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The next 25 years?: future scenarios and future directions for education and technology

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Abstract The educational technology research field has been at the heart of debates about the future of education for the last quarter century. This paper explores the socio-technical developments that the next 25 years might bring and the implications of such developments for educators and for educational technology research. The paper begins by outlining the diverse approaches to educational futures that are currently visible in the field, and suggests four principles to underpin future thinking in educational technology. It then describes the methods used to inquire into long-term socio-technical futures in the 2-year Beyond Current Horizons Programme. These included a foresight and scenario development process bringing together evidence reviews and insights from over 100 researchers from disciplines as diverse as computer science, demography and sociology of childhood, as well as consultation with over 130 organizations and individuals from industry, practice and educational beneficiary groups. The outcomes of this programme are then presented, including a set of future scenarios for education and a set of socio-technical developments that might underpin such scenarios. The scenarios emerge from three future worlds ('Trust Yourself', 'Loyalty Points' and 'Only Connect'), and from projections including: changing demography, new human–machine relations and a weakening of institutional boundaries. The paper then argues that the next 25 years will challenge our current organization of education around the unit of the individual child, the school and the discourses of the knowledge economy; and will require the development of new approaches to curriculum, cross-institutional relationships, workforce development and decision-making in education. Finally, the paper argues that these developments challenge educational technology research to move beyond pedagogy to curriculum; beyond the school to the community, home and workplace; and beyond social sciences to collaborations with medical and bio-ethics fields.

Keywords educational change, ethics, futures, policy, technology.

Introduction

Education is a future-facing activity. Assumptions about and aspirations for the future underpin all levels of educational activity: from learners deciding what to study in the light of their aspirations for their future lives, to national debates over the curriculum and teaching methods that will best equip societies for future social, economic and cultural worlds. From discussions of national strategy, to day-to-day interactions between educators and learners, ideas about possible futures are instrumental in rationalizing and generating educational change. In the UK alone, for example, the government is investing £45bn in its 'Building Schools for the Future' programme,[1] intended to re-imagine and redesign the schools estate for the next century; in the US, the call for '21st century skills' is becoming more vocal

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as schools and advocates argue for new curriculum aims.[2] Around the world, there are foundations, public-private partnerships, government initiatives and commercial entities leading calls for a redesign of '21st century education'.[3] The educational technology research field plays diverse roles in these discourses of educational and social futures.

In many policy fields, for example, the 'imaginary'[4] upon which future-oriented projects are premised often takes for granted the contemporary existence of and continued progress towards a universal, technologically-rich, global 'knowledge economy', the so-called 'flat world' of neo-liberal rhetoric (Friedman 2005). It is towards this imminent world that governments and educators are exhorted to propel students and citizens;[5] and it is this imminent flat world that is used to mobilize support for funding allocations, to justify investment in new technologies or to rationalize curriculum decisions. In these discourses, the possibility of alternative futures frequently remains unarticulated, or is presented simply as a rationale for further support to ensure that specific individuals or countries are enabled to *keep up*. Within these discourses, technology-enhanced learning is often presented, by researchers and policy-makers, as an essential modernizing tool for education (see, for example, Negroponte 1996; Lego, quoted in Jenson 2006; Prensky 2005; Heppell 2009).

Such universalist discourses of inevitable 'flat worlds' or 'knowledge economies' are, however, subject to critique; both from the sociology of the future (Bell 1997; Adam & Groves 2007), from critical studies in education (Gough 2000; Robertson *et al.* 2007), and from economists (Stiglitz 2006). These criticisms are often concerned with resisting the chronological imperialism of accounts of inevitable and universal futures; with testifying to the availability of diverse alternative trajectories for the coming century; with re-stating the openness of the future; and with reminding us of our responsibility for the consequences of our actions in the future. In this tradition too, we find researchers contributing to the educational technology field and arguing for more nuanced accounts of possible futures (for example, Gee *et al.* 1996; Apple 1997).

The idea of 'the future' as a singular, inevitable trajectory in the face of which educators and citizens have no agency, is also subject to critique from the growing field of critical futures studies with its links with peace studies, sustainability and global citizenship agendas (Beare & Slaughter 2001; Inayatullah 2008). This field is committed to empowering learners, students, researchers and communities to envisage and take action to build alternative and desirable futures. In some ways, many researchers from the educational technology field could be considered to be in sympathy with such action-oriented approaches, including those such as Alan Kay who argue, paraphrasing Lincoln, that 'the best way to predict the future is to invent it'. The ethical dimensions of such an approach are also exemplified in the design research field and in projects such as the Massachusetts Institute of Technology fablab that aim to place the means to build new educational futures in the hands of communities, learners and educators.[6]

We are also currently seeing the emergence of a range of foresight initiatives, operating across global academic, commercial, governmental, and charitable institutions and networks.[7] Such endeavours have historically often been oriented towards economic or defence disciplines (Sandford & Facer 2007). Recently, however, education has been seen as a site for such inquiry with the commissioning of a number of major educationally oriented foresight projects. In the UK alone, for example, the last 5 years have seen four major educational futures projects,[8] while the Organisation for Economic Co-operation and Development's strategic future scenarios have, since the early 2000s, played an influential role in shaping international thinking about educational policy. Many of these studies have engaged with educational technology researchers as a central part of their work (Williams 2005).

The educational technology research community, therefore, can be seen to play many different roles in the development of discourses of the future of education. Some of its members are actively committed to promoting visions of a technology-rich future knowledge economy; others to critiquing and challenging this vision by presenting alternative and oppositional accounts; some are involved in building new models of institutions and pedagogies as templates for future development; and still others are concerned to examine the empirical data on current practices to provide insight into how such models might 'play out' over the longer term. Our participation in such futures-oriented work, however, is usually directed towards exploring the implications of potential future developments for educators, learners, schools and university education.

On the occasion of the 25th anniversary issue of *JCAL*, then, it seems appropriate to direct our futures inquiry towards the educational technology field itself, and to ask: what might be the implications of future socio-technical change for education, and what does this mean for research in this field over the coming 25 years?

As a basis for the discussion, the paper outlines the work of the Beyond Current Horizons[9] (BCH) programme, a 2-year project tasked with interrogating potential socio-technical futures for education which brought together over 100 academics from disciplines as diverse as computer science, demography, psychology, and sociology of childhood, and involved contributions from over 130 organizations and individuals from industry, practice, policy and research.

The paper explores:

1 A discussion of the principles and methods that underpinned the BCH programme.
2 A set of future scenarios for education in the context of long-term socio-technical change and a set of projections of socio-technical developments over the coming quarter century.
3 A discussion of the challenges that these scenarios and projections imply for the design of education.
4 A discussion of the challenges and opportunities that this programme presents for the educational technology research field.

Inquiry into future socio-technical change: the BCH programme approach

Principles for researching educational futures in the context of socio-technical change

The BCH programme was commissioned in 2007 by the Technology Futures Unit of the UK's Department for Children, Schools and Families (DCSF), with a broad remit to inquire into possible future trajectories for socio-technical change. Its task was:

> To understand what society might look like in 2025 in order to anticipate the demands that will be placed on the UK education system, taking as a focus not 'the future' in its entirety, but specifically the intersection between technological, educational and social futures.

