

The Future of Learning: Technology and Pedagogy

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The transition that takes place in the lives of young people in the second half of their teenage years is one that takes them from the managed and dependent space of compulsory schooling to the threshold of adulthood. That transition is not just an educational one, but impacts on all aspects of the individual's experience, including social, economic and emotional factors (Baker & Stirling, 2016). Leaving compulsory schooling for the next stage of life raises important questions about the readiness of 16 year olds for higher education or skilled employment, the value of summative testing and the risks of early departure of many young people from education and training (Pring et al., 2012). For young people in industrialised nations, terminating their education at the post-compulsory age is likely to have a negative impact on their life chances (Jaik & Wolter, 2016). While we cannot predict the future of work in a society rapidly changing technologically and socially, there is as yet no evidence of a trend towards deskilling in an economic context of growing complexity and knowledge intensity (Hodgson, 2016). This suggests that 16-19 year olds need more sophisticated career preparation than ever before.

A major force at work in contemporary education is the rapid development of technology, particularly digital technology, and its increasing pervasiveness in global society. This is leading to an ongoing debate about pedagogy in the modern world, and how it serves the broader aims of education. To prepare students for their futures, we need to understand this complex interrelationship between technology and pedagogy so that students can learn both with technology and about technology in ways that heighten their understanding of their role as humans in an increasingly technological society. Education itself is a wicked problem in terms of its complexity and multiple assumptions and expectations, as we look for new pedagogies that can best integrate technology into learning (Mishra & Koehler, 2008). In this contested space there is no single solution or stopping point to the questions raised by the interface between education and technology. Any discussion of this topic, then, needs to include multiple perspectives. This article begins with a discussion around the purposes of education, considers the role of technology in education and in the transition from compulsory education, and looks at the relationship between digital technologies and the curriculum. It then explores some specific ideas around mobile and blended learning and the role of agile and lean education, before summarising some drivers of change.

What is education for?

Getting an education has long been a key to personal and societal development, but exactly what is expected of education in a particular place and time is contested by multiple perspectives. An education system serves three major purposes; to prepare learners to become contributing citizens to the economy, integrate into the cultures and traditions of society, and become functioning individuals who are autonomous and independent thinkers. Biesta (2009) refers to these three as the *qualification*, *socialisation* and *subjectification* functions of education. Different systems may privilege some of these purposes over others, but they all have a role to play. When, driven by technology, societies and economies are evolving rapidly, and half the current work roles in society may be replaced (Paterson, 2002) then these contextual factors impact on the nature of qualification and culture and thus on the self-actualisation of individuals. It should be noted, however, that the qualification component should not be overemphasised beyond compulsory schooling. As Chang (2010) states, “Education is valuable, but its main value is not in raising productivity. It lies in its ability to help us develop our potentials and live a more fulfilling and independent life” (p.189).

A frequently asked question of those who have completed their education is “what do you wish you had learned in school?” The answers to this often challenge traditional views of the curriculum. Responses to Richard Branson, who asked the question online in 2017, included “Finance skills, life skills, emotional intelligence, relationships, time management, leadership, experimental learning, global issues, mental health, coding, nutrition, public speaking and kindness.” (Branson, 2017). Only a few of these figure highly in formal education. We should note, however, that such responses are driven by the past experiences of adults in current society, not the future that school students of today will join and shape. A longer-term viewpoint is that education helps us to adapt to varied ecological situations by storing, analysing and transmitting information to the next generation such that humans have the unique ability to delay their own extinction (Francis & King, 1994). Education as a repository and means of transmission is not, alone, enough for this task. It must also nurture new knowledge, ideas and skills, an ambition that can be addressed with the support of technology in the context of appropriate pedagogies, the background to which is outlined in the next section.

Education and technology

The relationship between education and technology is a long and complex one. The very beginnings of formal education were based on the technology of writing on clay tablets for the accounting of trade (Mlodinow, 2016). The foundations of the education systems we see in developed countries today have their origins, as is often stated, in the factory model of production, developed in the post-agrarian period when mass education became the preferred model to address the needs of industrial societies (Murphy & Mayborn, 2013). In what some regard as post-industrial societies, commentators often reflect that this model is anachronistic (Martin, 1995). Dewey’s work from the early 20th century described more agentic ways to integrate the technology of the day, where radical schools in the Chicago area were enabling their students to build contemporary cutting edge technology such as vacuum cleaners and

combustion engines, building the machine rather than serving it (Dewey & Dewey, 1915). Later educational theorists such as Freire and Illich speculated on how technology might be part of a new learning infrastructure that might 'de-school' society and provide new forms of non-oppressive pedagogy.

