

14-19 and Digital Technologies: A review of research and projects

Chris Davies, Geoff Hayward, Linariah Lukman

▶ **To cite this version:**

Chris Davies, Geoff Hayward, Linariah Lukman. 14-19 and Digital Technologies: A review of research and projects. 2005. hal-00190495

HAL Id: hal-00190495
https://telearn.hal.science/hal-00190495

Submitted on 23 Nov 2007

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

FUTURELAB SERIES

REPORT 13:

14-19 and Digital Technologies: A review of research and projects

Chris Davies, Geoff Hayward and Linariah Lukman
Department of Educational Studies, Oxford University



REPORT 13:

14-19 and Digital Technologies: A review of research and projects

Chris Davies, Geoff Hayward and Linariah Lukman
Department of Educational Studies, Oxford University

CONTENTS:

EXECUTIVE SUMMARY 2
SECTION 1 INTRODUCTION 5
SECTION 2 UNDERSTANDING THE 14-19 DEBATES 7
SECTION 3 DIGITAL TECHNOLOGIES AND THE 14-19 AGE GROUP 22
SECTION 4 CASE STUDIES 30
SECTION 5 CONCLUSION 37
REFERENCES 40

FOREWORD

The 14-19 debate goes to the heart of a number of core questions: What is education for? Who should benefit? What attributes do we value and need in our young people as workers, as learners? Where does learning happen? What role should young people themselves play in shaping their education? These have been the subject of heated debate in policy, research and practice circles in recent years and we are beginning to see this spill out into a new national debate on the purpose and value of education.

One thing is clear: the most radical changes proposed - enabling young people to create coherent pathways through the welter of educational choices, to access diverse learning experiences in multiple sites of learning and work, to take responsibility for their own assessment – cannot be achieved without digital technologies. At the same time, these technologies also have the potential to offer radically new approaches to the processes of teaching and learning for this age group. What then, is the role for digital technologies in the development of a new learning environment for 14-19 year-olds?

The authors of this review offer a clear and coherent response to this question: by outlining the key issues in these debates and reviewing the evidence on young people's learning and development in this age range, they map out a framework within which we can create a coherent strategy for the design and use of digital technologies for learning – whether in conventional academic contexts, or in the myriad sites of learning in more radical visions.

As always, we hope that this review will serve to stimulate debate and act as a useful resource for those looking to develop learning environments that meet the needs of young people in the 21st century.

Keri Facer
Learning Research Director
Futurelab

EXECUTIVE SUMMARY



the 14-19 period is one of huge personal, social and psychological change

EXECUTIVE SUMMARY

The 14-19 phase is a period of transition for young people as they move from compulsory to post-compulsory education and training, into the labour market and to higher education. The outcome is an increasingly heterogeneous population of learners distributed across a wide range of learning situations with different and often highly specific learning needs. Choices made during this phase – whether to carry on studying, what to study, where and how – all have the potential to affect the future life course. As a consequence, the 14-19 phase has been moving inexorably up the political agenda given current policy concerns with competitiveness, productivity, the need for a more skilled workforce and a more socially inclusive society.

AN EMERGING SET OF POLICIES

However, despite almost 30 years of reform the 14-19 phase is not underpinned by a coherent system of education and training. Young people and their families are faced by a welter of disparate learning opportunities from which to construct a learning career. Guidance to support the formation of such a career remains weak, with the result that too many young people choose poorly, ending up either in a learning blind alley or in low skilled and often temporary work that does not offer prospects for further learning that leads to qualifications. Increasingly, therefore, education and training policy for this phase has focused on reducing the academic-vocational divide, producing a more coherent system that is simpler to navigate and providing more scope for young people to construct an individualised learning career that matches their needs and interests. Digital technologies are seen as having an important role to play in delivering all of these policy objectives.

LEARNING AND DEVELOPMENT

The 14-19 period is also one of huge personal, social and psychological change. Young people continue to develop their higher cognitive skills and their ability to self-regulate their learning. Such development is best fostered by providing challenging learning tasks, with young people having meaningful choice over the tasks they choose to do and how they complete them. Achieving these twin aims of increased development of higher cognitive skills and improving self-regulation is central to wider concerns about promoting lifelong learning. To make sure more young people are successful in developing these attributes requires access to powerful learning environments which are often heavily reliant on digital technologies.

Another major concern is that young people in this age range are thought to lack motivation or to have low self-esteem. However, the use of such terms can obscure as well as illuminate. Thus it is never the case that young people are unmotivated but rather that they are more motivated to undertake some sorts of activities than others. A more in-depth understanding of the multifaceted nature of self-worth is therefore needed to underpin the construction of powerful learning environments than relying on more surface use of the constructs of motivation and self-esteem. In general, young people's feelings of self-worth are likely to grow if they are engaged in tasks which they perceive as being important

and in which they are successful. This promotes person-environment fit and leads to growth.

However, using digital technologies simply for their motivational affordances will not be enough to ensure young people have the opportunity to achieve. The research evidence suggests that motivational variables do not directly affect achievement outcomes. Rather the effects of such variables are mediated by variables linked to the development of self-regulation and higher cognitive skills. Thus developing digital solutions to meet the learning needs of young people in this phase has to take account of this complexity.

Developing powerful learning environments for the future will, therefore, need to take account of a range of research evidence about how young people develop during this phase, in addition to linking strongly to policy imperatives if they are going to be successful. The design of such learning environments can be guided by six questions derived from recent research on constructivist and social constructivist learning theory:

1 Are the intended outcomes of the learning environment durable, flexible, functional, meaningful, generalisable, and application-oriented?

2 Are thinking, learning, collaboration and regulation skills being taught?

3 Is there a shift of focus towards more experiential learning: more active, cumulative, constructive, goal-directed, diagnostic and reflective learning?

4 Is there a shift of focus towards more independent learning: more discovery-oriented, contextual, problem-oriented, case-based, socially and intrinsically motivated learning?

5 Is there conscious attention for the gradual increase of independence according to the sequence of independent work, strategic learning and self-directed learning?

6 Is there modelling, external monitoring, scaffolding, metacognitive guidance, attention for self-evaluation, practice of skills, feedback and reflection?

DIGITAL TECHNOLOGIES AND THE 14-19 AGE GROUP

Digital technologies are deployed in a wide range of elaborate and inventive ways in order to manage and support young people's current learning, and their processes of making key choices about future learning. These different kinds of provision encompass affordances such as helping young people to plot learning pathways that enable them to get the best out of a range of local educational provision; some allow their teachers and others to keep detailed records of progress and achievement as they move through that provision; and some allow for innovative ways of making that provision engaging and accessible. This includes, importantly, provision for those excluded from the mainstream educational system. A tension still exists, though, between the desire to use digital technologies to provide learning opportunities that support more independent and adult forms of learning, and the need that many teachers feel not to lose control over the curriculum and associated modes of learning.

using digital technologies simply for their motivational affordances will not be enough to ensure young people have the opportunity to achieve

EXECUTIVE SUMMARY



new thinking envisages the construction of very different sorts of learning environments

CASE STUDIES

Four case studies are used to illuminate the ways in which digital technologies can be used to support learning during this phase. The case studies represent a gradual change in the extent to which the use of the digital technology is embedded in the learning environment. All the case studies testify, at least to some extent, to the need to think again about the nature of learning environments, the need for teachers and learners to mutually reconfigure their roles, and the costs of developing innovative solutions if digital technologies are to fulfill their potential in improving learning opportunities for all young people in this age range. At its boldest, such new thinking envisages the construction of very different sorts of learning environments, especially for those in vocational education and training, which aim to surmount theory-practice divides whilst encouraging the use of higher cognitive skills by increasingly self-regulated learners.

CONCLUSION

Overall, however, the research base on which to base practice for the use of digital technologies to enhance the learning of 14-19 year-olds is weak. Much of the 'literature' consists of nascent solutions based upon interesting ideas or a form of promotional discourse that portrays learners in very false ways. However, we cannot wait for research to answer all the questions we might have about the efficacy of digital technologies in promoting learning before we proceed to implementation. A way forward would be to use a design experiment approach involving collaborations of teachers, software manufacturers and instructional design experts. This would require teachers to adopt an experimental stance to their teaching. The extent to which this can happen widely enough to make a real difference to our understanding of how these technologies can help to improve the quality of the learning experience for young people in this phase, is seriously weakened by the Government's continuing insistence, at least in England, to rely on narrow accountability measures based on exam success.

INTRODUCTION

1 INTRODUCTION

The context in which young people are educated and prepared for the future is undergoing rapid change throughout the developed world at the beginning of the 21st century. Such changes are characterised by changing labour markets, a new cultural ethos shaping young people's attitudes and values, and a lengthened period of transition from education into the world of employment. In combination these various pressures lead to changing demands upon the education and training system from the state, learners and their families, employers, higher education and the wider community.

In the UK context a particular set of concerns and demands are articulated through general skills policy. This highlights the poor labour productivity performance of the UK relative to our industrial competitors and attributes this, at least in part, to the low level of skill amongst the workforce, as signalled by the lower than desirable proportion of workers holding qualifications, especially vocational qualifications. Another set of concerns is articulated through social welfare policy, where the route out of poverty is increasingly seen as lying in moving welfare recipients off benefits and into the workforce. However, to achieve the desired levels of social inclusion requires that people are made more employable, which is again seen in terms of ensuring that they achieve qualifications. A particular concern with this latter group of people is their low level of basic skills, which makes employment in anything other than unskilled occupations problematic.

These twin concerns, of upskilling the workforce and promoting social inclusion, are manifest in the objectives of 14-19 education and training policy (eg Brown, Corney and Stanton 2004; Hayward et al 2004; Stasz and Wright 2004):

- increase levels of post-compulsory participation to match that found amongst our international competitors by countering the significant levels of disengagement from the education system found amongst some young people[1]
- provide coherent progression routes for young people, especially in the vocational component of the 14-19 curriculum, to counter the tendency to 'drop-out' at 16 and 17
- increase levels of achievement so that we match our international competitors in terms of the proportion of the labour force qualified to Levels 2, 3 and 4
- provide a more demanding academic offer to stretch the 'brightest' young people
- focus on core competencies judged essential for working life – communication, numeracy, problem solving and team working skills.

Achieving these worthwhile objectives involves a variety of policy measures, such as increasing choice for young people and providing more customised learning. Such policy measures, it is hoped, will increase the invitational qualities of the 14-19 phase for all learners but especially for those who are currently disengaged and disaffected. In addition, there is also the need to provide a more demanding curriculum for the academically more able,

the context in which young people are educated and prepared for the future is undergoing rapid change

[1] Documented by many sources including N Pearce and J Hillman (1998) Wasted Youth: Raising Achievement and Tackling Social Exclusion. London: IPPR

INTRODUCTION



a learning career describes the changes in a student's dispositions to knowledge and learning across contexts and time

leading to calls for greater flexibility in when such young people sit examinations, accelerated progression, and the opportunity to study Higher Education material whilst still at school. Reforms of A-level assessment will also probably result in such young people being provided with the opportunity to answer more demanding questions on the A-level examinations, similar to those currently being asked on the Advanced Extension Award Papers.

The Government sees digital technologies as playing a central role in delivering these policy objectives, and any new initiatives must certainly pay due heed to the likely future developments of policy for this age group. However, to extract the greatest benefit from digital technologies we must go beyond policy to the developmental and learning needs of 14-19 year-olds. Here two conceptual tools – learning careers and powerful learning environments – seem to provide a helpful bridge from the generality of policy to the specificity of the classroom (broadly conceived).

A **learning career** describes the changes in a student's dispositions to knowledge and learning across contexts and time (Bloomer 1997). The concept reflects the concern that locating learners only through reference "to positions within institutional structures – to course and subject group membership, year of programme, entry qualifications and such like – is not an adequate way of capturing the essential qualities of learners..." (ibid, p149). Furthermore, whilst the concept of a learning career refers to the development of a learner's dispositions to knowledge and learning over space and time, this should not be interpreted as arising from the effect of some set of enduring personality traits upon such dispositions and the consequent actions of learners. Rather, it reflects a concern with understanding how individual young people perceive the opportunities made available to them. Thus the concept of a learning career rejects the idea that given external influences, for example the availability of digital technology, will have similar effects upon different individuals.

Powerful learning environments are usually defined as being environments that seek to develop complex and higher order cognitive skills, deep conceptual understanding and metacognitive skills such as the ability to self-regulate one's own learning (de Corte 1990; van Merriënboer and Paas 2003). Such outcomes, which foster the productive use of acquired knowledge and skill and support the transfer of learning, have long been deemed desirable, and recent research has shown how digital technologies can positively affect powerful learning environments (de Corte 1994; Bereiter and Scardamalia 2003; Lehtinen 2003; Kremer 2004).

