Chapter 24
Future Directions in Mobile Learning

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Abstract The shape of mobile learning (m-learning) depends very much on the complex cultural, social, political, economic and, above all, educational ecologies in which mobile technologies are embedded. Focusing primarily on the developed world, this chapter begins by surveying our contemporary technological context, highlighting new forms of hardware and emerging patterns of usage. It then turns to our contemporary educational context, outlining seven major trends—towards contextualisation, personalisation and diversification of learning; towards student support, engagement and creativity; and towards wider collaboration—which reflect aspects of the broader cultural, social, political and economic landscape. It is suggested that the future of digital learning generally, and m-learning in particular, will take shape at the point where ongoing technological developments intersect with ongoing educational trends.

24.1 Introduction

In any discussion of the future of m-learning, we must take into consideration the larger cultural, social, political, economic and educational ecologies in which mobile technologies, like all technologies, are embedded (Selwyn 2014; Warschauer 2011). In particular, we must consider dominant educational trends, since these will play a major role in determining which current and future technologies will find their way into education, and how they will or will not be deployed. In exploring this territory in this chapter, we will focus primarily on the developed world: while m-learning has extensive applications in the developing world, where it serves to increase educational access in line with a social justice agenda (GSMA 2010; UNESCO 2013), cutting-edge technologies and new educational strategies typically emerge from the developed world.

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After sketching out a definition of m-learning, we will survey today's *technological context,* with its growing mobile ecosystem nestled within a larger digital ecosystem, and consider innovations in the form of new hardware and emerging patterns of technology usage. We will then turn to the *educational context,* pinpointing seven contemporary educational trends, and considering how each intersects with new technological developments. Specifically, we will focus on educational shifts towards: contextualisation of learning (enabled, notably, through augmented reality), personalisation of learning (through big data and learning analytics), diversification of learning (through Massive Open Online Courses, or MOOCs), student support (through virtual assistants), student engagement (through gaming and gamification), student creativity (through makerspaces), and wider collaboration (through digital networking).

Ultimately, it is in the space where ongoing technological developments intersect with ongoing educational trends that the future of m-learning will take shape. Yet because unexpected technological developments may arise, and because the educational landscape, like the wider social, cultural, political and economic landscape, is a partially contested, evolving terrain, it is impossible to chart the future with certainty. With this caveat, this chapter extrapolates from current developments and trends to offer glimpses of a possible future.

24.2 Present and Future Mobile Learning

Mobile learning is of course governed by the principle of mobility, which can apply variously to the devices, the learners, and the learning experiences. The most fundamental of these categories is that of the devices since, unless we make mobile digital devices central to our definition of m-learning, we are obliged to widen it to include other kinds of learning-on-the-move, such as learning supported by toys or books (Pegrum 2014, in press b). It has been suggested that the category of mobile digital devices comprises those which can be used at Point A and Point B, as well as everywhere in between, without stopping (Puentedura 2012). This conception makes room for yesterday's personal digital assistants (PDAs) and digital music players like Apple's discontinued iPod, as well as still widely used feature phones; it makes room for today's multifunctional smart devices, notably smartphones and tablets, as well as increasingly niche products like digital cameras; and, perhaps most importantly, it makes room for emerging devices carried on or in the body, such as wearables and embeddables/implantables, as well as independently or semi-independently mobile technologies like drones or robots. In light of these newer developments, we might slightly modify Puentedura's definition to say that mobile devices are *digital devices which can operate* (rather than 'be used') *at Point A, Point B, and continuously everywhere in between.*

M-learning, then, would be *any learning involving mobile digital devices,* as defined above. Yet if the category of devices is the most important when it comes to the *mobile* part of mobile learning, it is not necessarily the most important when it comes to the *learning* part. It is only when the devices *and* the learners *and* ideally the learning experience are all mobile that the full educational potential of mobile devices can be realised, that is, where their potential to support collaborative, constructivist learning meets their potential to support situated, embodied learning in real-world contexts (Pegrum 2014, in press b). It is important to bear in mind this complex character of m-learning as we consider how it is likely to develop at the intersection of present and future technological and educational trends.

