule und Hochschule - Erkenntnisse zu Rahmenbedingungen, Einflussgrößen, hemmenden und fördernden Faktoren sowie Herausförderungen bei der Einführung und nachhaltigen Implementation digitaler Technologien im schulischen Unterricht, in Lehre, Studium und Weiterbildung im Überblick zusammengefasst.

Stichwörter: Bildungstechnologien, E-Learning, Nutzungsverhalten, Schule, Hochschule, Weiterbildung, Bildungsinhalte, Lernumgebungen, Internet der Dinge, Mediennutzung, Virtuelle Hochschule, Marktanalysen, intelligent-tutorielle Systeme, MOOCS, Learning Analytics

Abstract

This article focuses on the development, deployment and use of innovative technologies to support education scenarios in schools, universities and further training. Building on the various phases of corporate learning, social learning, mobile learning and intelligent learning, the first section examines the technology usage behaviour of children, young people and (young) adults in schools, studies and teaching. This is followed by a

presentation of technological developments using the technology life cycle and the consequences of the differing devel-opment states and maturity levels of technologies such as content learning management, social networks, mobile devices, multidimensional and multimodal spaces, augmented reality applications, and the internet of things, services and data for deployment and use in education scenarios. The article subsequently sets out the requirements placed on digital technologies in terms of content, didactics and methodology, of content creation, recycling, digitisation and retrievability, and of standards. A further section offers methodological guidelines for the use of digital technologies for teacher and student interaction, social interaction, collaborative authorship, commenting, evaluation and assessment. Differentiating between school and university environments, the final portion offers a summary overview of findings regarding framework conditions, influencing variables, limiting and supporting factors, and challenges in introducing and sustainably implementing digital technologies within school lessons, teaching, studies and further training.

Keywords: Educational technologies, e-learning, usage behaviour, school, university, continuing training, educational content, learning environments, internet of things, media usage, virtual university, market analyses, intelligent tutoring systems, MOOCs, learning analytics

1 Educational development through new technologies

Over the past decade, technological development has proven to be a major factor accelerating the modernisation and change of content, curricula, structures and processes within educational institutions. The late 1990s was a period of initial hype caused by the testing and implementation of first hypermedia then multimedia applications on the World Wide Web (such as web-based training, content and learning management systems, authoring suites and online assessments). Today, we are now seeing aspects such as the widespread use of social networks, rapid spread of mobile devices, opportunities for multimodal content development and availability in global repositories, and the potential for semantic web technologies using AI methods revive educational development through the emergence of content, methods and technologies in unforeseeable ways. This affects educational institutions such as kindergartens, schools, universities and also training providers in and for businesses (corporate universities, human resource departments) as a whole. Technology-based personal teaching and learning, social learning, ubiquitous learning, and teaching and learning with intelligent adaptive systems have spawned (semi) virtual education providers at all levels and in all areas of lifelong learning which identify the broad use of educational technologies and e-learning as a profile element of their institutional development – or, in a few cases, deliberately avoid their use.

Significant factors in these changes are the opportunities and added value created by innovative technologies in school, university and business-related educational scenarios in hybrid teaching, learning and examination spaces. Whilst (within a traditional understanding of schools, universities and education providers) these were formerly teacher-centric and used the approaches of cognitivism and instructional design, we now also have learner-centric constructivist approaches to concepts such as situated learning and connectivism. These developments changed our understanding of education from an originally isolated qualification measure focusing on individual advancement of knowledge and oriented

towards fixed curricula to a process of lifelong learning aiming to deftly generate emerging knowledge in networked and hybrid spheres of life. As was the case in the late 1990s, in Germany it is also schools, universities and businesses which were the first to get involved and organise massive open online courses (MOOCs) [1] often in conjunction with educational technology providers or research institutions. They were also the first to support the use of smartphones and tablet computers in classrooms, lecture halls, leisure time and at home, and offer training, advice and support for students and lecturers.

It is already possible to predict that the next generation of innovative technologies and applications relating to the internet of things, services and data will once again prompt a change to educational programmes and provide ample opportunities for pedagogical innovation. This is evidenced by prototype developments and initial experimental approaches to cyber-physical systems and intelligent knowledge and action services [2] or by developments regarding the topic of big data as a fourth factor of production alongside capital, labour and raw materials. [3] Further rapid technological advances and the increasing willingness of teachers and students to use a variety of technological services and facilities for their individual educational interests have apparently meant that educational institutions in general and schools, universities and businesses in Germany in particular are confronted with similar issues to those they faced in the early 2000s:

- What are the major trends and are they of strategic relevance to institutional development?
- How will schools, universities and corporate universities be altered by innovative technologies and usage behaviour and what does this mean for their profiles?
- How can we act locally to both observe and take account of global changes?
- What are the driving forces behind global development and what are the obstacles for educational institutions?
- Which education scenarios are feasible and can be financed?
- Can existing educational content be used in conventional form or does it need to be transformed – and if yes, how and into what target formats?
- Which education scenarios are didactically and methodologically sound and can be recommended from a learning and cognitive psychology perspective? Which teaching and learning scenarios prove unsuitable for digital technology support?
- How can new momentum for education using innovative technologies be evaluated and sustainably implemented?
- What opportunities and prospects, as well as risks and dangers, are associated with the use and deployment of digital technologies in teaching, learning and examination?
- What new business models are there and how is value created?
- What will modern education governance for educational institutions with digital media and e-learning look like?

2 Usage behaviour as a change factor

Smartphones and tablet computers have long since found their way beneath school desks, into lecture halls and in the workplace, and are a living reality across all age groups. 2012 saw the number of mobile devices sold exceed the number of laptops sold for the first time, and the degree of smartphone penetration among teenagers and young adults is almost 100 percent. [4] Internet services such as YouTube, Google, Twitter and Wikipedia have superseded teachers, university lecturers and trainers as the preferred way to access knowledge, replacing the omniscience of teaching staff and traditional libraries as the sole place of globally available knowledge. Social networks such as Facebook, Google+, SchülerVZ, Xing or LinkedIn are currently the preferred location for encounters, exchange and peer-to-peer communication among school pupils and students. The gap between older and younger people – and thus also between teachers and learners as well as those responsible for organisational development in schools, universities and businesses – is widening in terms of interaction, affinity and skills with the systematic, targeted and structured use of digital media and modern internet technologies for teaching, learning and educational purposes. On the one hand we have digital immigrants (currently still the vast majority of the teaching generation) who have learned to work with computers and the internet. On the other we have digital natives, younger subsequent generations who were born into a world with the internet, in other words school pupils, students and young employees. Digital natives are also described as a media-omnipotent 'net generation' in specialist and popular scientific literature. [5] Characteristics used to describe this generation are multitasking, pronounced visual orientation, active learning, inductive learning, self-organisation, tolerant of minorities, team-oriented, able to quickly shift their attention, and short response times for internet enquiries. The reason given for this is a strong capacity for competent, knowledgeable handling of modern techniques and technologies.

Meta-analyses of global studies looking at the frequency, type and media usage of the net generation, which have been repeatedly presented and analysed since 2010, have shown that digital natives are a myth rather than a reality. [6] Publications on this topic demonstrate that media usage by teenagers and young adults takes place primarily during their leisure time, without transfer to other spheres of life such as school, university or the working environment. Media are used primarily for peer communication, or exchange with other members of their generation. It is individual motivation and peers rather than instructions from parents or teachers which determines the effect and use of digital media. Analyses of the study-related usage of digital media and internet technologies have also shown that students are making increasing use of external services such as Google and Wikipedia regardless of their course or university type. Stationary network access among this group also continues to be superseded by mobile internet access and the number of mobile flat rates is growing rapidly, but the take-up of internet services requiring active participation such as wikis, blogs, chatrooms or forums is low. This confirms the fundamental findings of what is to date the only representative survey of 4,400 students in Germany from the year 2008: 73% of students already used the internet for one to three hours a day, 60% chose Wikipedia as their preferred source of information and knowledge (with 80% of students reading the website but only 0.3% writing and 1% commenting on existing entries) and 51% were active in social communities such as Facebook and Xing

(more than 70% for private purposes but only 34% for studies). It also emerged that more than half of the students surveyed trusted the content of online encyclopaedia Wikipedia, but only 26% the entries in the Encyclopaedia Britannica. [7]

3 From web-based training via social learning to multimodal environments

The deployment and use of digital media and internet technologies in schools, universities and businesses has changed substantially over the last ten years. In the mid to late 1990s the dominant option was still online learning programmes developed by teachers for students as computer-based or web-based training at great expense and made available online via content learning management systems. The arrival of web 2.0 and the associated change in usage behaviour from receptive, passive consumers to prosumers, in other worlds active and creative users developing their own content and also consumers of internet services including the use of digital technologies for teaching, learning and examination, created manifold potential for change. However, an observation of the current usage behaviour of school pupils and students clearly shows that it is a far cry from the prosumer ideal. Wikis, blogs and social networks now enable attractive, dynamic, multidimensional learning content, information and knowledge to be published online in minutes without media discontinuities or programming skills. Teachers – previously sources of knowledge and information and holding a primarily instructional role in classrooms, lecture halls and seminar rooms – have been able to develop into moderators of teaching and learning materials available from across the world at the click of a mouse. They have also become knowledge workers tasked with quality testing and brokering the knowledge and skills of knowledge providers. Libraries and archives have become places of the non-digital past, whereas the internet itself has developed into a memory of humanity where every person leaves an indelible trace.