The programme developed four principles to underpin its inquiry (described below). These were built on a review of the existing fields of futures research and educational futures (see Sandford & Facer 2007); on theoretical gains from social studies of technology (for example, Williams 2007; Woolgar 2002); on insights from educational philosophy (for example, Biesta 2007); and on liaison with the commissioners of the research from policy and practice fields to identify the nature of the insights that such an inquiry could usefully produce. These are presented here not only as a context for the rest of the paper, but because these principles, we feel, could be usefully appropriated by the educational technology field in its discussions and representations of the future more broadly.

Principle 1: educational futures work should aim to challenge assumptions rather than present definitive predictions

Researching the future cannot simply be a case of producing a set of predictions of what 'will happen' as though this were beyond the intervention of individuals or societies.[10] Nor can it simply be a case of discussing what we 'want' or 'will make' happen, as though there were no prior contexts to shape our actions. Instead, in Bell's (1997, p.73) terms, futures research can best be understood as an attempt to explore the relationships between 'possible, probable, and preferable' futures: 'what can or could be (the possible), what is likely to be (the probable), and what ought to be (the preferable)'. In order to begin to explore these questions, however, the first task of futures research must necessarily be to critique the assumption that there is an inevitable future to which we must simply adapt or resist.

Principle 2: the future is not determined by its technologies

Technological determinism saturates many of the future educational visions promoted by policy-makers, industry and even some researchers. The sociology of technology, actor network theory, socio-cultural psychology and post-structural critical theory, however, all critique this perspective by making visible the complex relationship between technological development and social change (see, for example, Wertsch 1991; Latour 1993; Deleuze & Guattari 1988; Woolgar 2002). Although there are different positions on this spectrum, these perspectives imply an understanding of social change as

a co-production of technical, discursive and social factors.

Principle 3: thinking about the future always involves values and politics

Visions of the future are powerful rhetorical devices to promote change in the present (consider Martin Luther King's dream of a very different future). As such, they are powerful political tools. Any futures work, which aims to empower individuals and groups to make decisions about possible future paths rather than simply coerce them towards certain predetermined actions, needs therefore to be clear about the values underpinning the visions it is presenting. It needs to clearly explain the people involved in the production of future visions (whose voices are represented?) and the methods by which these future visions are produced (what is the basis for the ideas represented?)

Principle 4: education has a range of responsibilities that need to be reflected in any inquiry into or visions of its future

Any futures research is shaped by its origins. Research into the future of oil companies, for example, encourages researchers to examine issues such as geo-political stability and energy supply; research into the future of health care requires attention to bio-medical breakthroughs, public housing, population ageing. These different perspectives are underpinned by an understanding of the purpose of the organization – for oil companies, to drive shareholder returns for example; for public health care, to reduce mortality. As such, the first challenge in educational futures research is to answer the question: What do we see as the purpose of education? Inevitably, the response to such a question is driven by the values and philosophies of the researchers undertaking the research.

Translating principles for futures inquiry into programme design

These principles require us to challenge our assumptions about the inevitability of a single future trajectory, to recognize the co-construction of society and technology, to make visible the methods and voices that shape the inquiry into possible futures, and to articulate our understanding of the purpose of education. Thus they shape both the domains to be examined in the inquiry and the tools that can be used.

First a view of the future that sees it as informed both by existing social contexts and by human agency, requires an exploration of historical trends, forecast projections, the factors capable of frustrating such trends, and insights into social actors, desired future developments (captured neatly in Bell's (1997) description of probable, possible and preferable futures). As such, a combination of foresight and scenarios approaches was selected for the BCH programme. By foresight, we mean the attempt to map projections (Textor 1995) of recent and current developments into the future and to explore their potential implications.[11] By scenarios work, we mean the attempt to work with those who are concerned with the futures inquiry and its implications to generate a set of plausible divergent future worlds that can be productively used to test out current strategies and to challenge current assumptions (Schwartz 1991; Van der Heijden 2005). A scenario-based approach is not only the most common approach in the futures field, but is one that challenges the assumption of a single inevitable future and provides an accessible means of collating significant amounts of evidence and opinion.

Second the consideration of socio-technical change as co-produced requires an understanding both of the potential capabilities or affordances of emergent technologies and the ways in which such developments might be appropriated or resisted in social contexts. Such a perspective, again, requires an interdisciplinary approach that brings together science, technology and social science disciplines. The programme could not, then, simply produce a trajectory of future technical developments and read off a set of deterministic social outcomes. Instead, we needed to explore how social and cultural contexts might shape the production of new technologies, and reciprocally, how the clusters of capabilities (Williams 2006) offered by scientific and technological development might be amplified, resisted or modified by a range of social and cultural developments. The process of mapping scientific and technical trends and outlining their potential capabilities, then examining which socio-cultural and socio-economic trends might resist or amplify these developments, was our primary mechanism for enacting this principle (see Fig 1).

Third a view of educational futures inquiry as necessarily partial places upon the researchers a responsibility