From these historical contexts we can see that the formal education systems of societies tend to be driven by the technological imperative the day, whether wax tablets, combustion engines or computers. Since the advent of the World Wide Web in the 1990s (and particularly since Web 2.0 in the 2000s), along with an increasing range of digital devices, new ways of teaching and learning have become possible, leading to net-aware theories of learning such as Networked Learning, Connectivism and Learning as a Network (among other variations on a similar theme). All of these exploit electronic connections between learners to open up new ways of learning that were not possible before Web 2.0 allowed the online experience to become interactive. These changes in what is possible have impacted on the roles of teachers and learners, the ecologies in which people learn, the nature of knowledge and learning tasks, and the concept of learning as a lifelong and life wide enterprise (Gros, 2016). These technologies have allowed the vision of theorists to become reality. We now have "educational webs which heighten the opportunity for each one to transform each moment of his living into one of learning, sharing, and caring" (as envisioned by Ivan Illich in 1971) and are able to see creative, transformational knowledge, constructed through learners driving their own enquiries, supported by multimedia technologies, which Freire (1970) saw as the alternative to the traditional "banking model" of education where learners are just containers to be filled with information.

Students aged 16-19 today have grown up with technology in their lives and learning, and technology has an important role to play in the transition from compulsory schooling to the next stage of their lives. Whether or not we accept the concept of the *digital native* as being a different sort of learner, the lifeworlds of young people are inextricably linked with technological experience, and educators need to consider how best to address the role of technology in learning (Selwyn, 2009). Baker and Stirling (2016) show how technology can work as a tool for the transition into university, where social media weaves a social fabric among groups of young people in transition, keeping them aware of events, providing mutual support for learning, and easing the transition into higher education. The importance of social media in education is also stressed in the transition from school to employment, as one factor in preparing students for a globalised economy in which technology rapidly changes (Beadle, 2016). Social media alone, however, does not address all dimensions of the digital literacies required for school students to transition into further study or employment. This requires a more developed view of curriculum, as outlined in the next section,

Digital literacies and curriculum

For decades, educators have been looking for ways to introduce knowledge and understanding of digital tools to students of all ages, across the curriculum. It is now more than 50 years since the development of the Logo programming language, an "object-to-think-with" (Papert, 1980), intended to provide a channel for children to develop the cognitive skills that are now often

called computational thinking (Wing, 2006). Since then, changing technologies have driven a cycle from students learning to create digital artefacts by writing code, through students learning to engage with business software productivity tools, then back again to the construction of digital artefacts with new generations of creative coding tools (Resnick et al., 2007). This evolutionary change in emphasis raises questions about how digital technology can or should be integrated into the broader curriculum. There are many perspectives, and the proliferation of terms like digital proficiency, digital literacy, digital fluency and digital competency, and their various inconsistent definitions, indicate the range of beliefs about what this might mean in practice.

There are many ways in which we can think about digital technology in the curriculum. Perhaps the simplest is the idea that students growing up in a technological world should be able to use the technology that they will encounter beyond the classroom, a traditional concept of skills development that fits within the paradigm of industrial-age education. There are, however, other important ideas, for example digital citizenship, preparing students to operate effectively and safely in the broader world of technology. Both perspectives are acknowledged in the UK computing curriculum when it refers to “Learners being able to express themselves and develop their ideas through ICT both for work readiness and as digital citizens” (Department for Education, 2013). Even this is a rather narrow view of preparing students for a digital future. A more expansive view of integrating digital technologies across the curriculum is to develop the social, emotional and cognitive abilities that enable individuals to face the challenges and adapt to the demands of digital life (Park, 2016).

There are several dimensions to achieving such overarching goals. There is the *integration* of digital technology into the curriculum as a discrete subject and skill set, along with a broader *embedding* of digital technology across subject domains. There is also the *placing* of digital technology in the curriculum, whether the features of digital tools are used to drive learning activities, or whether learning activities seek transformational tools of expression. This links to the *nature* of digital technologies, ranging from simple software apps to mechatronics. Digital technologies include many very different types of tool, and their specific relevance to learning may take many different forms. The final dimension is that of *authenticity*, which encompasses relevance to real world practice, relevance to the learner, and relevance to other audiences (Kafai & Burke, 2014). Across these different dimensions, learners take a journey from learning about digital environments, where they gather and share information, through learning with digital environments, where they apply digital tools to communicate, collaborate and learn within authentic contexts, and on to leveraging digital environments for creative, enterprising, authentic learning.

Importantly, the types of learning discussed above assume that technology is being integrated into the curriculum in situations where learning takes place not only online, but as part of the classroom experience. Despite the popularity of purely online e-learning, as shown for example by the increasing number of Massive Online Open Courses (MOOCs), most formal education for the foreseeable future will involve students attending at least some face-to-face classes, facilitated by specialist educators. In this context, the roles of mobile and blended learning,

described in the next section, are central in terms of integrating technology into the learning experience.

Mobile and blended learning

From the earliest days of educational technology there was a desire to bring learning resources into the classroom in ways that complemented what teachers could deliver with more traditional materials. Multimedia sources such as film began to be used for educational purposes in the 1950s, as can be seen in footage of educational psychologist Jerome Bruner talking about film providing experiences “that the child cannot have with the naked eye” (Friesen, 2018). Narrating the action on screen, in a discovery-based science classroom, Bruner explains how the audio-visual media reinforces the discovery learning being experienced by the students, the technology serving as an amplifier rather than the provider of capabilities. Similarly, Skinner’s (1961) early work on teaching machines was predicated on an assumption that such a machine did not replace the teacher-student relationship, but rather enhanced the value of that relationship by scaffolding basic skills. A similar philosophy can be seen in the flipped classroom approach (Bergmann & Sams, 2012) where e-learning of foundational knowledge provides more opportunities for exploration and interaction in the classroom.

