Literature Review in Creativity, New Technologies and Learning

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futurelab

REPORT 4:

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FUTURELAB SERIES

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AIMS

This review is intended to provide:

1 a sound theoretical and empirically informed basis for prototype development of digital learning resources to support the teaching and learning of creativity

2 a sound theoretical and empirically informed basis for informing policy on the teaching and learning of creativity

3 a basis for communication between the educational research community and the commercial sector on the subject of the teaching and learning of creativity with ICT.

This report has been designed to enable both rapid identification of the key findings and in-depth exploration of the literature.

The key findings and implications of the report are presented within the Executive Summary and Implications Sections. The main body of the review enables readers to explore in more detail the background to these headline issues.

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EXECUTIVE SUMMARY

creativity can
be regarded as
an essential
life skill

EXECUTIVE SUMMARY

In recent years people in many sectors of society have expressed disquiet about a lack of creativity in the curriculum. From Telford to Tokyo artists, writers, performers, teachers, psychologists, philosophers and representatives of the cultural and commercial industries have warned against the consequences of constraining children and young people's creative potential.

What then, might we mean by 'creativity'? Creativity can be regarded as not only a quality found in exceptional individuals, but also as an essential life skill through which people can develop their potential to use their imagination to express themselves, and make original and valued choices in their lives. Societies of the 21st century require active participation in the fast-changing 'Knowledge Age' in which there is an interaction between people, communities, creative processes, knowledge domains and wider social contexts.

What is the role of digital technologies in these processes? Digital information and communications technologies (ICT) can be seen as a set of tools which can be chosen as and when they are appropriate in the creative process. In addition, it can be argued that the characteristics of ICT can also make a distinctive contribution to those processes, providing new tools, media and environments for learning to be creative and learning through being creative. Learners and teachers can use ICT to support imaginative expression, autonomy and collaboration, fashioning and making, pursuing purpose, being original and judging value. ICT can offer opportunities to be creative in authentic contexts in ways which have not been as accessible or immediate without new technologies. Such accessibility and flexibility, however, present challenges to teachers and schools in confronting present models of resources, timetables, curriculum and assessment requirements, which can inhibit learners' engagement with creative processes and lead to a superficial or fragmented focus on products. Creativity can be promoted and extended with the use of new technologies where there is understanding of, and opportunities for, the variety of creative processes in which learners can engage. Key issues to be discussed by those interested in creativity in education include the understandings of 'creativity'; the features of ICT which enable learners to be creative; the creative activities which are already going on and the contexts in which learners can realise their creative potential.

WHAT IS THE ROLE OF CREATIVITY IN EDUCATION?

The British Government responded to the debates about creative and cultural education to meet the economic, technological and social challenges of the 21st century by initiating a range of projects to enhance learners' creative experiences. The potential of digital technologies to enable new forms of engagement, access and educational achievement is recognised in the development of proposals such as 'Culture Online' - a service offering interactive access to national arts and cultural resources through the internet and digital television. Providing access to culture through the internet does not, however, make the experience creative in itself, and our perceptions of what we might mean by 'creativity' need to be explored.

Understandings of the nature of creativity have changed in scope and depth over the last hundred years. Many have focused on the characteristics of exceptional individuals in our culture, from van Eyk to Van Gogh, Darwin to Dawkins, Telemann to Thelonius Monk. More recently there has been an acknowledgement of the creative potential of all individuals in different knowledge domains, or subjects not confined to traditional definitions of the 'arts' or 'sciences'. An ethos which encourages creativity in different communities and environments also has an influence on individuals and groups. Creativity can now be recognised and valued at the level of individuals, peer-groups or the wider society and considered as an essential element in participating in and contributing to the life and culture of society. There have been many attempts to define 'creativity' and useful theoretical frameworks have been formulated which describe the interaction between qualities in people and communities, creative processes, subject areas and social contexts. The National Advisory Committee on Creative and Cultural Education (NACCCE) draws upon a range of conceptualisations of creativity and presents a definition which is a useful framework for educators - 'imaginative activity fashioned so as to produce outcomes that are both original and of value'. This definition is helpful in that it expresses five characteristics of creativity: using imagination; a fashioning process; pursuing purpose; being original and judging value. Creativity in education can encompass learning to be creative in order to produce work that has originality and value to individuals, peers and society, as well as learning to be creative in order to support 'possibility thinking' in making choices in everyday life.

WHAT ARE THE POTENTIAL ROLES OF DIGITAL TECHNOLOGIES IN SUPPORTING CREATIVITY?

The use of the term ICT is inadequate to describe the variety of technologies, settings and interventions through which new technologies have an impact on people's lives. Digital technologies exhibit features of provisionality, interactivity, capacity, range, speed and automatic functions which enable users to do things that could not be done as effectively, or at all, using other tools. People who are 'ICT capable' are certainly able to use a variety of skills and techniques with particular technologies. More importantly, they are also able to understand the reasons why digital technologies might be appropriate for particular tasks and situations, make informed choices in their use, evaluate their impact and be open to new developments and possibilities. It is the interaction between the distinctive features of ICT and the characteristics of creativity that opens up new perspectives on the development of creativity in education.

HOW MIGHT WE TEACH FOR CREATIVITY WITH DIGITAL TECHNOLOGIES?

Teaching for creativity with digital technologies presents challenges in two areas – the use of ICT to support creativity in traditional settings such as schools, and the development of ICT resources to support innovation in new learning environments for creative activity and collaboration. Within the more familiar settings of schools and classrooms, models of access to ICT resources should reflect characteristics of creative

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environments and teaching strategies which include:

- awareness of the ways in which creativity is related to knowledge across the curriculum

- opportunities for exploration and play with materials, information and ideas;

- opportunities to take risks and make mistakes in a non-threatening atmosphere

- opportunities for reflection, resourcefulness and resilience

- flexibility in time and space for the different stages of creative activity

- sensitivity to the values of education which underpin individual and local interest, commitment, potential and quality of life

- teaching strategies which acknowledge 'teaching for creativity' as well as 'teaching creatively'.

The designs of new communications technologies for creative interactions are presenting challenges to expectations of traditional classroom settings in terms of spaces, time, portability, connectivity and flexibility for individuals and communities. Learners can engage in a range of activities, from using interactive whiteboards and wireless portable computers, to working together in virtual spaces to exchange and build ideas and artefacts.

HOW ARE PEOPLE USING DIGITAL TECHNOLOGIES CREATIVELY?

Many learners and teachers have established a wide range of activities to support approaches to creativity and exploit the features of digital technologies in processes such as:

- **developing ideas:** supporting imaginative conjecture, exploration and representation of ideas

- **making connections:** supporting, challenging, informing and developing ideas by making connections with information, people, projects and resources

- **creating and making:** engaging in making meanings though fashioning processes of capture, manipulation and transformation of media

- **collaboration:** working with others in immediate and dynamic ways to collaborate on outcomes and construct shared knowledge

- **communication and evaluation:** publishing and communicating outcomes for evaluation and critique from a range of audiences.

These activities are not always discrete or sequential and there can be synchronicity in their expression and overlap of applications for different purposes. Examples of such activities range from using simulations and adventure games to explore the question 'what would happen if…?', to publishing hypertext stories or constructing avatars to meet and interact in three-dimensional, virtual worlds. This wealth of activity illustrates how children and young people are able to use ICT to demonstrate creative characteristics in the interaction between people and processes in subject areas which are authentic, relevant and challenging.

HOW CAN WE ASSESS CREATIVITY, LEARNING AND DIGITAL TECHNOLOGIES?

Attempts to produce methods for the assessment of creativity have not been straightforward, and few of the many instruments and tests devised have been able to measure the concept adequately. There are tensions between assessment of creative activities for different reasons. Do we want measures of creativity for 'high stake standards', such as statutory tests and national examinations? Do we want to be able to assess creativity in order to give feedback to individuals on their achievements and ways forward for progression? Do we want to have means to recognise and celebrate meaningful and original personal expression? Assessment of pupils' ICT capability is no less problematic. It is easier to identify whether pupils can or can't use particular skills and techniques than to find correlations between the use of these techniques and their attainment in other subjects. It is not easy to use traditional measures and tests to identify the indirect effects of the use of ICT on motivation, attitude, problem-solving capability, critical thinking and information handling abilities. Some teachers and researchers have developed positive approaches to the complexity of assessment by using dimensions along a range of criteria for the use of technologies to support creative processes. Many have recognised that traditions and expertise in assessment in both art and media education can inform approaches to peer review, evaluation and formative assessment, recognising the unique contributions of new technologies.

