



technology, children, schools and families

Knowledge, creativity and communication

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1 Introduction

This report considers the potential effects of social and technological change on the character of knowledge, creativity and communication over the next three decades. It draws on evidence and insights from a set of 20 commissioned reviews in order to suggest longstanding trends and major issues of uncertainty for the future and the potential implications of these for education.

The purpose of this report is to enable people to rapidly access the knowledge, evidence and ideas identified from the challenge area reviews in order to support, inform and promote debates on the possible futures of education. It does not offer a clear consensus or set out to design the future.

A set of 20 reviews was commissioned that cover a broad range of topics key to the challenge of knowledge, creativity and communication and the futures of education. These include risk, identity, global expansion, neuroscience, affect, collaboration, participation and networking, innovation, representation, multimodal design, curriculum, argumentation, information, the role of institutions, learning, community, connectivity, convergence, literacy, and knowledge construction. The reviews are written by leading figures in the area of knowledge, creativity and communication drawn from the UK, Sweden, Germany, USA, Australia, and South Africa. (See Appendix 1).

Two consultative day events were held to inform the challenge (see Appendix 2). The events ensured that the Challenge outputs were informed by consultation with leading-edge science and social science thinkers from across a range of disciplines. The events included a mixture of presentations, workshop discussion and activities and were attended by participants from a variety of disciplines.

2 Findings

This section presents key socio-technological trends and issues synthesised from the reviews commissioned for the challenge area. What clearly emerges from the evidence is the need to look at the interaction between the social requirements of knowledge, creativity and communication and the practices that the development and use of technology is always embedded within.

2.1 Long-standing issues and trends

A long-standing issue or trend is one that several reviews anticipate will be relevant to the landscape of knowledge, creativity and communication in 2025. This section outlines ten long-standing issues and trends for the future:

- 1) The practices and knowledge associated with dealing with increasing ease of access to increasing amounts of information.
- 2) The potential for increasing collaboration across time and space and its effects on communication and creativity.
- 3) The ever broadening extent of connection and networking that will characterise the future.
- 4) The trend towards increasing personalisation and creative customisation of experiences, artefacts, learning and how this shapes communication and knowledge.
- 5) Changes in the availability, and configuration of representational and communicational resources in the future, and the effects of this on how people engage with knowledge, creativity and communication.
- 6) The ways in which literacy and information practices are changing will impact on the role of writing and the emergence of new forms of literacy.
- 7) Diversifying location, space and site will have consequences for who we communicate with, and how, and sites of learning.
- 8) The marketization of knowledge is briefly highlighted as a trend for the future.
- 9) All of the aforementioned trends impact in key ways on changes in knowledge production, the role of the author and the relationship of production and consumption.
- 10) Finally, the trend towards the openness of ownership of knowledge is discussed.

2.1.1 Increasing access to information

There will continue to be an increase in the ease of access to the information that people have access to and control over, as well as the amount and quality of information. This will expand the possibilities for knowledge, creativity and communication. It will also place new demands and requirements on people, and the development of skills.

What information is and how adults and institutions control and exercise authority over information is shifting. Children now have access to alternative sources of information other than school and the family and this trend seems set to continue. The Internet and portable technology have dramatically increased access to information over the past decade, albeit unevenly.

There have been changes in both the quality and especially the *quantity* of information that is now easily accessible. With this technology, interaction and communication will be 'transformed by objects, transactions and places endowed with the ability to speak themselves – an ability inherent in almost all schemes for the deployment of ubiquitous informatics now being contemplated.' (Greenfield 2008:57 cited in Carrington and Marsh). The development of more sophisticated context-sensitive technologies will mean that people will have access to relevant information and texts at the point of need. Price et al, point out that intra-body interfaces that rely on proximity, can use the human body as a transition medium to allow people to store, display, and exchange information.

Mobile phones and other multi-functional handheld or personal devices can be carried around, enable access to, recording of and communication of various forms of information and data, including photos, video, scientific measurements, and survey records. This serves to embed information in people's personal experiences and interests. As mobile technologies develop to provide more on-demand services 'cloud computing' will enable people to access information and 'take what they need' whilst being mobile (Price et al). Saljo and colleagues suggest that these digital tools (e.g. search engines, calculators,) serve as powerful extensions of the human mind and are increasingly sophisticated and powerful as cognitive amplifiers (Nickerson, 2005 cited in Saljo et al). Thus powerful human knowledge is built into the design and capacity of digital tools.

New types of literacy will be associated with the capabilities of accessing and handling massive amounts of textual information and the increasing significance of images and other forms of mediated communication (Saljo, Kress, Carrington and Marsh). New searching and writing processes are emerging and will continue to emerge, while some processes will remain constant (see 2.1.9). These changes have implications for cognitive processes and communication. Increases in the amount of information are likely to produce an information environment that requires increased collaboration among people with different knowledge bases and across time and space (see 2.1.2 – 2.1.3). Processes of searching this vast amount of information, and how to seek alternative synonyms for searches will become a key skill as will practices in checking the relevance of information gathered through diverse sources, and skills in the analysis, synthesis, reproduction and collation of information (Goodings).

Information on its own is not the same as knowledge: the latter involves interpretation and signification (Hendricks, 2005 cited in Gooding) which in turn pre-supposes a purpose in acquiring and using the information. The increase in information affects what is valued; in these circumstances our knowing to a considerable extent reflects our abilities to make productive use of such resources in accountable and creative ways for specific purposes (Saljo, Brown, Goodings). As well as who makes and circulates knowledge, the capacity to store knowledge electronically may well shift the central role of universities as the places where new knowledge is produced. People's engagement with huge amounts of data in meaningful ways is, in some contexts, likely to increase the personalisation of information and the production of knowledge, authorship and ownership. Digital technology provides some solutions to the problem of storing information. It provides resources for building up a collective memory of an incredible magnitude (Brown, Saljo).

2.1.2 Increasing collaboration across time and space

Socio-technological shifts will continue to facilitate a greater capacity and ease of collaboration across different locations and knowledge bases. This will involve changes in people's customs and practices and have implications for the production of knowledge, communication and creativity as well as boundaries between the physical and the virtual.

Collaboration has, Horst argues, "become a 'buzzword' which defines the ethos, if not the ideology, of the digital age". Gooding makes the point, drawing on McLuhan that technological environments are active processes that reshape people and other technologies, not passive containers. Technologies are increasing the connection and networks between people locally and globally in ways that redistribute information, roles, relationships and tasks across people's work and home lives. Eventually increases in collaboration are likely to reshape the boundaries between digital and physical, virtual and real, and notions of distance itself. Face-to-face communication will not disappear or lose its cultural value, rather it will be taken on specific roles and meanings.

Collaboration can be understood, in part, as re-thinking the connection of mind, body and environment. It marks a moving away from an educational focus on the individual internal mind. The emergence of a new participatory culture is predicted that will be essential for effective engagement with contemporary meaning-making practice. The notion of *Collective Intelligences* argues that new online communities create access to a new kind of 'knowledge space' explicitly for the production and exchange of knowledge. Sawyer argues that the majority of creative production involves *distributed cognition*. Most of today's important creative products are, he argues, too large and complex to be generated by a single individual. Collaboration enables participants to build on each other's ideas to jointly construct a new understanding that none of the participants had prior to the encounter. Collaboration thus moves knowledge, creativity and communication beyond transmission and acquisition, and engages with patterns of participation in collaborative activity change over time.

Sawyer suggests that collaboration in social networks accelerates innovation because more individuals can have more ideas. This presents the challenge of how to design effective organizational systems that can allow ideas to be developed cumulatively over time in a creative manner. This suggests the need to create learning environments that move beyond opposition or competition. Technology that connects people at a distance will change some practices previously considered individual into collaborative practices. Various information technologies, including the Internet, have enabled new forms of collaboration such as *mash-ups* and *modding*. This form of collaboration and concepts such as distributed cognition and collective intelligence are important for conceptualizing and legitimating contemporary literacy practices. For instance, practices such as the selection of elements from a variety of sources that are then incorporated into a new text for a different purpose (what is referred to as 'appropriation').

An enhanced participatory and collaborative framework for communication and knowledge is likely to affect social relationships in the future. For example, this may include a shift to more fluid expert-novice learning relationships linked to specific aspects of tasks and technologies rather than traditional adult-child hierarchies (Carrington and Marsh; Goodings). Horst argues that collaborating with experienced members of the community through talk cannot replace learning by observation. She argues that learning by observing, doing and talking are intertwined, and central to participatory learning, suggesting that collaboration online will need to support a range of ways of learning at a distance.