Reviewing current policy for the 14-19 phase through these two conceptual lenses provides a more learner-focused conceptualisation of what needs to be done to achieve desired policy objectives. From a learning career perspective the challenge is to increase the capacity of the 14-19 phase of education and training to allow young people to construct a variety of different types of learning careers that are matched to their interests. The development of these careers then needs to be supported by access to powerful learning environments, which meet both general and specific learning needs. In both cases digital technologies, from the

UNDERSTANDING THE 14-19 DEBATES

provision of online guidance with which to construct the learning career to complex simulations underpinning powerful learning environments, have the potential to make a significant contribution to the learning of young people in the 14-19 phase.

The remainder of this review is divided into four sections. In Section 2 we unpack in more detail issues of policy, developmental and learning needs for the 14-19 phase and arrive at a preliminary definition of the sort of general learning outcomes we should be aiming to foster in this phase. In Section 3 we examine the ways in which digital technologies are currently being used in the 14-19 phase. Section 4 provides some more detailed case studies highlighting how digital technology is being used to support learning in this age group. Section 5 provides a more personalised view of where we think we should go next in developing the use of digital technologies for this age group.

2 UNDERSTANDING THE 14-19 DEBATES

There is a need to think afresh about education and training and about how it is organised, to determine what would be appropriate and beneficial both for the young people themselves and for the economic and social world which they are entering. In this section we first examine the current position[2]; then we provide a brief historical sketch of how we reached the current position; and thirdly we examine the current debates and the new proposals for the 14-19 phase in England. Finally in this section we turn to an element that is largely missing from current policy debates about the 14-19 phase but which is absolutely crucial if we are to design more powerful learning environments for young people: cognitive and motivational development over the phase and the need for concomitant new sorts of learning outcomes and processes.



there is a need to think afresh about education and training and about how it is organised

2.1 14-19: WHERE WE ARE NOW

The 14-19 phase starts at the end of Key Stage 3 when students' performance is measured in the core subjects of English, mathematics and science. This is the first point in their learning career at which students are offered meaningful curriculum choices outside of compulsory subject areas such as English; mathematics; science, personal, social and health education; religious education; and physical education. They have to:

[2] We focus here on English policy but there are clear differences in Northern Irish, Welsh and Scottish policy for this age group. However, space does not permit us to explore all of these. For reviews of the other systems see Hayward et al 2004; Raffe 2001. Nonetheless, the general conclusions we draw about the use of digital technologies to construct powerful learning environments for this age group we believe apply equally across all four countries of the United Kingdom.

UNDERSTANDING THE 14-19 DEBATES



- select which subjects they wish to study for GCSE including the new applied GCSEs
- decide whether they wish to pursue vocational options such as foundation and intermediate General National Vocational Qualifications (GNVQs) instead of GCSEs
- consider whether to undertake part of their optional Work Based Learning (WBL) programme away from their school, for example in a local FE college, a private training provider or an employer. Currently more than 100,000 students have taken up this option and the numbers are likely to grow.

In addition to these voluntary elements in the curriculum, students in the state sector have to undertake compulsory work experience. Careers advice programmes also begin to kick in as young people have to make even more profound choices at the age of 16.

At the end of Key Stage 4 young people have to make essentially three choices. First, whether to stay in education and training at all – currently about 13% of 16 year-olds in England and 16% in Wales leave the education and training system, mostly to enter the labour market. Surprisingly little is known about this group given their clear importance for policy makers. The vast majority have very poor levels of attainment and the likelihood is that most are entering low skilled jobs with very limited prospects of further training leading to qualifications[3].

Second, if they decide to stay on, they have to choose what to study. The reality is that most young people divide themselves into two tracks: the academic and the vocational[4]. The academic option involves choosing which AS subjects to study, followed at 17 by deciding which of these to take forward to the full A-level. This is the route overwhelmingly favoured by those with five or more GCSEs at Grades A* to C.

The vocational options are far more complicated. Some young people can opt to follow a work-based route based on Apprenticeship and Advanced Apprenticeship[5]. However, the popularity of such routes has declined considerably over the last 20 years so that today less than 10 % of 16-18 year-olds are engaged in Apprenticeship learning. However, there is evidence of growth in this route albeit only on the Level[6] 2 Apprenticeship route. The implication of this is that there has been a shift in vocational learning for this age group from the workplace to educational institutions through full-time provision such as Advanced Vocational Certificates of Education (AVCE) commonly

3 See Hayward et al (2004) for a fuller discussion.

4 These two terms are of course problematic. For example, to what extent is a young person choosing to study A-levels in biology, chemistry and physics in order to study medicine at university pursuing a vocational route? See Pring (1995) for a fuller discussion of these issues.

5 These are the new terms coined in 2004 to replace Foundation Modern Apprenticeship and Advanced Modern Apprenticeship respectively.

6 The concept of qualification level comes from the National Qualifications Framework. Over the 14-19 phase we are concerned primarily with four levels: Entry, Level 1, Level 2 and Level 3. GCSEs, Intermediate GNVQ and BTEC First are Level 2 qualifications and A-levels, AVCES and BTEC National Diplomas are Level 3 qualifications. Foundation GNVQs are Level 1 qualifications whilst many basic skills qualifications form Entry Level.

called Vocational A-levels, General National Vocational Qualifications (GNVQs), BTEC National Diplomas and Firsts, and a variety of City and Guilds qualifications. This shift brings with it huge pedagogical challenges - in terms of supplying a rich, hands-on vocational experience – and in the capacity of the education and training system to provide enough teachers and lecturers with the necessary qualifications and background to teach vocational subjects in a meaningful way.

For those who choose to take the school/college vocational route there are still innumerable decisions to be made either by the young people themselves or by others on their behalf. Prior attainment at GCSE largely dictates which level of vocational programme a learner finds themselves on. Those who achieve four GCSEs at Grade C and above are likely to end up on Level 3 programmes, such as the Advanced Vocational Certificate of Education (AVCE) or a BTEC National Diploma, though this depends at least to some extent on the policies of the institution they choose to study in. For example, in one Local Education Authority we have found some schools offering Level 3 courses to such learners whilst another has offered only Level 2 provision.

In addition to deciding what level of qualification is to be pursued, and within those levels what type of qualification is to be taken, young people opting for full-time study have to choose where to study. For those achieving five or more GCSEs at Grade C and above in 11-18 secondary schools the likelihood is that they will progress to the sixth form in that school and study for A-levels. This seems less like a choice and more like an expectation. It is worth noting that a small percentage of 16 year-olds with such GCSE grades will actively choose to opt for vocational courses, notably Advanced Apprenticeships in sectors such as engineering and electrical installation. It would be in line with one strand of government policy to support such a choice, however research suggests that the careers advice being offered to such young people, particularly in relation to Advanced Apprenticeship, is not impartial (Foskett et al 2004).

Some young people may choose at 16 to leave school to pursue their A-level studies in further education (FE), sixth form or tertiary colleges. In those authorities, such as Hampshire, where secondary schools cater for 11-16 year-olds and post-16 provision is delivered through a well-developed tertiary sector, this is not really a choice. But in most Local Education Authorities the college sector and the maintained schools are potentially in competition for post-16 students. There is some division of labour within the post-16 sector with, for example, FE and tertiary colleges catering for the majority of vocational learners whilst schools and sixth form colleges have the majority of A-level learners.

A consequence of this diversity of curriculum provision, particularly in the vocational route, by different sorts of institutions is that the age cohort becomes increasingly fractured as it ages. We can therefore conceptualise the current 14-19 system as consisting of a variety of **stocks** of young people engaging in different activities – full-time education of various types, work-based learning, full and part-time employment and so on (Figure 1 provides one way of characterising such

the age cohort becomes increasingly fractured as it ages

UNDERSTANDING THE 14-19 DEBATES

Figure 1 classifies the population of 16-18 year-olds in England (1,062,000) and Wales (111,500) along two dimensions. First, whether they are in full-time, part-time or not in education or training: this is the horizontal dimension in the diagram. For example, 191,200 English 16-18 year-olds (18%) are in part-time education compared to 594,700 (58%) who are in full-time education and 265,500 (25%) who are not in education or training. Second, they are categorised on the basis of their employment status: this is the vertical dimension in the diagram. For example, 594,700 English 16-18 year-olds (56%) are in either full or part-time employment, compared to 350,400 (33%) who are economically inactive, ie not in the labour market, and 116,800 classified as unemployed using the International Labour Organisation (ILO) criteria. Individuals can then be categorised by their education and employment status. For example, of the 594,700 English 16-18 year-olds in full-time education, 254,900 are also employed, 286,700 are economically inactive and 31,900 are ILO unemployed.

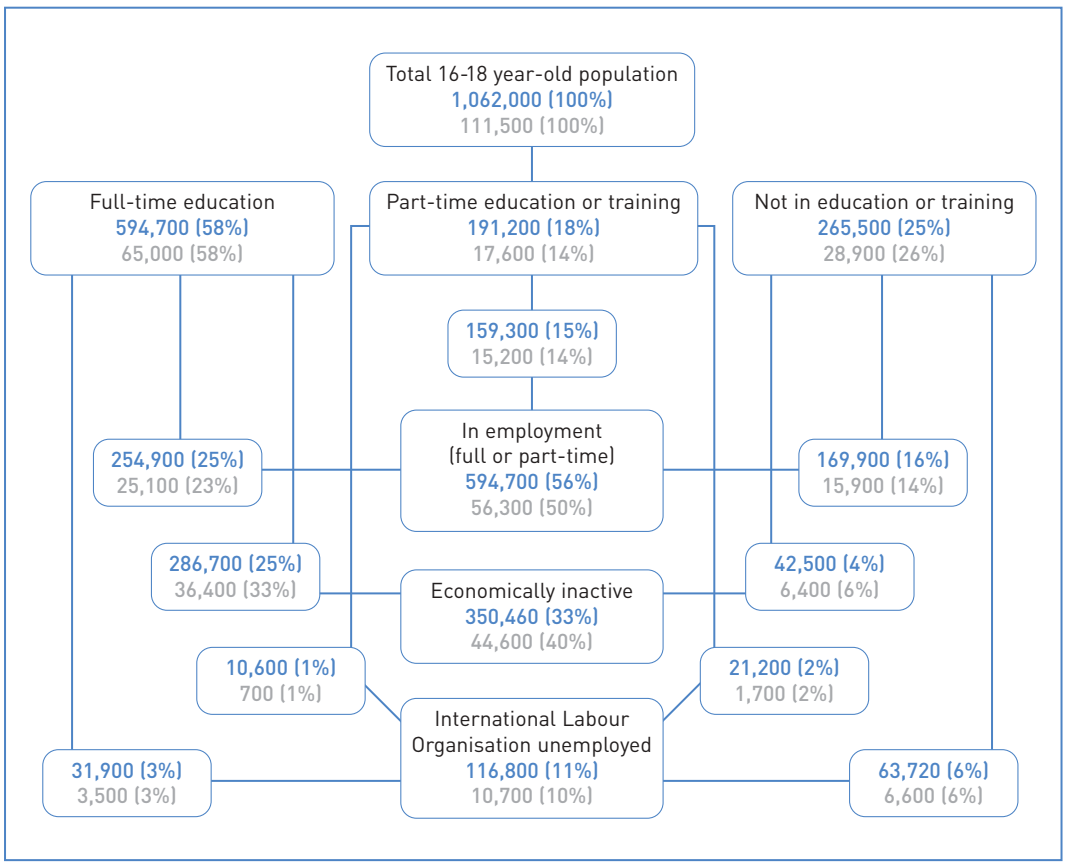


Fig 1: The size of different stocks of 16-18 year-olds in learning and the labour market: 2001/02. England blue, Wales grey.

stocks for 16-18 year-olds) – and **flows** between those stocks[7]. Figure 1 also shows that almost half of these young people are engaged in both full-time education and part-time work. The outcome is an increasingly diverse population of learners, learning in different contexts, with some general learning needs but also with quite different sorts of specific needs. This suggests that there are a number of different uses that digital technologies might be put to in the 14-19 phase to meet both general and specific learning needs of different groups of young people. We shall return to the general learning needs in section 2.4 below, but first we consider why there is a need for further reform of the 14-19 system and the plans being made for this phase.

[7] The idea of stocks and flows comes from the economics literature. A stock is a measurement of quantity at one specific point of time. A flow is a measurement of quantity over a specific period of time. Unlike a flow, a stock is not a function of time, whereas a flow measures quantity passing per minute, hour, day, year or whatever. The analogy is frequently made between a reservoir holding a given stock of water, and water entering and leaving the tank as the flow of water per minute: the water entering and leaving the reservoir is the flow; the water actually in the reservoir at any one time is the stock.

2.2 WHY DOES THE 14-19 SYSTEM NEED FURTHER REFORM?

At first sight the flexibility of current 14-19 provision suggests that young people do have the opportunity to construct a variety of different types of learning career to meet their different aspirations and needs. However, such flexibility comes at the cost of coherence. A consequence of this is that young people can construct learning careers that ultimately become dead ends and so offer little in the way of further progression. Providing a more coherent system is therefore the first major reason for embarking on further reform of the 14-19 phase. This need was clearly recognised in the Green Paper 14-19: Extending Opportunities, Raising Standards (DfES 2002), which first suggested the concept of a single 14-19 phase as government policy, in the subsequent discussion document 14-19: Opportunity and Excellence (DfES 2003), and remains a central concern of the most recent White Paper 14-19 Education and Skills (DfES 2005). The problem is most acute in the area of vocational education and training where the unwary learner is met with a veritable jungle of qualifications, through which they have to hack their way as they construct a learning career.