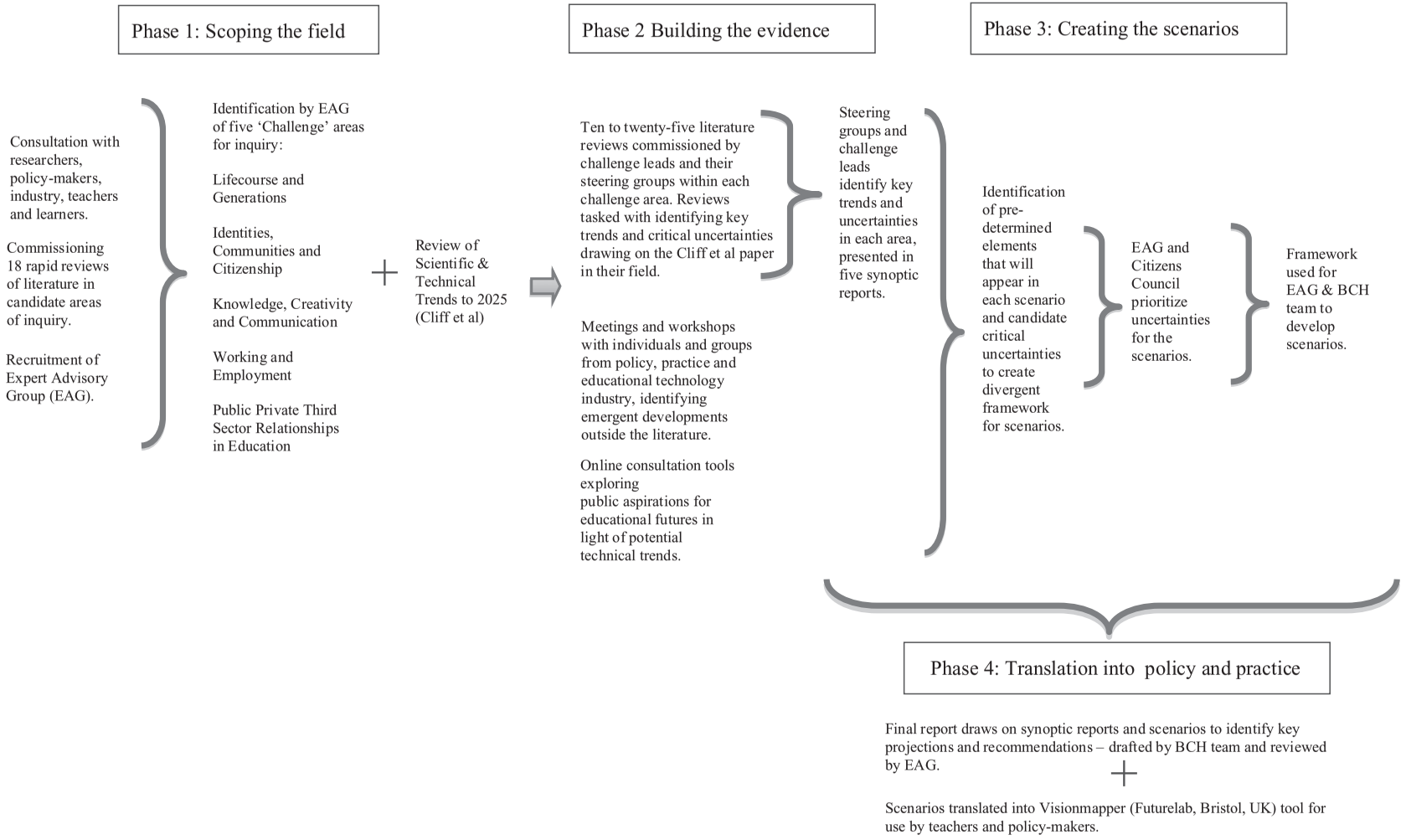

Fig 1 The Beyond Current Horizons process.

to explore the emergent findings and insights of the programme with other groups; in particular, with the practitioners and beneficiaries of education. This principle required the programme to attempt to involve diverse groups in the production of insight and evidence of current and future developments; to develop an explicit statement of its assumptions about educational purposes (see principle 4 above); and to make visible its methods in reporting its scenarios more widely. In essence, the programme took the position that the future visions arising from this project, like all other representations of the future, will necessarily be partial. However, the reader should know the origins of their partiality and be able to read and interpret the findings accordingly.

Finally, the requirement to state our assumptions about educational goals led to the following articulation of educational goals: drawing both on the stated objectives of the DCSF's Children's Plan, and on Biesta (2007), we argued that education has a responsibility for: qualifying learners to take on certain roles (requiring the development of knowledge and competencies); socializing learners to participate in wider community, family and social contexts; and equipping learners to develop their own sense of selves, identity and agency. Such a broad view of educational goals requires an exploration of highly diverse disciplines in order to engage with the broad areas of social, economic, cultural and political life that might impact on questions of qualification, socialization and subjectification. Consequently, the programme involved researchers from a highly divergent range of disciplines reflecting the diverse lifeworlds, civic worlds and economic worlds of learners.

Project overview

Building the future scenarios and projections

This section provides an account of the activities that led to the development of the scenarios and the key projections in the BCH programme (see Fig 1).

Scoping the Field

The aim of this phase of the study was to identify the broad areas within which socio-technical change was seen by academic, policy and practice fields to potentially have the most significant implications for education. Candidate areas of inquiry were identified through consultation and exploration of the field with social and computer scientists, educational policy-makers, educational philosophers and educational stakeholders. Certain areas of inquiry were discounted by mapping out other major futures or educational programmes taking place in the UK and internationally at the time, and by identifying areas in which the programme could not make a significant comparable contribution on the available resources, for example around climate change, energy supply etc.[12] A series of 18 rapid reviews of the literature in candidate areas were commissioned during these consultations in response to the questions below. These are included here to give a flavour of the discussions that shaped the early design of the programme:

1. Childhood 2025 and beyond – In what possible ways might childhood change over the next 18–50 years?
2. Knowledge in 2025 and beyond – How is knowledge produced, where, in what institutional settings, how is it regulated and how might disciplinary boundaries erode or change?
3. Diverse populations – Focusing on questions of demographic change, in particular lowering fertility, migration, increased aging societies, increased mobility within and between nations, immigration patterns.
4. Identities and communities – How might 'identity' and 'community' develop in relation to the development of networked, pervasive and personal technologies?
5. New modalities, new democracies – Focusing specifically upon questions of modalities of communication offered by developments in information and communications technologies.
6. What does 'work' mean in 2025 and beyond? – How might 'work' change over the next 18+ years – both in terms of wider changes and more specifically, the role that digital technologies might play in informing such developments?
7. Public/private education relationships in 2025 – Looking at ways in which public/private relationships may change over the next 18–50 years, particularly in relation to the potential role of the private sector and the market in education.
8. Coping with complexity – Problems currently faced by individuals and societies are more complex than simple linear relations of cause and effect – how best might we enable individuals and groups to

engage with complex questions and to think beyond linear cause and effect models of social and technological change?

9 Socio-technical change – How might cutting-edge technological developments in computing, biosciences and mathematics interact with social structures and practices over the next 18–50 years, and how might subsequent changes in social practices have implications for education?

10 Changing spaces, changing places? – Focusing specifically on attempting to explore how the use of space may be changing in the 21st century society, looking at the ways in which existing institutions may be changing their functions, their relationships with their communities, and their relationships with each other.

11 Post-crisis education – Looking at the effects of potential major disruptions to existing work, education and social patterns such as severe effects of climate change processes, lack of energy resources, pandemic, traffic gridlock, massive technology failure, economic failure, revolution.

Following this initial consultation and process of outline reviews, five areas for detailed attention in the programme were selected by the Expert Advisory Group. This group comprised 17 education policymakers, social scientists and computer scientists and was chaired by the BCH team (the authors of this paper). The five areas selected were:

1 Lifecourse and generations.
2 Identities, communities and citizenship.
3 Knowledge, creativity and communication.
4 Working and employment.
5 Public, private and third sector (non-profit) relationships in education provision.

As the position was taken that 'technology' did not in and of itself drive social change, but that scientific and technical development provided resources for social change, the decision was taken at this point to commission a review of current trends in scientific and technological development that might provide future clusters of capabilities (Williams 2006) for social actors over the coming 20–50 years. These clusters of capabilities would be considered within the five key areas above to examine how they might play out in interaction with wider socio-cultural and socio-economic developments. Eight key scientific and technical trends were identified as potentially providing resources for social change:

- Moore's Law continues – implying massive decreases in cost and massive increases in computing power available to individuals and organizations.
- Once per decade disruptions continue – with the expectation that the next decade will see a major shift from networked to ubiquitous computing,
- Computing as Bioscience – implying progress in the engineering of computer systems from biological material.
- Psychopharmacology (smart drugs and cognitive enhancement) – the emergence of more precise information about and tools to enable interventions to shape biology to enhance cognition in specific areas.
- Invasive and non-invasive brain-machine interfaces – enabling prosthetic enhancement and externalizing cognitive functions to external devices.
- Artificial intelligence remains hard – advances in semantic web technology may enable individuals to significantly augment capacity for intelligent analysis and synthesis of information, but distinctively human intelligence will continue to have value.
- 3D printing and plastic electronics – the capacity to print bespoke 'mechatronic' (integrated mechanical, electronic and software devices) becomes increasingly available in homes and offices.
- Large scale socio-technical systems of systems – network systems, utility computing, multi core processing and the integration of these systems increases the number of computing elements interacting with each other; while self-managing systems are also developed. These complex systems may be little understood even as the costs of their failure in social and economic terms increases (Cliff *et al.* 2008).