Physical and shareable multimodal interfaces encourage communication and collaboration, and the increasing move toward embodiment, external representations, and physical manipulation of 'digital objects' will put collaboration at the heart of knowledge, creativity and communication (Sawyer, Horst, Carrington and Marsh, Price). Price et al suggest that technologies can provide opportunities for interaction and learning to be more active, hands-on, and directly related to physical contexts. This they argue can lead to new forms of communication and collaboration promoting socially mediated learning. New tools that aid external cognitive support include complex interaction, sense of presence and immersion or embodiment in virtual environments, reorganising and connecting 'spaces' for collaboration. Tangible environments lend themselves to collaborative work, as usually a set of interaction objects can be manipulated both by a group and individually. They serve to increase collaboration by adding the advantages of concrete manipulation to shareable interfaces that encourage communication. Providing face-to-face interaction and multiple, simultaneous users enables the interactive properties of such shared interfaces to support productive collaborative knowledge building. How to translate some of the advantages of this kind of collaboration to collaboration across distances is a challenge for the future. One potential is that technology distributed across physical environments can be used to create collaborative dynamic simulations.

Web 2.0 spaces are significant learning spaces which support playful collaboration and support individuals to learn from others through sharing and discussing content online and scaffold people's creativity through organizational templates that structure text-making (Carrington and Marsh). Communication will become more collaborative and diverse 'affinity spaces' will develop to support more extensive means to engage in participatory activities (Horst, Goodings, Brown). Ito, et al (forthcoming, cited in Horst) identify friendship-driven and interest-driven genres of participation as two motivations which structure young people's collaborative engagement with new media. These affinity groups correspond to different genres of youth culture, social network structure, and ways of learning. Finally, collaboration and affective relations built online (e.g. in MySpace), and the information and communication and networks of connection that they support, are increasingly discussed in terms of new forms of work (labour). Work that does not result in the production of a material object or output, but rather that produces a social relationship, this is often referred to as 'immaterial labour' (see Gooding, Jones, Saljo, Lauder et al).

2.1.3 Broadening connection and networking

A key trend that the reviews anticipate will continue to evolve in the coming three decades is the capacity to connect via different kinds of networks to knowledge, texts and resources, and people. Connectivity is itself seen as a key activity across a wide range of contexts and purposes, in work, education, and life. The practice of staying in 'perpetual contact' is supported by the increased availability of mobile and networked technologies and the continual drive to hang out, or to be 'Always On' or 'link up' (Horst, Carrington and Marsh).

Networked and digital media has dramatically altered the media ecologies of young people in North America, Western Europe and East Asia (Horst). Web 2.0 social networking sites (SNS) provide opportunities and drivers for children and young people to create dense, sophisticated texts that do particular kinds of social work on their behalf (Goodings, Carrington and Marsh, and Horst). They serve as ongoing representations and commentaries on the lives of users. A profile on a social networking site also serves a commemorative function which is highly shaped by the medium (Brown). These texts mash together print, audio, animation and image and allow individuals opportunities to speak to diverse audiences across geographic locations, to craft representations of self and to reinforce intimate social connections with friends and family.

Carrington and Marsh point out that a new generation is growing up in a culture where it is normal social practice to design and deploy an avatar (or many) in a range of online worlds. They suggest that the growth in social networking and virtual worlds online as social destination for children and young people is linked to the decline of public spaces in which young people can congregate and engage in social interactions. One reason such sites are attractive to young people, Horst argues, is that they are largely outside the purview of adults and parents and offer the opportunity for virtual interaction with a wide range of people.

As technologies that enable connectivity and networking develop so will the social practices that drive the need to be connected in everyday lives, and across public and private spaces (Horst). Ito, Okabe and Anderson (2005, in Horst) suggest three practices characterize the mobility of technology. These are cocooning – a personalized media environment; camping – portable media into public spaces; and footprinting – using media to track of information and to mark presence. Changes in photographic technology have shaped this process. For example, the ways in which people exchange, tag and annotate their own and others photographs on websites such as Facebook and Flickr has broadened the scope of visually mediated collectively remembering.

The use of mobile technology enables people to participate in creating and maintaining a range of connections using these sites that bridge offline and online contexts. The connectivity and portability of networked and digital media are tied to broader trends in the changing structures of sociability. The constant connectivity that comes with networked media has produced flexibility in schedules and enables people to coordinate and re-adjust their time. The emergence of 'social network sites', or websites and software structured to maximize the possibility and frequency of connections between people, has altered the ways youth interact and develop relationships and stay connected to other teens who are not co-present (Ling, 2004 cited in Horst).

The division between public and private contexts may be dissolving or at least becoming more porous in an age of networked public culture (Horst). This demands different kinds of work for boundaries to be maintained and managed. It has implications for the colonization of different aspects of life by other people and institutions. Gooding discusses the difficulties and ethics of combining SNS with formal learning, as people attempt to balance and maintain the boundaries between aspects of their identities.

Overall, one-to-many communication is becoming more prevalent and creating diverse social contexts that effect for example, literacy and identity construction. This trend will continue to develop and will create more opportunities for creative knowledge production by individuals and groups. One of the fundamental questions in the digital age revolves around the extent to which new media and technology contribute to increasing connectedness, or to the atomization of society.

2.1.4 Increasing personalisation

There is an increasing trend towards the personalisation of knowledge, and experience. Although it is important to note that not all commentators are convinced by personalisation as an argument or as an achievable aim within education. One of the lessons of emerging virtual worlds is that young people coming of age as literate citizens in the early 21st century have an expectation of personalization through endless customization of experience and of self-representation.

This trend is intricately tied to changes in the social production of knowledge and the remaking of the boundaries between producer and consumer, as well as the commercial market, questions of location, space and place and the development of personal technologies. This trend is likely to continue, and is strongly associated with mobile and ubiquitous technologies that transform and re-mediate experience toward the individual and away from centralised systems and institutions (Price). Carrington and Marsh point out that this movement toward portable and personal technologies matches the ways in which adolescents engage with digital technologies outside the classroom. The use of this technology has the potential to lead to more authentic and engaging learning experiences that bridge school and community contexts, opening up new forms of inquiry.

The ways in which technologies enable data and experiences to be made, stored and manipulated by individuals serves to distribute knowledge in new ways. It is distributed over a series of nodal collaborations and networks shaped and motivated by interest and friendship rather than location (though location continues to be a factor). Thus personalization reshapes the notion of a centralized storage space from physical institution, to the institutional and commercial power of the network (e.g. Flickr or MySpace) that the individual is embedded within.

Personalization is linked with identity work. Goodings notes that the visual appearance of a Social Networking Site profile page is of great importance with many users spending hours modifying their profile page. The constant remaking and customising of a profile page exemplifies the wider web 2.0 genre that is obsessed with creativity and communication. VLEs offer many possibilities for activities that will allow students to

recreate settings and experiences that promote creativity, communication and personalised routes through these (Gooding). Users deploy their avatars to create an identity, with physical, social and behavioural attributes (e.g. Second Life, MySpace.). This form of personalisation (and anonymity) offers opportunities to explore and experiment with the nature of self and identity, concepts and relationships. It also offers the potential to engage with views and behaviours of others that may be difficult to negotiate in the physical world. This is not to suggest that interaction in the virtual world is free of the tensions of social life in the physical world (e.g. online bullying).

Creativity is positioned as a key aspect of a personalised interest driven activity (Craft). Sawyer argues that the goals of standard models of school and work, that is to ensure standardization, are becoming less relevant and that what is now required for effective learning is a move toward personalisation. A significant issue here is the need for new forms of assessment if learning is to be customized to the individual student. For example in the form of portfolios, flexible formative assessment and project based work.

Personalization is seen as a factor underpinning the design of digital environments. There is an increasing focus on learning environments as problem-orientated spaces that are flexible enough to accommodate different interests and to cultivate learning across a range of needs (Horst). Ito et al's recent work on informal learning with digital media with young people found that personal, or individualized, interests were one of the primary motivators for using digital media for learning. Further, Price et al, suggest that giving young people opportunities to express themselves through the representations they create and the use of constructive kits that allow children to build their own, personalized models, stimulating their creativity and imagination, can support deeper learning. The use of digital technologies are recognised for their potential to promote learning that is 'increasingly more personalized, informal and emergent – rather than the outcome of highly structured institutional practices' (Ravenscroft and Cook, 2007, cited in Wolf and Alexander). This has prompted researchers to investigate how development of effective argumentation might be supported and enhanced with appropriately designed 'digital tools' that enable personalisation.

2.1.5 Representational and communicational resources

Significant changes in the representational and communicational landscape over the next 30 years is a theme across many of the reviews (Carrington and Marsh; Saljo et al; Price et al; Kress and Bezemer; Horst). Changing social demands and technological innovation will continue to shape and reconfigure existing representational resources and practices of communication.

The continued development of audio, sensory, and embodied communicational modes and technologies will alter the place of written, print mode in the communicational landscape. The use of representational and communicational resources will become increasingly reliant on a range of forms of communication, drawing image, writing, action, sound and so on, into new relationships (i.e. multimodal in character). It will offer new modes of expressing oneself, representing the world and manipulating it and new modes of articulating knowing and insight.

Despite the shift away from technologies of print, writing will remain an efficient way of communicating in many contexts. Being competent in writing and speech will, however, not in itself, be enough for negotiating the future communicational landscape and image, sound, and the body will be further elaborated and extended in the future communicational landscape.