Furthermore, reforms over the last ten years have had little impact on a key indicator of system performance: participation rates. These have remained virtually static over the last decade. As GCSE grades have improved, a greater proportion of young people have chosen to take Level 3 courses, especially GCE A-levels. Participation in full-time Level 3 vocational programmes has also increased with a concomitant decline in post-16 participation at Levels 1 and 2. Thus, a key policy outcome, engaging a greater proportion of learners with lower levels of academic attainment, is still not being met.

A third reason for reform is the evident lack of demand being placed on higher attaining students. Such learners can advance through the system collecting high grades in both GCSE and A-level examinations without either being conceptually challenged or experiencing breadth in their learning.

Thus the 14-19 phase continues to lack coherence, maintains a vocational-academic divide, remains unattractive for a significant proportion of learners, and fails to provide the breadth and stretch deemed appropriate for the highest attaining learners. These factors, combined with the A-level examination problems in 2002, led the government to establish a further inquiry into the 14-19 phase. Chaired by Mike Tomlinson, this focused primarily on qualifications and the general design of the curriculum. It is to the findings of this inquiry, and the subsequent White Paper that responded to its findings, that we turn next.

2.3 CURRENT DEBATES AND FUTURE DEVELOPMENTS

In this section we consider the two most recent documents concerning the 14-19 phase: the Review of 14-19 qualifications led by Mike Tomlinson, and the Government's response to the Review in the White Paper 14-19 Education and Skills (DfES 2005).

2.3.1 THE TOMLINSON REVIEW

The radical suggestion that emerged from the Tomlinson Review was that in order to

the unwary learner is met with a veritable jungle of qualifications, through which they have to hack their way as they construct a learning career

UNDERSTANDING THE 14-19 DEBATES



have both breadth and demand in the 14-19 curriculum, to raise the status of vocational education, and to improve student motivation, a unified framework of qualifications was required. Any such framework must encompass all young people and promote progression from Foundation via Intermediate to Advanced levels. Over time, GCSEs, GCE A-levels and all vocational qualifications would be subsumed into this overarching framework, becoming an integral part of a Diploma offered at four levels. Linking the different levels of the Diploma would then provide young people with much better and clearer progression opportunities. The consequence would be that all young people would be able to choose from a range of courses and qualifications covering a wider range of subjects and skills from the age of 14. This would enable them to develop their own mix of subjects from 14, combining a broad range with more specialist choices to meet their aspirations and interests. The hope was that this expanded choice, within an overarching framework of Diplomas to provide coherence, would result in an increase in motivation and so encourage more young people to stay on and progress to more advanced courses at 16 and 17. To further promote this, the Review recommended doing away with the idea that young people should take examinations at 16 in favour of an assessment system that examined young people when it was appropriate for them.

In addition to the flexible elements, all the Diplomas would contain a mandatory core of studies emphasising functional literacy, numeracy and ICT skills[8]. Furthermore, the curriculum and assessment arrangements should emphasise and promote competence in analysis, problem-solving and thinking, so that young people have the confidence to explain and defend their conclusions.

A special emphasis was placed on providing learning opportunities for those with special needs and those facing difficult family, personal and social circumstances so that they can overcome these problems and so engage with learning. The Review also recognised the crucial need for learners in this age range to be able to study across a range of sites to promote access to different types of provision, centres of excellence and other relevant expertise. Consequently, the Review stressed the fundamental importance of partnership and collaboration between schools and colleges in order to meet the needs of all learners.

Finally the Review questioned the assessment burden being placed on young people in the 14-19 age range and recommended increased teacher assessment, especially in courses below Level 3. It was recognised that this would require a cadre of teachers who were highly trained and qualified in assessment and verification procedures.

2.3.2 THE GOVERNMENT'S RESPONSE TO TOMLINSON

Key recommendations of the Tomlinson Review clearly resonate with key elements of current Government policy for the 14-19

8 Other areas of study - science, citizenship, sex education, careers education and physical education – would also remain mandatory as appropriate for the age group.

phase: greater choice; a more personalised approach to the curriculum; strengthening the parity of esteem between vocational and academic qualifications; and providing extra 'stretch' for high attaining learners. However, it also moved against certain other basic tenets of Government policy: an emphasis on external assessment to ensure validity and credibility; simple (and narrow) accountability measures based on league tables linked to management by objectives; and recommendations for greater autonomy for schools, with successful 11-16 schools being encouraged to develop sixth form provision.

Unsurprisingly, therefore, the White Paper 14-19 Education and Skills (DfES 2005) that emerged as a response to the Tomlinson Review to some extent, at least, involved cherry picking. It is currently politically unacceptable to subsume GCSEs and GCE A-levels within a unified qualifications framework and this central recommendation of the Tomlinson Review has been ignored[9]. Instead, a new system of specialised Vocational Diplomas spanning the 14-19 age range covering 14 'lines' of employment is being recommended. The first four Diplomas in Information and Communications Technology, Engineering, Health and Social Care, and Creative and Media are intended to be available from 2008, with all 14 lines available nationally from 2015. The detailed design of these remains to be worked out but the intention appears to be to subsume all existing vocational qualifications and apprenticeship provision for this age group within the Diploma framework. Employers, through the Sector Skills Councils, and supported by the Qualifications and Curriculum Authority (QCA), and Higher Education institutions are envisaged as playing the key role in the design of the Diplomas.

In addition, the White Paper also appears to reject the recommendations on assessment made by Tomlinson, arguing that the current balance "between internal and external assessment is essentially the right one to secure public confidence in the examinations system. We therefore do not propose major change." (ibid, p7) We will suggest in Section 5 of this review that this decision, combined with a renewed emphasis on narrowly conceived accountability measures as set out in the White Paper, potentially represents a major stumbling block for the construction of powerful learning environments incorporating digital technologies.

The White Paper has, however, embraced a number of the recommendations made by Tomlinson, albeit with a 'back to basics' twist. For example, there is an increased emphasis on functional literacy and numeracy, with young people who do not achieve Level 2 in these areas being required to undertake remedial provision (presumably at the expense of other elements in the curriculum) for which schools will be held accountable. In addition, young people who face serious social and family problems will receive extra support, the nature of which, however, remains to be decided. In particular, a new programme based on Entry to Employment (E2E) will be developed for 14-16 year-olds to provide an alternative route for those most likely to drop out.

There is also a welcome recognition in the White Paper of the need to develop the

9 However, the possibility remains when A-levels are reviewed in 2008 that such a move could occur then.

UNDERSTANDING THE 14-19 DEBATES



providing tasks that do not provide the opportunity to develop higher level cognitive skills will inevitably hamper growth

14-19 education and training system's capacity to deliver vocational education and training if the desired outcomes are to be achieved. And the clear intention is to make the whole system much more focused on the needs of individual learners. Clearly both these commitments represent major challenges and opportunities for digital technology development. However, the nature of learners in the 14-19 phase, the way they develop personally, socially, cognitively and motivationally remains, understandably, unexplored in both the Tomlinson Review and the White Paper. Meeting the challenge of using digital technologies to create powerful learning environments within which young people can develop their learning careers must pay due attention to such development. This is discussed in the next section.

2.4 DEVELOPMENT 14-19

There is, therefore, a clear policy desire to increase choice for 14-19 year-olds and to personalise learning needs, but this needs to take account of their development between these ages. Very few periods in a person's life are characterised by so many development changes at so many different levels. These changes relate to the biological process of development in puberty, social role definitions, and the emergence of sexuality. There are also well-documented changes in self-concept, motivation, cognition and achievement. Space does not permit an exhaustive treatment of these topics so we focus on aspects of cognitive and motivational development which are key to the Government's reform agenda.

2.4.1 COGNITIVE DEVELOPMENT AND SELF-REGULATION OF LEARNING

Over the 14-19 phase a considerable body of research points to significant changes in the way young people think. There is an increasing ability to:

- think abstractly
- consider the hypothetical as well as the real
- engage in more sophisticated and elaborate information-processing strategies
- consider multiple dimensions of a problem simultaneously
- reflect on the nature of complex problems and oneself.

Development of these higher cognitive functions clearly needs to be fostered by educational experiences in the 14-19 phase. The key element here would appear to be the quality of the tasks young people are asked to undertake. Providing tasks that do not provide the opportunity to develop higher level cognitive skills will inevitably hamper growth. Thus, developing personalised learning must focus on providing young people with tasks that will aid their development. This is important for all young people, not just the most academically able, as such higher cognitive functions are essential for decision making and exercising the proposed enhanced opportunities for choice wisely. The extent to which this can be achieved by enhancing learning environments with digital technologies, or redesigning learning environments to embed digital technologies, needs to be explored.

In addition, considerable attention has been focused on the growing extent to which young people in this phase can regulate their cognition and learning in educational settings. Zimmerman (1989b, p4) describes self-regulated students as being "metacognitively, motivationally, and behaviourally active participants in their own learning processes" and argues that developing self-regulation should be an important educational goal. This is supported by work which shows that increasing levels of cognitive self-regulation are associated with the use of effective learning strategies, meaningful engagement in learning and attainment of learning goals. Again the questions that need to be explored are the ways in which and the extent to which different uses of digital technologies could support the development of such self-regulated cognitive activity.

2.4.2 MOTIVATION IS NOT ENOUGH

A particular policy concern with young people in this phase is the significant proportion who drop out of education and training at the earliest opportunity. Typically such behaviour is associated with processes of school detachment that begin during early adolescence. Such young people are variously described as disaffected or disengaged, and solutions to this problem are typically conceived in terms of raising motivation, self-esteem and self-confidence. Digital technologies are seen in policy to provide particular affordances that will encourage the development of these desirable attributes and dispositions.

However the use of such terms can obscure rather than illuminate. Thus, young people are never unmotivated; rather they may be more motivated to do some things rather than others, such as school work. As they age, young people's opportunities to engage in a wider range of social activities, for example, provide additional sources of motivation. Moving through the surface of these terms is therefore necessary if we are to understand how such attributes may develop during the 14-19 phase. This involves considering research findings about young people's self-beliefs, including self-concept beliefs, and beliefs about their achievement activities.

A person's self-concept is the mental and conceptual awareness and persistent regard they hold with regard to their own being. There has been considerable debate as to whether the social and biological changes experienced during adolescence alter an individual's self-concept. Some researchers believe that adolescence is a time of instability in self-concept, but the early research evidence was inconclusive. In part this can be attributed to the focus on global self-concept (crudely self-esteem) rather than domain-specific self-concepts. Recent research and theorising argues for a multifaceted rather than a single, general construct model of self-concept. Thus, self-concept is now considered to consist of multiple domains[10] such as global self-worth, scholastic competence, social acceptance, athletic competence, job competence, romantic appeal, behavioural conduct, close friendships, and physical appearance. Research evidence indicates that:

developing self-regulation should be an important educational goal

[10] The exact titles given to these domains varies depending upon the instruments being used to measure them. The terms here come from Harter's Self-Perception Profile for Adolescents (Harter 1988).

UNDERSTANDING THE 14-19 DEBATES



- domain-specific self-concepts are less stable than general self-concept
- the rate of change during adolescence differs across domains
- there are differences among individuals of different age, gender, ethnic and socioeconomic groups.

The key issue for this review is how specific aspects of self-concept relate to general self-worth, which in turn is correlated with self-esteem and motivation. The research evidence suggests that an:

"individual's general self-worth is determined in part by the synchrony between their sense of competence at different activities and the importance of those activities to them. Doing well on activities that are important should foster positive general self-worth... Children who believe they are good at activities they think are important have more positive general self-worth than do children who believe certain activities are important but do not think they are competent at those activities." (Wigfield et al 1996, p153)

The implications of this research are clear. Young people are likely to remain engaged with the education and training activities in the 14-19 phase to the extent that they believe that such activities are important for them and they do well in them. If task performance declines, or the young person decides that school or college is not that important to their imagined futures, then engagement will decline. Thus, using digital technologies both to help young people to appreciate the importance of education and training activities and to improve their competence at those activities should yield dividends in terms of improved feelings of self-worth.

motivating a young person by improving their feelings of self-worth is only the first step in improving achievement

Motivating a young person by improving their feelings of self-worth is, however, only the first step in improving achievement. Research suggests that young people's interpretations of their achievement outcomes are critical mediators of subsequent achievement behaviour, such as effort expended. Cross-sectional studies indicate that such achievement beliefs may follow a U-shaped profile during adolescence, with young teenagers having particularly negative achievement beliefs in the domain of mathematics, an area of current policy concern (Wigfield et al 1996).