This technical paper, in combination with the identification of the five challenge areas, provided the structure for the building of evidence and insight in the next stage of the programme.

Building the evidence

The aim of this phase of the programme was to build a body of evidence and insight relating to current trends and critical uncertainties concerning future development. In each of the five challenge areas, a

leading academic[13] was recruited to establish a steering group of specialists in the field and to oversee the commissioning and review of up to 25 literature reviews. Each review author was asked to map out current trends in their field, possible long-term projections and critical uncertainties concerning future development. The following provides a flavour of the types of reviews[14] that were commissioned in each of the five challenges:

Lifecourse and Generations

- Family structures and intergenerational transfers of learning: changes and challenges.
- Generation Y and the Opportunities for a Globalized, Networked Educational System.
- Evolving family structures, roles and relationships in light of ethnic and social change.

Identities, Communities and Citizenship

- National Identities: Are they declining?
- Communities and Citizenship: paths for engagement?
- Virtual Disruptions: Traditional and New Media's Challenges to Heteronormativity in Education.

Knowledge, Creativity and Communication

- Risk as Mediation: Societal Change, Self-Endangerment and Self-Education.
- Thinking about the future: Lessons from the sociology of knowledge.
- Forms of literacy.

Working and Employment:

- Happiness and Well-being.
- How will technological change affect opportunities for creating new economic activities, new sectors and new industries to the year 2025?
- The R&D, knowledge, innovation triangle: education and economic performance.

Public/Private and Third Sector Relations in Education

- Private Public Education.
- Relationships between Health and Education Providers.
- Operating Systems? An analysis of the structural relationship between the ICT Industries and Education.

In total, 84 reviews were commissioned within the five challenge areas, which were summarized in five synoptic reports to provide insights into the broad areas of consensus as to the 'probable' futures within each field.

Alongside the academic review process, a programme of interviews and workshops with industry and policy figures in the technology, educational technology and education sectors was conducted to identify whether they perceived any counter-developments that might radically challenge the evidence from the literature reviews and to explore emergent developments not yet visible in the research literature. Such processes provide insights into the divergent 'possible' futures that are currently less visible in the research literature.

At the same time, a process of face to face and online consultation with diverse educational stakeholder groups (parents, learners and educators) was conducted in order to identify what people's aspirations were for education over the coming years, and the broad attitudes towards socio-technical change amongst these groups. Such consultations provide insights into the 'preferred' futures for education, and into the ways in which individuals and groups might act to resist or promote certain future trajectories.

Creating the scenarios

The reviews and outcomes from the events were used as a basis for the creation of a framework to structure a set of future scenarios for education 2025 and beyond.

In order to create this framework, the reviews, interviews and workshops and consultation activities were analysed to identify (1) those developments that could be considered as common features of all potential futures (predetermined elements); and (2) those developments that could be understood as having the capacity to divert socio-technical development towards radically different futures (critical uncertainties).[15]

The selected predetermined elements comprised: an ageing population, a two-degree rise in global temperatures[16] and a set of socio-technical developments comprising: the intensification and diversity of information resources; increased familiarity with distributed

working, learning and families; expectations of connectivity to people, resources and information; organization of services, resources and information around the person rather than the institution; a continued role for geography in determining access to technical infrastructure; public demand for 'quick fixes' from neuro and bioscience; increasing comfort with machines as social actors; continuing globalising pressures.

The critical uncertainties selected to structure the scenarios were: social values (the competing tendency to collective or individual responses to social risks); and the response of the education system (the competing tendency to rapid transformations in policy and practice or resistance and incremental change).

These predetermined elements and critical uncertainties were selected in order to generate both challenging and plausible scenarios for an education policy audience, and to focus attention in the scenarios on areas of specific concern to the programme. The scenarios were developed between February and May 2009, with the Expert Advisory Group producing early outlines and commenting on drafts produced by the BCH team.

Translating the scenarios into policy recommendations and action

The last and ongoing phase of the programme is the translation of the evidence reviews and scenario activity into a set of recommendations for action. This is a continuing process that includes using the scenarios as prompts with teachers, students, policy-makers, researchers and others to examine how they challenge current assumptions about education.

The official final report for the programme, however, was completed in June 2009 after a re-analysis of the final reports from each of the five challenges and a review of the outcomes from the scenario development process. This report articulates the socio-technical developments that were identified as likely to play a critical role in shaping educational futures, and the challenges they were seen to provide to current educational institutions, values and practices. The report was drafted and circulated for comment to the five challenge leads and the expert advisory group, redrafted in the light of comments, and published in June 2009.

This paper now provides a summary of the main outcomes from this process.

The future scenarios and projections

The BCH programme represents a sustained and significant attempt to understand potential future socio-technical development and its implications for education. It draws on insights and evidence from research, policy and practice fields to present a set of challenging long-term scenarios for education and a set of long-term socio-technical projections.

This section provides an outline of these scenarios and describes the socio-technical projections that were identified by the participants in the programme as providing critical challenges to current educational policy.

The scenarios

The scenario process led to the production of three complex future worlds and, within each world, two alternative educational futures. As discussed earlier, these future worlds were produced by exploring the intersection between divergent social values and the pre-determined socio-technical, demographic and environmental trends identified from the reviews. Within each of the worlds produced by this intersection, we then explored how educational responses might diverge to create different systems and practices depending upon the speed and coherence of change, and the degree to which education was seen as actively sustaining or resisting the socio-cultural contexts in which it was located.

The following provides a highly abbreviated summary of the (5000 words) scenarios which are available elsewhere for detailed exploration.[17] Their inclusion here, however, indicates the extent to which the programme conceived the potential for both socio-cultural and socio-economic contexts to undergo significant change over a 25–35 year timescale, and the divergent educational relationships and institutions that might emerge in these contexts.

World 1: trust yourself

A highly individualized world of contingent and shifting allegiances in which there is no support for collective responses to social problems, and in which individuals are free/required to take high levels of personal responsibility for their actions. In this environment, we see two education systems emerging:

1 'Informed Choice' – a highly personalized education system structured around the individual collaborating lifelong with paid mentors and structuring education provision from diverse sources around their needs.
2 'Independent consumer' – a highly atomized education system in which individuals are able to choose from a complex menu of standardized provision from private, public and not for profit sectors.

World 2: loyalty points
A world where relationships between people and the groups they belong to are managed by contracts, where rewards and benefits are achieved in response to contributions and where personal reputations are carefully managed within their employment/community/religious groups associations. Individuals are required/enabled to find their place within these groupings. In this environment, we see two education systems emerging:

1 'Discovery' – an education system that enables individuals to understand where they might most effectively contribute to particular social and economic associations, and to build reputations within those associations.
2 'Diagnosis' – an education system targeted at early identification of capacity and potential and the close alignment of individuals' educational experiences with projected future economic roles.