24.3 The Technological Context

The signs of our shift into a mobile, wireless era are clear. As of late 2014, some 60 % of all internet-connected devices were estimated to be smartphones or tablets, with some 70 % of all new computing devices running the Android mobile operating system (Blodget et al. 2014). Over time, internet connectivity and accessibility will gradually become a reality for the more than 50 % of the world's population who currently remain offline; this is thanks to a range of projects like Facebook Zero, Google Free Zone and Wikipedia Zero; cooperative alliances like the Facebook-led Internet.org; and experiments in beaming internet access from drones, as in Facebook's Aquila project, or balloons, as in Google's Project Loon. Yet for the foreseeable future the developed world will remain far ahead in terms of speed and bandwidth, and is thus likely to originate most new technological and related educational developments.

As the educational potential of smart devices is becoming more widely recognised in the developed world, we are seeing a shift towards Bring Your Own Device (BYOD) approaches and, particularly in Western institutions which promote student autonomy, technology-supported flipped classroom approaches (Johnson et al. 2015). Teachers and students have been working with educational apps (Oakley et al. 2012)—despite some concerns over their pedagogical limitations (Gardner and Davies 2013; Pegrum 2014)—as well as exploring the value of social media for facilitating multimodal communication and constructivist networking, of MOOCs for opening up access to diverse educational content and learning communities, of gaming platforms for engaging attention and reinforcing learning, and of new learning spaces for supporting blended educational interactions.

But m-learning is not all about phones and tablets: the mobile ecosystem is rapidly becoming larger and more diverse, as older devices mix with emerging devices that heighten the power of mobility. Leading the new category of *wearables,* most of which do not currently function as standalone tools but rather sync by Bluetooth to accompanying smart devices, are two device types: increasingly popular fitness trackers, often in the form of digital wristbands, which encourage users to make interventions in their lifestyles on the basis of tracked patterns of activity and sleep, visualised through mobile apps; and multipurpose smartwatches, which display notifications, messages and information, control other digital devices, and double as fitness trackers. Smart clothing, such as sensor-imbued shirts, socks or shoes, has to date been used largely to improve sporting performance, though wider applications may be in the pipeline, such as clothing that detects and responds to a user's mood (Bryner 2010).

Additionally in this category we find smart glasses. As distinct from virtual reality (VR) headsets, which provide an immersive experience of a fully simulated environment, smart glasses are *augmented reality* (*AR*) tools that superimpose digital information and communication channels on our existing view of the real world. The first publicly available product, Google Glass, carries a small screen mounted above the user's right eye which serves as an information display and a recording and communication interface synced to a smart device. Although, in the wake of limited commercial success, Google has halted sales to individuals and begun redevelopment work (Barr 2015), the device has already started to find a role in medical and other educational programmes (Johnson et al. 2015; Open Colleges, n.d. b). Microsoft's new HoloLens goggles, while bulkier, contain a small Windows 10 computer and appear to offer a more integrated AR approach where digital information will be literally overlaid on our view of our surroundings (Lee 2015). It is likely, however, that AR glasses and headsets are only the first stage on the road to smart contact lenses (Carmigniani and Furht 2011; Scoble and Israel 2014).

It is conceivable that multiple wearable devices could be connected into a 'body area network' or 'BAN', perhaps co-ordinated through a smartphone (Woodill 2015). A set of wearables that enable on-time, in-place access to digital information, communication channels and recording options, most likely controlled through an AR interface, has the potential to support many kinds of situated, embedded, embodied learning (Delgado 2014; Johnson et al. 2015), including just-in-time workplace learning (Baty 2014), and moreover to support those with special needs (ELI 2013c).

It has been suggested that 'the long-term survival for the keyboard, mouse and monitor suddenly seems precarious' (Lee 2015), due largely to the rise of *natural user interfaces,* which have proven to be intuitive for young children and accessible for many users with disabilities (Johnson et al. 2012; Kukulska-Hulme 2010). These may involve touch recognition, like the ubiquitous swiping and pinching motions used on today's touchscreens. They may involve gesture recognition, as seen in Microsoft's Kinect or the Leap Motion controller, 'enabling 3D input that involves users in the computing activity' (ELI 2014b), with likely implications for situated learning, notably in combination with AR (ibid.). Or they may involve voice recognition, as seen in virtual assistants like Apple's Siri, Google Now, or the open source Sirius (Hauswald et al. 2015), which represent early examples of a 'conversational user interface' (Kaplan 2013) that facilitates our interaction with digital data.