Although concepts of embodiment are not new, current theoretical trends suggest that more importance will continue to be placed on embodied interaction. Sense of presence, immersion and embodiment is a trend that is connected with the emergence of mobile

and ubiquitous technologies, but also with developments within cognitive approaches, multimodal theories, learning sciences and neuroscience. Increased hands on learning directly related to physical contexts offers increased cognitive external support for learning. The focus on mind is extended into the external world via a focus on interaction that moves away from mind as internal distinct and bounded and connects body and mind. There is a trend (e.g. tangible computing) for learning environments that increase the pairing of the physical, digital, social interface and human sensory systems. Through these developments technology is redefining understanding of embodied interaction, these include implantable interfaces, proximity interfaces, wearable computing, etc. It is likely, Price et al suggest, that representational resources will expand as technology develops to use of a range of sensory-specific interfaces, including olfactory, haptic and visual that focus on human senses as inputs (smell, touch, vision). The constantly and rapidly evolving relationships between the physical and the virtual body are likely to provide an increased focus on expression, affect and the body.

Increased combinations of representations require people to attend to and integrate diverse pieces of information from different data sources. The degree to which novices are able to focus on and extract appropriate information impacts on their abilities to engage in effective knowledge acquisition activities (deGroot, 1965; Glaser, 1992 cited in Price et al). The choice of mode and thus modal affordances will become more important for the work of design with respect to knowledge, creativity and communication. The layers of visual symbols, audio, print and hyperlinked meaning-making pathways will highlight the need for a deeper understanding of how modal layers create meanings. Added to this the development of the skills to bring these modes into different kinds of configurations and relations will increase in value.

2.1.6 Literacy and information practices

Literacy and information practices will broaden in response to diverse texts, media, and new purposes for literacy. The desire and need to engage in social interaction and communication at the root of literacy practices remains. What *is new* and will continue is the range and type of media that facilitate this interaction and the emphasis that different media place on various modes. Writing will continue to be a key form of communication but other forms will emerge and become increasingly important.

It is broadly agreed that the communicational and representational landscape is changing in significant ways and that technologies are an integral part of these changes. Key future developments in literacy are likely to intersect with patterns in technological development in relation to ubiquity, convergence, mobilisation and personalization (Carrington and Marsh). The effect of these changes on how people engage with literacy and information practices is complex as the primary purposes of literacy and information have not, and are not expected to, change at the same rate or to the same extent. Saljo and colleagues make clear that what counts as literacy and change is itself contested, some argue that the use of technology might result in losses of traditional skills. Others claim that traditional literacy skills (reading and synthesizing) are more central than ever in engaging with complex and huge amounts of data. Meanwhile, others argue that there is nothing new, that scrolling, skimming and browsing is essentially the same kind of reading that we know from print.

Specific literacy and information practices will continue to become more significant, others will be reconfigured through technology, and some new practices will enter the literacy repertoires of young people and children. New purposes for literacy will continue to emerge from the ability to communicate across space and time with known and unknown people. These will be supported by developments of mobile and social networking technologies and the increasingly embedded character of these in the everyday will produce emergent and fluid sub-cultures and sharing networks which enable a broad set of practices with text. Overall, the blurring of traditional distinctions

between producer (author) and consumer (reader) will escalate, and require a complex range of skills, knowledge and understanding.

The ability to understand, use, manipulate and distribute the power of images and sounds will be paramount in the 21st century. It will be increasingly valuable to be able to create multimodal texts that can operate across a range of platforms, to recognize the affordances of a mode will become a key competency, along with the choice of media, skills in use of various modes, and ability to analyze multimodal texts, and to rapidly critique information from a range of sources. To be literate will be associated with a person's potential to be a code breaker, to be a meaning maker, a text user or a text critic (Freebody and Luke, 1990, in Carrington and Marsh). Literacy practices will continue to change, if unevenly and to different extents, with the advent of digital technologies. These new practices will not replace existing literacy practices, rather they will overlay them. This will serve to increase the complexity of learning with the demands of multi-layered meanings and more complex semiotic systems (Higgins, Kress, 2003).

Letters, words and symbols will continue to be an integral part of many texts and print-based texts will continue to perform important social work for individuals and communities. Learners will continue to need to learn the principles of reading and writing print and writing will always be a significant form of communication with high cultural value. However, processes of writing will inevitably change with technological developments that will facilitate extensive on-screen writing such as the refinement of voice-recognition software. The range of multimodal texts and technologies in use are likely to lead to modes other than writing becoming pervasive when undertaking everyday activities. Likewise, repertoires of literacy practice will continue to expand and diversify across different technologies, creating a complex environment and challenging the dominance of writing.

2.1.7 Diversifying location, space and time

Location, space and time will become increasingly important in mediating, constraining and providing opportunities for knowledge, creativity and communication. New sites of learning are emerging, and old sites are being reframed and brought into new relationships with one another. Future developments and social uses of wireless, networked and mobile technologies and virtual and mixed-reality will continue to push boundaries of where and how to distribute information in ways that offer the capability to change learning environments and outcomes (Dourish, 2001; Rogers et al., 2006 cited in Price et al). In the process, the division between public and private spaces is likely to dissolve into hybrid configurations. This may have significant impacts on the production, boundaries and purposes of knowledge. Places and communities that people learn in will continue to be intimately connected to social practices and knowledge, identities, as well as the semiotic resources available (Sefton-Green).

Initiatives to integrate 'education' into the home, or to turn the home into a new site for conventional education are likely to continue. The home, particularly the 'digital bedroom' (Livingstone, 2002, cited in Sefton Green) is positioned at the heart of the consumption and use of digital technologies and the marketization of education and thus within a larger socio-economic geography of learning (Sefton-Green, Carrington and Marsh). Differential access within the home to technological, economic and social capital will continue to shape future models of education.

The re-distribution of the function of schooling across other kinds of sites to form a network of learning is one vision for the future (Sawyer, Sefton-Green). This places significant responsibility on the learner in a further elaboration of personalisation of learning trajectories across a wider 'ecology' of education diffused across a variety of sites- schools, homes, play grounds, libraries and the museum – each of which has the

potential to contribute in different ways to education (Sawyer, Sefton Green, Horst). These networks of sites provide potentials for educators to mobilize learning within, between and outside of the classroom in the future. Particularly when supported by context-based ubiquitous, wearable and mobile technologies that augment real-world contexts (e.g. museums, field trips) and geo-networking and physical web technologies that pair virtual online information from social networking sites with physical location and events in the real world (Price et al). This will have significance for the re-organisation of the time and space of education. As a result, the 'geo-social' relationships of learners to their home, communities, non-formal learning spaces, and virtual spaces are likely to be reshaped to offer different kinds of possibilities for engaging with knowledge, creativity and communication. Part of this is the remaking of home school relations and boundaries. Young and Muller drawing on Bernstein, argue it will continue to be important to differentiate learning in schools, colleges and universities from learning in homes, workplaces and communities as boundaries play an important role in creating learner identities and are part of the condition for acquiring 'powerful knowledge'.

Learners position themselves in relation to the wider community beyond their immediate locale through a range of mechanisms including online and virtual communities. Flexibility will become a key feature of establishing new ecologies for learning in the future that facilitate pockets of flexible space, time and ways of learning, reorganize across age phases, curriculum areas, and collaboration. The potential to flex and de-centre time in the school (through the use of technologies) can be used to create a range of spaces for learning that may connect more easily across sites of learning (Higgins). The deployment of technologies will continue to create flexible virtual online spaces for learning many of which are leisure or informal spaces (e.g. games, social networking sites) which may open the door to more complex interactions as well as 'mixed reality' spaces (Price et al, Saljo). The use of features of mobility and sensor embedding technologies may provide new opportunities to re-think space and place organisation in fundamental ways. The notion of network also has implications for the porous character of the classroom and the relationship between schools and the rest of society. Network technologies allow learners to interact with adult professionals outside the school. The use of such networks may lead to learning will become more diffuse and relocated, such as the on-line virtual schools in the USA and Australia offering home-based activities organized at the level of neighbourhoods (Sawyer). At its most radical this is a vision of a "de-schooled" future (Illich, 1973, cited in Higgins).

Sefton-Green argues the increasing currency of informal learning describes different processes and organisational structures of knowing in alternative and complementary time-spaces, driven by particular interests and purposes, and the development of new kinds of knowledge-communities. These suggest new ways of learning, being and knowing, that challenge the epistemological conventions of mass schooling. Although, as Gooding points out these may echo learning spaces in offline contexts (e.g. auditorium lecture theatres in second life). Experiments such as on-line virtual schools (Sawyer) and the Institute of Play that merges gaming principles of design with standardized curriculum (Horst), and the Schome project (Sawyer) are likely to expand. However, the school as a site of learning, although transformed and probably diversified is, likely to remain.

