

**Deep learning with technology in 14- to 19-year-old  
learners**

**Ian Abbot  
Andrew Townsend  
Sue Johnstone-Wilder  
Lynne Reynolds**

**The Warwick Institute of Education, University of Warwick**

## Table of contents

<b>Acknowledgments</b> .....	<b>4</b>
<b>Introduction</b> .....	<b>4</b>
Structure of the report .....	6
<b>Perspectives on the nature of deep learning</b> .....	<b>6</b>
<b>Action research: Key findings</b> .....	<b>9</b>
Staff perceptions of the notion of deep learning, Selby High School: Amanda Lumb (action researcher) .....	9
Using ICT as tool to motivate students and promote independent learning, Selby High School: Amanda Lumb (action researcher).....	9
Using a learning platform as a repository for information that promotes student self-direction, Plantsbrook College: Tom Pole (action researcher) .....	10
Using ICT to provide students with more challenging homework tasks that required sustained engagement and planning skills, Plantsbrook College: Tom Pole (action researcher).....	10
Building the use of ICT into a course design for teaching A-level at a further education college, Newcastle-Under-Lyme College: Richard Simpson (action researcher).....	11
Integrating ICT with the pedagogic approach of maths teachers, Burton College: Larissa Sidor (action researcher) .....	11
Examining the potential of 3D software to help students experience abstract concepts from different perspectives, Greensward Academy: Ian Courtenay (action researcher).....	12
Providing opportunities for students to use course materials via a learning platform outside of formal lessons.....	12
Using handheld games with maths software, CTC Kingshurst Academy: Michael Mayes (action researcher).....	12
Providing opportunities for learners to engage independently with subject materials via a learning platform .....	12
Examining the potential of using games to enhance learning, University of Warwick: Wee Hoe (action researcher).....	13
Using ICT as a medium for sustained collaborative projects, John Port School: Graham Pemberton (action researcher).....	13
Using ICT to develop skills to bridge the gap between studying at GCSE and at a higher level, King Edwards Five Ways: Elizabeth Bridgett (action researcher) .....	15
<b>Themes arising from the action research</b> .....	<b>16</b>
Embedding skills to enhance deep learning .....	17
The application of knowledge and skills in different settings.....	18
The association between independent and deep learning .....	20
Providing opportunities for deep learning .....	21
The difficulty of assessing deep learning.....	22

The importance of the overarching pedagogical approach in the use of ICT ..... 23

**Conclusions and wider emerging themes ..... 26**

Perspectives on the nature of deep learning ..... 26

Perspectives on the potential for ICT to enhance deep learning ..... 26

Perspectives on wider issues ..... 27

Further areas of research ..... 27

**References ..... 28**

**Appendix 1: Technical note, project methodology ..... 29**

Key aims ..... 29

Literature review ..... 29

Action research ..... 30

Organisation and management of action research projects ..... 30

## Acknowledgments

We would like to thank Becta and, in particular, Dr Gaynor Sharp, for ongoing support and encouragement. We would also like to thank the all the practitioner colleagues and learners who contributed to the action research case studies.

## Introduction

Over a number of years there has been ongoing reform of 14-19 education and training in England, in an attempt to address some long-standing and interrelated problems (Jephcote and Abbott 2005). The White Paper, 14-19 Education and Skills sets out what it describes as a 'once in a generation opportunity' to transform secondary and post-compulsory education (DCSF 2005, p10). The need to raise educational standards has been at the core of government policy and allied to this is the drive to improve skills to make the UK a global leader by 2020 (Leitch 2006).

The most recent reforms have been wide-ranging and aim to transform the delivery of learning from Key Stage 4 onwards. They reflect key priorities from the National Strategies, the Five-year Strategy for Children and Learners, Every Child Matters, the Framework for Achievement and the UK Skills Agenda. All types of education providers working with 14- to 19-year-olds will be expected to engage with the reforms. Some of the explicit aims of the reforms are to:

- provide broad, balanced and flexible curricula
- encourage attainment and retention at age 16
- offer a wide range of assessment levels to promote inclusion
- improve core skills for employability
- close the gap between vocational and academic provision
- promote partnership working across providers (Becta 2008).

A range of new initiatives has been developed with the introduction of specialised Diplomas in 2008 followed by the extension of these programmes until 2013. The Diplomas will enable learners to benefit from:

- rich and varied learning environments that engage learners in authentic tasks
- different ways of learning, including 'learning by doing', use of new technologies and collaborative, problem-based approaches, that meet affective as well as cognitive needs
- playing a central role in planning and reviewing their own learning to meet their interests and needs
- interactions with a variety of others, particularly those with experience of working in relevant sectors or contexts

- assessment for learning and development of meta-cognitive capabilities, such as reflection, that promote deeper learning and the making of connections between contexts and subjects (QCDA 2008, p3).