Much like AR glasses, such input mechanisms may be temporary stopping points on a longer journey towards more intimate human–machine interaction. Biometrics like fingerprint or iris scanning can already be used to unlock digital devices. Research is underway on brain–computer interfaces (Pegrum 2014; Scoble and Israel 2014), with applications ranging from neurogaming to supporting those with special needs, for instance through devices like the Indian 'brainphone' which allows users to navigate the web via brainwaves (Trivedi 2013). At the same time as input mechanisms are becoming more natural, so too are output mechanisms, as seen in the automated translations enabled by Google Translate or Microsoft's Skype (Orsini 2015), or indeed a recent Microsoft technology which can synthesise a speaker's voice translated into a foreign language he or she has never learned (Microsoft Research, n.d.). Work is also proceeding on new devices which will simulate smell and taste (Woodill and Udell 2015).

It is likely that 'the human body will be the next computer interface' (Goodman and Righetto 2013), a trend whose beginnings we can observe in today's gesture-based computing and in emerging hardware like smart contact lenses. Yet we can, and will, go much further in the 'embodiment of mobile devices' (Woodill 2015, Kindle location 2255). In time, what we might call *embeddables* or *implantables* will find their way both onto and under the skin, leading us into the territory of human–machine *cyborgs*. Early experiments include Motorola's passcode tattoo and an indigestible pill which, activated by stomach acids, effectively turns the body into a passcode transmitter (Gannes 2013), thus taking the idea of a BAN to a whole new level. Going beyond today's retinal and cochlear implants—arguably early cyborg technologies—humans could conceivably one day hear ultrasonic sounds or see ultraviolet light (Kaku 2014). There is speculation, too, about where brain implants might lead (Open Colleges, n.d., a); Google's Sergey Brin has suggested: 'Perhaps in the future, we can attach a little version of Google that you just plug into your brain' (cited in Carr 2008, p. 213). Meanwhile, research in *nanotechnology* is opening up the possibility of *nanobots* swimming through the bloodstream; futurists imagine that these tiny robots might eventually move beyond their envisaged medical and health applications and interact with neurons to extend human intelligence (Kurzweil 2013). Whatever the exact development trajectory of this technology as it extends into the far future, it seems that its immediate effect will be to further expand and blend the concepts of mobility and ubiquity of computing, thereby boosting the potential for situated, digitally enhanced learning already seen in today's wearables.

While the mobility of all the above devices depends on human wearers or carriers, we are also beginning to see the appearance of *independently or semi-independently mobile technologies*. These include *connected cars* with dashboards of apps projected from a synced smartphone using software like Apple's CarPlay or Google's Android Auto; but, like wearables, more and more cars will be manufactured with embedded connections which link them directly to the internet. Connected cars will in time give way to the fully autonomous *self-driving cars* being developed by technology companies like Google and Uber as well as car manufacturers like Ford. Here, the initial self-study possibilities inherent in an in-car app dashboard will explode into a plethora of informational and communicational resources available to 'drivers' who no longer have to focus on the road.

More direct educational applications are evident with camera- and sensor-carrying *drones,* which may be controlled by humans via mobile devices or may be programmed to fly autonomously. As they gradually move out of the shadow of their military origins, these helicopter-like machines are finding their way into areas like surveying and mapping; remote viewing of difficult-to-access terrain, flora and fauna; news-gathering; and even the filming of movies or creation of digital stories (ELI 2015).

Telepresence *robots*—which for now are controlled remotely through smart devices but may in the future allow gesture-based control, and which for now are grounded but in the future might fly like drones—permit distant teachers to show their faces on a screen on the robot's head, to view and move around a local space, and to engage in an embodied manner with participants in that space (ELI 2013b). Meanwhile, semi-independent robotic language teaching assistants have already found their way into Asian classrooms, where they can interact in simple ways with students (Han 2012; Pegrum 2014). Ongoing research into *affective technologies* (as in MIT's Personal Robots project at www.media.mit.edu/research/groups/personal-robots) and, more broadly, *empathic systems* (as in the EU's Empathic Products project at www.empathic.eu) is leading to robots and systems capable of evaluating human emotions and reacting appropriately, allowing 'a more organic relationship' (Isaías 2014) between humans and our (mobile) technologies.