Blended learning, a term first used in 2000 to mean supplementing a face to face class with web-based support materials (Parsons, 2011) recognises the complementary value of face to face human contact supported by online resources. There are many different models of blended learning, ranging from extensive online learning with occasional face to face sessions to the use of digital resources inside the classroom in various activity rotations. The benefits of blended learning include flexibility, personalisation, and the maximization of resources, both on site and online.

Mobile learning, which provides the ability to learn freely at any place, any time, through the portable nature of digital devices may be integrated into other approaches to teaching and learning but also provides its own unique affordances and experiences. While mobile devices allow learners to move across spaces and times, they are also able to anchor learning to specific spaces and times as required. Mobility is, of course, the fundamental uniqueness of these devices, but in addition they carry with them the tools to capture data and experiences from the world in ways that non-mobile devices cannot. They can effectively and unobtrusively capture images, videos, sounds and measurements from the world. Their sensors help to not only locate them in three-dimensional space but to sense light, noise level, temperature, orientation, acceleration and many other external inputs. They carry with them multiple means of communication and a range of applications far beyond those available for larger devices. Their size enables them to be integrated into other tools such as Virtual and Augmented Reality headsets. Being capable of using mobile devices for productive purposes is increasingly required of both learners and workers, as increasing numbers of mobile knowledge workers rely on mobile technologies to support their spatial, temporal, contextual, and social mobilization (Nelson, Jarrahi & Thomson, 2017).

For young people in transition from compulsory schooling to higher education or employment, mobile and blended learning provide invaluable experience in self-management and the integration of technology into broader learning experiences, providing a realistic reflection of the modern workplace and higher education, where self-directed workers and learners who can seamlessly move between, and interact with, different contexts are expected.

Design, Lean and Agile Thinking

One aspect of education that is likely to see increasing development and interest is the more explicit alignment between processes of learning in education and the processes of design and production in the world of work, in particular ways in which learning can be delivered using approaches that have been successful in industry and commerce. If it is indeed the case that schools have been in the past built upon the principles and processes of mass production, then it should be no surprise that schools may be adopting more modern forms of productive enterprise. There is certainly an increasing interest in schools in the role of entrepreneurialism and enterprise, engaging students in enterprise development, both commercial and social, as one response to changes in the world of work, not just so they may become entrepreneurs but so they can shape their own identities (Edwards & Muir, 2012).

Another area where lessons from the wider economy are brought into schools is the adoption of creative, team-based and adaptive processes such as design thinking, lean thinking and agile methods that can support creativity, empathy, teamwork and critical thinking. It may appear that bringing ideas from industry into the classroom is a retrograde step, particularly if those industries are vehicle manufacturing, product and software development, which might at first glance appear to privilege the technical over the human, but reinterpreting these ideas for learning reveals some powerful ideas. Design thinking is a human-centered design process that requires characteristics such as empathy, integrative thinking, optimism, experimentalism and collaboration (Brown, 2008). Bringing design thinking into the classroom can help students to develop these characteristics through constructed, self-regulated, situated and collaborative (CSSC) learning (Scheer, Noweski & Meinel, 2012).

From Lean Manufacturing, which originated in the Japanese car industry, we can apply concepts such as *pull* (rather than *push*), whereby the learner pulls the learning they need rather than having content pushed at them. They can self-manage their learning flow using a Kanban board, and avoid wasteful activities that do not contribute to their learning. From agile methods, developed in the late 1990s in the software industry, students can learn how to work in self-organising teams, where they can prioritise, plan and manage their learning while identifying regular meaningful outcomes from their classroom activities. Agile techniques such as pair learning, learning stories and information radiators can provide much greater collaboration and visibility for the learning process. Such approaches to learning have already seen success in the classroom with agile learning methods such as EduScrum (Wijnands & Stolze, 2019) and lean ideas applied to learning such as kaizen in education (Wiid, 2019). Learning to be productive in these collaborative, adaptive and goal-oriented environments can only ease the transition of students into the workplace.

Drivers of change

There are many drivers of change in education and those responsible for developing and delivering it worldwide must remain aware of a range of continually evolving factors that impact directly or indirectly on teaching and learning. External factors of technological, economic and societal change all impact on how we guide students from school to the life beyond. Internal factors such as student needs and the reflective practice of educators also drive constant re-appraisal of how best to serve learners and wider society. In many cases these factors are directly influenced by the needs of students in post-school transition. 16-19 year olds need help with practical and emotional skills, engagement with the technology of the day, engagement with the world and with each other. Their learning needs to have both local relevance and broad reach, emphasising whole person learning, cultural growth, equity and sustainability. Humans form communities, we share ideas with others, we build our own tools, we quest for the unknown (Thornburg & Thornburg, 2009). As we move towards whatever education systems we build in the future, we need to ensure that these are the reasons that we use technology for learning, and that we guide students with these motivations as they navigate their transition into the grown-up world.

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