WHAT ARE THE IMPLICATIONS FOR PRACTICE, CURRICULUM AND DESIGN?

Thinking about the potential of digital technologies to promote teaching and learning for creativity raises a number of issues for teachers' work in classrooms and informal sessions, for teacher education and for the types of questions investigated in research. It is important to realise that there are a number of frameworks for describing and supporting our shared understanding of creativity, and recognise that the use of digital technologies can make a unique contribution to creative processes. It will be challenging to approach the planning and management of creative learning environments and develop confidence in appropriate teaching strategies. The design of strategies for assessment of pupils' creativity with ICT will be complex, and will need to recognise the ways in which our understanding of the interaction between creativity and digital technologies is emerging from practice and reflection. We can therefore learn much from careful case studies of each other's experiences and discussion of a range of imaginative research methodologies for further investigation. Lastly we need to continue in our attempts to find ways in which we can describe, explain and analyse our creative practices with ICT, in order to contribute to theoretical frameworks which are useful to educators in a variety of contexts.

WHAT ARE SOME OF THE BARRIERS?

The review has indicated that there are key factors which underpin creative processes and have an impact on the success of

attempts to produce methods for the assessment of creativity have not been straightforward

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teaching for creativity, and that digital technologies can play a distinctive role in both of these aspects of creativity and learning. There are, however, barriers to the development of creativity in traditional educational settings, in that the creative ethos of schools and classrooms and the approaches to the uses of ICT will need to be addressed. Neither are insurmountable, but each needs to be recognised as a constraint upon learners realising the potential of the creative use of digital technologies.

It is said that fear and vanity are often the two emotions which prevent us from realising our potential in many areas of life, and addressing them takes confidence, trust and courage in individuals and within communities. New approaches to flexibility and exploration in ways of working, teaching strategies, curriculum, assessment and management of time and resources in schools could be tried, but this will require the encouragement of an ethos of creative challenge and celebration of imagination and 'possibility thinking' for teachers, learners and designers.

1 INTRODUCTION

The focus of the review is on the interaction between characteristics of creativity in people, communities, subject domains and social contexts, and features of digital technologies which make a distinctive contribution to those processes. The term 'creativity' had been defined in wide-ranging ways. These include descriptions of creative processes as 'spiritual paths' (Nachmanovitch 1990); or a seeming mystery and paradox which needs to be 'tamed' in order to be

understood as the computational psychology of Artificial Intelligence (Boden 1992); or reflected in neurobiological processes (Zeki 2001). Prentice highlights the dangers of using a 'complex and slippery concept' leading to confusions and contradictions which do not help educators to focus on the purpose and possibilities of creative processes in the curriculum:

Too often the case for creativity is made either in general terms that do little more than assert that it is intrinsically a good thing for each individual to have a dose of, or more narrowly in instrumental terms that link it to the economy.
(Prentice 2000, p147)

Bold claims are made for the expression of creativity in children and young people through the use of new technologies, from mobile phones to digital video and music. International governments' policies reflect a priority for the use of ICT in the spheres of education and culture (Sharp and Le Metais 2000), and awards are granted to individuals and organizations that use technology creatively to benefit society (Rosencrance 2000). Commentators on the convergence of digital technologies in entertainment such as TV and video games state that audiences are getting new creative options (Fishcetti 2000), and computer games are an emerging art form (Jenkins 2000). Sectors of the creative industries are able to draw upon the ease and availability of digital production, reproduction and distribution, and consumers of cultural 'products', from texts to performances, can also be potential producers (Blythe 2001). Yet some critics assert that the presence of computers stifles children's experiences of play, community and creativity and constrains opportunities for physical

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experiences in a range of media and social settings (Healy 1998).

The British Government has responded to the debates about creative and cultural education to meet the economic, technological and social challenges of the 21st century. The Minister of State for the Arts, Baroness Blackstone, identified a range of projects and initiatives to enhance learners' experiences of the creative arts. These initiatives highlight the role of new technologies in developing particular projects. The potential of digital technologies to enable new forms of engagement, access and educational achievement is recognised in the development of proposals such as 'Culture Online' - a service offering interactive access to national arts and cultural resources through the internet and digital television. BBC Education produces programming and content for television, radio and the BBC Learning website and, at the time of writing (summer 2002), a digital Curriculum Online is being developed to supply digital content for schools (Blackstone 2002). The National Foundation for Educational Research in England and Wales (NFER) carried out a thematic review on behalf of the Qualifications and Curriculum Authority (QCA), focusing on information from 19 educational systems to provide a comparative analysis of the arts, creativity and cultural education. The potential of new technology to provide resources for arts education was recognised in many countries (Sharp and Le Metais 2000). At the time of writing the QCA is also undertaking a literature review in the area of Creativity and Education and developing materials which will be available in 2003.

This review attempts to present a framework of themes arising from the literature in order to inform the debate among educators, policy makers, technology developers and the wider community. It emphasises the complexities of the interaction between a variety of factors in the consideration of creativity, ICT and learning, in contrast to a clear distinction between ICT as an 'Electronic Prometheus' (Kirschenmann 2001) or a 'Fool's Gold' (Cordes and Miller 2000).

2 WHAT IS THE ROLE OF CREATIVITY IN EDUCATION?

2.1 HOW HAS CREATIVITY BEEN DEFINED?

2.1.1 WHAT ARE SOME KEY THEMES IN DEFINING CREATIVITY?

The development of different perspectives in describing creativity has been traced, from the concerns of the 1950s to 1970s in areas of personality, cognition and the stimulation of creativity in individuals, to the awareness in the 1980s and 1990s of the influence of environments and social contexts on the creativity of individuals, groups and organizations (Rhyammar and Brolin 1999). Cropley (2001) reviews a range of attempts to classify creativity: from Guilford's address to the American Psychological Association in 1949 in which he called for attention to 'divergent' thinking in human psychology, to the imperative to consider the role of creativity in successful technological and economic ventures after the shock to the US of Sputnick in 1957. He identifies common elements to the variety of discussions of creativity – novelty, effectiveness and ethicality - and focuses his approach to creativity on people demonstrating

thinking about the concept of creativity has changed in recent years

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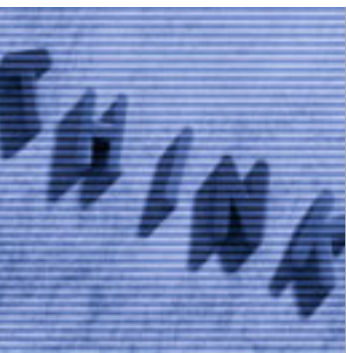
characteristics and interacting with others in environments congenial to creativity. Jeffrey and Craft argue that thinking about the concept of creativity has changed in recent years and suggest that current creativity discourse also encompasses:

• 'operating in the economic and political field

• acting as a possible vehicle for individual empowerment in institutions and organizations; and

• being used to develop effective learning'. (Jeffrey and Craft 2001, p3)

There have been several recent reviews of the literature which help to describe and theorise understandings of the nature of creativity (Yeomans 1996; Dust 1999; Rhyammar and Brolin 1999; Sternberg 1999; Beattie 2000; Craft 2000; Edwards 2000 - 2001; Cropley 2001). Dust's review (1999) draws upon the work of a number of researchers such as Barron, Gardner and Csikszentmihalyi to discuss the processes and levels of creativity, the characteristics of creative individuals and the role played by the domain of endeavour and the wider society. The review addresses the stated aims of the National Endowment for Science, Technology and the Arts (NESTA), making recommendations for achieving the objectives of exploration, exploitation and explanation in order to fulfil the main aim to promote talent, innovation and creativity in the fields of science, technology and the arts. Craft reminds us that much of the work cited in the literatures has been undertaken in the US, UK and Europe and the debate needs to acknowledge the possibilities of 'cultural saturation' in western concepts of creativity which might limit our understandings of creativity in other cultures (Craft, 2000, p14).

A key issue in discussing and defining creativity is whether the focus is upon exceptional creative individuals, such as Albert Einstein or Charlie Parker, who shift paradigms in society's ways of knowing, or upon all individuals and their potential for self-actualisation through 'little c creativity' or 'possibility thinking' supporting people in making choices in everyday life (Craft 2000). It is this broader view of promoting creativity in all individuals which underpins this paper.