World 3: only connect
A world organized around a collective understanding of interdependence between people, between individuals and machines, between individuals and ecosystems, in which the concepts of 'identity', benefit and action are understood as profoundly social. In this environment, we see two education systems emerging:

1 'Integrated experience' – an education system embedded indistinguishably in society, economy and community, in which learners learn through ongoing participation.
2 'Service and citizenship' – an education system distinct from society in which social cohesion and competencies for social participation are explicitly taught.

From current trends to longer term socio-technical developments

The analysis of recurring, complementary and mutually reinforcing themes in the reviews, and the recurrence of particular outcomes across diverse scenarios, led to the identification of the following long-term developments as being particularly important in challenging our assumptions about educational policy.

The information landscape gets denser, deeper and more diverse
Social trends towards accountability and security, the decreasing cost and increasing availability of digital storage capacity, the development of new forms of bio- and genetic information, the ability to digitally tag almost any physical object, space or person, the ability to represent information in diverse modes – all of these developments increase the capacity to simply 'know more stuff about more stuff'. We will be able to gather, store, examine, archive and circulate more data, in more diverse forms, about more aspects of ourselves and our world, than ever before.

Creating the personal cloud
In the near future, the capacity to connect to a network and be constantly connected to knowledge, resources, people and tools will be taken for granted in most countries with a robust technology infrastructure. Individuals will have the capacity to remain in 'perpetual contact' with diverse networks and communities, both physical and virtual. The rise in mobile and personal technologies and the lowering of barriers to data storage mean that individuals are increasingly likely to 'wrap' their information landscape around themselves rather than managing it through institutions (for reviews exploring these first two issues, see Cliff *et al.* 2008; Goodings 2009; Horst 2009; Jewitt 2009; Reich 2009; Riley 2009; Young & Muller 2009).

Working and living alongside machines becomes increasingly normal and our understanding of what we mean by 'machines' may change as non-human entities are more radically embedded into human bodies, and machines become semi-autonomous actors in social networks. Over the coming two decades, people are

likely to become increasingly accustomed to machines taking on more roles previously occupied by humans across both professional and manual occupations and in homes and workplaces. Whether through devolving simple tasks or outsourcing the management of complex systems, such devolution of responsibility potentially brings a number of adjustments in our understanding of the respective roles of machines and humans. It may raise significant ethical tensions and generate public debate relating to questions of dependence and autonomy, and of privacy and trust, particularly when it comes to the use of complex systems to manage sensitive data and critical systems. Such debates may play themselves out particularly between different generations with different attitudes to delegating power and responsibility to machines (for reviews exploring these and related issues, see Cliff *et al.* 2008; Jewitt 2009; Kelan & Lehnert 2009; Price *et al.* 2009).

Distance matters less, but geography still counts

The separation of 'information resources' from physical locations will continue. On top of this, people are likely to become more familiar with, and more used to, working together at a distance. As technological developments help to increase a 'sense of presence' in remote interactions, and as social norms and etiquette for such interactions are developed between families, friends and in workplaces, being 'together apart' is likely to become a more familiar aspect of working, personal and leisure lives. This is amplified by trends towards increased mobility within and between countries for work opportunities, and towards increasingly 'distributed' families where family members live in different places. However, geography is likely to continue to play a role in shaping the level of access that individuals and groups will have to digital networks: pricing and infrastructure, legal constraints and regulatory issues will still be influenced by physical geography. Similarly, people will still continue to use 'place' and physical location as a marker for identity however 'virtual' their interactions, and the 'face to face' is likely to retain its importance for specific interactions. Physical proximity is also important in creating cultures of innovation and development, particularly from an economic perspective (for reviews exploring these and related issues, see Atwell & Costa 2009; Felstead 2009; Greenhill 2009; Sefton-Green 2009a; Sindic 2009).

Digital Natives grow up and need to keep learning

On current trends, Western Europe will be characterized by an ageing population over the coming two decades, with over 50% of the population aged over 50 by 2030 with a further 40-year life expectancy. Such population ageing is also expected worldwide, with Asian countries also experiencing significant downturns in fertility. The adult–child relationships of the 20th century are likely to continue to be unsettled and evolve new forms. Care will need to be passed up as well as down the generations. Today's so-called 'digital natives' will, like their parents before them, need to learn to use new technological environments throughout their lives. Substantial changes to distribution of educational resources across the lifecourse will need to be envisaged as this cohort will be required to work (and learn) later in life. Moreover, such late life activities will be patterned by significant inequalities in health and wealth (for reviews exploring these and related issues, see Dorling 2008; Casey 2009; Harper 2009; Hoff 2009; Hogarth & Bosworth 2009; Howse 2009; Jessel 2009; Lee 2008; Lee 2009a; Mann 2009).

Weakening of institutional boundaries

The disaggregation of information from institution, the capacity to interact easily at a distance, the apparent preference for merging 'working' and 'leisure' practices amongst certain age groups and in certain workplaces, the creation of personal 'clouds' of information, people and resources, the erosion of strict boundaries between education, working and retirement as people have to work longer and develop new skills later in life, the demand for adults to manage multiple working and caring roles and for employers to find ways of enabling more flexibility in managing work practices, the increasing merging of public and private provision of public services; all of these different trends suggest that the next two decades may see an increased weakening of boundaries between institutions previously seen as separate – between workplace and home, entertainment venue and educational establishment (for reviews exploring these and related issues, see Dex 2009; Farook 2009; Felstead 2009; Harper 2009; Powdthavee 2009; Round 2009; Wilson 2009).

The decline of the knowledge economy as a utopian future

As a result of the intersection of demographic and technological trends over the coming two decades, the world of work is likely to become increasingly polarized. Highly competitive R&D activities and knowledge work will continue to be needed. However, digital technologies enable offshoring of work, enable the reduction of human input into goods and services, and enable centralised groups to manage ever greater numbers of people across dispersed locations. These trends suggest that highly rewarded, creative and autonomous R&D work is likely to be increasingly restricted over the coming two decades to ever smaller global elites. In contrast, ageing populations are likely to see a rise in demand for caring, face to face and personal service roles, often roles which, today, are poorly rewarded and valued. These developments may bring an end to current hopes of a universal, democratic 'knowledge economy' and a rise in massive inequalities. They may hasten the search for changed social values to mitigate the potential inequalities of a polarized workforce; or they may bring a search for new sites of investment and development (such as in the environmental or 'virtual world' sectors) (for reviews exploring these and related issues, see Bosworth 2009; Lauder & Brown 2009; Lauder *et al.* 2009; Unwin 2009).

'Silver bullets' are not expected for complex educational problems

Despite the continuing demand for quick fixes, neuroscience, computing and bioscience are not expected to provide easy solutions to educational issues over the coming two decades. Progress may be made in relation to specific disabilities or difficulties; for example, the development of better prostheses, new learning methods or targeted pharmacological enhancements for particular conditions. However, significant tensions may emerge around the ethics of such developments, their commercialization and their wider application. Silver bullets, also, are not expected to emerge in relation to economic affairs, with constraints on public finances expected to continue and no significant new sources of revenue emerging for education[18] (for reviews exploring these and related issues, see Blakemore 2009; Howard Jones, 2009; Lee 2009b; Sandford 2009; Turney 2009).

Implications for education

The scenarios and projections arising from the BCH programme present three significant challenges to current educational assumptions, challenges that, if taken seriously, require us to fundamentally re-examine the aspirations, institutions and practices of education.