Innovative technologies developed by users and businesses worldwide are a major driving force behind these developments. They always have their own particular technology life cycle, a fact known by schools, universities and businesses based on their own experience. According to the technology life cycle, as the technological development first reaches maturity there is a trigger which comes with high, sometimes inflated expectations of the new technology’s performance and a phase of technological euphoria. This is generally followed by a phase of disillusionment which leads to a plateau of productivity for the newly developed technology. The extent to which the new technology can in fact be considered an innovation is visible in the market, demand and business model. Based on experience from previous years, schools, universities and businesses now know that the purchase of technologies for teaching, learning and examination or alternatively pilot measures represent only around 10% of the total cost of ownership. Knowledge of the technology life cycle and the TCO calculation represent arguments for schools, universities and corporate universities to hold back from piloting or introducing new education and qualification technologies.

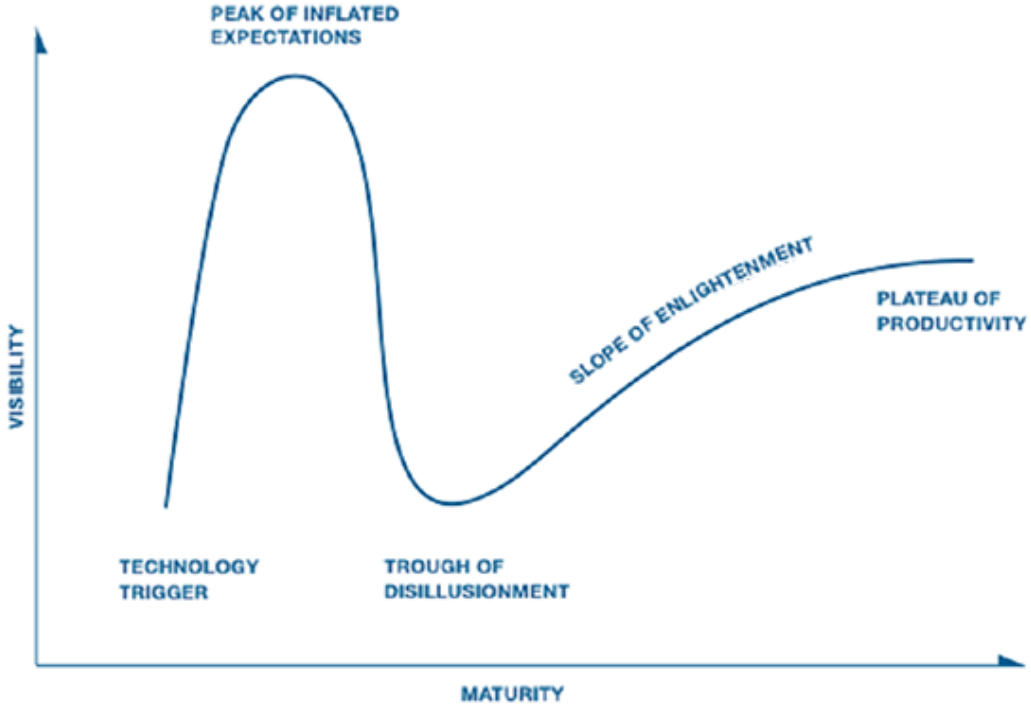

Figure 1: Diagram of the development of the technology life cycle

Innovative technologies in a variety of development states and at different degrees of maturity within the technology life cycle include mobile devices such as smartphones and tablet computers and the many applications they use, as well as multimodal technologies used for example in developing three-dimensional teaching and learning environments. [8] New technologies serve to develop and test augmented realities for education and qualification as well as cyber-physical systems, representing the first step in the internet of things, services and data and controlling real-world objects from the cloud by collecting sensor data and using it to control the flow of information, knowledge and people. [9]

4 Content, didactic and methodological requirements of digital technologies

Mobile technologies and internet applications in educational institutions must primarily be geared to support the use of content in lessons, teaching, studies, training and further education in classrooms, lecture halls and seminar rooms. These technologies should also be used to design procedures for the development, use, deployment and retrievability of educational content in teaching, learning and examination processes. The key points to note here are:

(i) *Content creation:* incentives must be created to motivate authors to make their materials available online in appropriate structure and media form. An example of such an incentive is the Chinese Ministry of Education's 'China Quality Course' programme. [10] University lecturers receive grant to make their lectures available online for a period of five years, with more than 20,000 courses put online since 2003. Easy-to-use tools for the preparation of content and pedagogically sound educational scenarios must be provided to support such incentive programmes for authors, for example an integrated Office package or a multimedia suite. This is a challenging task as these processes should be supported by as many devices as possible, in particular smartphones and tablets.