2.1.2 CREATIVITY IN INDIVIDUALS

A useful starting point for considering frameworks for creativity is to consider characteristics in individuals. Examples of personal qualities of creative individuals have been collated by Shallcross (1981) and described as: openness to experience; independence; self-confidence; willingness to take risk; sense of humour or playfulness; enjoyment of experimentation; sensitivity; lack of a feeling of being threatened; personal courage; unconventionality; flexibility; preference for complexity; goal orientation; internal control; originality; self-reliance; persistance (cited in Craft 2000, p13). Another perspective on the personal qualities of creative individuals is described in Sternberg and Lubart's 'confluence model', in which six resources converge: intellectual abilities; knowledge; styles of thinking; personality; motivation and environment (Sternberg and Lubart 1999). Gardner presents a pluralist theory of mind which recognises multiple intelligences in individuals (Gardner 1983; Gardner 1996).

Csikszentmihalyi identifies a common characteristic of creative people as 'flow' – the automatic, effortless, yet highly

focused state of consciousness when engaged in activities, often painful, risky or difficult, which stretch a person's capacity whilst involving an element of novelty or discovery (Csikszentmihalyi 1996). He elaborates the description of this characteristic in identifying nine elements which such activity provides:

- clear goals
- immediate feedback
- balance between challenges and skills
- merging of action and awareness
- elimination of distractions
- lack of fear of failure
- lack of self-consciousness
- distortion of sense of time
- autotelic activity (enjoyment for its own sake).

Individual states of intuition, rumination, reverie, even boredom play a role in creativity and problem-solving, and some studies indicate how creativity is enhanced in a state of reverie and imagery (Lynn and Rhue 1986; Claxton 1999; Claxton 2000). Such states are not just 'letting it flow' or 'leaving it to luck', but acknowledging a way of knowing which is not necessarily conscious and draws upon resources of knowledge, skill and experience in order to make new combinations, explorations and transformations (Boden 2001).

2.1.3 CREATIVITY IN SUBJECTS

A different conceptual framework for describing creativity acknowledges the influence of a range of researchers in the field, yet presents a holistic view of people, processes and domains (Craft 2000). She

asserts that creativity involves people having agency over their environment, being able to make and act upon choices to be creative and inventive. People can adapt to existing problems and find ways of getting round them, or innovate and do things differently. Creativity involves being in relationship with oneself, other people and with subject domains, and such relationships can also be reflected in the need for an audience and feedback for the outcomes of creative activity. She also includes discussion of people's multiple facets of mind or intelligences, including unconscious intelligence and 'flow' as well as essentialist personality factors. The description of creative processes in Craft's framework identifies the impulse or source of creativity which feeds the unconscious, intuitive, spiritual and emotional levels, which in turn support levels of imagination, problem-solving and divergent thinking. Being able to take risks is the next level in which the person engages in the 'creativity cycle' of preparation, letting go, germination, assimilation, completion and preparation. These processes express, shape and encourage creativity as an approach to life.

Domains are suggested in her framework as a way of describing ways of knowing beyond rigid subject definitions, and open up the consideration of creativity in all areas of knowledge, not just the traditional 'arts' or 'creative subjects'. The term 'creative subjects' refers to curriculum areas broadly corresponding to Bell's framework for 'Education through the Arts' (Bell 2000, p11):

- visual and performing arts, minimally music/art/drama including dance
- designing and making, minimally three-dimensional design including crafts,

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creativity involves being in relationship with oneself, other people and with subject domains

technology and the built environment

• written arts, minimally poetry-making, creative writing and more broadly the literary arts including story-telling.

Such a conceptualisation of creativity highlights the interactions of personal qualities and creative processes within subject domains and areas of the curriculum. Beattie (2000) cites Fishkin's use of the term 'germinal creativity' to describe young people's creative potential as they develop their knowledge and understanding of particular domains (Fishkin 1998).

2.1.4 CREATIVITY AS A SOCIAL PRACTICE

The importance of the social and cultural context in which people demonstrate creativity must also be considered. Recent research in communities of practice also presents a view of learning as social, situated and characterised by interaction and communication between individuals (Lave and Wenger 1991; Wenger 1998). Leach (2001) cites examples of creative individuals, such as Nobel Prize winners or musicians, who benefited from association with other creative people within their communities which supported and celebrated the creative process. Feldman, Csikszentmihalyi and Gardner (1994) propose that creativity arises from the interaction between the 'intelligence' of individuals, the domain or areas of human endeavour, disciplines, crafts or pursuits, and the field, such as people, institutions, award mechanisms and 'knowledgeable others' through which judgements of individual performances in society are made.

Csikszentmihalyi develops his discussion of the field as a component of creativity wherein other individuals act as 'gatekeepers' to a domain by recognising, preserving and remembering creative outcomes (Csikszentmihalyi 1996). He presents a systems model in which creativity is in the interaction between a person's thoughts and actions, their knowledge and skills within a domain and a sociocultural context which can encourage, evaluate and reward. In such a systems model, the recognition and value of creativity is related as much to the wider context of domains and fields as to individuals. This has important implications for thinking about creativity and learning, where the context could be a school classroom or a large corporation which can either nurture or dismiss the development of creative individuals, groups and communities.

2.2 WHAT IS THE PLACE OF CREATIVITY IN EDUCATION?

'Creativity is an essential life skill, which needs to be fostered by the education system(s) from the early years onward' (Craft 1999, p137). Such a statement emphasises the importance of playfulness, imagination and creativity in learning for children, young people and adults and the role that schools might play in promoting these qualities in learning experiences (Anning 1994; Shagoury-Hubbard 1996; Whitaker 1997).

The National Advisory Committee on Creative and Cultural Education (NACCCE) responded to the 1997 UK Government White Paper 'Excellence in Schools' by presenting a report that argued for a national strategy in creative and cultural

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education to ensure a broad and flexible education that recognised the talents of all children. The report, 'All Our Futures', defined creativity as, 'imaginative activity fashioned so as to produce outcomes that are both original and of value' (NACCCE 1999, p29). This definition is helpful in that it expresses five characteristics of creativity:

- using imagination – the process of imagining, supposing and generating ideas which are original, providing an alternative to the expected, the conventional, or the routine

- a fashioning process – the active and deliberate focus of attention and skills in order to shape, refine and manage an idea

- pursuing purpose – the application of imagination to produce tangible outcomes from purposeful goals. motivation and sustained engagement are important to the solving of the problem

- being original – the originality of an outcome which can be at different levels of achievement: individual originality in relation to a person's own previous work; relative originality in relation to a peer group; and historic originality in relation to works which are completely new and unique

- judging value – the evaluative mode of thought which is reciprocal to the generative mode of imaginative activity and provides critical, reflective review from individuals and peers.

The NACCCE framework and report raises questions about the nature and purposes of creative experiences for learners in schools and communities, and the distinction between teaching for creativity and creative teaching (Jeffrey 2000; Prentice 2000; Joubert 2001). The five elements arising from the NACCCE definition can be used with the interactive dimensions of people and communities, processes, domains, and fields, discussed in the definitions of creativity in Section 2.1, to provide a framework to describe the contribution of ICT to creativity in learning.

3 WHAT ARE THE POTENTIAL ROLES OF DIGITAL TECHNOLOGIES IN SUPPORTING CREATIVITY?

The use of the term ICT as a single term is inadequate to describe the range of technologies and the wide variety of settings and interventions in which they are used. McFarlane argues that there is a need for a more detailed and developed discourse to reflect the relationship between a form of ICT, the way in which it is used and any impact it may have on the users, from using word processors for writing letters to monitoring and measuring environmental changes with sensors (McFarlane 2001). Tolmie also draws attention to the need to consider the complexities of the contexts in which ICT resources are used, rather than expect a blanket take-up which produces uniform outcomes for all pupils in all situations (Tolmie 2001). Kennewell considers the analysis of the effects of ICT in combination with other factors and describes a framework for using affordances and constraints of ICT in educational settings (Kennewell 2001). In this paper, the use of the term ICT implies the broad range of information and communications technologies which can be used for different purposes by learners and teachers in many situations.

the provisionality of ICT enables users to make changes, try out alternatives and keep a 'trace' of the development of ideas. Interactivity can engage users at a number of levels

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the speed and automatic functions of ICT allow tasks of storing, transforming and displaying information to be carried out by the technologies

Digital technologies exhibit features which can be exploited by users in order to make a distinctive contribution to activities, that is, enable the users to do things that could not be done as effectively, or at all, using other tools. These features have been described as provisionality, interactivity, capacity, range, speed and automatic functions (Department for Education and Employment 1998). The provisionality of ICT enables users to make changes, try out alternatives and keep a 'trace' of the development of ideas. Interactivity can engage users at a number of levels, from the playing of a game which gives feedback on decisions made, to the monitoring of a space probe through immediate and dynamic feedback. ICT demonstrates capacity and range in the ways in which it affords access to vast amounts of information locally and globally in different time zones and geographical places. The speed and automatic functions of ICT allow tasks of storing, transforming and displaying information to be carried out by the technologies, enabling users to read, observe, interrogate, interpret, analyse and synthesise information at higher levels. Recognising the potential of these features is a significant element of ICT capability, enabling children and teachers to make decisions about when the use of ICT in a particular context is appropriate (Sharp, Potter et al 2000).