The term 'deep learning' has become widely accepted as it encapsulates the interest in the transformation and personalisation of the learning process. How we prepare young people for life, leisure and work today is a question that employers, governments, parents, educators and young people themselves are asking in response to the changing landscape of the 21<sup>st</sup> century. The curriculum is evolving rapidly to address the needs of young people with changes to teaching, learning and assessment. Central to this is the changing role of the learner who is no longer the passive recipient of knowledge, but an active part of every facet of the change process, from design to implementation.

A deep learner is thought to be one who approaches knowledge and learning by relating new knowledge to previous knowledge. This is described as 'knowledge transformation' by Entwistle (2000). A deep learner also relates theoretical ideas to everyday experience; distinguishes between evidence and argument; organises and structures content into a coherent whole; combines knowledge from different sources; and is self-motivated (Atherton, 2005). These attributes are highly desirable as they describe the flexible and independent learner who will succeed in a changing society.

A clear understanding of deep learning is needed to explore the possible benefits to the learner and to the wider community. Although there is no single specific definition, Simms (2006) gives the following working definition: "Deep learning is secured when, through personalisation, the conditions for student learning are transformed."

This is useful as it highlights the importance of the conditions for deep learning and its close association with personalisation. The emergence of the term 'personalisation' reflects the shift towards a much more learner-centred and inclusive education system. The focus on the individual found in deep learning makes this a potential source of personalisation.

Simms (2006) also gives a description of a learner engaged in deep learning: "An articulate, autonomous but collaborative learner, with high meta-cognitive control and the generic skills of learning, gained through engaging educational experiences with enriched opportunities and challenges, and supported by various people, materials and ICT linked to general well-being but crucially focused on learning, in schools whose culture and structures sustain the continuous co-construction of education through shared leadership."

## Structure of the report

This report contains the findings from a small scale-study funded by Becta into deep learning experiences among 14- to 19-year-old learners. It was carried out by researchers from the Universities of Warwick and Bristol between October 2008 and April 2009. Although operating as a joint team, the researchers from the two universities utilised different research approaches. The Warwick group carried out a literature review of deep learning and co-ordinated a series of action research projects, which are available to view online in both [PDF](#) and [Word](#) format. This report contains details of the various action research projects, key findings and recommendations.

The summary of findings section outlines the work of the action researchers who, between them, report on a total of 13 projects related to deep learning and ICT. (For more information on the methodology of this project, please refer to Appendix 1.) Although the action research group is relatively small, these projects are best seen as a series of exploratory studies examining the implications of adopting strategies intending to enhance deep learning and the potential that ICT offers in achieving this with learners aged 14-19. Accordingly, the findings address the relevance of a notion of deep learning to the practitioners involved and the ways in which using ICT can achieve deep learning.

## Perspectives on the nature of deep learning

Practitioner action researchers in this project felt that deep learning was both a phrase they had encountered and also a concept that had relevance for their work. The connections they drew between deep learning, their practice and the use of ICT are summarised below:

- **The use of ICT must be seen in relation to the overarching pedagogic approach.** While ICT was regarded as having the potential to enhance deep learning, its use must be built into pedagogic approaches in order for its potential to be realised by tutors and learners alike.
- **Deep learning is not achieved through a simple focus on examination performance.** While deep learning might be associated with a better performance in tests or exams, deep learning as an aspiration involves developing complex perspectives on the concepts in question. Such complex perspectives are not easily measured and so would not be easy to assess. On a more principled point, however, deep learning is believed to be an aspiration towards more holistic views of subjects under study in ways which interact with other subjects and with learners' lives. Thus an aspiration to achieve deep learning is much more than – and in principle different from – learning associated with outcome test performance. ICT can help provide a link between studying and other aspects of a learner's life by making use of technologies that learners are acquainted with – and

by giving them opportunities to engage in learning at points appropriate to them, as explored in the following item.