2.1.8 Marketization of knowledge and creativity

Access to knowledge and capacity for creativity, in a variety of forms, is claimed to be central to a competitive future in the knowledge economy (Sawyer, Craft, Sefton-Green, Guile). Knowledge and creativity are increasingly claimed to be equally or more important than land, tools or labour in determining a society's standard of living (Sawyer, Jones). Although this claim is disputed, the direct linking of knowledge with the economy serves to reposition knowledge as a transferable market commodity and the

child as a social resource for economic potential. This perspective stands behind the increased focus on generic skills and creative innovation industries and positions the development of and access to knowledge primarily in instrumental and competitive terms (Guile). Commercial market forces are powerful in many domains of children's lives and the boundary between the private market and the public sphere continue to blur and shift in significant ways (Buckingham, Sefton-Green). Several reviews fear that the commodification of skills, creativity and knowledge, will reduce the role of education to meeting the demand for labour (Craft, Jones, Lauder et al, Saljo et al).

2.1.9 Changes in knowledge production

Authorship and ownership of knowledge are being remade by new technologies, indeed in some scenarios knowledge is seen as diffuse and networked and 'in the hands of the people' in a range of activities. The distinction between producer and consumer will continue to blur to the point of hybridity and practices of remixing will increase toward an intensification of creative production and consumption.

The complexity and unevenness of this emphasis on the purposive action of participants in knowledge production is also noted in relation to structural inequalities that shape the parameters of participation in the new media ecology (Horst, Saljo, Kress and Bezemer). In contrast, other reviews see these changes as superficial and with little real power with control of powerful knowledge remaining located in pockets (nodes) around the globe – in the form of the super research universities, elite universities and multinational corporations (Baker, Young and Muller, Lauder et al). Thus the questions of who is creating/authoring knowledge and who is enabled to access it is key to determining whether these changes will be superficial or not.

Increasing access to digital technologies and the capacities they afford mean text production will increasingly be informed by the processes of 'remixing', 'mash-up' and 'sampling' which involves cutting and pasting, reformulating and recontextualising texts, which has implications for the development of learners' ability to judge sources and evaluate their appropriateness. This remix culture will continue to raise questions of fair use, intellectual property and copyright. Carrington and Marsh argue this will lead to the democratization of the tools of remixing media across a range of modes, purposes and audiences and to a greater expectation of individual creativity rather than static reception of heritage text forms. Gooding supports this view of a move to a more open and free authorship of knowledge, arguing that the *Convergence Culture* signifies a form of participation that perpetuates the creation of user generated content on the Web that enables consumers to archive, annotate, appropriate, and re-circulate media content. Both see this process continuing and escalating into the foreseeable future.

Social and technological changes culminate in a trend toward the intensification of creative production and consumption and these have already led to an emphasis on agency. While this may well be illusory to some degree, young people do act out of such understandings of their power in relation to design and knowledge production (Goodings). In other words, the social changes manifest themselves in an assumption of significant agency on the part of the young in the domain of their own cultural production (Gooding). This trend is not fully developed with social class, race and gender differences in the access and skills that young people have in production. More subtle shifts in the relation between reader and author are a part of this trend, attending to the ways in which readers produce and remake texts – the possibilities for remaking are broadened by the multi-directional reading paths of digital texts and environments, the unsettled genres and practices of 'reading' digital texts, and the participatory culture of online environments. These unsettled spaces offer opportunities for innovation, control, risk taking and ownership for young people – spaces that education needs to understand how to create and harness.

2.1.10 Knowledge ownership

Changes in knowledge production and authoring will intensify and raise questions concerning copyright and access to information. There will be a trend towards openness and collaborative sharing of digital information.

Web 2.0 is a platform for content creation and is built on the presumption that people will re-distribute content across the web. Goodings suggests that users are often unaware of the relevant legal, pragmatic and ethical guidelines. These sites also make use of the Creative Commons license that involves a number of re-use policies for the public to avoid being held liable for copyright infringements. Indeed the collaborative culture and Creative Commons License have enabled the production of a wide range of open educational resources. Gooding agrees with Jenkins (2006) that 'powerful institutions and practices (law, religion, education, advertising and politics, among them) are being redefined by a growing recognition of what is to be gained through fostering – or at least tolerating – participatory cultures'. Goodings suggests that information and communication will increasingly become the currency of new Web-based products and services and that a growing numbers of media industries will look to the 'meaning' that people construct in communities of user-generated content as a highly marketable resource in the new media industry. A move towards a more open and free use of information is the most likely direction for the future. Alternatively, at least in some contexts, copyright may be used as a powerful form of regulation to restrict and manage the circulation of information and knowledge and tie it to commercial interests. There are important questions about the degrees of freedom of knowledge and how knowledge will be regulated in the future. This also links with questions of authenticity and trust.

2.2 Major issues of uncertainty

This section of the report highlights three areas of potentially major significance but which the reviews suggest there is considerable uncertainty about their future development and direction. The first relates to creativity, and the question of whether creativity will become more widely spread across the population, become democratized or if it will become ever more elite to become the right of the few. The second concerns the management of knowledge and communication, and whether this will coalesce around individuals or communities. The third uncertainty is focused on information and questions of trust, risk and ethics.

2.2.1 Creativity - democratization or elitism

Who has access to creative work and practices is a significant issue for the future, it is also surrounded by uncertainty – will creativity be available to all or will it be only for the elite echelons of society?

The reviews focus on the empowering democratising potentials of creativity – available to all, opening up the space for being creative, the increased engagement with creative production and consumption enabled by new technologies and a shifting communicational landscape in the future (Craft, Carrington and Marsh, Horst, Kress and Bezemer). These coalesce around the economic imperative of creativity for innovation in industry and services that, together with concern with student disengagement and social inclusion have helped to raise the profile and credentials of creativity in education more generally (Craft). Banaji et al (2006) note multiple distinctive discourses circulating in respect of creativity in education.

Sawyer, Jones and Lauder however both point to an alternative scenario with an increasingly myopic focus on the efficiency of the global economic landscape of labour and the standardization of working practices. The Internet is called upon as a

democratizing force for knowledge in several reviews (Carrington and Marsh, Gooding, Horst) but Lauder argues that the 'crucial point here is that data and information from the Internet needs interpreting and evaluating'. Indeed, Lauder sees creativity in the light of intensified 'positional competition' and greater elitism and selectivity. Rather than democratization of powerful knowledge and creativity, he suggests a more class-based outcome in which creativity and powerful knowledge will more likely reside with the few. Here knowledge and practice is automated and fostering creative abilities and opportunities is restricted to a small elite. Far from becoming increasingly democratized, fewer and fewer employees will be asked to exercise creative autonomy, choice and control in their work. Instead, the rise of a global elite of 'creative knowledge workers' will be complemented by increasingly standardized and routinized (highly scripted and constrained) working practices for a majority with no 'permission to think' (Lauder et al) and no room for *disciplined improvisation* (Sawyer). Sawyer and Lauder suggest that the automatization of work, combined with increased globalization and the re-location of unskilled jobs to low-wage countries may create 'a radically tiered social structure'; what Lauder calls 'Digital Taylorism'

It is unclear how this tension between creativity and social inequity will play-out or inform policy and the future. In part this uncertainty is tied to the question of what the purposes of education are to be in the future in relation to work, economy, and citizenship. The future may bring further social stratification. Creativity will, Sawyer suggests, become central to the education of elite groups and restricted notions of creativity will inform the education of other groups. Democratic approaches to education employ notions of creativity to focus on the raising of standards for all to the same level. This serves to position the child as located in society/culture in which there is no such thing as a unique bounded individual. Creativity is a discourse of inclusion, empowerment and viewed as inherent in everyday activities. The other primary use of creativity is in the more competitive sense of standards and the gifted and talented. This is underpinned by a view of creativity as the uniqueness of the individual, and the self as personal project – creative genius, it draws on exclusivity, competition, and capacity to thrive in a market economy (Sawyer, Craft). If such a vision were to come to pass Sawyer (and Baker differently so) suggests this would pose the risk of a social order that reproduces itself through these imbalances in the education system.

2.2.2 Management of knowledge and communication: individual vs communal

Whether knowledge and communication will be primarily individual or communal is a key uncertainty for the future.

The extent to which knowledge and communication will be shaped by the ways in which people will be connected via communities, family and intergenerational relations, interests, identity and affinity groups. A key aspect of this is the extent to which the future may lead to an atomised or individualised society and in response how knowledge or communication may coalesce around individuals or communities/groups. This tension suggests two possible future trajectories, or configurations of these, one moving towards increasingly communal and social management of knowledge and information, and the other moving towards increasingly individualised and atomised management of knowledge and information.

Further, this remaking of communities around interests raises questions for how people maintain identities and culture across generations (Jones). One outcome that may pertain to the future is the increasing production of surveillance as a form of 'connection' where adults' roles are to protect children, in which content and forms of communication are restricted through technology or social relations. For example, parents increasingly use mobile phones and online technologies to maintain communication, monitor and control the movement of their children outside of the home and the institutionalized context of the school (Iverson, Carrington and Marsh, Horst).