Loveless argues that 'ICT capability' is more than competence with a set of skills and techniques with particular digital technologies, but encompasses such skills being turned to use. It can be described as an ability which is used actively, involving understanding, informed choice, critical evaluation and being open to or susceptible to development (Loveless 1995). Learners can demonstrate such capability in knowing, not only how to search the world wide web or manipulate a digital photograph, but also why and when such skills might be appropriate for different reasons in different situations to solve different problems. Such a description of ICT capability relates to an ecological concept of ability in which 'ability is person plus the opportunities for assistance which their environment affords, plus the skill at detecting, creating and managing these resources' (Claxton 1999, p226).

A characteristic of creativity with digital technologies would be the recognition of the potential of the features of ICT to be exploited and experimented with to support creative processes. Learners and teachers therefore need to have a range of experiences in which they can engage, play and become familiar with the distinctive contributions that ICT can make to their creative practices which other media and tools do not offer. See Table 1.

Table 1: The features of ICT and the NACCCE Framework for Creativity

Features of ICT	NACCCE Framework for Creativity
Provisionality	Using imagination
Interactivity	A fashioning process
Capacity	Pursuing purpose
Range	Being original
Speed	Judging value
Automatic functions	

HOW MIGHT WE TEACH FOR CREATIVITY?

4 HOW MIGHT WE TEACH FOR CREATIVITY?

4.1 DESIGNING ENVIRONMENTS FOR LEARNING

Establishing environments with ICT in which learners and teachers can develop creativity presents challenges in two areas – the use of ICT to support creativity in traditional settings such as schools, and the development of ICT resources to support innovation in learning environments. Edwards cites Arieti (1979) who describes how societies and cultures have the ability to both enhance and detract from creativity and asserts that technology plays a crucial role in providing access to cultural means (Edwards 2000 - 2001, p226).

Craft et al [2001] present a range of well-supported discussions of the elements of learning environments which are conducive to creative developments. Characteristics of these environments include:

- awareness of the ways in which creativity is related to knowledge across the curriculum, not just the 'arts' and that the rules and structures underpinning 'conceptual spaces' in different knowledge domains can be combined, explored and transformed (Boden 2001)

- opportunities for exploration and play with materials, information and ideas (Craft 2000)

- opportunities to take risks and make mistakes in a non-threatening atmosphere (Davies 1999)

- opportunities for reflection, resourcefulness and resilience (Claxton 2000)

- flexibility in time and space for the different stages of creative activity (Claxton 1999)

- sensitivity to the values of education which underpin individual and local interest, commitment, potential and quality of life (Beetlestone 1998)

- teaching strategies which acknowledge 'teaching for creativity' as well as 'teaching creatively.' (NACCCE 1999)

4.2 ICT AND THE PHYSICAL LEARNING ENVIRONMENT

Examples of the use of ICT to support creativity in traditional settings have been presented in earlier sections, but there needs to be recognition of the different models of access to ICT resources in schools. Consideration needs to be given to the development of teaching strategies which are appropriate and purposeful in these different contexts. There is an increasing presence of whiteboards and data projectors to support interactive whole-class teaching and presentation (Glover and Miller 2001); ICT suites are available in pooled, timetabled rooms in primary and secondary schools (Loveless 2001); and portable technologies for student and teacher use are used in many curriculum areas (Thorpe and Roberts-Young 2001). Researchers have identified a range of factors of personal approaches in professional development for both creativity and the integration of ICT in teaching (see for example Craft 1997; Watson 2001).

Challenges are being made to expectations of traditional classroom settings. Open and flexible spaces for interaction between people and technologies have been

societies and cultures have the ability to both enhance and detract from creativity

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challenges are being made to expectations of traditional classroom settings

designed to support creativity and resourcefulness. Commercial and university research laboratories have been established to reflect the need for flexibility and multi-disciplinary teams (Anonymous 2001). An example of an educational environment designed for creative interaction can be found at Highwire, a City Learning Centre in London (see www.highwire.org.uk). As well as using ICT in fixed, physical spaces, the developments in the design of personal mobile and wearable technologies can support learners in any location at any time. Sariola and his colleagues working in Finland (2002) describe the early 'weak signals' they detected in the potential of 'mobile learning' with digital technologies ranging from telephony to video conferencing, which indicated ways in which students could extend the times and places of their learning (Sariola 2002). Sharples describes a framework for the design and formative evaluation of a new genre of educational technology which raises questions about theories of computer-mediated learning and developments in human-computer interfaces (Sharples 2000), and developments in improving human-technology interaction for stimulating creativity and intuition are currently being investigated in the INVITE research project (Intuitive Human-Technology Interaction in the Information Society) (Bullinger and Ziegler 2002).

4.3 ICT AND THE VIRTUAL LEARNING ENVIRONMENT

As well as the physical spaces in which ICT resources are made available to promote learners' creativity, ICT applications themselves can provide environments for creative activity. Storyboard software, such as Kar2ouche, has been demonstrated to support pupils' engagement with and understanding of complex texts (Birmingham and Davies 2001). The use of Virtual Reality environments and Knowledge Forums as spaces for potentially creative collaboration is discussed in more detail in Section 5 (Bruckman and Resnick 1995; Scardamalia 2000; Ahlberg, Kaasinen et al 2001; Bailey and Moar 2001; Leach 2001). There is development in the use of Managed Learning Environments or Virtual Learning Environments in education, yet in the field of Knowledge Management, however, Shani et al indicated that the contribution of specific groupware technology to team creativity was inconclusive and there was a complex interaction of many factors in the team's performance (Shani, Sena et al 2000).

The use of Knowledge Forums for collaborative knowledge building within groups of peers, novices and experts can also be seen as the development of tools for creative collaboration which reflect beliefs, values and theories about how learners learn and the roles that teachers might adopt. Scardamalia describes the design challenges in developing knowledge building communities in which participants work creatively with ideas:

- provide 'a way in' to knowledge creation for all students. This requires that students acquire agency over their own minds. It is this 'epistemic agency' that allows them to begin to create, examine and improve ideas
- engage students directly with 'idea improvement' and with 'problems of understanding'. This requires that students become constructivists

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themselves – understanding that knowledge is constructed and continually improved upon by people, and this is something they can do

- render the hidden aspects of knowledge creation transparent and foster these processes in day-to-day discourse. 'Knowledge-building technology' serves this purpose

- provide social supports for knowledge creation. This is the role of 'knowledge building communities'

- sustain work at the cutting edge of abilities and disciplines. This is fostered through a 'Knowledge Society Network'. (Scardamalia 2000, p5)

In thinking about how we might teach for creativity with digital technologies, a key factor is the development of learning environments which provide opportunities and promote an ethos which support creativity. Contexts which are conducive to creativity reflect qualities of exploration, play, taking risks, reflection, flexibility, focus, commitment and sensitivity to valuing the endeavours of individuals and communities. Such environments may be traditional classrooms and schools, or innovative approaches to the design and location of places to learn, or even virtual spaces created by the technologies themselves.

Teachers and learners working in more traditional spaces need to consider the demands placed upon them by the sheer physicality of the resources, from ICT suites to portable computers, and recognise that in such a fast-changing field, today's 'solution' may be tomorrow's 'problem'. Establishing a suite of computers or sets of interactive whiteboards in a school may address

problems of access and coverage of material at a particular time in a school's development, yet become too fixed and inflexible as the confidence, competence and rationale for using ICT in creative ways develops. Designers of innovative environments for creative learning, whether in physical places such as Highwire, or with resources such as mobile technologies, can consider the 'weak signals' in early work in human-technology interaction which can indicate possibilities for further development.

Creative imagination is needed to recognise the potential of the technologies themselves, from Virtual Reality to Knowledge Forums, to afford new kinds of spaces for trying out ideas, collaborating and building knowledge communities. The following section will address various creative practices which are currently being expressed with digital technologies.