(ii) *Content recycling:* interfaces must be made available for a variety of systems to ensure that content can be recycled. These include content learning management systems (e.g. Moodle, Ilias, CLIX, Blackboard) and content databases (e.g. MIT OCW, [11] edusharing.net [12]). Integrated search functions enable users to search for content in specific databases, repositories and connected systems. Depending on the licence, content from connected systems can be imported or simply linked to. Alternatively, remote systems can be used to render unknown content formats in multiple target formats. [13] China for example has the 'China Open Resources for Education (CORE)' initiative, a consortium of more than 100 Chinese universities promoting the re-use of open educational resources (OER) using such systems as MIT OCW. [14] A framework programme is also in place for deployment, translation, authoring and evaluation.

(iii) *Content digitalisation:* as creating high-quality content is a time-consuming and costly task, it is appropriate to reuse existing non-digital resources. This requires tools to digitise and encode said material. For example, a simple tool can support scanning and uploading lecture notes. A subsequent step sees OCR software being used to extract text from the scans for manual revision in accordance with educational institutions' quality requirements.

(iv) *Retrievability:* the past decade has seen the development of numerous metadata standards which are potentially suitable as the basis for the metadata schemes of educational technology applications. Dublin Core (DC), [15] Learning Object Metadata (LOM) [16] and the Sharable Content Object Reference Model (SCORM) [17] have become quasi standards for metadata across the e-learning community worldwide. DC is used to encode administrative tasks for the content such as the licence, authors or publisher. LOM and SCORM on the other hand are employed to annotate educational characteristics, for example associated concepts or level of difficulty. Pharus is an example of a metadata-based search machine offering simple access to learning resources.

(v) *Standards:* to enable easy access to digital content, thought must be given to the authentication and content formats of current standards. Open ID is an open-source single-sign-on solution for the web which enables users to log in to services which support Open ID using a single identifier. [18] Shibboleth is an implementation of the SAML (Security Assertion Markup Language) open standard, and can be used to apply single-sign-on solutions across organisations. [19] OAuth is a widespread open protocol enabling services to implement access controls amongst themselves. [20] This does not enable single-sign-on, but is often used in addition to SSO solutions such as Open ID for access control purposes. Many content formats must also be supported, such as ePub, PDF, various video formats (including MP4, FLV, AVI, MOV), WBT and open document standards such as DOCX or XLSX. To transfer content between services and systems, standards such as

XML, JSON, IMS Common Cartridge, IMS Learning Tools Interoperability, RSS, LOM and SCORM must be respected in the deployment and use of digital media and technology in education.

In addition to the focus on content in education processes, creation, deployment, use and retrievability, it is important that methodological approaches remain the emphasis in using technologies, internet, tablets and computers. Examples include:

(i) *Learner interaction via the internet:* learning is a process shaped by society, but some aspects are primarily individual in nature. Functions must be provided which are designed for personal use, for example to find and develop relevant learning content. Learning unit planning tools must also be provided, e.g. to formulate long-term learning and performance goals. It is also important to be able reflect on completed activities via a comprehensible representation of the user's history within the system. Explorative learning is promoted by integrated domain-specific tools such as mathematical systems or programming environments.

(ii) *Teacher interaction via the internet:* the key to the dissemination and growth of digital educational technologies is their acceptance by teachers and lecturers. Teaching staff must be provided with specific services to integrate the digital elements into their workflows, for ex-ample allowing grade books and curricula to be managed online. They also require teaching tools such as coordination and computer-based proficiency tests. The exchange of teaching material between teachers and lecturers via newsfeeds, mailing lists, content repositories or social networks is also important.

(iii) *Interaction between learners and computers:* from a methodological perspective and on the basis of knowledge founded on media pedagogy and learning psychology, the use of interactive e-book functions is recommended in areas such as MINT subjects for various potential applications. These include integrating picture series and films, exercises of varying difficulty, vocabulary trainers, geometry software, spoken dialogue at configurable speed, and simulations and demonstration experiments. Another option is to use digital educational games, which are recommended due to their motivational aspects and potential adaptive functionality arising from the mobility and easy handling of tablets and the like.

(iv) *Social interaction via the internet:* location-independent and time-independent group learning is becoming increasingly important. This requires both asynchronous (e.g. email) and synchronous (e.g. chat, audio/video calling) communication channels. Webinars must be provided as collaboration spaces for teaching, and contain teaching materials, application sharing and virtual workspaces which can be accessed and used in any place at any time. The emergence of learning groups via social networks can be promoted using a private social network PSN).