As noted earlier, the mobile ecosystem is part of a larger hardware ecosystem. Indeed, the power of mobile technologies derives in part from their capacity to connect easily to more stationary devices, like desktop and laptop computers which offer superior computing power and enhanced input options; data projectors and smart TVs which facilitate sharing and collaboration via large displays; emerging 3D printers, which foster a 3D literacy linked to novel approaches to design thinking (Thompson 2013); and even 4D printers, which will produce objects that mutate over time (Marks 2013), fostering further sophisticated digital literacy skills. But even more than this, the power of mobiles derives from their connection to the network of devices, sensors and beacons that make up the evolving *internet of things*:

> The Internet of Things, or IoT, represents a major departure in the history of the Internet. The Internet is moving beyond the rectangular confines of smartphones and tablets and helping to power billions of everyday devices, from parking meters to home thermostats. (Rubin 2013, p. 2)

The use of low-power sensors and transmitters is permitting growing numbers of everyday devices to become 'smart', collecting and sharing data with each other and with us, often via smartphone apps that can be used for data visualisation as well as device management. Wearable, embeddable or implantable devices can hook into this same communicational network, as can independently or semi-independently mobile technologies like smart cars, drones or robots. Indeed, extending beyond the internet of things, we are arguably seeing the advent of an *internet of everything:*

> It is no longer far-fetched to envision a world where all people, objects and devices are connected to act in concert, regardless of brand or vendor. This idea is also known as The Internet of Everything (IoE), which is comprised of machine-to-machine (M2M), machine-to-person, and person-to-person networked technologies. (Johnson et al. 2015, p. 46)

By weaving our mobile and stationary devices together, the IoT (or IoE) amplifies the educational potential inherent in individual devices. Considerable implications follow from our devices' capacity to receive or retrieve detailed localised data from objects in our real-world environments, possibly displayed in AR interfaces. In this way they can support 'hypersituation', where learning is informed by 'a host of interdisciplinary information that is pushed to [us] from [our] surroundings' (Johnson et al. 2015, p. 47), or indeed pulled by us from those surroundings.

Similarly, considerable implications follow from our growing ability to generate, collect, access and analyse networked, up-to-the-minute *big data* (Mayer-Schönberger and Cukier 2013). Mobile apps already display our *quantified selves,* based on the tracking, evaluation and visualisation of our health, fitness and sleep patterns (Feinleib 2013; Mayer-Schönberger and Cukier 2013). These quantified selves will increasingly intersect with *learning analytics* (Johnson et al. 2014), where our learning patterns are analysed to predict our future successes and challenges (US Dept of Education 2012). As time goes on, our devices will provide us with even more tailored answers to our questions, along with even more tailored advice which we have not yet thought to request.

As our machines increasingly offer what appears to be intelligent advice, delivered in what appears to be the right emotional tone, we might feel we are witnessing the birth of *artificial intelligence* (*AI*). But this is at best weak AI, where machines simulate thinking in a narrowly defined area, often based largely on the rapid processing of big data, rather than strong AI, where machines actually think (Russell and Norvig 2010). This may change: in today's AI research there is a new interest in biological models and processes as well as the role of emotions and embodiment in shaping intelligence (Kaku 2014; Warwick 2012), and there is speculation on the eventual merging of human and technological intelligence in more fundamental ways than via implants (Kaku 2014; Kurzweil 2013; Warwick 2012). The consequences of such distant developments are difficult to anticipate from our current standpoint, though it is probable that along the way we will learn a great deal more about learning itself. In the meantime, it is important to keep a critical eye on these, and all, new technological developments, remembering that today's immediate concerns around privacy, surveillance and security (Mayer-Schönberger and Cukier 2013; Schneier 2015) are likely to be heightened by tomorrow's concerns around the control of AI and robots (Kaku 2014; Russell and Norvig 2010).