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It is important to note that it is not the access to digital resources which 'delivers' creativity, but the opportunities such access affords for interaction, participation and the active demonstration of imagination, production, purpose, originality and value. Creative activities with new technologies can include developing ideas, making connections, creating and making, collaboration, communication and evaluation. Each of these activities draws upon an interaction of the features of ICT and elements of creative processes. These activities are not always discrete or sequential and there can be synchronicity in their expression and overlap of applications for different

contexts which are conducive to creativity reflect qualities of exploration, play, taking risks, reflection, flexibility, focus, commitment and sensitivity

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purposes. The following sections present examples of such activities which illustrate how children and young people are able to use ICT not only to demonstrate elements of ICT capability, but also to support and enhance the development of creative characteristics in the interaction between people, processes, domains and fields.

5.1 DEVELOPING IDEAS WITH ICT

The ICT strand of 'Developing ideas and making things happen' is often associated with the use of digital technology to explore the question 'what would happen if....? The provisionality, interactivity and capacity of ICT to represent information in a variety of modes underpins the potential of digital technologies to promote resources for imaginative play, exploration, trying out ideas, approaches to problem-solving, taking risks in conjecture, and making connections between ideas. Software to support this includes simulations for modelling, spreadsheets or control technology to sense, monitor, measure and control sequences of events mediated by devices such as programmable toys or control software applications. Examples and discussion of such applications have been available in the literature for many years (see for example Loveless 1995). Loveless cites Kemmis et al who developed a model in which Computer Assisted Learning (CAL) could be described. They outlined paradigms of computer use as Instructional, Emancipatory, Revelatory and Conjectural Computer use which is 'revelatory' allows guided discovery and the revealing and construction of underlying models. This paradigm can be seen in the use of simulations and adventure games. Computer use which is

'conjectural' encourages playful exploration and the testing of ideas which enable learners to construct their own models and test hypotheses (Kemmis, Atkins et al 1977).

Examples of the conjectural approach to the use of computers are found in the use of Logo as a programming language which could support a 'constructionist' view of learning, in which exploration, play and the testing of hypotheses in 'Microworlds' play an important role (Subhi 1999). Papert's early vision of the use of Logo in schools has not been realised, yet there have been a number of developments arising from the work in this field. Imagine is a new generation of Logo which is a computational system 'to stimulate the emergence of new cultures for constructing, exploring and understanding... It employs creative computer environments to:

- encourage motivation in specific topics
- explore, visualise and demonstrate relations and dependencies
- simulate and model
- act as a microworld for discovery... creating and building...
- solve problems with constraints
- test...'
  (Kalas and Blaho 2002, p91-92)

See also the 'Thinking Skills, Technology and Learning' Literature Review for Futurelab, in which Logo is also discussed in some detail.

Developments are also being made in the design of materials to support children's exploration, problem-solving and scientific enquiry. In the US, researchers in the MIT

Media Laboratory have developed a range of programmable 'toys' or 'digital manipulatives' - beads, blocks and bricks - which reflect this purpose (Sargent, Resnick et al 1996) (see http://toys.media.mit.edu/). The Beyond Black Boxes (BBB) Project used tiny, programmable computational devices called Crickets which could be embedded into everyday objects to control, sense and communicate with one another via infrared light. The aim of the project was to 'reintroduce a vigorously creative, aesthetic, and personal dimension into the design of scientific instrumentation – particularly in the context of science education' (Resnick, Berg et al 2000, p2). Such work was also an attempt to counter the 'opacity' of computers in scientific processes. This project has been developed further in the Playful Invention and Exploration Network (PIE), which has established a network of museums working in collaboration with the MIT Media Laboratory, to disseminate the constructive use of new digital technologies (see http://llk.media.mit.edu/projects/pie). In Europe, the eTui project is part of the i3 – 'I cubed': Intelligent Information Interfaces – research organization. The collaborative project investigated 'tool-cases' for learning about learning, and in the UK, Ultralab developed an interactive toy that can learn, and be taught by children (see http://www.ultralab.ac.uk/projects/etui/index.shtml).

There is a wealth of high specification digital technology available for exploration and creation of ideas from film production tools to CAD/CAM and virtual reality simulations. These are used in a range of professions and occupations such as architecture, engineering, film-making and design. One example of such applications is provided in the description of a course in Virtual Design and Representation at Cornell University (winter 2000). The application of cheaper and more accessible versions of such software for developing ideas with children and young people is taking place in some contexts within and out of schools.

Web based resources are also available for learners to explore and test ideas online. Cannon et al investigated the design of a web-based National Laboratory of Virtual Manipulatives, in which elementary school children could interact with and design new mathematical objects that are not easily constructed physically (Cannon, Heal et al 2000). Other examples of the provisionality, interactivity and range of ICT which can underpin playful approaches to trying out imaginative ideas include the Tracy Beaker web pages on the BBC Schools website (see http://www.bbc.co.uk/cbbc/tracybeaker/); the BlockCorner site (see http://www.blockcorner.com/content.html) or the Sodaplay site which enables users to construct and animate models on screen (see http://www.sodaplay.com/). Building on developments in shared 3D Virtual Environments accessible on the internet, The Vertex Project focused on the ways in which children explored the design and creation of virtual spaces and objects using interactive virtual reality software (Bailey and Moar 2001).

Digital technologies have also been used to support the early stages of imaginative play, speculation and 'brainstorming'. Baron et al review the literature to support the development of methodologies for investigating representations of the relationships in IT systems using concept

digital technologies have also been used to support the early stages of imaginative play, speculation and 'brainstorming'

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finding things out in order to support, challenge, inform and develop ideas is an important element in the processes of using imagination, fashioning and pursuing purpose

maps and computer-based concept mapping tools (Baron, Bruillard et al 1999). The use of software applications such as Inspiration is supported by a bibliography on visual learning to underpin an approach to the use of concept maps by individuals and groups (see http://www.inspiration.com/vlearning/suggestread/index.cfm?fuseaction=suggested).

An innovative use of ICT in drama has been developed by Simpson, who describes the ways in which digital cameras and image manipulation software can be used in exploration and improvisation 'within' drama activities rather than just recording final outcomes. Digital images are used in the 'sketching' stages of the exploration and interpretation of texts, such as the multi-layered illustrated children's book, 'Not Now, Bernard'. They are then developed as an integral element of the drama as children respond to their constructed, manipulated images and incorporate them into their developing improvisations (Simpson 1999).

5.2 MAKING CONNECTIONS

Finding things out in order to support, challenge, inform and develop ideas is an important element in the processes of using imagination, fashioning and pursuing purpose. ICT can play a role in making connections with other people, projects, information and resources through the internet, world wide web and CD-Rom and the use of these communications technologies is well-documented (see http://www.teachingideas.co.uk/welcome). Many websites act as portals or starting points for information about creative uses of new technology. It is beyond the scope of this review to provide a comprehensive list

of such sites, but examples of sites with news, events, resources, research and links to related sites can be found through government and public agency portals. (See Table 2 for examples in the UK.)

As reviewed in Section 1, the British Government has identified a number of initiatives to provide online access to creative practitioners and materials (Blackstone 2002). Culture Online will provide new digital materials for the school curriculum and lifelong learning. They will be made available in a variety of ways, including new and existing websites, through a Culture Online gateway and linked to the DfES Curriculum Online portal and the National Grid for Learning. Projects will be developed by partnerships which might include cultural and arts organisations, broadcasters, creative media companies and educational publishers (see http://www.cultureonline.gov.uk/).

Table 2: Examples of websites for information and networking in the UK

British Educational Communications Technology Agency (Becta)
www.becta.org.uk

National Endowment for Science, Technology and the Arts (NESTA)
www.nesta.org.uk

Association of Teachers of Mathematics (ATM)
http://www.atm.org.uk/

Association of Teachers of English (NATE)
http://www.nate.org.uk

National Drama – the association
for drama educators
http://www.nationaldrama.co.uk

Association for Science
Education (ASE)
www.ase.org.uk

Design and Technology
Association (DATA)
http://www.data.org.uk

National Society for Education in
Art and Design (NSEAD)
http://www.nsead.org/

Creating Spaces, network of education
professionals promoting the creative
use of digital technologies
http://www.creatingspaces.org.uk

There are also many examples of websites created by individuals or organizations to provide resources for particular age phases and subject areas. One example is the EarlyBirds Music website which provides multimedia examples of video, sound and links to music resources for early, primary and special education (see http://www.earlybirdsmusic.com). BBCi provides access to artists' work which can be downloaded, viewed and listened to through its website (see http://www.bbc.co.uk/arts/digital/guestartists/index.shtml). Another example in the secondary sector is the Digital Art Resource for Education, DARE (see http://www.dareonline.org). This initiative is a collaboration between the Institute of International Visual Arts (inIVA), Middlesex University's School of Lifelong Learning and Education (LLE) and the Lansdown Centre for Electronic Arts (LCEA).