2.2.3 Trust, risk and ethics

Against the backdrop of ever increasing flow, access and storage of information and engagement in online economies, communities and identity work embedded in everyday life a number of reviews raise the theme of trust and authenticity, risk and ethics as central for the future (Brown, Goodings, Horst, Craft, Sawyer, Sefton-Green).

These issues may go in different directions in the future, which can be understood as the outcome of a combination of two factors. The first factor is either increasing or decreasing trust, and second, increasing or decreasing acceptance with information being held via others and systems. Underpinning the question of what direction these issues may take are broad issues of security and privacy, and attitudes regarding the potential of social and technological trends towards surveillance or empowerment.

Issues of authenticity of knowledge (that is trust in the value, correctness, and origin of information as well as who has produced or communicated information) will persist. These are likely to become increasingly important as knowledge is increasingly generated within complex systems and through collaborations and in online contexts in which it is relatively easy to find personal information. Mechanisms and strategies will need to be developed that serve to establish and maintain trust for the users of technology and equip them with enhanced skills to assess online authenticity and value. Many children are able to recognise and avoid risky behaviour (Livingstone, Bober & Helsper (2005) cited in Gooding). Here the need to understand how risk acts as mediator for interaction is key (Schillmeier).

Trust and reputation in online environments are increasingly built up over time and across people's experiences rather than on an individual basis. These are constructed from markers such as discourse styles, use of the textual practices of particular affinity groups and the deployment of inter-textual references (Davies, in press cited in Carrington and Marsh), for instance in the forms of ratings to construct online reputations. Children and young people will need to develop strategies that will enable them to manage their online identities in terms of the level of detail they are prepared to share with different audiences – and sites and institutions will be increasingly called upon to monitor and maintain the privacy of their users. Changes in the character of knowledge are likely to have significant meaning for the basis of authority of teachers and teacher professionalism, as well as curriculum and processes of knowledge production in education.

2.3 Key socio-economic factors likely to underpin future directions

This section highlights the key socio-economic factors that are likely to underpin future directions in the practices of knowledge production, creativity and communication over the coming years.

The key potential levers and drivers shaping knowledge, creativity and communication for the next 30 years are the continuing development of technology and its social use, the expansion of the global knowledge economy, the place of creative industries within this broader economy, the marketization of education, policy and technological focus on personalisation and the individual, and increasing diversity within the population.

Potential challenges that will force the trends for knowledge, creativity and communication identified in this report in different directions over the next 30 years include, legal and regulatory frameworks, tension between standards and creativity, social inequity, and the inability of education to respond to developments in technologies and changes in the population.

2.3.1 Potential levers and drivers

The continuing development of technology and its take up for social purposes is a key driver for knowledge, creativity and communication in a number of ways. In particular the use of open shared resources, social networking sites, the storage and circulation of information, images, video, music etc across sites are a part of the social collaborative and participatory culture. The use of mobile, network, ubiquitous technologies and perhaps more importantly the development of innovative ways to use and deploy these technologies for social purposes will support knowledge production and communication and provide sites for creative work and its dissemination.

The expansion of the global knowledge economy, supported by the use and development of networked technology to support collaboration across time and space is a significant driver for knowledge, creativity and communication. In particular the drive to speed the cycle of production from innovation to distribution through 24-hour production that 'follows the sun'. These socio-technological trends will drive the role of knowledge, creativity and communication in the global economy in two parallel but distinct directions. On the one hand, work that relies on automated and routinized knowledge, severely limited possibilities for creativity with no 'permission to think', and highly scripted and regulated communication. On the other hand, a circuit of 'talented' elites will be required to engage in complex knowledge production, using creative skills and requiring sophisticated communicational resources. In the past it was assumed the knowledge economy would mean creative knowledge service work in the UK, however, with the rise of cheap specialist labour elsewhere, the role of the UK labour force in this global market is not clear. This will give shape the future labour force required in the UK. The degree to which educational policy will be tied to economic policy in the future is unclear.

Educational interest in creativity as an essential skill or disposition for the future is strongly linked to its anticipated economic benefits. The success and economic productivity of the creative industries is therefore a strong driver for creativity in the UK and globally.

The increased marketization of education is a driver that will have significance for knowledge, creativity and communication. In particular the increasing unbundling of education from the state as a central provider and the move toward online educational possibilities may serve to diversify and open up education. Hybrid private-public relationships in education may increase, for example between work and education. This may result in increasing social stratification of education as a market in ways that strongly shape the kinds of knowledge, creativity and communication that people have access to.

A general focus on the individual is driving educational policy and socio-technology agenda for personalization and personal technologies. At the same time as proposing an opening up of the space of schooling to the interests of students this raises many questions for what knowledge is in the school.

Increasing diversity within the population combined with increasing collaboration and networking is a driver for knowledge and communication. If the global economy becomes increasingly multilingual, or leads to increased circulation of global labour, this may lead to linguistic and cultural diversity within education which may have profound consequences for communication as well as curricular knowledge. This relates to issues of multilingualism and cultural pluralism, and identities across nation-states (Jones).

Anxiety and fear concerning the disenfranchisement of young people (a concern linked to diversity and the individual) is a key driver for the weakening of boundaries

between disciplines and sites of learning that has implications for the status of specialised knowledge, and everyday knowledge.

2.3.2 Potential challenges

The increasing openness of technology is in a constant struggle with legal and regulatory frameworks with respect to intellectual property rights and copyright, as well as concerns for privacy and safety. This struggle is connected with political, economic, and ethical issues as well as authenticity, trust and risk. The control and regulation of images, video, music etc on the Internet is vital, but may introduce forces that have a negative effect for the future of knowledge, creativity and communication.

There is much interest in personalisation, customisation, and creativity but how this interest will play-out with respect to standardisation is unclear. These two trends may be in tension, and if the weight is given to standardisation this may present challenges for creativity.

Social inequity, especially in the context of increasing marketization of education, may have profound consequences for how children and young people access and experience education, and exacerbate the social differentiation of access to knowledge and creativity. However, the unbundling of education may serve to provide schooling for a variety of people who are disenfranchised from education.

The failure of education to respond quickly to future technological developments is a potential challenge for the future trajectories of knowledge, creativity and communication identified in this report. There are many complex forces that operate on the school that make the changes technologies promise difficult to realise. This may result in the possibilities for knowledge, creativity and communication in educational sites being in a state of stasis.

The failure of education to respond to increasing diversity (e.g. through migration and globalization) may prove a challenge to the future direction of knowledge, creativity and communication. Diversity may be erased, smoothed over, through potentially monolingual contexts (physical and virtual) that develop over time. The question of how difference will be marked in the future remains very open.

The direction these factors will take will depend on social and political decisions that will be made about the role of education in the global economy.

2.4 Potential implications for education

This section addresses the potential implications of the findings presented in sections 2.1 – 2.3 for education with attention to the demands of a changing landscape, the goals of education, teachers and learners, organisation and governance of education, supporting learning and learning cycles.

2.4.1 The demands of a changing landscape

The changing landscape of knowledge, creativity and communication will place new demands on education with respect to the skills needed to participate in, navigate through, connect with and interpret this landscape.

Learning how to collate, search, interpret, evaluate and transform information into salient knowledge is increasingly important, as is the ability to authenticate information from diverse sources. People will need to assess and manage risk and establish trust in

virtual spaces and work with risk as well as the politics of information, ethics and legality. People will need to be creative, self-directed and curious about new forms of knowledge and be able to manage complexity and risk taking.

People will need to be fluent in working with a complex range of static, virtual and blended texts. Literacy will need multimodal design at its centre and the interpretation and creation of meaning beyond language as its purpose, that said, the ability to write and read, and numeracy will remain relevant key skills.

Increasingly people may be expected to participate in a variety of textual knowledge production and the boundary between consumer and producer will continue to blur. The ability to engage with content creatively via experience is likely to be a growing demand for the future. This is likely to be the case in relation to finding individualised pathways through curricular knowledge. This will also pertain to the customisation and personalisation of spaces through the use of technologies and the creative expression of identities. The ability to work across disciplinary, technological and spatial boundaries will be essential in this changing landscape. The multimodal media ecologies of young people are expected to continue to expand and diversify, particularly with the growth and development of mobile and ubiquitous technologies. How to harness (and regulate) technologies will become important questions for education.

The increasing focus on networked connectivity will require people to have the communication skills and knowledge to support effective collaboration and communication. A central element of the changing landscape is the development of resources and spaces (in education, work and home) to support people to create and innovate. This may stand in tension with the potential that the knowledge economy may lead to the demand for a work force in which the dominant requirement will be the ability to follow tight scripts and automated routines.

2.4.2 The goals of education

The future of education is likely to continue to be focused on the following three goals: the need to project learners into official discourses of knowledge; an agenda for social inclusion, personal growth and active citizenship; and providing people with skills for work. Whilst these reflect the current goals of education, it is the context and conditions of their articulation that will be crucial for the future.