24.4 The Educational Context

In the foregoing account of our technological context, we have begun to sketch out the educational potential of new and emerging technological developments. But the realisation of that potential depends on whether, and how, these developments fit with today's major educational trends. We will turn now to these trends, seeking an example of the technological developments that might be enlisted to support each trend. Neither the list of educational trends, nor the list of supporting technologies, is exhaustive. Rather, they serve as pointers to the possible shape of future m-learning at the intersection of technology and pedagogy.

24.4.1 Contextualisation of Learning (E.G., Through Augmented Reality)

Recent years have seen a growing emphasis on contextualised learning, that is, learning which occurs in contexts as similar as possible to real-world contexts, and ideally in the actual real-world contexts themselves where the learning applies. Unlike desktop devices that 'operate in their own little world', mobile devices 'operate in *the* world' (Traxler 2010, p. 5, italics in original), meaning that m-learning reverses the move away from the real world inherent in much e-learning, and opens up the possibility of situated learning (Lave and Wenger 1991) and indeed embodied learning (Lipson Lawrence 2012) in everyday surroundings. Mobile devices can thus help break down the walls between the classroom and the world, thereby alleviating the problem of transfer distance, that is, the need to transfer learning across the gap between formal learning contexts and everyday contexts.

There is little doubt that today's smart devices permit ubiquitous learning or *u-learning* (Milrad et al. 2013), provided we treat them not as screens but as lenses:

> The mobile device as a *lens rather than a screen* is a critical design metaphor … it is critical that designers do not create experiences where the technology becomes a barrier to the environment. Rather the technology needs to drive the students deeper into the authentic observation and interaction with the environment and with each other… (Dunleavy 2014, p. 32)

Here, an appropriate AR interface could mediate between the digital and the real, immersing us in a ubiquitous, omnipresent *mixed reality* where digital material is directly overlaid on our view of the real world. In other words, AR could offer us a magnifying lens rather than an impermeable screen (even if, pending fuller development of AR wearables, the lens will be displayed for now on a mobile screen) to support and enhance situated, embodied learning.

Within the classroom, mixed reality technologies already offer students simulated environments with which they can physically interact (Lindgren and Johnson-Glenberg 2013). But the greatest promise may lie outside the classroom: on the AR Heritage Trails in Singapore, students learn about their city's history in surroundings whose significance is unlocked by digital overlays (Pegrum 2014); on the AR TIEs (Trails of Integrity and Ethics) in Hong Kong, students engage with ethical issues in the everyday university settings where they may arise (Chow et al. 2015); and in the MASELTOV project in Europe, a dashboard app provides students with context-aware language learning recommendations (Gaved et al. 2014).

Indeed, with the support of mobile, and ideally AR, technologies, students can turn any real-world context of their choice into a user-generated learning context (Cook 2010). While early educational forays into this area augur well for the future, we must bear in mind that challenges may arise for students in disentangling the real from its representations, and for teachers in deciding how best to guide, track and evaluate learning which ebbs and flows between the virtual and the real.

24.4.2 Personalisation of Learning (E.G., Through Big Data and Learning Analytics)

Much is heard nowadays about the personalisation of learning. This may be achieved in multiple, overlapping ways: for instance through BYOD approaches where students use individually customised hardware (Pegrum 2014), through flipped approaches which enhance student control over information delivery (Johnson et al. 2015), or through user-generated learning contexts which students create in their own everyday environments, as described above. Digital, including mobile, technologies also lend themselves to the differentiation of learning to suit varying student needs.

Such differentiation is now becoming possible at a large scale through the use of big data subjected to learning analytics. After collecting and analysing past performance data, an *adaptive learning system* can decide what and how to teach a student next (Feinleib 2013; Waters 2014), so that each student may see a different, tailored version of an online course (Johnson et al. 2014), with an early warning system serving to identify at-risk students (Aljohani and Davis 2012; de Freitas et al. 2014). Ideally, students should have access to an open learner dashboard, or 'personal dashboard' (Aljohani and Davis 2012), which displays an overview of their learning journey, their strengths, and their challenges. On the basis of group performance, course design as a whole may be adapted automatically, or adapted by teachers operating as informed *learning designers* (Feinleib 2013; Johnson et al. 2015; Mor et al. 2015). Because we carry our mobile devices with us at all times, they can gather far more data about us than our desktop or even laptop computers, especially in terms of our quantified selves. As briefly noted earlier, new insights are sure to emerge at the intersection of the quantified self and learning analytics, highlighting the link between lifestyles and learning outcomes (de Freitas et al. 2014; Johnson et al. 2014).