A key aim of DARE is to enable teachers and young people to access some of the ideas, issues and processes of a culturally and stylistically diverse matrix of recent work. The internet is probably unique in its existence as both an experimental medium and as a space for research, display and exchange, and the DARE site allows users to view how artists have been exploiting as well as critiquing the internet. (Sinker 2001, p33)

Access to worldwide galleries and museums can provide resources for stimulation and research. Access to practitioners such as artists, designers, engineers and architects through e-mail or video conferencing can establish networks and communities sharing expertise, questions and work in progress. The 24 Hour Museum is the National Virtual Museum which acts as a gateway to over 2,500 museums, galleries and heritage attractions in the UK (see http://www.24hourmuseum.org.uk). The Museum Open Learning Initiatives (MOLLI) is another example of such a 'window' to artefacts, activities and work produced by children and adults in the community in response to particular exhibitions and to individual artists' work (see http://www.molli.org.uk). The Quest website of the Natural History Museum in London is an example of a constructivist approach to use of the web for scientific enquiry (see www.nhm.ac.uk).

5.3 CREATING AND MAKING MEANING

The weaving of imagination, fashioning, pursuing purposes and being original needs to move beyond the use of tools and techniques for their own sake in the

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the weaving of imagination, fashioning, pursuing purposes and being original needs to move beyond the use of tools and techniques for their own sake

creation, drafting, editing and refining processes towards creating tangible outcomes, such as an image, a poem, a drama, a 3D construction or a movie. This involves not only the physical act of making, but also an ongoing 'dialogue' where 'the maker produces and the work responds'. The artist Terry Taylor places this dialogue at the centre of his work with children and digital images:

It is the representation of meaning that is the key that elevates production to a position beyond the merely decorative... By dialogue I mean the dynamic and creative cognitive processes involved when encoding and decoding meaning in visual texts...This takes time and a continuation of intention and cannot be achieved by ad hoc projects based on mechanical processes.
(Loveless 2000)

The Glebe Project and the Access Project took place in primary schools where children worked with visual artists. They used different media, including the digital technologies of scanners, cameras and graphics software, to capture and manipulate images in order to create and make meanings in the visual arts. The children produced pieces in response to a variety of stimuli and were encouraged to display and evaluate each other's work in progress. The digital images were not always the final products, but sometimes acted as stimuli or sketches for development of representations in other media. The children's skills with ICT techniques were demonstrated and developed in the context of their desire to explore and produce specific effects, whilst the aims of the projects were clearly focused on the creative expression of meanings (Loveless 1999; Loveless 2000).

The investigation of children's use of multimedia and presentation tools to create multimodal texts with images, written text and sound also recognises the development of multiliteracies in work across the curriculum (Cope and Kalantzis 2000; Callow 2002). Mavers draws on the work of Kress in discussing young children's understandings of multimodality in the use of the internet and the changing 'communicational landscape' (Mavers 2002). Atherton has carried out extensive work with primary school children using multimedia across the curriculum and described the planning and time required for the children to engage with the processes of creating and making complex multimedia pieces. The children's work demonstrated a good understanding of the ways in which the authors could construct interactive presentations with visual images, sound, animation and hyperlinks (Atherton 2002).

In a research project carried out with secondary pupils using multimedia authoring in the art curriculum, Long demonstrates not only the processes of development, manipulation and evaluation of digital images, but also growing awareness of the potential of multimodality in pupils' art work. During an eight month period, pupils worked with multimedia software on an art project taking 'Movement' as a theme. They expressed some disquiet as to whether their pieces were 'art' as they incorporated moving visual images and sound with reference to popular culture. In challenging their conceptualisations that art inhabits space whilst music inhabits time, as well as different aspects of the school curriculum, they 'also experienced the idea that art and image making is changed as a process when it

becomes part of a transmittable and infinitely repeatable set of information' (Long 2001, p261).

In these examples the technology played a distinctive role in these activities by providing opportunities for the pupils to capture, edit and transform digital data in order to make meanings. The creative processes of imagination, fashioning and 'flow' were supported by the immediacy of the presentation, the ease of manipulation and the possibilities of 'leaving a trail' of work in progress in order to trace the development of ideas, or revisit them in order to explore other possible routes. These characteristics of ICT are also being exploited in software applications which are accessible for young learners for the creative moving images with digital video, music, and the creation of 3D virtual worlds.

The British Educational Communications and Technology Agency (Becta) is running an award scheme for Creativity in Digital Video (www.becta.org.uk) which will present examples of DV work in schools. See also the website of Apple Computer, Inc for examples of pupils' work with creating and editing digital video (see http://www.apple.com/education/dv/). The Interactive Education Project at the University of Bristol includes work with digital music (Sutherland, Breeze et al 2002) (see also http://www. interactiveeducation.ac.uk/music_designs. htm). The Vertex Project at Middlesex University is exploring the ways in which children build and use structures, spaces and avatars in virtual worlds shared with other users on the Internet (Bailey and Moar 2001).

In a response to concerns from the Alliance for Childhood that computers stifle creativity (Cordes and Miller 2000), Abbott et al present a critique and describe a range of examples of children's creating and making work with multimedia and web technologies (Abbott, Lachs et al, 2001; Lachs and Wiliam 1998; Lachs 2000). However, there could be a danger of reading many of the published examples and descriptions of creative production as positive and progressive. Some researchers, however, draw attention to more problematic aspects of the creating and making work with digital technologies. Sefton-Green and Buckingham noted the limited nature of 'creative production' that was taking place in young people's experience with and access to digital technologies at school and at home (Sefton-Green and Buckingham 1998). Sefton-Green and Parker investigated how primary school children used edutainment software to create and edit stories, recognising that editing is the key creative act in the production of moving image 'texts' such as films or television programmes. The research demonstrated that the software available for this age range supports animation and composition, rather than conventional editing and the report argued that existing edutainment software packages aimed at children are severely limited in their creative potential (Sefton-Green and Parker 2000) (see http://www.bfi.org.uk/ education/research/edit-play/).

5.4 COLLABORATION

Recent understandings of the characteristics of human learning have recognised its social, situated and distributed nature in which knowledge is constructed through interaction and

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communication with others in communities (Lave and Wenger 1991; Somekh 2001). The speed and range of communications technology enable learners to collaborate with others in immediate and dynamic ways during their creative work in progress. Collaboration with artists, writers and fictional characters in 'non-residence' through e-mail or video conferences offers learners opportunities to work with others to generate ideas, pursue purpose and evaluate ongoing, original work. Junior children in Robin Hood School in Birmingham used video conferencing facilities to establish contact with artist Nick Eastwood, look at his work, ask him questions and receive feedback from him on their own work created in response to the experience (see http://www.becta. org.uk/technology/desktopvc/telecomms/ art.html). Children participating in the Interactive Education Project focused on the use of e-mail to explore how awareness of audience and purpose shapes writing by corresponding with two 'Viking settlers' (Sutherland, Breeze et al 2002).

The Bristol Internet Project was set up in 1998 to enable children in schools in two different communities in the city to collaborate with each other on making visual images over time and distance. They used digital cameras and 'paint' programs to construct images of themselves which were attached to e-mail messages to their 'key pals' in the other school, asking questions such as 'Who am I?'. Artists in each school worked with the children to interpret, respond to and manipulate the images received before sending them back with their developed ideas (Loveless 2000). Similarly, the Virtual Identities Digital Arts Project involved post-16 art and design

students in schools in Liverpool and Kent. The students sent 'digital postcards' which represented their personal identity to their partners who interpreted and manipulated the image, whilst keeping 20 per cent of the original image (Leach 2001).

The internet can also be used as a 'shared space' beyond a straightforward exchange and collaborative manipulation of images. The Hands-On Dance project at the University of Leeds enabled interactive dance workshops between novice and more experienced dancers to take place using e-mail discussion, internet video conference rehearsals and an interactive website (Popat 2001). Text-based virtual reality environments can be viewed as spaces for creative collaborations in story telling and role play. Bruckman and Resnick, for example, have worked with researchers and children using MUDS (Multi-User Domains) (Bruckman and Resnick 1995), and Abbott discusses the linguistic forms of real time written chat in such environments (Abbott 1998). The development of 3D shared spaces in virtual reality internet games and applications has been highlighted in the work of the Vertex Project (Bailey and Moar 2001).