Challenge 1: should education continue to be organized around the unit of the individual learner?

The programme argued that the solitary spaces of self-reflection, in which the Enlightenment idea of 'the individual' was forged, will be increasingly difficult to find and occupy with individuals having the capacity for constant connection with people, tools and resources. The programme also argued that we were likely to see the emergence of new cognitive divisions of labour in which machines will be co-operating with human beings on most high level tasks, each according to their strengths. At the same time, the programme discussed the development of social networks as mechanisms for managing the depth and complexity of the information landscape through repurposing of materials for group purposes and as sites for production of economic value. Finally, the programme argued that participation in social networks is not inevitable, with networks offering a range of conditions of entry and with some individuals able to generate and mobilize such networks effectively. On this basis, effective participation in networks comprising both technical and social elements is likely to play an increasingly important role in life chances. As socio-technical networks become a more important means of gaining, sharing and generating knowledge (whether personal, social, political or professional) so the stakes for non-participation or exclusion from such networks may be higher. Such developments question whether education systems should continue to privilege individual and autonomous attainment at the expense of the capacity to exercise distributed agency in and through networks.

Challenge 2: should 'the school' retain its dominant position in assumptions about educational futures?

The programme suggests that the coming two decades will see a shift away from the equation of 'learning' with 'educational institutions' that developed with

industrialization, towards a more diverse and complex learning landscape which sees formal and informal learning taking place across a wide range of different sites and institutions. Over the next 20 years, the demographic shift that sees much older adults needing to continue to work and learn, the need to balance working and caring and the cultural shifts that see younger cohorts wishing to blend work/life/play, all provide an impetus towards extending educational activities lifelong and lifewide. At the same time, the historic reasons for attending formal educational institutions (that these were sites where you could access the information and educators necessary for learning) are being increasingly eroded. New models of educational exchange have been developed and educational services are being disaggregated – teaching, access to resources, participation in peer learning and accreditation are being separated out as distinct functions. Over the coming 20 years, the monopoly of the 'school' or the 'university' as the sole sites of education may be profoundly challenged, leading to an examination of what it means to be an educational institution and of how to enable learners to navigate a significantly more complex landscape of educational provision.

Challenge 3: should preparation for competition within a knowledge economy remain a primary goal for education?

The vision of a universally beneficial knowledge economy with high levels of creative and rewarding employment seems to be unsustainable based on current trends described in the programme reviews. Trends towards standardization in multi-national corporations in which smaller and smaller elites are offered autonomy and responsibility while other workers increasingly operate according to prescribed scripts and regulations; developments in virtual presence that begin to offer the opportunity to offshore not only manufacturing jobs but also those of the middle class professions such as law and education; enhanced capacity to take on creative, high value knowledge jobs in countries around the globe; all of these make it increasingly unlikely that any country will be able to employ all of its citizens in high value, highly rewarded work. At the same time, there will be a rise in demand for workers able to take on roles that cannot be automated or offshored, with the demographic demands for (currently low paid and low value) caring roles potentially taking up the slack. Such a landscape hollows out the middle tier of employment and creates an increasingly polarized labour market with significant challenges for compulsory education in terms of motivation and aspiration. There are a number of choices for education from such an economic picture – might education reorient itself away from the formal economy to rediscover its role in supporting informal economies, caring and community commitment, or to promoting new values (of well-being, happiness and so forth)? Alternatively, might education ever more fiercely dedicate itself to innovation and competition, reorienting itself to a central role in building locally based innovation cultures and articulating itself ever more closely with industrial and competitive agendas?

On the basis of these philosophical challenges, the programme recommended a set of priority agendas for development and practical action:

Recommendation 1 – work towards the design of a 'curriculum for networked learning'

Such a curriculum would enable individuals to learn to work effectively within social networks for educational, social and civic purposes, and to develop strategies to establish and mobilize social networks for their own purposes. Such a curriculum might comprise: for example, opportunities for learners to learn and work within meaningful socio-technical networks not wholly within single educational institutions; to be assessed in interaction with tools, resources and collaborators; to develop capacities to manage information and intellectual property, build reputation and trust, develop experience of working remotely and in mediated environments; to create new learning networks; to reflect upon how learning is connected with other areas of personal, social, and working lives and manage and negotiate these relationships; to explore the human–machine relationships involved in socio-technical networks.

Recommendation 2 – work towards the creation of open, flexible and networked relationships across diverse educational institutions, both formal and informal

Such working arrangements would attempt to limit the barriers to participation across institutions, increase the

chances of learners' experiencing high quality educational experiences based on shared understanding of learners' histories and prior understanding, and ensure that education in workplaces and other settings was valued. This would include, for example, the development of compatible personal learning records owned and managed by learners that can be carried across diverse settings; interoperable systems and standards that enable learners to demonstrate attainment and experience across diverse settings; timetabling arrangements and tools that enable learners flexibly to build timetables across different providers to take advantage of learning opportunities in schools, museums, community settings, workplaces, universities, and homes; and a map of the diverse learning landscape that can support learners and mentors to navigate this complex environment effectively.

Recommendation 3 – work towards the development of a mentoring and networking workforce

Such a workforce would tackle the potential for amplification of socio-economic inequalities latent in a diversification of educational provision across multiple providers and locations, and enable learners to take informed educational decisions in the context of labour market information. This might include a cohort of lifelong mentors or guides to ensure learners can take informed choices from diverse education providers and balance education, working, caring and personal development choices across the lifecourse and at key transitions; the diversification of 'teacher identity' and professional organization to include experts in workplaces, community educators, school and university lecturers, and voluntary providers; a review of existing child protection arrangements to facilitate participation of diverse expertise in the provision of education; and a cohort of educators skilled in establishing and working within social networks across institutions and ages.

Recommendation 4 – work towards the creation of public forums for debate on socio-technical change and education

Such forums are needed to ensure that education can be considered a public good, responding to the needs and aspirations of citizens in the context of socio-technical change. These forums would enable educators, policy-makers, learners, communities, businesses and parents to explore how best to appropriate or resist emergent socio-technical developments, and to debate the political and ethical questions raised by 'the unpredictability and indeed serendipity of social and technical outcomes' (Williams 2006). These forums, such as those commonly used in medical science, would bring together researchers, educators, policy-makers, journalists and students to explore the latest research and developments in arenas as diverse as genomics, demography, economics and computing. Such forums challenge the notion of researching 'the future' as a one-off exercise in forecasting, and instead, foreground the exploration and creation of possible futures as an ongoing activity.

These recommendations and philosophical challenges are currently being used as a basis for discussion of education strategy in a range of national, regional and institutional contexts. What remains to be explored, however, are the implications of such potential socio-technical futures for the goals and aspirations of the educational technology research field.

Discussion: implications for research in education and technology

If the next 25 years look likely to bring significant institutional, philosophical and practical challenges to education, what might be the role of the educational technology research field in building the theoretical and practical knowledge that will enable our societies to understand and intervene in the developing relationship between education and socio-technical change?

Our own view is that there are four key areas in which the research community needs to take both intellectual and practical leadership if it is to continue to speak to the problems and opportunities that education seems likely to face over the coming quarter century.