Explorations are underway in this space by private companies such as Knewton, for-profit universities like the University of Phoenix (with its patented Adaptive Activity Stream), public universities like the University of Michigan (with its GradeCraft learning management system) and, increasingly, private-public hybrids like Smart Sparrow (spun off from the University of New South Wales) and ventures like the ongoing collaboration between Arizona State University, Knewton and Pearson (Johnson et al. 2015; Waters 2014). There would seem to be potential for strengthening engagement by gamifying both the quantified self, notwithstanding certain risks (Whitson 2013), and adaptive learning systems, as seen in GradeCraft, which may open up future avenues of research. Important questions, however, remain about the accuracy and limitations of big data (boyd and Crawford 2012; note that danah boyd does not capitalise her name), the level of data literacy required of those who interpret it (Pegrum, in press a), and its privacy and surveillance implications (Mayer-Schönberger and Cukier 2013).

24.4.3 Diversification of Learning (E.G., Through MOOCs)

Diversification of learning correlates to some extent with personalisation of learning, in the sense that greater diversity opens up scope for greater personalisation. This can be seen for example in the growing diversification of hardware through BYOD, of courses through learning analytics, and of learning environments through user-generated contexts. The spread of MOOCs can also support the diversification of learning on a mass scale. Of course, MOOCs have been plagued with bad press: not unlike some first-generation e-learning innovations, many MOOCs simply wrap up old pedagogies in new technologies; most have startlingly low completion rates of between 5 and 16 % (Johnson et al. 2014); and nearly all appeal only to an educated elite rather than the once hoped-for broader demographic. On the other hand, there are MOOCs, sometimes called cMOOCs, which hold to the original connectivist ideal of autonomous, flexible, networked learning shaped by students' interests, in contrast with cognitivist–behaviourist xMOOCs whose instructor-determined videos, quizzes and discussion forums mirror more standard online courses (Hew 2014; Margaryan et al. 2015). At least within the boundaries of an upper secondary- and tertiary-educated demographic, MOOCs offer access to a wide range of content and teachers (especially, though not only, in the case of xMOOCs) and peers and learning communities (especially, though not only, in the case of cMOOCs). Once accreditation issues are settled, MOOCs may prove especially useful in diversifying flipped approaches (Hew 2014).

There is something of a trend towards MOOCs about mobile learning as well as a trend towards MOOCs intended to be accessible through mobile devices, with the latter sometimes called mMOOCs (de Waard 2013). These trends are seen for instance in the 2011 and 2012 mobiMOOC (mobimooc.wikispaces.com); the 2013 #IDML13 (Instructional Design for Mobile Learning; facultyecommons.org/instructional-design-for-mobile-learning-idml13-2/); and the 2015 #MOSOMELT (MObile SOcial MEdia Learning Technologies; mosomelt.wordpress.com). While only the last of these explicitly badges itself as a cMOOC, all have a connectivist orientation. mMOOCs which are simultaneously cMOOCs capitalise on the capacity of today's chief networking tool, mobile devices, to support networked learning, while mMOOCs in general facilitate contextualised learning in our everyday surroundings and personalised learning on our own devices. As such, mMOOCs are ‘a step forward in realizing an m-learning format that fits the contemporary and future needs of education in this knowledge era’ (de Waard 2013, p. 360).

In the European 3D World MOOC project, empathic technologies are being built into a virtual world-based MOOC with the aim of better immersing and supporting students in the learning process (Isaías 2014). While there is still much research to be done, we might ask whether there is future potential in the merging of empathic systems with mMOOCs that take the real world as their learning context. But before tackling such questions, we may need to address more basic concerns about the role of MOOCs in fostering a postmodern, even neoliberal, marketplace of learning, linked to the unbundling of today’s educational institutions (Barber et al. 2013), and conceivably threatening the conceptual coherence of traditional qualifications.