(v) *Collaborative authorship of content:* users can work together on entries in integrated wikis, or jointly author documents shared within a learning group. Embedded virtual laboratories or micro-worlds enable collaboration on domain-specific artefacts. These collaborative efforts have the potential to be included in the teaching material corpus as user-generated content, but quality control of such items is not a trivial matter. Connexions is one of the few successful projects in this field. [21]

(vi) *Peer community comments, evaluation and assessment:* learners must increasingly be able to comment upon and evaluate teaching material. This function can be used for ongoing quality optimisation processes. Large courses must be provided with a peer review function which learners can use to evaluate and comment on each other's suggested task solutions or individual learning progress.

(vii) *Access and use via heterogeneous devices:* since different users use different devices (including browsers, smartphones, tablets and smart boards) to access the internet and its services and applications, application user interfaces must automatically adapt to the relevant device. Interfaces should only display functions which can be effectively used in multivalent form on the relevant device. The content display must also be tailored to the device. This places high demand on content creation, as it must be adaptable to the changing performance and limitations of the device. In recent years, HTML 5 has become a virtual standard for meeting requirements of this type. Since mobile use is continuing to increase, native applications for such operating systems as iOS, Android and Windows Mobile can be used to offer more convenient access to teaching materials on tablets and smartphones. The can also support content creation on the move thanks to the consequently expanded design possibilities.

5 Framework conditions, influencing variables and challenges in schools

Empirical studies have shown that media usage by school teaching staff has significantly changed over the past ten years. [22] Given the autonomy of German federal states in cultural and educational affairs, corresponding analyses typically refer to a single state. Studies from federal states such as Bavaria, Lower Saxony, North Rhine-Westphalia and Hesse have shown that frequent to very frequent use (more than once a week) has grown from 17% to 53% since 2003. Occasional use increased from 34% to 42% whilst the number of people not using media in schools dropped from 49% in 2003 to 5% in 2010. Whereas in 2000 69% of teaching staff still made no use of media in schools and only 5% used media regularly, by 2012 the situation had fundamentally changed: 10% used media regularly and 23% occasionally, with only 26% still not using any media. This change is even more significant when examining the use of websites: in 2000 98% of teaching staff did not use the internet and 2% used it rarely to very rarely, whilst in 2012 10% used the internet regularly, 23% occasionally and only 26% still did not use it at all.

Effective and multivalent use of media in schools requires sustainable and structural integration of media into the school system, an exceedingly complex and multi-layered framework with numerous stakeholders working at a variety of levels. Educational policy sets the framework conditions through states' school laws and defines curricula for schools, with staff development and staffing in schools also determined by the state's ministry of culture (the 'staff cost bearer') via teacher training. Municipalities on the other hand (the 'material cost bearers', understood to mean school maintenance with the exception of staff costs) are responsible for infrastructure, material resources and school administration. A further key aspect is the free supply of teaching and learning materials, i.e. teaching and learning materials are available to pupils free of charge regardless of their parents' income. This is partially embedded in state constitutions. The increasing use of media, computers and tablets in schools has meanwhile prompted broad discussion of the free supply of

digital teaching and learning materials – not just free access, but also the use of free licences and free formats. The expectation is therefore that this usage will result in increased competition and higher quality in the teaching and learning material sector. Open educational resources are a specific manifestation of this and represent an opportunity for the free supply of digital teaching material.

Experiences from everyday school life and the findings of accompanying scientific research have shown that integrating media, computers, tablets and technologies into schools to support educational processes (teaching, learning, examination) presents six fundamental challenges:

1. The attitudes and orientations of teachers, learners, school management, school supervising authorities, ministries of culture and parents.
2. The media education skills of primarily teachers and learners (not to be confused with media handling skills and media usage skills).
3. The configuration and accessibility of media, computers, laptops, software and the internet.
4. School culture and the organisational environment in terms of openness to media usage.
5. External framework conditions, generally defined via legislation and regulations from ministries of culture, regulations from material cost bearers, or parental involvement.
6. Pedagogical and technological support for and in schools regarding the use and deployment of media, computers, tablets and technologies to support teaching, learning and examination processes.

Let us examine two points in further depth as an example. Analyses by Breiter et al. (2010) have shown that access to technologies and media in schools is generally only possible after login or by arrangement. More than 40% of specialist rooms in schools could only be accessed in this way, more than 88% of computer rooms were subject to constant monitoring, laptops were not found in more than 80% of schools, and in 75% of cases mobile presentation units could only be used after login or by arrangement. There is extensive complexity regarding pedagogical and technological support during everyday school life. There are four factors affecting this:

1. Internal and external school issues such as pedagogical networks, administrative net-works and school networks.
2. Teachers' educational freedom, often resulting in a proliferation of hardware and software and in absent or unclear responsibility structures and process.
3. Overstretched services providers in and for schools – more specifically, primary schools do not usually have overstretched providers whilst in secondary schools it is not unusual for IT teachers to have a 'top dog' complex and exclude service providers.
4. Educational authorities and staff cost bearers can be overstretched as a result of insufficient IT skills, and companies with extensive specialist skills in hardware, software and the internet in turn do not have sufficient knowledge of the school system.