The sorts of cognitive strategies that young people employ, and the sorts of tasks they choose to undertake or expend effort in, are also related to their achievement goal orientations. Two such orientations have been suggested: **ego involvement** and **task involvement**. Individuals who adopt an ego-involved orientation aim to maximise the likelihood of receiving favourable evaluations, and minimise the likelihood of receiving negative evaluations, of their competence. As a consequence they are likely to choose tasks that they are confident that they can do. This could inhibit both the broadening of the cognitive repertoire and limit the possibilities for practising regulation of cognitive activity. By contrast, individuals adopting task-involvement orientations are more concerned with mastering the material being presented and improving their competence across a range of different tasks. This leads them to choose more challenging tasks and a concern with their own performance on those tasks rather than outperforming their peers. However, the evidence suggests that young people are increasingly likely to adopt ego-involvement orientations as they age and

this will hamper the development of both self-regulation and their use of higher cognitive strategies.

Clearly then there is a great complexity of factors that act to promote and undermine young people's expectancies of success in and valuation of different types of subjects, tasks and activities. Space does not permit a full examination of all of the issues. However, one final set of key findings comes from the work of Paul Pintrich and his colleagues (eg Pintrich 1995) which examined the link between cognition and motivation. This research demonstrates a clear link between motivational variables (students' perceived self-efficacy and achievement values), and their use of cognitive strategies and self-regulation. However, the evidence suggests that the motivational variables do not relate directly to performance on a task. Rather a student's self-efficacy may facilitate their cognitive engagement with a task, and their achievement values may affect their decision to undertake a task, but it is the use of appropriate cognitive strategies and self-regulation that relate more directly to performance, ie the effects of motivation on performance are mediated through cognitive variables. The implication is that we need to think about the use of digital technologies not just in terms of their motivational benefits but also in terms of how they can be used to support the development of higher cognitive strategies and self-regulation through this age phase. This is a far more demanding task which requires the definition of new types of learning outcomes, over and above examination success, if we are to ensure young people continue to learn through adulthood. It is to suggesting the possible nature of these learning outcomes that we turn next.

2.5 NEW LEARNING OUTCOMES AND PROCESSES FOR THE 14-19 PHASE

Current policy clearly requires something new in terms of learning to achieve a range of outcomes, and digital technologies are seen as playing a key role in the construction of such learning environments. However, numerous authors (eg Cuban 2001; De Corte et al 2003; Hargreaves 2004) have made the point that digital technologies, to produce the impact on learning desired by policy makers and educators, must be embedded in powerful learning environments. Simply providing access to, for example, the internet will not necessarily result in much learning or at least learning at a deep level of understanding. Strong mediation of the use of digital technologies, at least in the early stages, is needed if students are not to waste their time surfing the internet looking for relevant material, ideas or sources of evidence. Online web resources[11] provide introductory guides to searching, for example, but students will need help not just in finding material but also in evaluating its usefulness, its quality and its validity. Powerful learning environments provide such support but we need to know (as far as we can on the basis of current knowledge) what the characteristics of such environments are and their key design features. However, this research remains in its infancy and, as a consequence, "very little is known about the basic blueprint components and the systematic design of powerful learning environments" (van Merriënboer and Paas 2003, p3).



[11] For example, RDN's virtual training suite at www.vts.rdn.ac.uk

UNDERSTANDING THE 14-19 DEBATES



Examining the issues raised by the desire to construct more powerful learning environments would require us to address issues of knowledge and the nature of knowing, since building powerful learning environments requires us to move beyond folk theories of mind as a container and knowledge as 'stuff' that is acquired through a process called learning. However, such questions are beyond the scope of the current review[12]. Instead we focus on what current ideas about learning[13] can tell us about the outcomes of learning for the 14-19 phase of education and training, and the sorts of learning processes that are likely to produce such outcomes.

2.5.1 LEARNING OUTCOMES

Traditionally learning outcomes are couched in terms of the acquisition of certain types of knowledge or the development of certain sorts of skills. This is not an unhelpful approach in terms of developing a scheme of work in a subject or vocational area. However, in terms of examining the totality of the 14-19 phase, the range of learning requirements that need to be met in this transitional phase, and the development of understanding what is needed are rather more general or abstract learning outcomes which provide a meta-language to talk about learning over the whole phase. This enables us, first, to encompass the range of knowledge-based, skill-related and dispositional learning outcomes referred to in 14-19 education and training policy; and, second, to recognise the potential of digital technologies to achieve these learning outcomes.

Simons (2001, pp174-175) identifies a range of learning outcomes described by politicians, parents, teachers and business which seem relevant to this phase and which help us to unpack the idea of what deep understanding might look like. First learning outcomes should be:

1 **Durable:** "in the sense that they remain over long periods of time. Instead of learning for today and tomorrow people should be learning for months, years or even a lifetime." To achieve this requires the acquisition of good habits of learning as young people near the end of compulsory education and the development of deep understanding.

2 **Flexible:** "in that they can be approached from different angles and perspectives instead of being rigidly tied to one perspective. Results of this learning should be adaptable to new contexts and to changing contexts. This can only happen when there is deep understanding instead of rote learning. Flexibility relates to internal relational networks between knowledge elements that are approachable in an easy way."

3 **Functional:** in that they have a 'just in time, just in place' character; "people should learn what they need at a certain time and place, not less not more".

[12] See Carl Bereiter (2002) Education and Mind in the Knowledge Age for a full discussion of these issues.

[13] Previous Futurelab reviews have provided detailed accounts of different theoretical conceptualisations of learning and the processes of learning. This is not ground therefore that we wish to go over again. Rather our starting point is what such theorisation tells us about the construction of powerful learning environments and the role of digital technologies in such learning processes.

4 **Meaningful:** in that the outcomes provide "a real understanding of a few basic principles with far-reaching importance for understanding [which] is more important than superficial understanding of many facts that become obsolete anyhow."

5 **Generalisable:** "in the sense that they are not restricted to one context or situation but should also cover other contexts and situations."

5 **Application-oriented:** "people should know the possible applications and their conditions of use: when and where is application of the learning possible or necessary."

In addition to these rather traditional knowledge-oriented learning outcomes we also need to consider learning outcomes that relate to skills that can be applied to information and learning processes: learning, thinking, collaboration and regulation skills (Simons 2001, p175). Finally we also need to consider dispositional learning outcomes that are related to aspirations and attitudes, and maintaining learning careers such as resilience, persistence, creativity, initiative taking and risk management.

2.5.2 LEARNING PROCESSES

Embracing such learning outcomes requires a shift in emphasis in learning processes from **guided learning** towards more independent and experiential learning (Simons, Van der Linden and Duffy 2000; Simons 2001; Simons and Bolhuis 2004). During guided learning the responsibility for deciding goals of learning, the strategies to be used and making judgements about whether appropriate learning has occurred and to what degree lies primarily with a teacher or a trainer. The learner's role is largely passive: committing themselves to follow the decisions made by the teacher/trainer. This is the sort of learning that many learners currently experience during formal schooling.

In **experiential learning**, "circumstances, personal motivation, other people, innovations, discoveries and experiments determine what and how one learns. There is not an... explicit set of learning goals, nor is there an explicit learning strategy. Instead, learning is a side effect of the activities one is undertaking without conscious awareness of the fact that one is learning. The outcomes of this kind of learning can become conscious afterwards" (ibid, pp175-176). Clearly this type of learning relates closely to informal and non-formal modes of learning and the development of tacit knowledge. We suspect a considerable amount of knowledge that 14-19 year-olds have about how to use digital technologies will take this largely tacit form which then underpins the routinised operation of such technologies.

Independent learning involves the use of more explicit learning goals and strategies than experiential learning. "Learning is central and not a side-effect, but the learners themselves determine the goals of learning according to needs arising in their actions [at school or elsewhere]... Learning is not pre-organised and pre-planned by an outsider or expert, nor is it dependent on coincidental intrinsic motivations. It is self-organised and self-planned. Furthermore learners determine their own ways of testing" (ibid, p176). Reflection by learners and the explicit use

UNDERSTANDING THE 14-19 DEBATES



learners should undertake activities such as monitoring, self-testing and checking in order to help them check whether they are still pursuing the goal that they originally set

of regulative strategies now play a crucial role in deciding what and how to learn.

The desiderata in a number of recent publications about learning in the information age and for the knowledge economy (eg Hargreaves 2004) imply a shift from guided learning to more independent learning (involving the increased activity of learners in making decisions about their own learning), and to more experiential learning through which learners undergo important personal experiences, are engaged in active thinking and problem solving, finding out things that interest them and so learn for its own sake. This is not to say that guided learning is unimportant or that teachers have to adopt completely new roles but merely to argue for a shift in the balance of the three types of learning if we are to enable young people to understand the world deeply. Nonetheless, the shift from guided to independent and experiential learning does require a greater emphasis on fostering the sorts of learning processes identified in Table 1.

From guided to independent learning

Shuell (1988, pp277-278) characterises such new learning as "... an active, constructive cumulative and goal-directed process... It is active in that the student must do certain things while processing incoming information in order to learn the material in a meaningful manner. It is constructive in that new information must be elaborated and related to other information in order for the student to retain simple information and to understand complex material. It is cumulative in that all new learning builds upon and/or utilizes the learners' prior knowledge in ways that determine what and how much is learned. It is goal-oriented in that learning is most likely to be successful if the learner is aware of the goal (at least in a general sense) towards which he or she is working and possesses expectations that are appropriate for attaining the desired outcome."

To this list of characteristics of good learning, Simons (2001) adds diagnosis and reflection. Learners should undertake activities such as monitoring, self-testing and checking in order to help them check whether they are still pursuing the goal that they originally set. In so doing they will become more aware of their ways of learning through reflecting on what they have and have not achieved. Together

Shift from guided learning towards independent learning	Shift from guided learning towards experiential learning
More active learning	More discovery-oriented learning
More cumulative learning	More contextual learning
More constructive learning	More problem-oriented learning
More goal-directed learning	More case-based learning
More diagnostic learning	More social learning
More reflective learning	More intrinsically motivated learning

Table 1: Overview of 12 kinds of new learning processes and strategies in relation to the three ways to learn.

these characteristics of good learning result in the acquisition of metacognitive knowledge that is essential to the success of future learning in the domain.

From guided to experiential learning

This entails a move away from learning in a deductive receptive way to inductive learning which emphasises discovery, context and problem solving. Such learning is likely to be case-based and highly social, with an emphasis on real life contextualised knowledge rather then the decontextualised knowledge typically taught in schools and colleges. Such an emphasis brings with it a number of positive effects identified in the literature: intrinsic motivation to learn, and the durability and transferability of learning. However, effective experiential learning requires access to authentic learning contexts and this can involve high transaction and opportunity costs. In addition, the shift to implicit modes of learning implied by Table 1 results in outcomes which are more difficult to assess using conventional means.

2.5.3 PROCESS-ORIENTED INSTRUCTION

Striving for the new sorts of learning outcomes within a learning environment which rebalances guided, independent and experiential learning must result in a new instructional approach within which digital technologies could play a key role for this age group. Process-oriented instruction (Simons 2001, p179) is focused "on the further development of thinking, learning and self-regulation of learning and thinking integrated in regular domain instruction". Thus adopting this perspective does not require us to abandon traditional subjects or vocational domains but emphasises the need for teaching to focus more on the kinds of general skills already mentioned whilst also **gradually** handing over responsibility for learning and teaching to the learner. Adopting process-oriented instruction does not imply a return to the 'fofo[14]' curriculum of new vocationalism, but letting the learner gradually acquire independence (Posthom et al 2004).

The extent to which learning environments, with their embedded digital technologies, are achieving at least some of these ends (no learning environment is likely to achieve all of them simultaneously) can be assessed through answering the following questions (Simons 2001; Simons and Bolhuis 2004):

1 Are the intended outcomes of the learning environment durable, flexible, functional, meaningful, generalisable, and application-oriented?

2 Are thinking, learning, collaboration and regulation skills being taught?

3 Is there a shift of focus towards more experiential learning: more active, cumulative, constructive, goal-directed, diagnostic and reflective learning?

4 Is there a shift of focus towards more independent learning: more discovery-oriented, contextual, problem-oriented, case-based, socially and intrinsically motivated learning?

effective experiential learning requires access to authentic learning contexts

[14] For the uninitiated 'fofo' stands for 'f**k off and find out'. See Unwin 2004 for a discussion.

DIGITAL TECHNOLOGIES AND THE 14-19 AGE GROUP



5 Is there conscious attention for the gradual increase of independence according to the sequence of independent work, strategic learning and self-directed learning?

6 Is there modelling, external monitoring, scaffolding, metacognitive guidance, attention for self-evaluation, practice of skills, feedback and reflection?

Taken together these questions provide a starting point for defining what the ideal features of a powerful learning environment might be and judging how digital technologies might play a role in the construction of such a learning environment.

Next, we shall examine and attempt to classify the scope of different ways in which this age group potentially interact with digital technologies in their learning lives.