24.4.4 Student Support (E.G., Through Virtual Assistants)

In an era of mass education, techniques for contextualising, personalising and diversifying learning at scale are of great importance. These processes can be reinforced by providing individualised support to students—not necessarily human support, which is difficult to scale, but the automated support of virtual assistants. Such virtual assistants depend on a convergence of three technological trends: conversational user interfaces, personal context awareness, and service delegation (Johnson et al. 2014). Conversational user interfaces, part of the trend towards natural user interfaces, allow us to interact with virtual assistants much as we would with human assistants. Personal context awareness involves understanding patterns in each individual’s manner of speaking, but also ties into a broader analysis of big data: ‘The most advanced versions of this software actually track user preferences and patterns so they can adapt over time to be more helpful to the individual’ (ibid., p. 46). Service delegation entails virtual assistants accessing and managing our collections of apps.

In time, we may see virtual assistants that can tailor AR displays to our needs at a given moment, and guide us through adaptive learning experiences based on patterns they have extracted at the point where our quantified selves intersect with our learning analytics trails. Meanwhile, empathic technologies and AI may make our assistants seem ever more lifelike and ever more intelligent. Yet as Scoble and Israel (2014) remind us in a broader discussion of big data: ‘The marvels of the contextual age are based on a tradeoff: the more the technology knows about you, the more benefits you will receive’ (Kindle location 225). Convenience and privacy are thus negatively correlated and, in observing the evolution of our apparently obsequious helpers, we should bear in mind the dangers of surveillance, the limitations of big data, and even the risks of AI which may slip out of our control.

24.4.5 Student Engagement (E.G., Through Gaming and Gamification)

Just as educational institutions are seeking to bolster student support, so too are they seeking to promote student engagement. In this respect, digital gaming would seem to hold some promise. First, complex multiplayer games (as opposed to behaviourist drills or quizzes dressed up as games) are 'pedagogically rich' (Klopfer 2008, Kindle location 22) spaces that involve critical thinking and creativity, negotiation of meaning and collaborative problem-solving (Gee 2007; Pegrum 2014); and they provide a clear learning structure incorporating reasons, goals, assessment criteria and potential rewards for all activities undertaken (Hoyle 2012). Second, games are highly motivating (ELI 2014a; Klopfer 2008) as players engage in intensive learning to accomplish in-game tasks. While lacking the full impact of gaming, *gamification*—essentially the process of using gaming elements like badges, levels and leaderboards to shape or reshape educational activities—can also offer motivational benefits (Johnson et al. 2014), as seen for example in the aforementioned GradeCraft (ELI 2014a).

We are now seeing a major shift towards mobile gaming. This can just mean app-based games played on small screens rather than big screens. But of much more interest is the use of networked, context-sensitive devices to engage in AR games played in real-world settings annotated with digital information (Klopfer 2008; Pegrum 2014). Early explorations are promising: in the US 'Alien Contact!' game, teams of students moved around their school grounds using GPS-enabled mobile devices to seek clues and develop an explanation as to why aliens had landed on earth (Dunleavy et al. 2009; Potter 2011); in 'Mentira', a US game for learners of Spanish, teams equipped with iPhones or iPod Touches seek clues to a historical murder mystery, which includes navigating a local Spanish-speaking neighbourhood (Holden and Sykes 2011; Pegrum 2014); and the MASELTOV app, discussed above, incorporates a competitive gaming element based on learners' real-world target language conversations (ibid.). As AR interfaces continue to improve in conjunction with wearables and embeddables, more and more situated learning options will open up, with Google's Ingress game (www.ingress.com) hinting at future possibilities. But educators will need to ensure that gamified learning is designed in line with sound pedagogical principles so that gaming does not overtake or trivialise learning.

24.4.6 Student Creativity (E.G., Through Makerspaces)

Much attention is currently focused on students' development of creativity and related 21st century skills (Khan 2012; Robinson 2011), in line with perceived national and international needs for innovative political leadership and entrepreneurial economic leadership. This notion is gaining considerable traction in Asia, where creativity is increasingly viewed as an essential complement to education systems which have traditionally produced strong performances on standardised international tests (Barber et al. 2012; Zhao 2012). One means of fostering creativity involves linking BYOD approaches with new learning spaces whose layouts and furnishings are crafted to support different kinds of learning, underpinned by different kinds of interactions, supported by students' own chosen mobile devices, and situated within an inviting, inspiring décor.