5.5 COMMUNICATION, PUBLICATION AND AUDIENCE

Presentation and communications technologies enable learners to present and celebrate their work to a range of audiences, from a Powerpoint presentation in a classroom to a website available to an unknown, and unpredictable, audience. Richard Hitcham School, for example, publishes children's work from all areas of the curriculum, including the variety of pieces produced in a project working with

an artist in residence sharing his own painting and digital work (see http://www.hitchams.suffolk.sch.uk/ict_art/index.htm). Similarly, initiatives such as 'Walkers' Showcase' enable children to publish a wide variety of their creative work, from scanned images of art work in other media to poetry and sound files of them playing musical instruments (see http://www.walkersshowcase.co.uk/index.jsp). Examples of a range of pupils' work with multimedia, digital video and web publishing can also be seen in the work of Highwire, a City Learning Centre in Shoreditch, London (see http://www.highwire.org.uk).

It is the consideration of purpose and audience which can lead children into more detailed evaluation of the levels of originality and the critical, reflective consideration of value in their work. Lachs emphasises the importance of the awareness of audience in the whole design, creation and presentation process of making multimedia (Lachs 2000). In Atherton's work with multimedia in primary classrooms, the children may be making a game for their younger siblings or a presentation for a visiting dignitary, but she places appropriate interaction and communication with audiences centrally to the processes of design, making and evaluation (Atherton 2002).

It is beyond the scope of this review to consider a particular domain in detail, but there are some useful indications of the potential of ICT in creativity and learning in the ways in which practitioners in the arts and cultural industries employ digital technologies. Mak presents evidence of negative attitudes towards computers in art amongst 64 high school students who were familiar with digital technologies and

art in their curriculum. She discusses the reinterpretations and changes which would need to take place in understandings of pluralistic styles, realism, interactivity, originality and ownership with 'digital art' (Mak 2001).

Some theatre practitioners warn against the loss of spontaneity and community which can accompany the use of technology in the theatre and theatre research practices (Carson 1999). Beardon, however, draws attention to the development of Visual Assistant software designed to promote improvisation, expression and communication of visual and spatial ideas about theatre performances (Beardon 1999). Designers also express concern that the high levels of technical expertise required in new inter-disciplinary design studies may lead to a loss of quality without evaluation of processes and outcomes. Neilson and Trias propose a model for evaluation which reflects reason, function, emotion and senses and technology (2000). Examples of the work of artists using digital media are commissioned and exhibited by galleries such as 'Wired Worlds' at the UK National Musuem of Photography, Film and Television (Ferris 2000); new works are presented and discussed at conferences such as ISEA (see http://www.isea.qc.ca), whilst 'tradigital' is a term used to describe artists and groups whose works bridge traditional and digital worlds (Gollifer 2000).

5.6 MOVING FORWARD

The practices described in the previous examples illustrate how people have engaged their imagination in recognising the potential of ICT to make a distinctive

ICT resources can support the creation and development of ideas if they reflect an approach to open-ended exploration in design and use

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contribution to creative processes of developing ideas, making connections, creating and making, collaboration and communication for audiences. This contribution affords opportunities for experiences which are not as easily accessible or possible with other media and tools.

ICT resources, whether hardware or software, can support the creation and development of ideas if they reflect an approach to open-ended exploration in design and use. Such resources are often developed to high specifications within commercial or research environments, but thoughtful and well-informed design can present these ideas more appropriately for younger or less-experienced users. The designers of the concept-mapping software Inspiration, for example, indicate a bibliography of resources and research into learning which stimulated their thinking in the design. It is the examination of the concepts which underpin ICT tools for practice in design, manufacture, editing or virtual reality which will support the development of hardware and software created to mediate learning, rather than the production of 'cut down' applications for office productivity. Analysis of case studies of innovative use of ICT in exploratory and playful ways could provide insights into deeper understandings of both creative processes and ICT capability.

The use of ICT to make connections is a powerful and positive use of the technology which provides access to cultural experiences and perspectives across time zones and geographical spaces. Access, however, is only part of the story, and attention could be given to the nature and design of truly interactive learning experiences with resources such as the

world wide web. The Quest website at the Natural History Museum, for example, provides not only access to artefacts but also opportunities for communication with 'experts' and knowledge building through activity.

Creating and making with ICT tools enables users to capture and manipulate information and provides immediacy for feedback and development, yet we must recognise that digital technologies are recent tools and media which we are still exploring. There are parallels with the introduction of earlier technologies such as photography and film which were first used to imitate rather than express new ideas. We are still in the early days of understanding the characteristics and potential of the new digital medium which can be manipulated to literally 'paint by numbers' in the manipulation, transformation and processing of data (Mitchell 1994; Loveless 1997). Designers and developers of ICT resources could consider innovative ways to work with and develop understandings of the nature of digital technologies as both a tool and a medium in creative processes.

The range of creative practices discussed in this review will of course develop with time, and probably in unpredictable ways. There are four questions we can ask to assist us in developing a critical awareness of our practices:

- how are we using digital technologies at present to mimic activities we have done by other means?
- what is gained and what is lost in experience and expression in using digital technologies in creative practices?

the use of ICT to make connections is a powerful and positive use of the technology

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- how are we exploiting features of ICT which enable us to express different ideas?
- how do we evaluate the processes and outcomes of work with these comparatively recent tools and media?

The following section indicates how we might develop our sense of value and judgement of creativity and digital technologies.

6 HOW CAN WE ASSESS CREATIVITY, LEARNING AND DIGITAL TECHNOLOGIES?

6.1 ASSESSING CREATIVITY

The assessment of creativity is complex and problematic in structures of assessment in which quantifiable, measurable outcomes are considered to be 'high stakes' and valued for the purpose of making judgements and comparisons between individuals, institutions and systems. Beattie draws attention to the complexity of identifying and assessing creativity, stating that over 200 instruments have been developed for the purpose and citing Sternberg (1991) in claiming that none have been able to measure the concept adequately. She offers detailed suggestions for the format of creativity assessment tasks and the criteria required for judgements which focus on creative processes, environments and student expression as well as final outcomes (Beattie 2000). Sefton-Green discusses the complexities of evaluation of creativity in relation to a range of curriculum subjects and highlights the tensions which underlie views of childhood and power relationships in assessment in

schooling. He acknowledges the dilemma which teachers face in evaluating pupils' creative work, not only in terms of the pupils as learners needing to improve and progress, but also regarding the pupils as makers of personal meanings, expression, values and attitudes (Sefton-Green 2000). The NACCCE report, 'All Our Futures', acknowledges the role of assessment and inspection frameworks in raising standards of school achievement in the UK, but includes recommendations for an easing of pressure of assessment, a closer consideration of appropriate assessment strategies for different areas of the National Curriculum, and greater emphasis on formative assessment for learning (NACCCE 1999).

6.2 ASSESSING ICT CAPABILITY

The assessment of ICT capability is no less problematic. McFarlane presents an account of the three perspectives on ICT in schools which influence policy, practice and perspectives on assessment:

- ICT as a set of skills or competences
- ICT as a vehicle for teaching and learning in and across the curriculum
- ICT as an agent of change in teaching and learning.

Her discussion highlights the inadequacy of approaching assessment strategies for ICT capability without consideration of the context and purpose of use of resources. She also emphasises the inappropriate nature of current standardised assessment and testing instruments which do not recognise the indirect effects of the use of ICT on learners' motivation, attitude, problem-solving capability, critical thinking

digital technologies are recent tools and media which we are still exploring

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and information-handling abilities (McFarlane 2001). The National Curriculum Attainment Target for ICT is presented in terms of process and higher order thinking, yet the terms are not closely defined, nor related to levels and areas of attainment in other curriculum subjects (McFarlane, Williams et al 2000).

There are, however, examples in the literature which indicate approaches to meaningful evaluation and assessment of learners' creativity and ICT capability. McFarlane et al describe how the use of multimedia authoring enabled 9/10 year old pupils to create multimedia pieces which demonstrated their understanding of content and conceptual relationships in drugs education topics more clearly than written tests. In discussing the potential of such tools and processes in assessment, they call for further research and discussion of how teachers can 'interpret, evaluate and assess the processes, practices, skills and competences evidenced in the form, structure and content of pupil-authored multimedia work' (McFarlane, Williams et al 2000, p210-211).

6.3 ASSESSING CREATIVITY AND ICT CAPABILITY

Useful starting points for the discussion of evaluation and assessment of creativity and ICT have been offered by Jonassen (Jonassen 2000) and Lachs (1998) who both suggest dimensions along a range of criteria. Jonassen focuses on the use of a range of ICT applications (or 'Mindtools') within subject domains to demonstrate knowledge construction, self-regulation, collaboration, critical thinking and creative thinking. Lachs emphasises the

importance of peer review and evaluation as well as teachers' formative assessment. In evaluating pupils' multimedia and web work she proposes dimensions for criteria for audience interactivity, planning non-linear environments, data collection and design, subject matter and working with others.