The focus on official discourses of knowledge looks to continue the move of mass education towards generic skills away from disciplinary knowledge. There is growing concern that the goals of education will become subsumed by the needs of the labour market. The rationales motivating investments in life-long learning (its functions and purpose and driving forces) will continue to shift from a means for promoting social inclusion, personal growth and active citizenship in a democratic society to a strategy for increasing a person's chances to compete with others in a changing labour market in a global economy. This increasingly instrumental view has spread widely and dominates the debate in the European Union on future policies, where the prime role of schools and universities is to make people "employable". This risks education being reduced to supplying an increasingly uneven labour market and may lead to the continuing marginalization of schools as institutions within society. This concern is accompanied by considerable uncertainty as to what it is legitimate and necessary to know in order to participate in a changing global context. Conversely the shifting balance in work, life, and education may shift the goals of education towards personal growth and development.

The question of how pedagogy and curriculum should respond to and manage the tension between the knowledge of learners outside of school and the official discourses of knowledge persists. The consequences of the stability, porous or bounded character

of disciplinary knowledge is a contested issue, as is how best to design these to meet the needs of future society. The question of how knowledge should be organised, whether people should be inducted into knowledge, or the degree to which people should be free to create the boundaries of knowledge around their own experience is a perennial problem within education and one that appears to be coming to the fore. Some call for increased porosity of the boundaries between knowledge disciplines and domains and others suggest that these are already in a state of semi-collapse. Children's use of digital technologies is seen as a powerful tool in reconfiguring knowledge in the classroom, particularly through digital text production. From this perspective the challenge for schooling is, Saljo et al argue, drawing on Dewey "to connect to children's everyday experiences and introduce new skills and knowledge in such a manner that they are able to bridge what they encounter in school with what they hear and see in other social settings. Schools must be seen as a form of social life in which children and young people engage in activities that they find relevant, meaningful, enabling and that are consequential in terms of learner interests and identities." A call to weaken the boundaries of schooling can be understood, Young and Muller argue as a desire to adapt 'to global trends towards greater flexibility and openness to change from individuals'. They emphasise the social differentiation of both knowledge and institutions, and challenge the assumption that boundaries are always barriers to be overcome rather than also conditions for innovation and the production and acquisition of new knowledge. One consequence of weakening boundaries would be that schooling would become less and less differentiated from other social institutions which may lead to an 'over-socialised' concept of knowledge. This is likely to lead to access to specialist knowledge migrating to elite and private sectors and institutions and public education becoming a competition within a context of 'credential inflation'.

Concerns about emotional well-being are increasingly a focus of social policy, particularly in education settings, and the placing of new ideas about emotion and creativity and communication in curriculum content, pedagogy and assessment, in ways that are significant in redefining what it is to 'know' (Hayes and Eccelstone). This marks a fundamental shift in ideas about what education is for, and what it means to be human (Young and Muller, Hayes and Eccelstone). This focus on emotion and well-being needs to be understood in the broader context of the knowledge economy and the rising importance of creativity and the linking of emotion (e.g. low self esteem) with social exclusion by policy makers. More specifically this debate centres on the emotional well-being of youth in contemporary society, the disengagement of students from formal schooling, concerns regarding the commercialization of childhood, and the effect of ICT on the emotional development of children and young people all of which shapes educational discourses on knowledge, creativity and communication.

2.4.3 Teachers and learners

The changing socio-technological character of knowledge, creativity and communication outlined in this report will diversify what it means to be a learner, who it is that learns, and impact on the relationships between teacher and learner.

The age range of learners is likely to expand, with people starting education earlier and leaving later than before, and leading to increased diversity in the age, background and expectations of learners. This may serve to collapse some of the boundaries that separate learners and teachers in education.

Sites of learning are likely to diversify and a broader range of people are likely to be involved in teaching and learning in the future. The home will have an increasing role to play in education in a number of ways including increased connection of home to school via technology, home access to information via new media, virtual learning environments that merge the boundaries between home and school, and 'edutainment'. This may draw parents and siblings more strongly into educational relationships with one another,

perhaps giving new emphasis to intergenerational learning, peer-learning, independent learning and informal learning. These new relations may solve *and* generate problems for education. The community and neighbourhood may also take a stronger role in education in the form of teaching and learning hubs, raising the significance of mentoring and out of school sites of learning. Online collaborations across networks are likely to increase peer learning and mentoring on interest driven sites and within specialist affinity groups.

The policy and technological move towards personalisation may support flexibility in school curriculum and time schedules. Increasingly the Internet and other participatory online spaces including social networking sites will supplement or substitute aspects of schooling. There is likely to be ever increasing attention to the learner. This may increase peer and mentoring relationships and dissolve the stratification of learners by age. This flexibility may result in some shifting from linear processes of education to more iterative processes of education.

The role of the teacher and what teaching means may change both with respect to the current trend towards the personalisation of learning and the routinization of teachers' work. In addition, technologies in the school may reconfigure teacher roles as that of guide rather than the main point of access to inquiry and knowledge production. There is a growing argument for the need to move toward dialogic teaching (Wolf and Alexander). As students are empowered, teachers may, some argue, be re-positioned alongside pupils (and the internet) as alternative sources of support and information, rather than gatekeepers of knowledge. At the same time this raises issues about students' competence at taking on a more independent self-generated activity or role that this demands, and teachers' ability or familiarity with facilitating learning. A particular challenge for education in the future is how to manage fluid and uncontrolled learning outcomes, and increased instances of small group interaction. Another possibility is that notions of pedagogy may change dramatically. It is becoming more common to try and merge social, cultural aspects of learning with individual notions of agency through personalisation and virtual interaction. The question that remains is the extent to which it is possible to create collaborative classrooms where personalized learning environments which are flexible enough to accommodate different interests and learning needs are cultivated and where tasks are problem-focused.

2.4.4 Organization and governance

The move towards a more diffuse and flexible ecology (and economy) of education will have significance for the organisation and governance of education. Sites of learning are likely to diversify although the school will remain although differently configured. This will raise new challenges for regulating and safe-guarding people.

The school will remain as a physical space at the heart of a diffused network of places and communities, both physical and virtual, including the home, play centred organisations, libraries and museums, and online environments. Each of these sites will contribute in different ways to education. People may flow through this network in different ways. There is likely to be increased attention on non-formal learning spaces, work and leisure spaces, and virtual spaces that offer different kinds of possibilities for learning, distinct leaning processes, experiences and activities. The potentials for mobilizing learning within, between and outside of the classroom and across school phases will most likely be enhanced by the use of a variety of technologies, in particular mobile, wireless, and ubiquitous.

Broadening the use of communication technologies within education will raises serious challenges about how to enable *safe, accessible and innovative e-Learning strategies*. Understanding of privacy and risk increases with age, and older teenagers tend to restrict access to the photos and videos, while older bloggers upload information in the

context of informed acceptance or management of risk. With ever increasing access to the Internet children of all ages are going to be continually faced with some form of unwanted content. New benchmarks are needed to control the way that children are able to search the net, this stems from parental controls at home through to legislative responsibility to reduce the amount of harmful content on the Web. The paradox is that while firewalls serve an important role in protecting children from inappropriate digital content they often prevent teachers and pupils from effectively using e-Learning tools and technologies in education.

2.4.5 Supporting learning: artefacts, interventions and practices

Opportunities to engage with the complex and diverse multimodal landscape of knowledge, creativity and communication will be key to supporting learning. This will mean diversifying the kinds of artefacts that enter sites of learning and what gets done with and to them, and providing increased opportunities to engage in production. Learners will need to acquire skills in working with complex data sets and texts, particularly in critiquing and translating them into meaningful knowledge that is relevant for a particular purpose. How to authenticate information from a variety of sources and spaces in which learners need to assess, take and manage risk in virtual and physical spaces will be needed to support learning.

Increasing opportunities for learners to be networked with experts and others will support their learning skills and knowledge to support effective working across different boundaries. Online, mobile, network, and ubiquitous technologies will diversify the spaces for learning and open up new connections between school and other sites of learning both physical and virtual. Creating spaces where learners can collaborate with each other and people outside of school is central for supporting learning. In particular finding ways to support learners in working across interests and to harness these towards engaging with bodies of curricular knowledge. When it is appropriate to personalise and customise learning, and how this can be done effectively for all learners, remains a key question for education.

Designing educational uses of modularized, any-time and any-where learning may be used to 'open up' the curriculum space more generally. This may have significant consequences for what is taught in the school, the role of the curriculum, and the place of knowledge in the organisational space of the school. There is considerable debate about what (or indeed whether) disciplinary knowledge will be required to meet the needs of future society. The question of how knowledge should be organised is central, that is, whether people should be inducted into knowledge, or the degree to which people should be free to create the boundaries of knowledge around their own experience. This is a perennial problem within education and one that appears to be coming to the fore. How it is addressed is key to the organisation of education and how learning and assessment might best be supported in the future. There is an increasing call for the use of context-situated learning to embed learning content in experience (mediated virtually or physically) in order to increase opportunities for interest driven, authentic, and customised activities. The place of 'powerful knowledge' in a more porous and flexible educational system with a focus on repertoires of skills and attitudes requires consideration.