- **The use of learning platforms provides learners with the chance to engage with learning materials online, at the same time giving them control of the timing of their own learning.** The use of learning platforms was a popular focus for action researchers. These were associated with deep learning in that they provided learners with opportunities to engage with learning materials at times which they could choose. In other words, they encouraged student self-direction in learning. The use of learning platforms was enhanced by making the content more varied and interesting, but the interactive components of these learning platforms were not well used by learners.
- **Deep learning involves learners developing a sufficiently comprehensive grasp of concepts to apply them to differing contexts.** When associated with the concepts being taught, deep learning is believed to be achieved when learners have a sufficiently firm grasp of the concepts to recall them with ease and apply them creatively to conceptual and subject areas other than those in which they were first encountered. One example of this was the use of ICT to model abstract concepts which would not have been possible otherwise. For instance, the development of three-dimensional (3D) modelling and associated learning environments provided learners with a range of perspectives on these concepts, which encouraged a more complex and complete understanding of them.
- **Deep learning involves learners developing their skills in such a way that their use becomes instinctive and supportive of conceptual learning.** Deep learning was associated with the development of skills, including those transferable between different subjects – such as drawing graphs (the learning of which could be enhanced by the use of graphing software) – as well as those associated with the use of ICT itself. This learning is considered deep when the skill in question is instinctively repeatable by the student and can then be applied creatively to settings and problems other than those in which the skill was first learnt.
- **Deep learning takes time and is cumulative.** Deep learning was perceived as being an outcome which had to be worked at and developed over a period of time. This is in part because it involves a full understanding of issues and concepts from multiple perspectives, and in part because it is associated with retained knowledge and skills. Both of these require sustained attention from learners and are built up over time. In the views of action researchers, deep learning is not quickly or easily achieved.
- **Deep learning is based around learners' individual development, thus associating it with independent learning.** This does not mean that deep learning can only be achieved by students learning on their own. Rather,

the implication practitioners perceived was that learners attempting to achieve deep learning take ownership of the concepts and skills being learnt. While this can happen in a social setting and through the support of tutors, the goal is student ownership of the learning content.

- **Deep learning involves making links.** Action researchers believed that learning that is viewed as deep involves making links between the multiple areas of learners' lives. This is both an outcome (for example, in learners being able to relate conceptual issues across subjects) and a process (for example, in requiring learners to relate their work to life outside their educational institution). ICT provides the chance to create actual links between the different aspects of learners' lives, for example, by using technologies which the learners have encountered in other settings.
- **The use of ICT can change the culture and climate of educational organisations, thereby creating greater potential for deep learning.** In addition to providing a stimulus and process for learning, the use of ICT also has the potential to influence learner motivation and interaction with others. This has the potential to influence the context of learning in ways that are more conducive to all learning. While this does not achieve deep learning in itself, it enhances the potential for doing so.
- **The functional use of some applications lets learners focus on interrogating the broader concepts in hand, rather than being bogged down in the minutiae of their tasks.** The use of some applications provided learners with the opportunity to focus on the wider implications of their work without having to be concerned with the specifics of the task in hand. This encouraged a more holistic perspective on the task in question, which meant that the specifics of the activity given could be seen in relation to the overall purpose of that activity.
- **Learners do not necessarily have to be highly competent in the use of ICT; however, learning the skills necessary to make the best of technology is one feature of a deep learning approach that employs ICT.** The use of ICT can be seen in and of itself as a skill which can be learnt and developed. With increasing confidence and competence, it can become a facilitator rather than a barrier to learning.



## **Action research: Key findings**

This section summarises the work of the action researchers and highlights a number of key themes about the use of ICT to enhance deep learning.

In total, eleven action researchers completed thirteen projects, each of which has resulted in a separate report. This section begins with a summary of each of the 13 projects and the issues raised. The next section discusses the key themes arising from each of the project reports.

### **Staff perceptions of the notion of deep learning, Selby High School: Amanda Lumb (action researcher)**

#### **Project summary**

This project explored whether or not teaching staff have an understanding of the term 'deep learning' and whether there is any consensus among staff from different curriculum areas regarding a definition. It also explored whether staff have strategies to promote deep learning, including using ICT.

#### **Issues raised**

In general, practitioners were found to have some understanding of the term 'deep learning'. There is a good, if not consistent, knowledge base regarding deep learning. There is a need for practitioner professional development related to the notion of deep learning. There is also a need for a whole-school understanding of this term and a need for sufficient time to be allocated to develop a deep learning toolkit. This toolkit would support practitioners in promoting deep learning strategies, including the deployment of ICT.

### **Using ICT as tool to motivate students and promote independent learning, Selby High School: Amanda Lumb (action researcher)**

#### **Project summary**

This project recognised that using ICT is one of a number of strategies that can be applied by tutors/teachers. As a result, the use of ICT should be embedded in schemes of work, which is strategic not only in the conceptual outcomes of learning, but in the principles on which these outcomes are founded.