3 DIGITAL TECHNOLOGIES AND THE 14-19 AGE GROUP

Given the lack of homogeneity in this particular age group, is it really possible to point to any common themes in the way that digital technologies are becoming established in the learning lives of these young people? What makes life for those aged 14 and above increasingly different from the previous years is the fact that they rapidly find themselves having to make major choices about their future, out of a range of bewilderingly complex and diverse possibilities. In theory, technology is being given a major role in helping 14-19 year-olds make these choices, as well as to support, monitor and assess them as they follow these through. In reality, given the Government's response to the Tomlinson inquiry, it is likely that those on predominantly academic routes will experience a somewhat less dramatic explosion of choice than those on VET routes.

For individual students, therefore, the experience of digital technologies in their learning lives will vary considerably in relation to the full scope of how digital technologies can potentially contribute to the education of the age group as a whole. That scope encompasses all the following forms of technology benefit or presence, each distinct from one another in some significant sense:

- supporting specialist learning
- supporting collaboration between institutions in the provision of choice
- planning personalised pathways through education provision
- monitoring progress; e-assessment and e-portfolios

- bringing the learning to the learner; workplace simulations
- enabling 'anytime anywhere' learning
- reaching learners outside the sphere of formal education
- enhancing established pedagogies
- enabling independent and collaborative learning
- developing new modes of learning.

The rest of this section will briefly describe and illustrate each of these.

3.1 SUPPORTING SPECIALIST LEARNING

A key element of the Government's post-14 strategy has been the introduction of a specialist system "intended to raise expectations and transform educational achievement through greater coherence, increased diversity of choice, greater freedoms in curriculum development, use of resources and teaching methodology, greater emphasis on innovation and change and effective sharing of good practice" (Ferl 2003). This involved the creation of specialist schools encompassing arts, languages, sport, technology, science, engineering, business and enterprise, maths and computing (with a target of 2,000 by 2006), and the building of federations, enabling groups of schools to work in close collaboration under a range of possible arrangements. The strategy emphasised e-learning in schools as a means of engaging disaffected students, empowering individuals' learning and allowing flexibility of pace and level. The strategy provides for the creation of many levels of collaboration, such as those between schools through the National Learning Communities, as well as through 'community hubs', involving 240 schools aiming to develop partnerships with parents and communities, for instance connecting Supplementary Schools that serve ethnic minority groups with local mainstream provision. ICT is viewed as the key medium of collaboration in all these projects, and is proving an essential means of improving provision in a range of academic contexts, including making possible the provision of previously unavailable GCSE and A-level subjects through class-to-class video-conferencing, such as through the Cambridge Schools Classics Project, the brief of which is to promote the teaching of Latin especially, in an environment "where an increasing shortage of specialist teachers and curriculum space makes access to learning ever more difficult" [15].

3.2 SUPPORTING COLLABORATION BETWEEN INSTITUTIONS IN THE PROVISION OF CHOICE

Regardless of the Government's decision not to proceed with key elements of Tomlinson's proposals, reorganisation of provision in the sector will continue to move ahead at a considerable pace, and – as Becta points out – in ways that would simply not be feasible without digital technologies:

"Implementation of reform assumes close partnerships and collaboration between learning providers. Becta's view is that ICT has a key role in facilitating this. ICT can enable institutions to work with each other

ICT is viewed as the key medium of collaboration and is providing an essential means of improving provision in a range of academic contexts

[15] http://lists.becta.org.uk/mailman/private/14-19e-learning/2004-September/000079.html

DIGITAL TECHNOLOGIES AND THE 14-19 AGE GROUP



across the traditional boundaries of education in response to the needs of the learner, industry and local area, enable effective provision of personalised learning, and allow for individual learning preferences, pace and contextualisation." (Becta 2005, p2)

The logistical difficulties of managing such collaborations should not be underestimated, given that previously competing institutions must learn to cooperate by sharing staff and resources, not merely in the interests of the education of this age group, but also in the interests of their own viability:

"Full and frank information exchange is essential where institutions may have previously seen themselves as competitors. Without a conviction that collaboration delivers benefits for all partners, such openness is hard to achieve... All partners need to accept that such consortia must be able to pay for essential central functions from the fees students bring with them if the collaboration is to be sustainable." (Central Gateshead Sixth Form 2004)

Collaborations of this kind are spreading across the whole country, both in urban centres ("A radical shake-up of education is being planned for inner city Leeds. The city council wants to set up four 'learning campuses' which would bring together secondary schools and further education colleges" BBC 2004) and in rural areas, such as Cornwall College, a federation of colleges creating the largest further and higher education in the UK, with over 56,000 students (Ferl 2004).

3.3 PLANNING PERSONALISED PATHWAYS THROUGH EDUCATION PROVISION

The Government promoted this notion through the launch in 2004 of 'A National Conversation about Personalised Learning', arguing that "a system that responds to individual pupils, by creating an education path that takes account of their needs, interests and aspirations will not only generate excellence, it will also make a strong contribution to equity and social justice" (DfES 2004a, p7). Technology is shown as having a key role to play in achieving this, both as a learning target (the aspiration is to create "clear learning pathways through the education system and the motivation to become independent, e-literate, fulfilled, lifelong learners" p7), and a means of delivering learning ("personalised learning requires a range of whole class, group and individual teaching, learning and ICT strategies..." p9). Most important of all, perhaps, is the way in which digital technologies are seen as enabling the management of personalised pathways, such as this example from Wolverhampton:

"The creation of a City-wide curriculum offer, with a multitude of learning pathways, requires excellent support for learners [including...]

- An electronic Individual Learning Plan (ILP), designed to solve the issues of pupil ownership, access, operational effectiveness and the exchange of information.
- Choosing A Real Deal (CARD), an innovative, City-wide approach to motivating and engaging learners, including a 14+ promise of guaranteed

places at 18+ in HE, FE and work-based learning. Students engage in a planned programme of experiences and activities which link into individual pupil review, with the ILP as a central tool.

- 'Coursefinder' Software to publicise and manage the curriculum offer (as well as the enrichment programme and CARD activities)."
  DfES (2004b)

Such a vision of technology's contribution to helping individuals to find and follow their paths through education and training is quite distinct from possible pedagogical and learning benefits of using ICT, although there is a tendency to lump these altogether as perhaps a more coherent and inter-dependent benefit of technology than is actually the case. Not all of these uses impact directly upon the learners, but it is increasingly evident that technology is intended to play a central role in mediating young people's learning lives – indeed, this is in effect one of the key tools referred to in Charles Clarke's introduction to Success for All:

"We must give further education and training its proper place as a vital mainstream part of the education system. The sector should be at the cutting edge of our aspiration to enshrine lifelong learning into the daily lives of our citizens and the culture of the country. Our commitment, embodied in this strategy, is to give you the tools to make this aspiration a reality." (DfES 2002, p2)

3.4 MONITORING PROGRESS: E-ASSESSMENT AND E-PORTFOLIOS

Using ICT for monitoring progress and for assessment crucially pulls together the various organisational and institutional reforms for the age group that digital technologies are intended to enable:

"The need to provide flexible delivery of courses and remote access to course materials involves coherent infrastructure, online resources and ideally some form of online tracking and assessment. Teaching and learning will of necessity be shared across physical school and college boundaries. ICT is integral to the successful implementation of these reforms" (Powell et al 2004, p4).

A case study of Lynn Grove High School's Virtual Learning Environment (a study written by the company which developed it) demonstrates how all-embracing of students' learning lives such technology might become:

"The VLE has increased the amount of information teachers can gather about students. They can now see which students have accessed work on the VLE, how long they've spent, whether they've returned to the work more than once and what time they accessed the work. Teachers can also load interactive tests for students to do online and access individuals' results."[16]

Ferl's Cornwall College case study shows even more vividly how students are connected into what has become a highly



it is increasingly evident that technology is intended to play a central role in mediating young people's learning lives

16 www.lynngrove.org.uk/school_files/lg_case_study.pdf p4

DIGITAL TECHNOLOGIES AND THE 14-19 AGE GROUP



elaborate system of tracking procedures through the use of these technologies:

"The e-ILP is a system which allows all the required learner data to be recorded in an electronic format. It operates alongside the MIS system, Unit-e, and the e-registration system, Tokairo, drawing in enrolment and attendance data to present a holistic picture of the student. The system records both educational and pastoral information, for example, qualification details, health information and attendance percentages from the point of entry to completion of the course. The system allows for the recording of initial assessment data, learning style preference and additional support needs. The monitoring of student progress is supported by the ability to send notes between staff alerting them either of achievement or of any potential problems." (Ferl 2004)

The implications for traditional processes of assessment are considerable, and examination boards are having to explore issues such as multilocation assessment, rolling online assessment (through online multiple-choice quizzes, or the submission of more analytical work), the development of electronic portfolios, and the use of digital video. The range and implications of such developments are addressed in depth in Futurelab Report 10 (Ridgway et al 2004).

work-related learning is already making considerable use of digitally-supported simulations and distance learning

3.5 BRINGING THE LEARNING TO THE LEARNER: WORKPLACE SIMULATIONS

Work-related learning is already making considerable use of digitally-supported simulations and distance learning in the specific sense, especially, of bringing the learning from some outside location to the learner in school. For younger students (ie in the 14-16 age bracket), this alleviates the duty of care difficulties entailed in providing levels of staff support for any trip outside school:

"For those vocational training areas which may cause problems, the use of digital cameras and webcasting are excellent solutions. An agricultural college is already utilising this technology to bring activity in the lambing pen to younger students. Transport of 14-year-olds is an issue which regularly arises [...] unless the learning travels to the learner." (Becta 2004, p8)

Simulations are used (especially higher up the age range) in vocational education in a wide range of different national contexts: "The use of computer-based simulations to develop competence in, for instance, managing fire at sea or using a fork-lift truck is an integral part of teaching" in the Shipping and Transport College in Rotterdam (Ofsted 2004, p13), and the same report describes how students in New South Wales are involved in virtual trading activities, such as taking orders, invoicing, marketing and keeping accounts (p28).

Further examples of simulations will be explored in greater depth in Section 4 of this review.

3.6 ENABLING 'ANYTIME ANYWHERE' LEARNING

This is a slightly different inflection of the concept of distance learning from that represented by the notion, referred to above, of bringing the learning to the learner. This version of the concept

focuses most specifically on connecting home with school. Ninestiles School in Birmingham has developed an 'anytime anywhere learning' (AAL) programme which provides most pupils with leased personal laptop computers, so that "learning can take place where you are at any time of the day and at any time of the week, including during holidays" (Specialist Schools Trust 2004, p10). The school claims this as a major reason for having improved its results.

Of particular significance in this respect is the commitment to connecting school learning with the home in a way that is not purely dependent on parents' capacity to buy a computer (although it must be noted that the costs of leasing laptops and using the internet from home are not inconsiderable). Arguably, though, the individual student's possession of their own laptop might moderate the problems of trying to stake a claim to the hardware available in the home described by Facer et al (2001, pp18–21).

3.7 REACHING LEARNERS OUTSIDE THE SPHERE OF FORMAL EDUCATION

Inevitably, even greater problems of access and opportunity are faced by those outside normal systems of provision for education and training, such as those with medical issues which prevent school attendance (including chronic psychiatric or emotional problems), and schoolgirl mothers. Young people in these circumstances generally experience lower levels of access to educationally-oriented forms of technology than any other group, whilst self-evidently being potentially in greater need than any other sub-group of the 14-19 age group. Many of such children are kept in touch with education through the Education Otherwise Than At School (EOTAS) service, which has developed some opportunities for electronically managed contact, along with a wide range of other equally important strategies. Thus, Birmingham's Education Service has developed the Virtual College, which assigns an individual tutor and a loaned laptop computer to each young person, so that the student receives five hours direct contact, along with a 20-hour online curriculum, with accreditation through ASDAN, as well as weekly access to group activities (Birmingham City Council 2002, p1). Coventry 14-19 Pathfinder has begun to explore the use of live broadcasts of lessons to pupils in hospital and a pregnant girls' unit.

This issue will be considered further in the Section 4 case studies.

3.8 ENHANCING ESTABLISHED PEDAGOGIES/ENABLING INDEPENDENT AND COLLABORATIVE LEARNING

Quite reasonably, teachers across the age ranges of formal schooling look to technology to enhance established modes of teaching and learning. They value its wealth as a resource and its motivational qualities (Becta 2003), and are pleased to make use of it in order to increase student activity in lessons, as well as self-confidence and sense of agency. Ruthven et al (2005) describe how teachers regularly organised lessons round teacher-supported ICT-based pupil activities as means of "... promoting more active student participation in lessons and engagement in thinking... capitalising on

of particular significance is the commitment to connecting school learning with the home in a way that is not purely dependent on parents' capacity to buy a computer

DIGITAL TECHNOLOGIES AND THE 14-19 AGE GROUP



enabling students to develop autonomy as learners and decision-makers is an underlying theme for the 14-19 age group

pupils' enjoyment of using computers to tackle realistic tasks and... helping in managing volatile pupils and co-opting them to classwork". In turn, this permitted teachers "to stand back and take more of an advisory role... to become less didactic in their approach" (p31). The authors see the projects they observed as providing evidence "more of modifications to the texture of classroom teaching and learning than of any radical refashioning" (p34). There is, indeed, little evidence of mainstream teaching seeking to use technology to bring about a substantial shift in the teacher-learning relationship. Enabling students to develop autonomy as learners and decision-makers is an underlying theme for the 14-19 age group, but in looking at what digital technologies can do in this respect, the question should perhaps be more about the extent of movement towards increased autonomy, rather than about evidence of any major transformation in this respect.