The trend towards customization will impact on the learning processes and expectations of individual students and may ultimately begin to shape, or put pressures on, the pedagogies of classroom instruction. The tension between the demand (and educational desire) for creativity and personalisation and discourses of standards may be a major tension for supporting learning and assessment. The conditions for education call for forms of assessment that are more fluid and adaptable to individual needs, and perhaps open up possibilities for a further emphasis on self-assessment. It seems that current constructions of the assessment regime are unlikely to be appropriate in the future.

2.4.6 Learning cycles in a lifetime of change

Education will need to respond to the effects of changing social demands and technological developments on learning cycles across people's life-course.

Changing demographics will serve to shift the balance between life and work and education. Further, learning must continue through the lifespan in order to survive in a changing workplace and wider world where knowledge expands and changes rapidly. It is in part due to the increasing pace of technological and cultural change that the concept of learning to learn has been extended in recent years to encompass this expansion, and the need to become more effective, more efficient and more resilient learners. In the expansion of learning beyond formal educational systems the transition from education to work or between sites of work is reconceptualised from a matter of the acquisition of qualifications to one of the development of work related practice and entrepreneurial expertise.

The central place of education across the life course will collapse the previous separations of life into mutually exclusive phases of education, work and retirement. The increasing detachment of learning from schooling will result in the unbundling of learning from mass schooling leading to future education models that move towards greater individualisation, personalisation, collaboration and niche experiences. There is considerable debate on the viability of generic skills as transferable commodities (see Ivinson, Young and Muller, Guile). Drawing on Bernstein, Ivinson suggests that generic skills 'create a fiction that learning can be disembodied and disconnected from persons, bodies and communities of practice'. Guile suggests the need to move towards an in-situ mix of knowledge, skill and judgement as for example in unpaid internships or work placements. This suggests that what is required is a less linear conception of professional formation.

Appendix 1 List of review authors and reviews

Professor David Baker
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The modernizing role of schools as institutions

Formal education transforms modern society and has generated a new type of society: *the schooled society*. Formal education has expanded and intensified to the point where along with effects on individuals, formal education generates new ideas about people, new privileged human capacities, new ideas about knowledge and its generation, new expanded social and occupational positions. This paper describes two major consequences of the schooled society on knowledge and its acquisition: 1) the unprecedented growth of a knowledge conglomerate in universities, and 2) the change towards ever-greater value placed on academic intelligence in human society.

Professor Steven Brown
School of Management, University of Leicester

Learning, Remembering and Meta-cognitive/communication skills

The review highlights contemporary trends in the study of remembering and their likely future development. The review is organised around a set of key debates on memory collective vs. individual memory, the character of memory, memory and history, embodied memory, mediated memory. The review draws out how these debates effect knowledge, creativity and communication.

Professor Anna Craft
Education Department, University of Exeter and the Open University

Creativity in the school

This review discusses how creativity has been seen to be increasingly significant in education, within cultural policy discussions and has appeared as a guide to other major public policies around, for example, inclusion and the economy. This ubiquitous use of the term, which rests on a 'universalized' conception of creativity, offers both opportunities and challenges in education. This paper explores the tensions and dilemmas arising from the mix of underpinning perspectives on creativity in education. The paper will consider, finally, wider questions about the nature and futures of education (Ref to Facer, Fielding, Twining, Craft etc), suggesting areas that need consideration in seeking to see beyond current horizons as regards creativity in education.

Dr John Cromby
Psychology Department, Loughborough University

The move from social explanations toward neuroscience

This review explores what neuroscience has to offer education, it outlines a number of 'neuromyths' that were prevalent have been decisively dismissed by neuroscientists, and calls for a more accurate assessment of its potential. It argues that despite its limitations, cognitive neuroscientists have made some striking progress with respect to the basic skills underpinning abilities such as reading and number. It also suggest that progress in applying neuroscience will be slow, and will continue to be bound up with other knowledge and events.

Lewis Goodings
Psychology Department, Loughborough University

Changes in knowledge construction, participation and networks

New communities that are formed around recent networking technological advances are explored for their potential to become effective learning space. The question of what such communities mean for knowledge is addressed. Issues related to the types of ethical rules, mutual goals, dilemmas and interests can be characterised in the social practices of these new learning spaces are examined as is the wider ideas of knowledge construction, participation and networks.

Dr David Guile
Faculty of Policy and Society, Institute of Education

Learning to work in the creative and cultural sector: new spaces, pedagogies and expertise

This review questions the link that policymakers assume exists between qualifications and access to employment in the creative and cultural sector. It identifies how labour market conditions in this sector undermine this assumption and how the UKs' policy formation process inhibits education and training actors from countering these labour market conditions. The review demonstrates how non-government agencies – 'intermediary organisations' – are creating new spaces to assist aspiring entrants to develop the requisite forms of 'vocational practice' expertise to enter and succeed in the sector. It concludes by identifying a number of new principles for governance, pedagogic strategies and skill formation issues for stakeholders to address.

Professor Denis Hayes, and Dr Kathryn Ecclestone
Education Department, Oxford Brookes University

Affect: Knowledge, communication, creativity and emotion

This review examines concerns about emotional well-being that have recently become the focus of social policy, particularly in education settings. This is a sudden and unique development in placing new ideas about emotion and creativity and communication in curriculum content, pedagogy and assessment, but also in redefining fundamentally what it is to 'know'. The review charts the creation of what the authors call an 'emotional epistemology' and draw out implications for educational aspirations and purposes and evaluates potential implications for these aspirations and purposes if trends we identify here continue into the future.

Professor Steve Higgins
Durham University

Learning to learn

This review focuses on learning to learn and future developments in education and provides a summary of evidence from leading-edge social science and science research. It identifies key trends in learning to learn (with respect to individuals, groups and societies) which are relevant to knowledge production, creation and communication to 2025 and beyond. Evidence is presented about current interventions, developments and strategies (from education and other sectors) which respond to these different trends in terms of what the implications for educational goals, structures, methods and resources.

Dr Helen Horst
Education Department, University of California, Irvine

Connectivity, flow, convergence and communication: Mobile, portable and personalized

This review considers the implications of digital and networked media in out-of-school settings for conceptualizing models of learning and engagement. Focusing upon the mobile and personalized nature of mobile devices and the mobile learning spaces that digital and networked media enable, it examines how innovations in connectivity,

communication, collaboration and convergence create new possibilities for the future of learning and education in the 21st century.

Dr Gabrielle Ivinson
Education Department, Cardiff University

The relationship between the constitution/construction of knowledge and identities, community

This review examines how society continuously creates, recreates and reproduces knowledge and the boundary between the knowledge(s) produced within society and the knowledge that has been taught through official instruction in educational institutions. It engages with debates about whether the school curriculum should be taught as subject content or skills including 'technical skills' and 'life skills'. It argues for the need to make a distinction between the classifications of forms of knowledge - the curriculum - and how knowledge is *learned* and investigates the struggle over curriculum and pedagogy, in relation to gender, class and changes in family structure.

Professor Ken Jones
Education Department, Keele University

The dynamic relationship between knowledge, identities, community and culture

This review outlines significant issues in current cultural and knowledge-related change in England, with particular emphasis on their impact on education and on young people. It draws together evidence to suggest that 'culture', 'knowledge' and 'creativity' denote areas of practice whose meaning varies according to their social location, and argues that issues of inequality and social differentiation –strongly affect how young people are positioned in relation to them. It concludes with reflections on future scenarios.

Professor Gunther Kress, and Dr Jeff Bezemer
Department of Language, Communication and Curriculum, Institute of Education, University of London

Multimodal Design: knowledge, communication and creativity

This review outlines key trends in knowledge, creativity and communication in education from the perspective of multimodal design. Multimodal design in education refers to the use of different 'modes', such as image and writing, to recontextualize a body of knowledge for a specific audience. It examines changes in multimodal design in education in the past, present and future, connecting them to social and technological change. Social change, such as shifts in the agency of learners, poses new challenges to design. The review illustrates trends in and connections between design, technology and education with key examples of learning materials for secondary education.

Professor Hugh Lauder, Department of Education, University of Bath
Professor Phillip Brown, School of Social Sciences, Cardiff University
Dr Ceri Brown, University of Bath

The consequences of global expansion for knowledge, creativity and communication

This review examines the fundamental trends concerning changes to the division of labour within the global economy and its consequences for education with particular reference to knowledge and creativity. It examines the fundamental drivers of the rapidly changing global division of labour. It argues that while the twentieth century brought what can be described as *mechanical Taylorism* characterized by the Fordist production line, the twenty-first century is the age of *digital Taylorism*. It shows how this involves translating *knowledge work* into *working knowledge* through the extraction,

codification and digitalization of knowledge that can be transmitted and manipulated by others regardless of location.