5. Increasingly complex IT facilities, characterised by a wide variety of usage scenarios, extensive hardware and software portfolios, considerable complexity regarding legal requirements and framework conditions (including protection of minors, data protection, copyright) culminating in absent or insufficiently qualified IT administrators at all levels of the school system.

6 Factors limiting and supporting media in universities schools

The late 1990s saw the 'alma mater virtualis' model first describe the relationship between the potential and added value of fields of application, target groups and (then still new) information and communication technologies in German universities and higher education institutions. [23] Three factors were considered relevant to the model: the field of application (study, further training), the target group (on campus, off campus) and the use of technology (low, high). The interaction between these three factors enabled the generation and derivation of various scenarios for the beneficial and multivalent use of digital media, computers and the internet in universities. Specific manifestations of the model in universities and educational institutions worldwide included the MIT OpenCourseWare initiative [24] and UNESCO's OER initiative, [25] as well as company-related offerings such as iTunesU or YouTubeEdu.

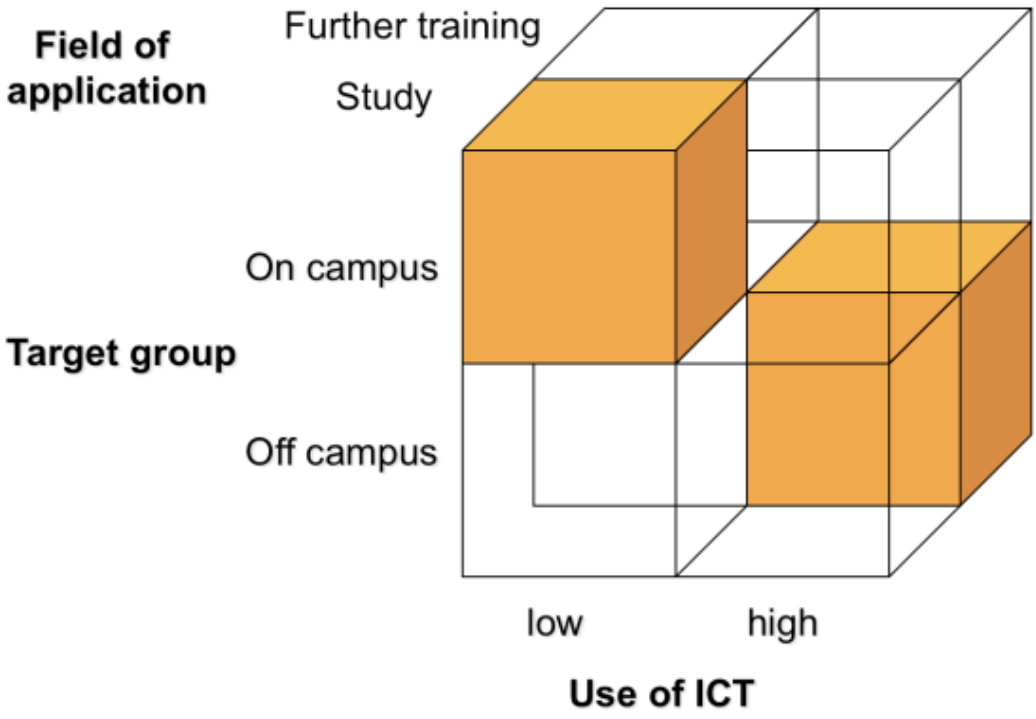

Figure 2: Diagram of the dimensions of the alma mater virtualis modelled after Müller-Böling (2000)

The alma mater virtualis and the widespread use of digital media and the internet in universities and higher education institutions prompted a variety of developments worldwide:

1. Work without media discontinuities in digital, globally available networks.
2. The stockpiling of knowledge was replaced with learning on demand and lifelong learning.
3. Educational products were now being offered in global education markets.
4. The emergence of corporate universities which crowded the education market.
5. Virtual and semi-virtual universities began to offer teleteaching and telelearning of their subject ranges online.

However, analyses have shown that in many cases, individual activities have developed which sometimes did not progress beyond trial status due often to a lack of strategies and concepts geared towards sustainability. Other issues include lack of evaluation and insufficient implementation and embedding as critical momentum for the widespread use of media in universities. There is a lack of resources and long-term renewal strategies, and too many individual solutions. Nevertheless, the level of diffusion achieved by digital media, the internet, computers and tablets in universities over a single decade is remarkably high and has surpassed many optimistic forecasts.