This perspective is explored further in the Section 4 case studies.

3.9 DEVELOPING NEW MODES OF LEARNING

The final element in this list involves those uses of digital technology that potentially play a significant role in radically reconfiguring classroom learning, or releasing learners from such settings altogether. Within the classroom, fairly familiar technology such as interactive whiteboards can, if used in conjunction with tablet technology, provide a more ready access to classroom communication. Some would claim that structured learning environments such as VLEs have the great advantage of giving voice to previously silent youngsters by allowing them to express their views in classroom settings through the relatively anonymous medium of synchronous electronic discussion:

"The anonymity that the VLE offers often helps to engage 'reluctant learners' who are more comfortable participating when not observed by their peers. It helps to dilute any peer group pressures around participating or the embarrassment of giving a wrong answer." (Lynn Grove High School 2005, p4)

Other applications of synchronous communication such as chat-rooms also form an important strand in such experimentation, as do more asynchronous forms such as discussion boards and weblogs.

In aiming to capitalise on technologies such as blogs and gaming, of course, educational institutions are consciously crossing a line into youth culture, in the hope of redirecting informal enthusiasms towards more formally conceived educational achievement:

"Because blogs seem so popular with youth, it is hard to ignore the implications for educational technology. Can blogs enhance learning environments? Can they be used in classroom settings? ... Blogs can be an important addition to educational technology initiates because they promote literacy through storytelling, allow collaborative learning, provide anytime-anywhere access..." (Huffaker 2004, p2)

More radically, perhaps, the notion of enabling students to utilise their skills as computer-games players in the classroom begins to privilege expertise that is

genuinely beyond the scope of the teacher. James Paul Gee's comment that "young gamers today aren't training to be gun-toting carjackers. They're learning how to learn" (Gee 2003, p1) does not sound particularly radical now in some quarters, although many teachers will still require convincing of arguments such as this:

"The secret of a videogame as a teaching medium isn't its immersive 3-D graphics, but its underlying architecture. Each level dances around the outer limits of the player's abilities, seeking at every point to be hard enough to be just doable. In cognitive science, this is referred to as the regime of the competence principle... Cognitive scientist Andy diSessa has argued that the best instruction hovers at the boundary of a student's competence. Most schools however, seek to avoid invoking feelings of both pleasure and frustration, blind to the fact that these emotions can be extremely useful when it comes to teaching kids." (Gee 2003, p2)

The use of mobile devices such as PDAs and GPRS systems is also becoming a more normal part of the educational landscape, with Becta claiming that these "could become a major factor in facilitating anytime, anywhere access to learning resources" (Becta 2005, p2). Researchers have been investigating these possibilities for some time in fact – for instance, the m-learning project, a pan-European research and development study, aims to use portable technologies to provide literacy and learning experiences for young adults (aged 16-24) who are not in a full-time education environment. The project is in particular exploring the feasibility of using phone-based games to improve spelling, reading, mathematics and foreign languages (Attewell and Saville-Smith 2004).

This section has examined ten particular ways in which digital technology is currently being used with this age group. In the next section, we adopt a more holistic approach through the use of four case studies to examine key issues about the interaction between technology and learning.

CASE STUDIES

4 CASE STUDIES

4.1 USING MULTIMEDIA IN A SCIENCE CLASSROOM

This case study of two Australian senior high school classes (Kearney 2004) was carried out from a social constructivist perspective, exploring whether students were enabled to have meaningful learning conversations during multimedia-supported Predict-Observe-Explain science tasks. The POE procedure is based on the classic model of scientific research – hypothesis, data gathering and discussion of findings – to enable students to "articulate, justify, debate and reflect on their own and peers' science views and negotiate new and shared meanings" (p429). The POE tasks used were created within a computer environment using multimedia authoring software, and consisted mainly of digital video clips viewed by students on shared computers. This then constituted "a technology-mediated probe of understanding" which, according to the author, played a crucial part in stimulating these "socially-based, co-constructions of contextualised knowledge".

Although relatively low-tech, the use of the computer is presented within this study as being a key element in stimulating discussion and thinking: "The rich contexts encouraged the students to reflect on and articulate their ideas relevant to the problems posed. Disputes over responses gave students an opportunity to justify and defend their viewpoints and the high incidence of students editing their written and drawn predictions was testimony to these meaningful discussions" (p436).

The research demonstrates that the great majority of students (43 out of 46) agreed or strongly agreed that "the computer tasks encouraged us to talk to each other about our ideas" (p438), but the research also makes clear that it was the dialogue rather than the technology that was found to be most stimulating by the students. Interestingly, in fact, the author points out that a "notable and unexpected aspect of the students' engagement with the computer-based POE tasks was the frequent use of off-computer mini-experiments by groups", such as dropping objects to the ground to compare the effects of gravity on different objects. Indeed, it is tempting to suggest that the role of technology was in fact relatively minor in the whole process, although the fact that boys could often be seen pointing to the video clips on the screen to trace pathways of objects with their fingers or their pen "indicated that students were using these gestures to enhance reflection on their ideas" (p443). The computer environment is also shown to have afforded student control "over the pacing of POE tasks" and "enhanced the quality of feedback on their earlier predictions" (p447), and was obviously a good focus for discussion.

The study claims that the computer-mediated nature of these activities was particularly significant in creating a context for collaborative learning. But perhaps the significance of this example of digitally-supported learning lies in the very fact of its relatively unremarkable nature. The POE form of science learning activity was developed independently of any particular use of digital technology, and has become a recognised element in a mainstream classroom setting. Clearly the use of computers to present material and to

focus discussion was an effective element within the context of deploying a familiar and well-established pedagogy. Whilst talk of social construction of meaning might be making too much of normal and unremarkable classroom pair-work, it does seem fair to argue that this is a convincing instance of how relatively low-key uses of technology can become normalised within mainstream educational practice to good effect, playing their part in the learning process relatively modestly alongside many other significant elements.

4.2 USING TECHNOLOGY TO SUPPORT THE LEARNING OF STUDENTS OUTSIDE FORMAL EDUCATION

This case presents alternatives to the EOTAS provision mentioned in the previous section. The Notschool project, funded by DfES and SEED at Ultralab, is an online project looking at ways of "re-engaging young people of school age back into learning" who have been out of the traditional system for a variety of personal and logistical reasons, and for whom home tutoring has not worked[17].

The project consists primarily of a website, Notschool.net, which is described as a community for learning. The young people themselves are referred to as a community of researchers, who enter information about themselves on their own page, and communicate with their peers, as well as with tutors and mentors. Tutors "encourage interest, prompt for ideas, set formal work, assess work, look around the community and tell their researchers what's new..." (Duckworth 2001, p6). The software allows debating, polls and other interactive methods of online communication to be used to motivate and encourage collaboration.

The pilot of this project involved 92 young people from Essex, Suffolk and Glasgow, who were out of school for reasons such as being phobic, ill, disruptive, disaffected and pregnant. As well as engaging in a wide range of learning activities, encompassing areas such as mathematics, literacy, dance, saxophone playing, juggling and the environment, the online community also was found to open up opportunities for non-virtual social activity between peers, mentors, tutors and experts. There was, indeed, a great deal of committed adult involvement in the community, to the extent at times that the young people – ie the researchers – felt overwhelmed and withdrew. Nonetheless, the adult nature of the project was, in other respects, crucial to its success – the project recognised, for instance, that the induction events where researchers were brought together to learn how to use the software environment and the hardware had to be run with an adult atmosphere, and areas where there was any atmosphere of school were less successful.

The details of this project show a considerable degree of care over crucial aspects of detail, such as avoiding time-lag in setting up connectivity for the young people, and in providing full-time support to ensuring that they had online access 24/7. The pilot showed that it was possible to successfully manage as many as 40-60 researchers with a central team of three full-time equivalent staff, thus establishing a model which would not be impossible to expand across individual LEAs in the country.

relatively low-key uses of technology can become normalised within mainstream educational practice to good effect

[17] www.notschool.net/?id=about_ns

CASE STUDIES



students thrive in settings where they are able to collaborate with one another in developing their own projects

Achievements were considerable during the pilot, in terms of involvement in the community, learning and accreditation – over 50% of the young people achieved formal accreditation of some sort. The learning gains in literacy were also dramatic: "Most researchers had very low levels of literacy when they joined Notschool.net. Some were unable to key simple words such as 'hi' and 'hello'. Improvements in literacy have been substantial. Most used 'stickies' and the language of text messaging as a starting point" (Ultralab 2001, p15). There were wider benefits for families also: "The 24/7 connection enabled all family members to access the internet freely. Where younger siblings had been following the pattern of non-attendance of elder brothers and sisters, we noted their access to technology improved their confidence and their standing amongst their peers... Parents who were unemployed or in low status work were empowered by the technology" (Ultralab 2001, p15).

The final conclusion of Ultralab's main report is that Notschool.net "undoubtedly works very successfully in reengaging this target group of teenagers back into the learning process... Notschool.net must have none of the systemic barriers to learning which exist in traditional school environments, so that the process of reengagement in learning can be enabled. We remove all the rhetoric, strictures and structure of school including the need to meet face-to-face with a tutor or teacher. The key engagement is participation in an online learning community which is both asynchronous and distributed" (Ultralab 2001, p16). This positive view from the project's main proponents is firmly backed up by the independent evaluation.

Ultralab acknowledge that Netschool.net does not work in seriously dysfunctional families where no support exists from adults or carers, but "with a spark of enthusiasm from anybody directly interested" then the model works. Indeed, the report goes so far as to claim that the model works in a 24/7 365 day time zone to reflect the needs of its population and perhaps the needs of all children.

4.3 DEVELOPING INDEPENDENT LEARNING IN PUPILS WORKING ON TECHNOLOGICAL PROJECTS

This case study from Israel (Barak 2004) raises a number of crucial issues regarding the use of technology to support workplace simulations, and independent learning. In particular, it calls traditional pedagogies into question, both generally and in the field of technical-vocational learning, and suggests that students thrive in settings where, with the support of technology, they are able to collaborate with one another in developing their own projects as they progress through stages of development which gradually remove them from the control of a teacher.

The project grew out of earlier projects involving the same author that had suggested that "modern technological workshops and computer-based projects raised pupils' self-image and motivation to study. The most important aspects, in pupils' eyes, are construction activities, teamwork and freedom of action" (Barak 2004, p172). Barak considers that the central question underlying these projects is "whether teachers really change their position from being the single source of knowledge and authority in the class,

towards becoming pupils' partner for learning, problem solving and decision making" (p173).

The research focused on pupils in six schools who were working on final electricity studies projects during the 12th grade, as part of what is for mid- to low-achieving pupils a blend of general and vocational education within comprehensive high schools. Traditionally, teachers' perceptions of the technical-vocational education of such students entailed offering a limited and highly directive range of choices for these final projects, citing the pupils' inexperience, the need to control classes, the need to avoid too many different explanations and the benefits of pupils working together on very similar activities as reasons for doing this.

Nonetheless, in carrying out the computer simulations of electronic systems, the students rapidly developed far more independent working procedures than those anticipated by the teachers. "Pupils' dependence on the teachers reduced progressively. First, they gained more experience and self-confidence. Second, each group progressed at a different rate and faced different problems. When the pupils spent too much time waiting for the teacher, they intensified their efforts to solve their problems and got help from their teachers, friends, or via the internet... After three to four months, over 75% of the pupils completed their construction and basic operation of their system. At this stage they become more and more autonomous, while only a minority of the pupils relied on the teacher to help up to the deadline" (p177).

Barak points out that the ten highly experienced electronics teachers each reacted to the pupils' growing independence differently, giving "different degrees of freedom to the class" (p.178), with one maintaining a highly traditionalist approach: "'I am responsible for preparing them for the final exam... I can't take risks... the pupils are inexperienced... they spoil expensive components...'" (p179). Most, though, adapted to the students' working methods, reflecting what the author sees as a particularly important shift "from a technical-vocational perception to an emphasis on the development of pupils' thinking skills and self-esteem" (p179). Barak characterises this change in teachers' classroom roles as a developmental process for the teachers, and out of these ideas the following key stages that teacher and students together were passing through were articulated: the 'show me' stage, where the teacher adopts a direct supervision and explanation approach; the 'advanced beginners' stage, where learners can define their own simple questions; the 'let's think together' stage, which benefits from a 'collaborative supervision' approach in which the teacher and learner work together to identify complex problems and solutions; a 'proficient learners' or 'trust me' stage, where the teacher plays a largely non-directive role.