First, we need to rebalance the research field to pay increased attention to learning and education in sites outside formal and mandatory educational practice

The programme calls into question the balance of investment in formal, classroom-based educational studies as compared with inquiries into learning in workplaces, homes, voluntary associations and community organizations. It challenges the current age segregation that pervades the research field, with specialists in

school-age research often rarely collaborating with specialists in higher education, adult education and lifelong learning; and it challenges the relatively limited investment in understanding inter-generational learning.

More importantly, however, this programme raises the question of how we might begin to develop a better understanding of how individuals navigate and, most importantly, move between diverse locations and diverse learning networks. Contemporary and familiar analyses of communities of practice and of situated learning, for example, need to be complemented by examination of the processes by which individuals operate across multiple settings, and the barriers to participation and movement between networks. Such a challenge requires the development not only of new theoretical insights, but of new research techniques and practices, to enable researchers to explore the complexity of participation in and across diverse sites and networks of learning.[19]

Second, we need to move beyond pedagogy towards curriculum debate

The development of new models of pedagogy mobilizing emergent technologies, and the theorization of learning in interaction with people and artefacts, are clearly familiar elements of the educational technology research field. Arguably, we already have the theoretical tools in socio-cultural and actor network theory (amongst others), to enable us to make sense of whatever new brain–machine prostheses, emergent cognitive enhancements, or new socio-technical assemblages might emerge over the coming years. Our challenge is to continue to develop the empirical work that really builds new pedagogic practice using these tools.

The significant and unresolved issue we face, however, is the question of curriculum – of which educational goals should pertain in the context of socio-technical change. The socio-economic context of potentially radical workforce polarization, combined with the challenge to the conception of the 'sovereign individual' posed by constant connectivity and socio-technical networks, have the combined potential to radically destabilize many of the consensual and progressive understandings of educational institutions premised upon enlightenment ideals. At heart, they require us to address the questions of what it means to become human and achieve agency in changed socio-technical contexts. Such questions suggest a need to re-engage the educational technology field with educational philosophy, with questions of sustainability and with concerns around social justice. Such questions also require a resistance to the appropriation of educational technology within discourses of 'educational modernisation' in which the goals and institutions of education remain unquestioned.

Third, we need to develop the interdisciplinary collaborations that will allow us to play an informed role in ethical debates

Ethical concerns are already being raised in relation to the emergent technologies that may be mobilized for educational goals over the coming quarter of a century. In particular, the fields of genomics, bio-computing, cognitive enhancement and prosthetics have the potential to radically challenge our conception of human–machine boundaries and could be seen to begin to offer the basis for new forms of educational (dis)advantage. While current evidence in the field suggests a need for caution both about claims for human progress and for harm, it is not hard to conjecture that, just as with the debates around computing in education, polarized and oppositional debates that generate more heat than light may well emerge in these areas. At the same time, it is far from clear which disciplines will be mobilized in attempting to answer these questions. Arguably, the medical field, along with biological science and genetics will increasingly be called upon to provide explanations for educational problems as these technologies develop. The challenge for the education technology field is both to build bridges with these disciplines and to explore key points of tension and critique with the accounts that are developed within them. If we are to provide insightful contributions to the debates that will inevitably emerge in these areas, we need to begin to create rich interdisciplinary accounts of the inter-relationship between social, biological, technological, cultural and historical elements in educational settings.

More importantly, however, we will need to further develop critical and discursive analysis in education technology by asking why it is that some issues rather than others become the focus for ethical debate and anxiety. We need to explore the origins of the proliferation of discourses of risk and concern around specific issues rather than others, and ask who benefits from

such clustering of anxiety. For example, why should the matter of relationship between technology and the body be a privileged area of ethical debate given the long-standing history of humanity in building human–machine assemblages, while issues such as the transformation of the educational exchange into data for test scores, auditing and accountability, are left relatively unexamined? Why should the enhancement of human intelligence be seen as a matter of inquiry when the ethical questions concerning the environmental impact of educational computing remain relatively unaddressed?[20] There is a real and urgent need to interrogate the longer term implications, not only of those technological developments that are seen to present spectacular and transformative changes to the nature of education, identity and knowledge, but also to pay attention to the banal and everyday technologies of data management, audit and accountability, for example, that with little fanfare come to structure the conditions of possibility for education and educators.

Keeping the future open

Finally, as discussed at the outset of this paper, ideas of the future play a fundamental role in shaping education policy and practice. Ideas about what the 21st century will bring will shape the design of educational institutions, assignment of funding, training of educators, curriculum planning and investment in infrastructure. Such ideas in the public domain, however, are often based upon the taken-for-granted assumptions of inevitable futures promoted by the globalizing discourses of dominant economic and political groupings. The risks of such approaches to thinking about the future in education are clear. If we can only operate with one vision of the future at any time, then we risk designing education systems and strategies that only serve their purpose if that particular future comes to pass. We risk overlooking the needs of future generations if we do not explore the possibility that our decisions today might serve to create significant unintended consequences in the future – consequences that cannot be 'researched' but can be imagined; and we risk disempowering educators, students and communities from intervening to change their own and their society's futures.

If we are concerned with creating educational strategies that can play a role in tackling social, environmental and economic inequalities and in equipping all citizens to harness socio-technical change to their benefit, then a critical function of the educational technology research community might therefore be to critique the unchallenged assumptions about 'inevitable futures' that abound, and to actively attempt to both understand and model alternatives. For such an endeavour, we are, arguably, well prepared. The field's proximity to technological development makes it well-positioned to articulate the uncertainties of processes of technological appropriation; the field's highly diverse disciplinary lineage makes a nuanced understanding of the relationship between social and technological change possible; finally, the field's diverse methodological tools, from philosophical inquiry to ethnographic observation, from design to action research, position it well for the combination of critique and action that are required to both imagine and build alternative futures.

While the last 25 years have seen *JCAL* shape the educational technology field, the next 25 years may see it playing an even more important role. By providing a critical and interdisciplinary forum for researchers to challenge, imagine and bring news of diverse possible futures for education, *JCAL* may help us to harness the socio-technical developments that the BCH programme has outlined to create fairer and more socially just alternatives than those that might otherwise emerge from the orthodox discourses of the 21st century 'knowledge economy'.

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Notes

[1]http://www.partnershipsforschools.org.uk/.

[2]The Partnership for 21st Century Skills (http://www.21stcenturyskills.org/).

[3]See, for example, the Microsoft School of the future programme http://www.bbcworld.com/Pages/ProgrammeFeature.aspx?id=18&FeatureID=304;

Cisco's 'school of the future' models http://www.cisco.com/web/strategy/education/primary.html.

[4]The educational 'imaginary' can be understood as a set of articulated images that support the creation of a 'master narrative' that acts as a commonsense resource for day to day action.

[5]See, for example, Education for Innovative Societies in the 21st century, http://en.g8russia.ru/docs/12.html.

[6]http://fab.cba.mit.edu/.

[7]See, for example, groups such as the foresight network, the global business network and the global scenario group: http://shapingtomorrowmain.ning.com/; http://www.gbn.com/; http://www.gsg.org/.