Among the new learning spaces emerging on campuses and in libraries are *makerspaces* (ELI 2013a; Johnson et al. 2014) equipped with a range of craft tools and digital tools–the latter sometimes including devices like 3D printers–which students can use as they actively engage in 'creative, higher-order problem solving through hands-on design, construction and iteration' (Johnson et al. 2015, p. 40). Makerspaces may also involve fully digital creation, as in the production of digital stories (ibid.) or the building of apps; indeed, as the Mozilla Webmaker slogan reminds us with reference to coding, 'making is learning' (Santo 2013). In makerspaces, students work both autonomously and collaboratively, cross disciplinary boundaries, and expand institutional limits as they focus on innovative approaches to real-world issues, and become 'creators rather than consumers' (Johnson et al. 2014, p. 7) of knowledge and design. Of course, perennial questions remain about how creativity is best guided and supported, and how it can be captured and assessed.

24.4.7 Wider Collaboration (E.G., Through Digital Networking)

There are great advantages in students learning about real-world issues alongside the real-world communities which are dealing with those issues. Participatory pedagogy, often underpinned by a problem-based or inquiry-based design, promotes engaging, hands-on, contextualised learning through which students come to understand that their learning can, and perhaps should, have an impact on the wider world (Pegrum, in press a):

> At the heart of the idea is to allow students to participate in knowledge-creating activities around shared objects and to share their efforts with the wider community for further knowledge building that is a legitimate part of civilization (Scardamalia and Bereiter 2006). (Vartiainen 2014, p. 109)

Such participation is very much facilitated by the shift towards a network society (Castells 2013; Rainie and Wellman 2012), where human networking is supported by digital networking thanks to pervasive social media accessed on mobile devices. Research shows a correlation between online networking and offline social and civic engagement (Castells 2013; Thompson 2013). The most dramatic results have been seen in protest movements like those surrounding the Arab Spring (Castells 2012), though naturally the online/offline nexus is likely to be promoted in more low-key ways in educational contexts. Within an appropriate educational design, digital networking with experts, peers and wider communities via mobile media allows students to situate their learning within real communities and contexts, develop their understanding with input from those communities, and share their emerging insights in the contexts where they might be of benefit. Again, as with creativity, and as with contextualised learning more broadly, questions remain about how best to capture and assess such learning.

24.5 Conclusion

Mobile hardware and software will continue to proliferate and mutate for the foreseeable future, but it is likely that much of it will sit within a cluster of ongoing technological trends, namely towards greater mobility of devices, greater ubiquity of computing, and more seamless integration of our devices with other devices and our wider environments. It may also link to subtrends towards smaller sizes (for wearable and embeddable technologies) and greater independence (for technologies like drones and robots). The relevance of these developments for education, however, will depend less on their fit with technological trends and more on their fit with ongoing educational trends, notably towards contextualisation, personalisation, and diversification of learning; towards student support, engagement, and creativity; and towards wider collaboration.

These educational trends are in turn influenced in complex ways by partially overlapping and partially conflicting cultural, social, political and economic trends. With the shift towards a network society comes an upswing in digital networking; with the shift towards a knowledge economy comes the promotion of transferrable 21st century skills; and with the shift towards neoliberalism comes an emphasis on marketplace diversification, not to mention personal entrepreneurship. At the same time the global emphasis on quantification of performance, and the standardised assessment of education, may fit neatly with big data and learning analytics, but it flies in the face of personalisation, diversification and notoriously difficult-to-assess 21st century skills.

As we noted at the outset, this chapter provides glimpses of a possible future for digital learning in general and mobile learning in particular. Exactly how the future plays out will depend on technological developments and, moreover, on how these fit with evolving educational—and cultural, social, political and economic—trends. In attempting to anticipate the future of m-learning, we need to keep an eye on both technological and educational trends, and ask ourselves constantly how the two are likely to intersect.

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