As in all cases, digital technologies were only part of the story. But it is strikingly clear in this particular case that the freedom to think and experiment offered by the opportunity to use computers for these final projects, rather than just building lower grade experiments with circuits, was critical in creating what appears to have been a number of outstanding instances of technology-enabled independent learning across the six schools involved.



CASE STUDIES



the switch from learning in a school to working in an enterprise is too often accompanied by the impression that the classroom has little to do with reality

4.4 VIRTUAL ENTERPRISE ARNOLD & STOLZENBERG GMBH

This last case study is drawn from Germany and involves a complex simulation designed for apprentice industrial clerks, one of the largest apprenticeship sectors in Germany (Achtenhagen 2004). Within Germany, there is a radically new vision of instructional design principles for VET emerging, based around the concept of **lernsfeld**, that aim to employ digital technologies in an integrated way. In part the new instructional design principles are intended to cope with what Sloane (2004) terms the 'swing' between theoretical and practical learning characteristic of the dual system of apprenticeship found in Germany and Austria. The concern is that the switch from learning in a school to working in an enterprise is too often accompanied by the impression that the classroom has little to do with reality. In this case study digital technologies are employed to overcome this problem of the transfer of knowledge between settings.

The work of the development team was guided by four assumptions (Achtenhagen 2004, p118, our emphasis):

1 Linearised and 'chopped-into-pieces' curricula and the corresponding teaching-learning processes do not support effective and responsible teaching and learning. This statement is formulated after close consideration of all modes of teaching and learning following new theoretical approaches, mainly based on constructivist hypotheses.

2 New modes of teaching and learning are necessary which help to develop an adequate and deep comprehension of the systemic character of the complex and dynamic processes at the workplace and in private life.

3 Complex teaching-learning environments can be judged here as the right choice as they try to model teaching and learning in a new way, especially by using new technology. **But the decisive aspect is their sense-making integration into newly structured curricula.**

4 The teachers have to develop new, alternative material and technical aids – to replace the transparencies and other materials they developed and used over time.

To solve the teaching-learning problems in the commercial schools attended on a part-time basis by the apprentices, the team developed solutions at three levels: the curriculum level; the didactic level; and the instructional level. A key assumption of the team was that 'curriculum embeddedness' is a necessary prerequisite for the successful use of a complex teaching-learning environment. To facilitate this, the team focused on the first unit prescribed by the newly developed State Curriculum for apprentice industrial clerks: the enterprise as a complex economic and financial system.
At the didactic level two educational objectives were picked out as central themes:

1 Bringing together the goals and content as prescribed by the curriculum on the one hand, and teaching and learning methods on the other since decisions on content have consequences for the choice of instructional methods and vice versa.

2 Bringing together general educational goals, such as equal learning opportunities, and the instructional approaches adopted in the classroom.

However, achieving these objectives for all students was complicated by the increasingly heterogeneous nature of the intake to the apprenticeship programme. Thus, to ensure that all learners had equal access, the team adopted a mastery learning approach. This had as its central goal that all apprentices, by the end of the first curriculum unit (after six months), would have developed a comparable mastery level of knowledge and a level of motivation that would enable teachers to provide instruction that resulted in comparable success for all students.

The instructional design level is where the digital technology appears. Using a multimedia approach the team developed a virtual enterprise 'Arnold & Stolzenberg'. This was based upon a detailed ethnographic study of a British-owned firm that makes industrial chains. Located near Göttingen, this firm has a worldwide market share of 25%. Using the data derived from the study of the firm and combining it with this set of theoretical ideas the team developed a CD-Rom that covered the content of the first curriculum unit. This CD-Rom contains a wealth of information that enables apprentices to solve authentic problems. These 'exploration tasks' structure the use of the material. The following extract explains the nature of one such task.

"The first of these tasks is to explore the earliest possible date for the delivery of a certain amount of industrial chains. The task is presented by a video sequence in which an apprentice gets a call with the corresponding question.

Each apprentice in the classroom then has to navigate through the virtual enterprise to collect all the necessary information. Via pictures, diagrams, videos, texts and simulated computer terminals the apprentices get the pieces of information needed to answer the question. All navigation steps, their sequence and also the time taken for working with a special screen are taken down. Each failure is automatically recorded and leads to a new attempt. After having worked out the correct solution the students come to a video which closes the first exploration task. It demonstrates how the answer is given to the client.

As the students need different amounts of time to find the right solution, a new task (in another format and mode of representation) is given to them immediately after they have completed the first task successfully. The second task has to be solved in the same lesson. As the first classroom unit consists of three lessons, only a few students manage both tasks within school time. But all students have to deliver the correct solution to the second task in the next classroom unit. This means they work at home or at their work-place in the firm (we received the permission of their superiors). Thus, additional learning time is to be administered outside the classroom. The same procedure applies if the students need more time for other tasks to be solved by navigating." (ibid, pp124-125)

The power of this simulation lies not just in its ability to recreate certain key aspects of the reality of the work of apprentice industrial clerks using digital technologies. Rather it lies in the way that the digital technology is embedded in a sophisticated model of a powerful teaching and learning environment. This model connects with

the power of this simulation lies in the way that the digital technology is embedded in a sophisticated model of a powerful teaching and learning environment

CASE STUDIES



policy makers' concerns (curriculum embeddedness) and adopts recent research evidence, largely derived from work in a social constructivist tradition, to produce a coherent teaching and learning platform. This ensures that the digital technologies are deployed in a way that maximises their potential to support the learning of the students.

4.5 ACHIEVING DESIRED LEARNING OUTCOMES

To what extent is the learning being promoted by the use of technologies in these case studies consistent with the desirable learning outcomes identified in Section 2? The case studies represent a gradual change in the extent to which the use of the digital technology is embedded in the learning environment. The first case study shows that even a modest use of digital technology can result in, for example, collaboration and regulation skills being taught. This example also shows how digital technology can be used to shift the focus from guided towards more independent learning relatively simply. However, we do not know the extent to which self-regulative skills and higher cognitive processes are being developed. Thus, this example suggests that only a limited range of desired learning outcomes are being achieved.

The second case study represents a very worthwhile attempt to engage with potentially the most challenging group. Here, the emphasis is on contact and engagement. The extent to which this leads to, for example, deep conceptual understanding and transferable knowledge and skills, needs to be assessed. However, it is worth pointing out that such projects run the risk of stopping at the level of achieving motivation rather than moving on to the more challenging task of raising attainment.

The third example represents an interesting case of progression from more independent work to self-directed learning. This leads to greater opportunities for exercising higher cognitive skills and, in particular, developing self-regulation of learning. However, what is striking is that it is the young people themselves who take the initiative here. The teachers, at least to some extent, follow behind and remain uncertain about the move from guided to more independent and experiential learning. This example therefore speaks volumes to the challenge of encouraging teachers to embrace this pedagogical move, whereas the young people themselves seem to have no trouble in accommodating such a shift in their learning.

The final case study does not start from the premise of adding technology to an existing mix of teaching and learning strategies. Rather, it questions the fundamental nature of this mix, and the ways in which technology can be used as an integral part of developing a new type of teaching and learning environment. This is the example that probably comes closest to the developing concept of a powerful learning environment, and clearly meets many of the demands for new types of learning outcomes and processes set out in Section 2. However, it also testifies to the high level of investment needed to produce such tailor-made solutions to develop both general and specific learning outcomes. If we wish to develop such powerful learning environments for our young people, the cost implications need to be recognised.

CONCLUSION

5 CONCLUSION

There are clear gaps in the current research into educational technologies that specifically refer to 14-19 education. Whilst there are considerable numbers of case studies outlining, for instance, the initial stages of implementing systems within the UK for managing and monitoring the education of young people in this group, few of these have been worked through sufficiently to have a great deal to report as yet, and adequate evaluations are scarce. In particular, it would be helpful to be able to access more meta-analyses than are currently available.

What is even harder to access, though, is the voice of the students themselves. This certainly does seem to us to be a particularly crucial dimension, given that we are talking about students whose increasingly adult status is supposed to be a defining feature of their educational provision. This perspective is interestingly raised by Deaney et al: "... pupils in our study were concerned about the extent to which, in future, teaching might become devolved from classroom settings by the adoption of more remote, digitally-based modes of delivery" (Deaney et al 2003, p18), with one pupil expressing the feeling that: "It's not the same as having a teacher in front of you because you can't talk to them after the lesson, ask the teacher additional questions or speak to them about things that you don't really understand or things like that" (p15).

Not only do we need to know more about students' feelings and attitudes towards issues such as this, we need to be able to relate policy development and implementation to better understandings of the sense that these young people are making of the world through their own uses of technology, and through those uses that formal education attempts to put in place for their benefit. In such respects, it clearly is not adequate merely to offer the kinds of things that policy makers want to hear, such as the girl quoted in the case study of Wolverhampton's highly elaborate ILP, who is reported – somewhat unconvincingly – as saying: "Our pathways are opened up by the choices we are given in the City" (DfES 2004b, p1).

These possibilities for using digital technologies offer distinct ways in which young people, at this crucial stage in their lives, might get more out of their education than was feasible before networked technologies were widely available. Viewed overall, this range of possibilities reflects a serious and committed effort on the part of educational providers to expand choice in terms of the range of learning opportunities available to young people, especially those not restricted to the A-level and university track.

Technologies could be crucial in this respect to inform young people about possibilities, to support the processes of choice-making, and to monitor the progress of all students through these choices, even those on the fringes of the system. In addition, it could be argued that the economic benefits of these technologies, for instance in enabling educational managers to harness and distribute resources in cost-efficient ways, benefits learners in the long term.
The capacity of technologies to do these jobs is one thing, and their capacity to support appropriate kinds of learning is another and, as suggested earlier, we should perhaps resist the temptation to create too great an impression of

we need to know more about students' feelings and attitudes

CONCLUSION



if we are to strive for the more ambitious developmental and learning outcomes then larger shifts in current practice are likely to be needed

coherence out of the very diverse jobs that technology can do for this age group. Admittedly, the range of jobs that institutions proudly proclaim on behalf of their new VLEs do make them look very much like a fully integrated solution, although in fact the capacity of a VLE to plan and track learners' progress through a task tells us very little about its capacity to deliver the new and more engaging kinds of learning that are claimed for digital technologies. To this end, we need well-researched answers to the following sorts of questions:

1 Is there evidence that digital technologies contribute significantly to established pedagogies?

2 Is there evidence that digital technologies specifically encourage independent and collaborative modes of learning?

3 Do digital technologies enable learning opportunities that specifically benefit the educationally disadvantaged?

4 In what contexts are digital technologies most effective for learners in this age range? How do these contexts relate to the specific needs of different sub-groups within the age range?

However, waiting for research to answer these questions and so 'prove' the value of digital technologies in enhancing learning in the 14-19 phase before implementation is, of course, not an option. What is needed, then, is a research and development agenda possibly based around, for example, the idea of 'design experiments'. Such experiments would involve the active collaboration of teachers, software designers, and experts in learning and instructional design. To attract funding they would need to target real policy issues, such as supporting the learning of disaffected young people outside of school or providing opportunities to develop the sorts of knowledge application and problem solving skills needed to answer the proposed extension questions on A-level papers. The starting point for such experiments would therefore be genuine curriculum problems and their initial development would involve reviewing what we know about pedagogical solutions to the curriculum issues so identified. These are the first steps in developing an overall solution design based upon constructing a powerful learning environment. Teachers' involvement throughout is crucial as they provide the situated knowledge essential to tailoring a general design to specific learners and contexts. Continual evaluation of the project leads to the development of new knowledge about what is successful and what is less so.

As we have seen in the case studies, quite small implementations of digitally enhanced learning can have a significant impact upon the learning of young people in this age group. But if we are to strive for the more ambitious developmental and learning outcomes discussed earlier, then larger shifts in current practice are likely to be needed since, as Lehtinen argues:

"The effects of ICT, however, depend not only on the equipment, but also, above all, on the pedagogical implementation of technology. Thus, the pedagogical approaches used are, in many cases, more important than the technical features of the applied technology. A successful application of ICT in education always means that many systemic changes in the



whole activity environment of the classrooms take place." (2003, p36)

Embracing such change will require teachers to adopt what Dewey (1916) referred to as an experimental stance towards their teaching. The history of curriculum development projects, such as those inspired by Lawrence Stenhouse, suggests that teachers are willing to do this. However, such projects took place in a very different climate and under very different accountability regimes. The extent to which teachers, lecturers and the institutions they work in are able to indulge in such risk-taking at a time of sharpened accountability, defined through narrowly specified learning outcomes is questionable. To do so they will require considerable support targeted at problems they consider to be important, and in the short to medium term we suspect these are more likely to be in the area of the provision of VET than in, say, teaching A-level. Furthermore, if the long-term political aim is to create educational institutions with greater flexibility to respond to the needs of their students, then there must be investment in the capacity of schools and colleges to respond to their learners, rather than in creating mechanisms and processes that control their behaviour and diminish their capacity to act independently. The challenge of enhancing learning in the 14-19 phase through the use of digital technologies is therefore not just a technological one, but also one of winning hearts and minds to develop better learning opportunities for all young people.