Various limiting factors in the use and deployment of media, technologies and internet in universities have thus been identified in recent years:

1. Universities' profile development, development plans and market positioning do not generally take a contemporary view of the media.
2. Universities' own self-image and self-perception is traditionally only media-related to a small extent, and based on long-term socialisation processes which struggle with the short innovation cycles of media and technologies.
3. Legal framework conditions (including data protection) and organisational implementa-tion conflict with the widespread use of media in universities in terms of public services law, copyright or business models.
4. Teaching at universities is given less structural priority than research and development.
5. The administrative burden of IT solutions in universities is considered very high, a burden which is generally only partially borne by universities, with outsourcing models discussed but usually only partly implemented.

On the other hand, supporting factors in the use and deployment of media, technologies and internet in universities are:

1. Universities increasingly need to position themselves within the international and national educational market, global budgets offer the opportunity for targeted investment.

2. The affinities of generations Y and Z, digital natives and the net generation regarding digital media and technologies are fundamentally changing usage behaviour and thus associated expectations of educational institutions.
3. Part-time studies, second degrees and lifelong learning have enabled universities to use new business models often implemented with and on the basis of technology.
4. Scientific findings on the effective and efficient use of technology in studies, teaching and further training as well as in the management and administration of universities have enabled well-founded alterations to educational development.
5. Technological innovations such as cloud computing and self-administration will facilitate the future use and administration of even complex IT systems.

7 Market analyses, factors and decision-making structures of education market

Market analyses since 2010 have shown that experts consider the school and university market to be moderately promising for the use and deployment of media, technologies, hardware and software. One major reason for this assessment is the sometimes extremely complex network of stakeholders involved in making decisions regarding the procurement of learning software and educational technologies. An example of this for school and university systems is described below.

The most important function in the acquisition process is fulfilled by the school principal or by the rector or president of universities and higher education institutions. It is their responsibility to make the decision regarding whether technology-based innovations will be introduced into education within their institution, and if so in what form and to what extent. An important role is played in this process by management and technical staff and by any teachers, university teaching staff and lecturers with full or part-time responsibility for supervising IT facilities in their educational institution, school, university, chair or faculty. Their experience as administrators and users (and often as evangelists, innovators and early adopters in personal environments) makes them key advisors to decision-makers. They are supplemented by other groups of individuals who have an interest in the hardware and software configuration and can provide decision-makers with a boost. However, teachers, university teaching staff and lecturers also include many sceptics who would prefer to retain the well-established forms of learning, teaching and examination. Their views are taken into consideration by decision-makers for the sake of harmony within the staff, school, university, faculty or institute. Another key group within the staff is trainee teachers and young researchers in faculties and institutes, who put forward fresh ideas and generally demonstrate a high level of affinity with learning and teaching technologies. Their knowledge and experience is in turn determined by teacher training and further training institutes and by socialisation during the process of young researcher advancement.

Given declining pupil and student numbers, the profile of educational institutions is becoming increasingly important. Technical facilities – such as the use of computers, internet, smartphones and tablets – play an important role in parents' choice of school and university. Parents whose children already attend school can (together with pupils) lobby the school council to purchase hardware and software. This particular opportunity to exert

influence does not exist in universities. However, it is possible to affect the university or higher education institution's profile via student self-administration, the student body and its organs (including the student parliament, general student committee and faculty student bodies), and student associations. In a school context we also have development associations run by parents and former pupils, representing a more than marginal force in such considerations. Finally, school principals are overseen by school authorities, established within a municipality or administrative district depending on the state and school type. School authorities determine the size of the budget available to the principal for material resources and are also able to pool expenditure, in other words to combine purchasing across multiple schools or over an extended period of time. This degree of specific supervisory authority given to a responsible body or ministry no longer exists at university level due to the autonomy of German universities and higher education institutions and the associated introduction of global budgets.

Schools and universities are supported by municipal or regional computer or IT university centres, which have retained a key remit in the form of advising educational institutions on hardware and software procurement or the use of services via the internet and intranet. They are also able to provide educational institutions with important services such as hosting and support, meaning that they influence the decision to opt for particular products as they are unable to offer the same services for all market offerings. A central role in technology procurement for educational institutions also falls to state ministries of education and science. In addition to procuring state software licences for all schools, universities and higher education institutions, they can also provide these education establishments with funding to support software procurement in light of said establishments' scant software budgets. Some federal state ministries do not recommend particular software, giving principals and university heads the freedom to purchase a system suited to their educational purposes. However, this also prevents the development of state-wide or nationwide standards and cost-effective purchases of larger licence packages.