Sinker offers a detailed discussion of the issues associated with evaluating young people's creative multimedia production (Sinker 2000). She suggests that there is a need to draw upon traditions and expertise in both art and media education in the use of multimedia technologies in teaching and learning, echoing earlier calls for such collaboration in the development of photography. She recognises that such work is still in its infancy and that the use of digital technologies raises questions about the evaluation and judgement of creative processes and products that are different from more traditional tools in arts practice.

The multimedia terrain, with its strata of meanings, its combination of media, its compilation of data, and its branching, tangential connections would seem the ideal tool for this 'postmodern' age. But its chameleon character – a tool for writing, reading, talking and listening, a tool for drawing and looking, a tool for animating and viewing and a tool for gaming, interacting and consuming – makes it less easy to gauge in evaluative terms. (Sinker 2000, p195)

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7 WHAT ARE THE IMPLICATIONS FOR PRACTICE, CURRICULUM AND DESIGN?

7.1 IMPLICATIONS FOR PRACTICE

In the context of this review, implications for practice are focused on three areas:

- classrooms or planned informal settings
- teacher education
- research.

7.1.1 IMPLICATIONS FOR PRACTICE IN CLASSROOMS OR PLANNED INFORMAL SETTINGS

A Creativity Framework should underpin planning, practice and evaluation. The framework should recognise the interaction between individuals and communities, processes, domains and fields, and the characteristics of imagination, fashioning, pursuing pur pose, originality and value judgements. In planning, for example, teachers could identify the learning intentions, teaching strategies and opportunities for assessment to reflect an area such as Developing Ideas or Collaboration, in which the features of ICT contribute to the NACCCE framework for creative processes.

The learning environment established in educational settings should acknowledge and reflect characteristics which are conducive to creative developments:

- awareness of the ways in which creativity is related to knowledge across the curriculum, not just the 'arts' and that the rules and structures underpinning 'conceptual spaces' in different knowledge domains can be combined, explored and transformed
- opportunities for exploration and play with materials, information and ideas
- opportunities to take risks and make mistakes in a non-threatening atmosphere
- opportunities for reflection, resourcefulness and resilience
- flexibility in time and space for the different stages of creative activity
- sensitivity to the values of education which underpin individual and local interest, commitment, potential and quality of life
- teaching strategies which acknowledge 'teaching for creativity' as well as 'teaching creatively'.

The models of access to ICT resources should provide opportunities for whole class, group and individual work which can be focused and flexible according the nature and demands of the processes and activities. This may involve a reappraisal of access to ICT in classrooms, dedicated suites, clusters, sets of portable resources and provision in the home.

Hardware and software resources should reflect a range of tools and media suitable for activities throughout the Creativity Framework, from developing ideas to publishing and reviewing outcomes.

Learners should have opportunities to develop ICT skills and techniques in authentic and challenging creative contexts.

a creativity framework should underpin planning, practice and evaluation

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Learners should have opportunities to make informed choices of ICT tools and media available for different creative processes and stages.

Consideration should be given to flexibility in time and space for creative activities.

Strategies for appropriate formative assessment of creativity and ICT capability should be developed and evaluated.

7.1.2 IMPLICATIONS FOR PRACTICE IN TEACHER EDUCATION

Continuing professional development should be available at local, regional and national level to develop awareness of and confidence in:

- frameworks for creativity
- potential for interaction with ICT capability
- pedagogy and management of learning environments
- evaluation and assessment strategies
- case studies of practice in other settings.

Models of professional development and initial teacher education should provide opportunities for experiences of creative processes with ICT in a range of curriculum subject domains.

7.1.3 IMPLICATIONS FOR PRACTICE IN RESEARCH

Research should conceptualise theoretical models of creativity with ICT which can support a range of research questions, methodologies and modes of presentation of the practices which are ongoing or being developed.

Research should make connections between the different strands of creativity research and educational ICT research.

Examples of creative practice and development with ICT should be described, analysed, theorised and presented for peer review in order to provide greater breadth and depth in the literature. This could be achieved through the encouragement of small-scale evaluations of ongoing work which apply rigorous research techniques, as well as more large scale and longitudinal research designs.

The role of ICT in supporting the research process itself as a creative activity should be investigated.

Strategies for research in the field should address the themes outlined in this review: the interaction between creativity and ICT capability; cross-disciplinary and cross-phase communication of practice; evaluation and assessment of creativity and ICT capability; developing learning environments for creativity with ICT.

7.2 IMPLICATIONS FOR CURRICULUM DEVELOPMENT

Consideration should be given to explorations of broad knowledge domains through cross-curricular and thematic work.

Curriculum areas should identify creativity frameworks in their subject domains, the interaction with ICT capability and the

WHAT ARE SOME OF THE BARRIERS?

appropriate use of ICT as a tool and as a medium.

Assessment strategies which are appropriate for identifying the interaction between creativity and ICT capability, and useful in providing formative feedback within knowledge domains, should be developed and evaluated.

Ongoing examples of innovative practice should be analysed in terms of their potential to inform curriculum development.

7.3 IMPLICATIONS FOR THE DESIGN OF LEARNING RESOURCES

Guidelines for a 'creative toolkit' of ICT resources should be identified to enable individuals and communities to have access to technologies which enable them to engage in a range of creative processes from conjecture to evaluation. This might include descriptions of the types of ICT applications and equipment which could support a range of creative practices - from portable devices to capture digital images and sound to multimedia authoring software or programmable toys.

Guidelines for the evaluation of 'creative learning resources' should be developed to enable designers and users to make informed decisions about the claims made for products and materials. These might include exemplars and questions to ask about ICT resources to determine their potential to support developing ideas or creating and making, or their potential to promote individual or collaborative work, or publish outcomes of creative work in order to engage in evaluative feedback from others.

Guidelines for the design of creative digital learning resources should provide opportunities for interaction between higher order ICT capability and creative processes. The design and development of learning resources, whether by commercial or non-commercial producers, should recognise potential to support progression and interaction in creative processes, from imaginative activity and making informed decisions about appropriate media and tools, to engaging in critical evaluation.

8 WHAT ARE SOME OF THE BARRIERS?

The review has indicated that there are key factors which underpin creative processes and have an impact on the success of teaching for creativity, and that digital technologies can play a distinctive role in both of these aspects of creativity and learning. There are, however, barriers to the development of creativity in traditional educational settings. None are insurmountable, but each needs to be recognised as a constraint upon learners realising the potential of the creative use of digital technologies.

There are some critical concerns about the development of creativity in schooling in the UK. Kimbell has highlighted the 'profound state of alarm about the creative condition of the experience received by our youngsters in school' (Kimbell 2000, p206). He states that the necessary conditions for creative acts are affective and cognitive support and a trusting relationship between children and teachers which allows risk and failure. Yet he argues that the artistry required of teachers to inspire and encourage pupils' creativity is

artistry required of teachers to inspire and encourage pupils' creativity is marginalised and damaged by the 'dead hand' of the regulatory organisations

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teachers need
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practice and
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development

marginalised and damaged by the 'dead hand' of the regulatory organisations, such as Ofsted, which value standards and management over creativity and risk-taking (p208).

Although many countries focus on creativity and cultural education, there are recognised to be challenges in curriculum overload and low status of the arts in schools (Sharp and Le Metais 2000). In the English National Curriculum the time and attention given to creative subjects in the primary curriculum is also being squeezed by the demands of the National Literacy and Numeracy Strategies and the focus upon school performance in league tables of children's achievement in Standard Assessment Tests in English, Mathematics and Science. There is also evidence that the time allocated to consideration of creative subjects is also limited in teacher education provision (RSA 1998).

Access to a range of technologies to support creative practices is important and sizeable government resources have been given to support the development of ICT in schools, libraries, museums and community spaces. Many of the British government initiatives relate to providing access to the internet to support the development of ICT capability in the creative spheres, yet in a preliminary consideration of the impact of the National Grid for Learning Initiative (NGfL), researchers note the need for caution in claiming significant and purposeful access to the internet for children and young people in school and home (Furlong, Furlong et al 2000). Teachers need not only access to technologies, but also a framework to promote understanding and confidence in their own creative teaching practice and professional development.

It is said that fear and vanity are often the two emotions which prevent us from realising our potential in many areas of life, and addressing them takes confidence, trust and courage in individuals and within communities. New approaches to flexibility and exploration in ways of working, pedagogy, curriculum, assessment and management of time and resources in schools could be tried, but this will require the encouragement of an ethos of creative challenge and celebration of imagination and 'possibility thinking'.

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