This has to involve not just teachers and policy makers, but young people as well, if they are to be more engaged by the educational opportunities made available to them.

"Kids are certainly not too stupid for school. Perhaps school is too stupid for them. Too stupid, too slow, too uncolourful, too mono for a bunch of kids for whom speed, excitement, words, pictures, sound and film are all parts of acquiring and passing on information, all ways of telling stories. At some point, decisions about the way we educate our kids will have to take a much more radical stance than arguments over whether A-levels are too easy, or if vocational subjects have the same value as 'proper', academic subjects. The form, content and method of knowledge delivery within schools is out of sync with the way that people learn elsewhere, with what they value, with what counts in the world." (Barham 2004, p234)

embracing such change will require teachers to adopt an experimental stance towards their teaching

REFERENCES

REFERENCES

Achtenhagen, F (2004). Mastery learning in and by complex teaching-learning arrangements, in: RH Mulder and PFE Sloane (eds) New Approaches to Vocational Education in Europe: the Construction of Complex Learning-Teaching Arrangements (pp115-130). Didcot: Symposium Books

Attewell, J and Saville-Smith, C (2004). Mobile learning and social inclusion: focusing on learners and learning, in: Attewell and Saville-Smith (eds) Learning with Mobile Devices: Research and Development. Learning and Skills Agency: London

Barak, M (2004). Issues involved in attempting to develop independent learning in pupils working on technological projects. Research in Science and Technological Education, Vol 22, No 2, November 2004

Barham, N (2004). Disconnected: Why Your Kids Are Turning Their Backs on Everything We Thought We Knew. Ebury Press: London

BBC (2004). Plan to link schools and colleges. http://news.bbc.co.uk/1/hi/england/west_yorkshire/3660162.stm

Becta (2003). What the Research Says About ICT and Motivation. Becta: Coventry

Becta (2005). Becta's View: The 14-19 Agenda. January 2005. Becta: Coventry

Bereiter, C (2002). Education and Mind in the Knowledge Age. Mahwah, NJ: Larence Erlbaum Associates

Bereiter, C and Scardamalia, M (2003). Learning to work creatively with knowledge, in: E De Corte, L Verschaffel, N Entwistle and J van Merriënboer (eds) Powerful Learning Environments: Unravelling Basic Components and Dimensions (pp55-68). Pergamon: Oxford

Bernard, M, Abrami, P, Lou, Y, Borokhovski, E, Wade, A, Wozney, L, Wallet, P, Fizet, M, and Huang, B (2004). How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. Review of Educational Research, Fall 2004, Vol 74, No 3, pp379-439

Bloomer, M (1997). Curriculum Making in Post-16 Education: The Social Conditions of Studentship. London: Routledge

Birmingham City Council (2002). Education Otherwise Than At School. Education Service, Policy Document

Brown, N, Corney, M and Stanton, G (2004). Breaking Out of the Silos: 14-30 Education & Skills Policy. London: Nigel Brown Associates

Central Gateshead Sixth Form (CG6) (2004). www.standards.dfes.gov.uk/personalisedlearning/downloads/centralgteshd.doc

Cuban, L (2001). Oversold and Under Used: Computers in the Classroom. Cambridge, MA: Harvard University Press

De Corte, E (1990). Towards powerful learning environments for the acquisition of problem solving skills. European Journal of Psychology of Education, 5, 5-19

De Corte, E (1994). Towards the integration of computers in powerful learning environments, in: S Vosnaidou, E De Corte & H Mandl (eds), Technology-Based Learnng Environments: Psychological and Educational Foundations (pp9-25). Berlin: Springer-Verlag

Dewey, J (1916). Democracy and Education. New York: Free Press

DfES (2002). 14-19: Extending Opportunities, Raising Standards. London: DfES

DfES (2002). Success for All: Reforming Further Education and Training. www.successforall.gov.uk/linkAttachments/Our%20Vision%20for%20the%20Future%20-%2011.02.pdf

DfES (2003). 14-19: Opportunity and Excellence. London: DfES

DfES (2004a). A National Conversation about Personalised Learning. DfES/0919/2004

DfES (2004b). Individual Learner Pathways in Wolverhampton. www.dfes.gov.uk/14-19/gp_reports/Wolverhampton%20individual%20learner%20pathways.doc (accessed 7/1/05)

DfES (2005). 14-19 Education and Skills. London: DfES

Duckworth, J (2001). Evaluation of the Notschool.net Research Project Initial Pilot. Cutter Wharf Consultants: Exmouth

Facer, K, Furlong, J and R, Sutherland, R (2001). Home is where the hardware is, in: I Hutchby & J Moran-Ellis (eds) Children, Technology and Culture. Routledge: London

Ferl (2003). Summary of a New Specialist System: Transforming Secondary Education. 13 March 2003, http://ferl.becta.org.uk/display.cfm?resID=5181&printable=1

Ferl (2004). Cornwall College: Supporting the 14-19 Phase Through the Development of an e-ILP. http://ferl.becta.org.uk/display.cfm?printable=1&resID=7032

Foskett, N, Dyke, M and Maringe, F (2004). The Influence of the School in the Decision to Participate in Learning Post-16. DfES RR538. Nottingham: DfES

Gee, JP (2003). High score education: games, not school, are teaching kids to think. The Wire, issue 11, 5 May 2003

Hargreaves, D (2004). Learning for Life: The Foundations for Lifelong Learning. Bristol: Policy Press

Harter, S (1988). Self-Perception Profile for Adolescents. Denver, CO: University of Denver Press

Hayward, G, Hodgson, A, Johnson, J, Keep, E, Oancea, A, Pring, R, Spours, K and Wright, S (2004). The Nuffield Review of 14-19 Education and Training Annual Report 2003-04. Oxford University Department of Educational Studies

Huffaker, D (2004). The educated blogger: using weblogs to promote literacy in the classroom. First Monday, Vol 9, No 6 (June 2004). www.firstmonday.org/issues/issue9_6/huffaker/index.html

Kremer, H-H (2004). New technologies and complex teaching-learning arrangements, in: RH Mulder and PFE Sloane (eds) New Approaches to Vocational Education in Europe: the Construction of Complex Learning-Teaching Arrangements. Didcot: Symposium Books

Lehtinen, E (2003). Computer-supported collaborative learning: an approach to powerful learning environments, in: E De Corte, L Verschaffel, N Entwistle and J van Merriënboer (eds) Powerful Learning Environments: Unravelling Basic Components and Dimensions (pp35-54). Pergamon: Oxford

REFERENCES

Lynn Grove High School (2005). A Virtual Learning Environment Innovation in Teaching and Learning. www.standards.dfes.gov.uk/personalised learning/downloads/lynngrovehigh.doc

Ofsted (2004). Pathways to Parity: a Survey of 14-19 Vocational Provision in Denmark, Netherlands and New South Wales. HMI 2124. January 2004. Ofsted: London

Pearce, N and Hillman, J (1998). Wasted Youth: Raising Achievement and Tackling Social Exclusion. London: IPPR

Pintrich, PR (ed) (1995). Understanding Self-Regulated Learning. San Francisco: Jossey Bass

Posthom, MB, Petterson, T, Gudmundsdottir, S and Flem, A (2004). The need for structure and guidance when ICT is used in project work. Mind, Culture and Activity, 11 (3), 178-200

Powell, B, Black, A, and Giles, T (2004), Using Technology to Support the 14-19 Agenda. Becta (ref. 15068)

Pring, R (1995). Closing the Gap: Liberal Education and Vocational Preparation. London: Hodder and Stoughton

Raffe, D (2001). Participation, inclusiveness, academic drift and parity of esteem: a comparison of post-compulsory education and training in England, Wales, Scotland and Northern Ireland. Oxford Review of Education, 27, 2, 173-203

Ruthven, K, Hennessy, S, Deaney, R (2005). Incorporating internet resources into secondary-school teaching: pedagogical perspectives and strategies of secondary-school subject teachers. Computers and Education, 2005 44/1, 1-34

Shuell, TJ (1988). The role of the student in learning from instruction. Contemporary Educational Psychology, 13, 276-295

Simons, P, R-J (2001). Six key questions for complex learning environments, in: Kremer, H-H and PFE Sloane (eds) Konstruktion, Implementation und Evaluation Komplexer Lehr-Lern-Arrangements (pp173-186). Paderborn: Eusl-Verlagsgesellschaft MBH

Simons, P, R-J, and Bolhuis, S (2004). Constructivist learning theories and complex learning environments, in: Mulder, RH and PFE Sloane (eds) New Approaches to Vocational Education in Europe: the Construction of Complex Learning-Teaching Arrangements (pp13-25). Didcot: Symposium Books

Sloane, PFE (2004). The application transfer between schools and enterprises in the German dual system: putting it into practice, in: RH Mulder and PFE Sloane (eds) New Approaches to Vocational Education in Europe: the Construction of Complex Learning-Teaching Arrangements (pp141-156). Didcot: Symposium Books

Specialist Schools Trust (2004). Top-Performing School Starts by Managing Behaviour. www.schoolsnetwork.org.uk/content/articles/2493/topperf0304.pdf

Stasz, C and Wright, S (2004). Emerging Policy for Vocational Learning in England: Will it Lead to a Better System? London: LSRC

Ultralab (2001). Notschool.net: Research Phase Final Report. Ultralab, December 2001. www.notschool.net/content/publications_pdf/report.pdf

Unwin, L (2004). Twenty-first century vocational education in the United Kingdom: what would Dickens think? Pedagogy, Culture and Society, 12, 2, 175-199

Van Merriënboer, JJG and Paas, F (2003). Powerful learning and the many faces of instructional design: towards a framework for the design of powerful learning environments, in: E De Corte, L Verschaffel, N Entwistle and J van Merriënboer (eds) Powerful Learning Environments: Unravelling Basic Components and Dimensions (pp3-20). Pergamon: Oxford

Wigfield, A, Eccles, JS and Pintrich, PR (1996). Development between the ages of 11 and 25, in: DC Berliner and RC Calfee (eds) Handbook of Educational Psychology. New York: Macmillan

Zimmerman, BJ (1989). Models of self-regulated and academic achievement, in: BJ Zimmerman and DH Schunk (eds) Self-regulated Learning and Academic Achievement: Theory, Research, and Practice (pp1-25). New York: Springer

About Futurelab

Futurelab is passionate about transforming the way people learn. Tapping into the huge potential offered by digital and other technologies, we are developing innovative learning resources and practices that support new approaches to education for the 21st century.

Working in partnership with industry, policy and practice, Futurelab:

- incubates new ideas, taking them from the lab to the classroom
- offers hard evidence and practical advice to support the design and use of innovative learning tools
- communicates the latest thinking and practice in educational ICT
- provides the space for experimentation and the exchange of ideas between the creative, technology and education sectors.

A not-for-profit organisation, Futurelab is committed to sharing the lessons learnt from our research and development in order to inform positive change to educational policy and practice.

Futurelab
1 Canons Road
Harbourside
Bristol BS1 5UH
United Kingdom

tel +44 (0)117 915 8200
fax +44 (0)117 915 8201
info@futurelab.org.uk

www.futurelab.org.uk

Registered charity 1113051

Acknowledgements

We are grateful to Ebrahim Talae for a number of helpful suggestions and comments, and to Keri Facer for her support and feedback.

This publication is available to download from the Futurelab website – www.futurelab.org.uk/research/lit_reviews.htm

Also from Futurelab:

Literature Reviews and Research Reports
Written by leading academics, these publications provide comprehensive surveys of research and practice in a range of different fields.

Handbooks
Drawing on Futurelab's in-house R&D programme as well as projects from around the world, these handbooks offer practical advice and guidance to support the design and development of new approaches to education.

Opening Education Series
Focusing on emergent ideas in education and technology, this series of publications opens up new areas for debate and discussion.

We encourage the use and circulation of the text content of these publications, which are available to download from the Futurelab website – www.futurelab.org.uk/research. For full details of our open access policy, go to www.futurelab.org.uk/open_access.htm.

Creative Commons

© Futurelab 2006. All rights reserved; Futurelab has an open access policy which encourages circulation of our work, including this report, under certain copyright conditions - however, please ensure that Futurelab is acknowledged. For full details of our Creative Commons licence, go to www.futurelab.org.uk/open_access.htm

Disclaimer

These reviews have been published to present useful and timely information and to stimulate thinking and debate. It should be recognised that the opinions expressed in this document are personal to the author and should not be taken to reflect the views of Futurelab. Futurelab does not guarantee the accuracy of the information or opinion contained within the review.



FUTURELAB SERIES

REPORT 13

ISBN: 0-9548594-3-X
Futurelab © 2005