#### **Issues raised**

ICT applications can be used to enhance student self-direction and independent learning. This, along with an interest in ICT, can be a motivating factor. Personal engagement with ICT, however, is not enough on its own. The development of a learning strategy, which encourages deep learning, must take into account the various learning experiences of students in a holistic manner.

## **Using a learning platform as a repository for information that promotes student self-direction, Plantsbrook College: Tom Pole (action researcher)**

### **Project summary**

Self-directed learning was achieved by giving learners the opportunity to access the learning platform at times that suited them and to use it in ways that they found most beneficial. Learning was further enhanced by providing different sorts of online materials. The variety of materials gave greater opportunities for students to personalise their learning and have a more varied experience.

### **Issues raised**

The aspect of deep learning being promoted in this case refers to student independence or self-direction. By giving students the opportunity to access materials online and outside class, they could choose when they would engage with these materials. This also enhanced independent and self-directed learning in respect of the nature of those materials selected by learners and the ways in which the materials were used. Deep learning is therefore believed to be enhanced by informing student understanding of learning and providing more choice over how and when students learn.

## **Using ICT to provide students with more challenging homework tasks that required sustained engagement and planning skills, Plantsbrook College: Tom Pole (action researcher)**

### **Project summary**

Sustained engagement was achieved by setting students more project-style tasks for homework which, while being directly related the learning objectives, also provided more freedom for students than previous practices. This offered scope for students to have more varied experiences and greater opportunities to be creative. This was implemented in a class which had previously routinely had 100 per cent completion rates for students.

### **Issues raised**

ICT can provide greater scope and freedom for students in completing their work. Making a transfer from rigid focused homework to more open ended, project-style tasks provided greater freedom and so was associated with more independence and self-direction. However, the greater freedom of this can also be a distraction. This change in approach resulted in a drop in completion rates for homework (although this did improve over the project). The implication, seemingly, is that setting tasks which require a higher level of engagement and higher level thinking skills, is more complex for students. These tasks therefore require greater support, especially in planning and managing time, still leaving room for the challenge of the task to remain. This need not necessarily be a negative experience.

## **Building the use of ICT into a course design for teaching A-level at a further education college, Newcastle-Under-Lyme College: Richard Simpson (action researcher)**

### **Project summary**

This project identified structural and operational aspects of the course and examined the potential for using ICT to enhance the teaching of both. In this case, ICT was used as a method for modelling and practicing that could then be applied by the learner. This approach to modelling and problem-solving techniques required a sustained engagement from learners. These approaches were also transferable to other contexts.

### **Issues raised**

Deep thinking of tutors in designing pedagogical approaches to their subject was an important prerequisite for achieving an approach that encouraged deep learning. In this case, deep learning was about providing skills related to processing information. ICT offered the potential to enhance this through modelling and practicing these skills, such that they could be applied in different, albeit related, contexts. The use of ICT here encouraged the development of a competence that provided the basis for deep learning.

## **Integrating ICT with the pedagogic approach of maths teachers, Burton College: Larissa Sidor (action researcher)**

### **Project summary**

The project analysed the use of technology in an advanced mathematics classroom. It identified the possible ways in which using technology encouraged deep learning approaches.

### **Issues raised**

ICT allowed an investigative approach to mathematics and created an experience that included experimentation, discovery and surprise. Teachers were able to encourage students to think and stretch their learning. Also, ICT often triggered discussions in class that were previously lacking. It enabled students to experience a wider range of cases and engage in activities such as 'predict and sketch'. They could then use ICT to check their answers. Use of ICT promoted deep learning. However, access to computers was not always available when it could have been useful, so there were logistic issues.

## **Examining the potential of 3D software to help students experience abstract concepts from different perspectives, Greensward Academy: Ian Courtenay (action researcher)**

### **Project summary**

This project provided students with a more rounded view of the concept in hand.

### **Issues raised**

Learning was enhanced by using ICT to facilitate a more rounded and complex view of abstract concepts. This learning is 'deep' in the sense that students had a more complete understanding of the concept in question.

## **Providing opportunities for students to use course materials via a learning platform outside of formal lessons.**

### **Project summary**

This approach encouraged student independence.

### **Issues raised**

Deep learning was achieved as a result of students becoming more independent learners and becoming increasingly well acquainted with subject materials. This was achieved by giving students opportunities to engage with materials remotely, an activity that encourages student self-direction.

## **Using handheld games with maths software, CTC Kingshurst Academy: Michael Mayes (action researcher)**

### **Project summary**

This project was intended to improve maths attainment. It was also well liked by students. It had a significant impact on classroom behaviour, especially in classes where behaviour had previously been a cause for concern.