[8]Teacher Development Agency (TDA) Futures (http://www.tda.gov.uk/partners/futures/general_interest_education.aspx), Qualification and Curriculum Authority (QCA) Futures (http://www.qcda.gov.uk/6073.aspx) National Institute of Adult Continuing Education (NIACE) Inquiry into the Future for Lifelong Learning (http://www.niace.org.uk/lifelonglearninginquiry/AboutIFLL.htm), Department for Children, Schools and Families (DCSF), Beyond Current Horizons (http://www.beyondcurrenthorizons.org.uk). See also the recent European Union initiative The Future of Learning: New ways to learn new skills for future jobs, launched in 2009 and pending publications.

[9]While this paper is based on the Beyond Current Horizons programme and its research, the implications for education technology research presented in the discussion should not be taken to reflect the views of all the programme participants or the programme's commissioners (DCSF). Some arguments have also been abbreviated to fit the confines of a journal paper. For the official final report and recommendations from the programme, see http://www.beyondcurrenthorizons.org.uk/outcomes

[10]The future cannot be understood simply as an unmapped terrain that already exists and that merely requires better cartographers and scouts to fully plot its dimensions. Reciprocally, the future is not simply 'ours for the making' (instead of the taking); the futures that we build are built upon the activities, materials and resources of the present and the past. This reciprocal relationship between present and future, between agency and predetermination, echoes Marx's (1852) recognition that 'men make their own history [albeit] they do not make it in circumstances of their own choosing' or Bhaskar's (1975) view of the 'necessary asymmetry' of social actors and social structures. The future cannot be considered, therefore, as a blank canvas waiting to be filled in, nor is it a predetermined world waiting simply to be inhabited (see Bell 2002).

[11]See, for example, the UK's 'foresight' centre, established to provide visions of the future 'using robust science' to inform government. http://www.foresight.gov.uk/About/index.asp.

[12]The key contextual projects included: 'Mental Capital and Wellbeing Programme' (GoScience/DIUS), the Inquiry into the Future of Lifelong Learning (NIACE), the Review of the Impact of the Commercial World on Children's Wellbeing (Professor David Buckingham for DCSF), the office of the communications regulator review of Public Sector Broadcasting. It is worth noting, however, that the idea that scientific and technological change would act as a driver for wider social change was not up for debate. Indeed, we at Futurelab were asked to run this programme precisely because of our interest in new technologies. The commissioners of the research did not ask researchers with a particular interest in environmental concerns, or a particular interest in children's welfare, to run such a programme. By choosing researchers with a focus on new technologies, and by specifying the area of inquiry as socio-technical change, the commissioners of the project were already working with an assumption about the future as shaped by digital technologies.

[13]Challenge 1: Professor Sarah Harper, University of Oxford; Challenge 2: Professor Helen Haste, Universities of Bath and Harvard; Challenge 3: Professor Carey Jewitt, London Knowledge Lab; Challenge 4: Professor Rob Wilson, University of Warwick. In the fifth area, there was insufficient academic expertise available within the time limit of the programme and, on review, remarkably little substantial analysis. As a result, the BCH team took on a limited commissioning and reviewing process and ran a roundtable to explore the issues with a range of research, policy and industry figures. This area was led by Richard Sandford, Futurelab.

[14]See http://www.beyondcurrenthorizons.org.uk/outcomes/final report for a full list of review authors.

[15]The BCH programme avoided the terms 'drivers', 'key factors' and so forth as they can impute a reified agency or independence to socio-technical or socio-cultural developments that is ultimately 'in the eye of the beholder' (see, for a discussion on the 'art' of the scenario, Schwartz 1991) and which would conlict with our position on the interdependence of social and technological change described earlier.

[16]The identification of a specific trajectory for climate change is, clearly, problematic under current conditions but assuming one particular projection over others enabled the programme to focus attention on issues of socio-technical change in the context of the climate scenario currently considered most likely, rather than on the debate over the likelihood or otherwise of efforts to prevent climate warming. This decision was taken because, at the current time, the international community is subject to deeply conflicting policies on climate change. In the view of the BCH programme (although with the exception of one member of its advisory panel) the critical uncertainty for the coming years was therefore not, whether we were likely to see at least a 2 °C rise in temperature (which would be achieved based upon the effects generated by the levels of greenhouse gases already in the earth's atmosphere and secondary effects already in train [IPCC (2007); United Nations Children's Fund (UNICEF) 2007] but how governments, industry and populations would respond to such change and whether attempts will be made to ameliorate its effects on diverse populations around the globe. See, for example, the debate between Kingsnorth and Monbiot at: http://www.guardian.co.uk/commentisfree/cif-green/2009/aug/17/environment-climate-change for an outline of different future trajectories currently envisaged and the different moral, ethical and practical questions these engender. Even a 2°C global increase in temperature is likely to generate, for example: Increased frequency and intensity of extreme and hazardous weather events, including storms, forest fires, droughts, flooding (UNICEF 2008); Complex effects upon global food supply; decreasing water availability and increasing drought at mid, semi and low latitudes – this exacerbated by increasing global demand for resources (UNICEF 2008; NIC 2008); increased conflict arising from conflict over natural resources, in particular over water (OECD 2005); brunt of climate change impact will be born by the world's poorest countries, in particular Northern and Sub Saharan Africa and most vulnerable people, in particular children – likely implications include increase in mortality, reduction in attendance at schools, increases in poverty and in inequalities and malnutrition (UNICEF 2008; NIC 2008); a likelihood of significant increases in refugees, approx 200 m climate refugees predicted by 2050 (UNICEF 2008; Stern 2007); cuts in global per capita consumption (Stern 2007). These complex effects were presented to participants in the Expert Advisory Group as a basis for scenario development.

[17]The power of scenarios and their recommendations as tools for challenging assumptions can diminish as individuals are more removed from their production, these outlines of the scenarios are presented here to provide an indication of the types of trajectories that were considered and which were used in producing the recommendations arising from the programme. Detailed discussion of the scenarios, and their implications for educational practice, is being prepared. Full text of the BCH scenarios is available here: http://www.beyondcurrenthorizons.org.uk/scenarios/ A set of tools developed to help educators use the scenarios to challenge current thinking is available here: http://www.visionmapper.org.uk

[18]NB – this last argument is particularly relevant for the UK but can not be taken to apply more widely. It may well be that other countries, particularly those with untapped mineral reserves or easily exploitable alternative and conventional energy supplies, may indeed be able to generate significant increases in investment in education.

[19]The Teaching and Learning Research Programme/Technology Enhanced Learning (TLRP/TEL) Interlife programme is one example of the development of practical technical insights into this issue as they are building an online space

to support learners' transition between different sites. It is not clear yet, whether the project will provide theoretical gains around diverse learning locations, but the tools developed may support other researchers to explore these issues (http://www.tlrp.org/tel/inter-life/).

[20]Approximately 500 000 computers are landed in Nigeria each month, of which only one in four is in working order (Danwatch 2008). This despite legislation to ban European Union companies from dumping its electrical and electronic waste outside its borders (Grossman 2006 and the Basel Action Network). Fifty per cent of the power to computers is wasted, generating excess heat and requiring air conditioning and further waste energy (ClimateSaversComputing 2009/http://www.climatesaverscomputing.org). See also http://www.jisc.ac.uk/publications/documents/sustainableictoverview.aspx.

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