Publishers and other content providers have the ability to exert control via the structure, pricing and scope of the content they bring to the market. If it is compatible with particular tech-nologies or already has established agreements with software providers, from the perspective of educational institution heads this will also represent an argument for purchasing the content and matching software if the content price is acceptable. Whether or not purchasers are reliant on external providers for this content depends on the content and service facilities, for instance in schools supported by municipalities, states or the federal government such as city or state media centres. If sufficient free resources are available which work with particular learning systems, it will influence the decision for or against content from publishers, as well as for or against a particular learning system.

The overall trends and driving forces behind digital learning in educational institutions can be summarised as follows:

1. Digital media are a component part and driving force within school and university development processes: the demographic development of pupils and students means that digital media may form a central element of school and university development for the purposes of supporting teaching, learning and examination processes. However, school principals and university rectors show little willingness in this area.

2. IT in schools and universities represents a competitive advantage and can be used for marketing. The resulting effects ensure transparency and access and can be viewed as a quality feature.
3. Small providers and open source products enjoy greater acceptance than the big players: educational institutions often feel powerless in the face of big players and fear the loss of educational freedom or freedom of teaching and research. The principle of ‘educators for educators’ is preferred.
4. Teachers decide upon technology acceptance: reduced workload, educational freedom, codetermination and freedom of choice are key factors in decision making.
5. Support is a success factor for IT acceptance: an appropriate support system facilitates media acceptance in educational institutions.
6. Safety and security are a key factor: educational institutions have a duty to protect their learners, particularly in schools. Personal data is considered highly sensitive and worthy of protection and must be respected as such.
7. State solutions are preferred in schools, local solutions in universities. The body which pays determines the decision made: in schools this is ministries of culture and material cost bearers, in universities it is the rectorate.
8. Communities encourage acceptance: in schools interaction between schools and be-tween teachers and pupils is important, whilst at universities it is interaction between faculties, professors, students and associated research institutes which is significant.
9. IT solutions and technologies support the development of local and global education spaces: networking leads to deregulation, globalisation, networking and transparency.

8 Summary and outlook

The aim of this article was to offer an overview of how technology has changed teaching and learning in schools, universities and businesses and what developments are still to come for education providers. This work is based on many years of experience from numerous re-search, development and innovation projects examining technology-based education and qualification in the corporate and public sector and taking into account the findings of accompanying scientific research. As is often the case for survey articles such as this, the content and structure is a depiction of the author’s own findings and experiences, rarely complete and making absolutely no claim to be exhaustive. There is still much to be said, for example on further changes to usage behaviour in coming (or even the older) generations, on the internet of things, services and data and its effect on education and qualification including using innovative and forward-looking technologies, and on the opportunities, potential and risks of multimodal education environments, virtual and augmented reality and the coming generation of wearables. Further areas to examine also include global activities regarding (quasi) standards for such areas as digital content and their reusability, limiting and supporting factors for the use of digital media in schools, universities and professional further training, and systemic factors and decision-making

structures in the introduction and in particular the (sustainable) use of education and qualification technologies in all education sectors. One final but important field is the necessity and requirement to further develop the education system and its structural disdain for digital media and technology-based teaching, learning and examination.

However, let us finish by once again looking to the (near) future. What momentum and stimuli from research, development and innovation will once again affect and alter education and qualification in schools, universities and professional further training over the coming years? Factors include:

(i) *Intelligent adaptive systems:* supported by artificial intelligence, these systems build on domain, didactic and user models to offer personalised support for teachers and learners. They often use the semantic web and learners' sociocultural characteristics to provide users with tailored content, learning pathways and functionality.

(ii) *Educational recommender systems:* a current trend in research deals with opportunities arising for educational technologies out of the reuse of adaptive recommendation systems, such as those used by Amazon or Netflix. Learner-specific behaviour patterns are analysed in the system to suggest the most suitable learning material possible.

(iii) *MOOCs and POOCs:* 'massive open online courses' represent an entire package of video lectures, tasks and a software platform. Use of these courses is firmly on the rise, but the underlying platform is not typically adaptive. There is therefore great potential for providing learners with new forms of support. One particular characteristic of MOOC platforms is their extraordinary scalability, as they must be able to support courses with several thousand students. Examples of these include Coursera and the open-source service edX. Furthermore, functionality enabling personalisation is increasingly becoming part of such course programmes, meaning that MOOCs are now being augmented with POOCs (personalised open online courses) being put to beneficial use.

(iv) *Learning analytics:* this describes processes which systematically analyse learner-specific behaviour patterns and settings, firstly to adapt learning content, methods and theories to these behaviour patterns and secondly to be able to show which such patterns may not be beneficial to learning. The process of analysing user activity via the internet generates reliable information which can form the basis for strategic decision-making.

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