Professor Victoria Carrington, Education Department, University of South Australia

Professor Jackie Marsh, Education Department University of Sheffield

Forms of literacy

This review outlines ways in which literacy is changing and reviews the implications for educational institutions in the future. A number of key themes are addressed in this review, including multimodal representational forms and configurations, new forms of literacy and knowledge production, new purposes for literacy and reconfigurations of resources in sites of learning. The review identifies key trends and emerging patterns of the current research base and indicates how these trends and patterns might develop and identify how educational institutions need to respond to them if they are to meet the needs of learners in the decades ahead.

Dr Sara Price, London Knowledge lab, Institute of Education, University of London

Dr George Roussos, London Knowledge Lab, Birkbeck College, University of London

Taciana Pontual Falcão and Dr Jennifer Sheridan, London Knowledge lab, Institute of Education, University of London

Embodiment/the body, knowledge, creativity and communication

This review begins by outlining the current theoretical underpinning of embodied cognition and embodied interaction and the implications for knowledge, creativity and communication in education.

It presents an overview of state of the art technologies, including key development trends, and their relationship with interaction and use; followed by a review of interaction and learning based research around these technologies. It outlines the implications of embodiment in today's climate of technology and society, its role in thinking about learning – both theoretically and practically, and explore the potential impact of current trends and developments on shaping the way we think about and operationalise the development of, knowledge, creativity and communication.

**Professor Roger Säljö, Dr Oskar Lindwall, and Dr Asa Mäkitalo
Lincs, University of Gothenburg**

Technology, representation and knowing

This review addresses features of the discourse on the knowledge society and how it seems to lead us into characterizing the value of schooling primarily in its instrumental functions in relation to short-term economic goals. It goes on to discuss the manner in which technology has become a central part of many young people's lives outside school – and what this development might imply in terms of the necessity of schools to adapt to the lives of students rather than the other way around.

**Professor Keith Sawyer
Education Department, Washington University, St. Louis**

The future of learning in the age of innovation

The innovation age requires people who maximize their creative potential, people who not only master existing skills and knowledge, but who are capable of creating new skills and knowledge. To maximize innovation and knowledge generation, many societal factors must be in alignment—political, legal, cultural, economic. This report focuses on the critical role to be played by schools. This report summarizes research on creativity,

collaboration, and learning, and provides advice about how to design learning environments that result in creative learning. The report identifies a range of challenges, and six future scenarios, for teaching and learning in the age of innovation.

**Dr Michael Schillmeier,
Ludwig-Maximilians-Universität München, Germany**

Risk as Mediation: Societal Change, Self-Endangerment and Self-Education

This review paper picks up the rhetoric of risk as an adequate discourse to reflect upon current modern societal change, self-endangerment and self-education. It offers an understanding of risk as a complex process of mediation of endangered futures that can be seen as central for rethinking (self-) educational efforts in world risk society.

**Julian Sefton-Green
Director, West-Hampstead Arts Centre**

Location, Location, Location: Rethinking Space and Place as sites and contexts for Learning

This review considers the role of context and site in common understandings of learning in general and describes models of learning that exist as complement, supplement or remediation with 'standard' versions of schooling especially those invoked by the idea of informal learning. It then looks at the 'geo-social' relationships of learners, homes, communities, non-formal learning spaces, regions, schools, nations and the globalised economy trying to tease out what may or may not change in future scenarios to offer different kinds of learning processes, experiences and activities in all of these domains.

**Dr Sylvia Wolf and Professor Robin Alexander
Education Department Cambridge University**

Pedagogy: Argumentation and dialogic teaching

This review explores how a climate of compliance and accountability in education is currently undergoing challenge at different levels in the system and by internal and external forces centred around evidence from studies of classroom talk that indicate a strong link between dialogic forms of communication and advances in knowledge and depth of understanding, for students and teachers. The review explores implications of these shifts for the re-conceptualisation of knowledge and changing roles and relationships between teachers and learners. The review concludes by considering the challenges and risks involved in such enterprises for practitioners and teacher educators.

**Professor Michael Young, London Knowledge Lab, Institute of Education,
University of London
Professor Johann Muller Cape Town University**

Thinking about the future: Lessons from the sociology of knowledge

This review draws on social realist approaches in the sociology of knowledge and in light of them constructs three scenarios for the future of education in the next decades. The focus is on the relationship between school and everyday or common sense knowledge. The different possibilities for how the school/non-school knowledge boundaries might be approached are expressed in three scenarios - 'boundaries as given', 'a boundary-less world' and the idea of 'boundary maintenance as a condition for boundary crossing'. The educational implications of each are explored.

Additional reference

Buckingham, D. (2009) 'The Impact of the Commercial World on Children's Wellbeing' DCSF/DCMS.

Appendix 2 Challenge process

The scope of the challenge

A steering group was established to ensure that the scoping of the challenge area benefited from diverse expert knowledge drawn from Sociology, Social Psychology, Cognitive Psychology, and Media and Literacy. Steering group members:

Professor Michael Young, Institute of Education, University of London
Professor Karen Littleton, Open University
Professor Steven Brown, Leicester University
Professor Jackie Marsh, Sheffield University

The steering group participated in mapping of the terrain of knowledge, creativity and communication, identifying key trends, issues and drivers and leading authors in the area; to the challenge seminar events; and peer-reviewed the challenge reviews. The scoping of the challenge was also informed by discussion with key academics, the BCH Expert Advisory Group, and key literature reviews and reports within BCH.

Review topic areas

The rationale for selecting review topics was based on three elements: first, a focus on the essence of technological and social practice rather than specific technologies (e.g. the notion of mobility rather than the mobile phone); second, looking beyond education to see the broader context for knowledge, creativity and communication; and third, the desire to engage with the complexity and lack of consensus in this area.

A set of 20 reviews was commissioned that cover a broad range of topics key to the challenge of knowledge, creativity and communication and the futures of education. These include risk, identity, global expansion, neuroscience, affect, collaboration, participation and networking, innovation, representation, multimodal design, curriculum, argumentation, information, the role of institutions, learning, community, connectivity, convergence, literacy, and knowledge construction. The reviews are written by leading figures in the area of knowledge, creativity and communication drawn from the UK, Sweden, Germany, USA, Australia, and South Africa. (A full list of authors and review titles is provided in the reference section.)

Challenge activities

Two consultative day events were held at the London Knowledge Lab in Autumn 2008 to inform the challenge, one in mid-September 2008 and the other in mid-November. The events ensured that the Challenge outputs were informed by consultation with leading-edge science and social science thinkers from across a range of disciplines. The events included a mixture of presentations, workshop discussion and activities. These were attended by twenty participants from linguistics, multi-lingual studies and new literacy studies, semiotics, social psychology, cognitive psychology, philosophy, sociology, cultural studies, computer science, media studies, educational studies, and art and design.

Knowledge, creativity and communication: Event 1

Event 1 enabled key commentators from a range of disciplines to connect and engage with the futures for KCC. The event generated ideas to contribute to mapping the challenge area and reviews, and room to explore trends from a variety of perspectives useful to the challenge area and BCH program. The tensions and difficulties of futures work that arose during the day were valuable tools for thinking through the challenge. The day also enabled initial work to begin to imagine potential futures for 2025 – 2050. The outputs of the event, which informed the scoping and interpretation of the reviews, included: detailed comments on review areas, identification of major themes and additional themes and gaps in the scoping exercise, and factors considered by participants as foundational for futures. In addition, several review authors attended the event and found the day helped to contextualize the program and inform their reviews.

Knowledge, creativity and communication: Event 2

Event 2 explored the changing face of knowledge, creativity and communication with an eye to the long term and emergent trends pertinent to the futures of education. The day's activities centered around three substantial presentations, each of which drew on a key set of review areas: 1. Changes in knowledge construction, participation and networks; 2. Creativity, entrepreneurialism and expertise; and 3. Rethinking distance, space and place. Each presentation generated a debate that focused on identifying key themes for the future. The day closed with a workshop on emerging scenarios, in which participants worked with the presenters and participants to identify key drivers and levers for change. The day's outputs, which informed this report, included the identification of key drivers and levers for change and interpretative themes and questions for debate.

Event participants**Name, institutional affiliation**

Name	Surname	Institution
Lewis	Gooding	Loughborough University
Andrew	Ravenscroft	London Metropolitan University
Julian	Stefon Green	West Hampstead Arts Centre
Kate	Pahl	Sheffield University
Sara	Price	Institute of Education
Jeff	Bezemer	Institute of Education
Julia	Gillen	Lancaster University
Brian	Street	Kings College London
Richard	Andrews	Institute of Education
Ken	Jones	Keele University
Jackie	Marsh	Sheffield University
Guy	Merchant	UKLA
Lynda	Graham	UKLA
Luckin	Rose	Institute of Education
Kress	Gunther	Institute of Education
Paganoni	MariaCristina	Milan University
Burn	Andrew	Institute of Education
Selander	Staffan	Stockholm University
Paul	Stenner	Brighton University
Rupert	Wegerif	University of Exeter
Rosie	Flewitt	Open University
Christian	Greiffenhagen	Manchester University
Diane	Mavers	Institute of Education
David	Guile	Institute of Education
Jan	Derry	Institute of Education
Nicolas	Addison	Institute of Education

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