### **Issues raised**

ICT created greater opportunities for deep learning by improving classroom climate and especially behaviour. However, handheld games did not necessarily automatically improve knowledge or skills any more than paper-based alternatives.

## **Providing opportunities for learners to engage independently with subject materials via a learning platform**

### **Project summary**

This project built on the skills of students on an ICT programme, removing barriers to learning. Basing work on existing skills, respected the existing competencies and interests of students. In doing so, this became one form of personalised learning.

### **Issues raised**

Deep learning was achieved by developing ICT skills such that they became second nature and enhanced, rather than restricted learning. A strategy for achieving deep learning required the educator to take into account student capabilities and to adjust the teaching approach accordingly. This included providing opportunities for learners to engage with materials, hardware and software with which the tutor might not have been familiar so as to promote autonomous learning.

### **Examining the potential of using games to enhance learning, University of Warwick: Wee Hoe (action researcher)**

#### **Project summary**

Exploring the potential of games was a strategy to enhance student motivation and attempt to establish links between the learner's life outside school and their experience of education. This was seen as being respectful of learners' prior interests and knowledge and was therefore more appreciative of the wider context for student learning. Skills were also developed through the use of games, which were also required for the subject of learners study. However, learners did not necessarily make the connection between that learning and the learning required for their subject.

#### **Issues raised**

Deep learning implies a wider appreciation of the learner's context than that limited to learning in class. Games are very much a part of students' wider experience and so can provide a bridge between learning at the educational institution and learning at home. This, however, provided a challenge as learners did not necessarily make connections between their life outside their studies and their subject learning. Therefore, they did not necessarily value the link between these two areas. While these games did have a learning dimension to them, they also had less formal learning outcomes. However, perhaps their best feature was to encourage a view of learning that was more than that defined purely by studies.

### **Using ICT as a medium for sustained collaborative projects, John Port School: Graham Pemberton (action researcher)**

#### **Project summary**

The project produced a video that was hosted by an online video hosting website. The video was designed for a wide audience of the public. The project also encouraged a sustained dialogue between a group of learners, which in turn encouraged a more complete understanding of the learning outcomes in question.

This was achieved through a sustained examination of the learning outcomes and an interpretation of them in reference to the outcome of the project.

## **Issues raised**

Deep thinking was encouraged through a sustained focus on a particular purpose. ICT can assist in this by giving a broader purpose than that restricted to classrooms and by providing a challenge that requires sustained engagement. This was both motivating for learners (as the outcome was visible and widely available) and encouraging of deep thinking. Achieving the aims of the project required an intensity of engagement of learners as individuals and as a group.

## **Using ICT to develop skills to bridge the gap between studying at GCSE and at a higher level, King Edwards Five Ways: Elizabeth Bridgett (action researcher)**

### **Project summary**

This project was based on the observation that students did not necessarily transfer what they had learnt from one setting to another. In order to enhance their learning, two applications of ICT were explored. In both, a variety of outcomes were observed. These ranged from the thoughtful use of ICT by students, to their attempts at 'trial and error', which seemed to take thought out of the process.

## **Issues raised**

Deep learning was interpreted as developing skills so that they became automatic. Initially these skills could be a barrier to learning the conceptual aspects of the subject but, once developed, these skills become both transferable and supportive of learning. The applications trialled certainly had the desired effect, but not universally. Indeed, some students simply used the applications as trial and error approaches. However, this had additional benefits as it provided a way for students to start engaging with problems that they might have previously found insurmountable. Also, this trial and error approach, while not achieving deep learning in itself, enabled students that might otherwise have 'given up' to start the journey. This emphasised the importance that ICT is one component of a pedagogical approach, but only one.

## Themes arising from the action research

A number of features of learning, which action researchers regarded as being ‘deep’ were discussed in both seminars and in the reports submitted to the University of Warwick. One action researcher highlighted four qualities that he regarded as constituting deep learning as follows:

Deep learning:

- is more likely to happen if learners take ownership of their work
- might only take place after rehearsal and repetition of skills
- is related to applying knowledge and skills in different contexts
- is related to organising content into a coherent whole.

(Tom Pole, action researcher)

In particular, the following themes have been drawn out from action research reports:

- Embedding skills to enhance deep learning.
- The application of knowledge and skills in different settings.
- The association between independent and deep learning.
- Providing opportunities for deep learning.
- The difficulty of assessing deep learning.
- The importance of the overarching pedagogical approach in the use of ICT.

These themes are discussed in further detail below and are informed by comments made by action researchers during their group discussions held during action research facilitation days. In fact, the term ‘deep learning’ was a phrase that almost all of the action researchers had encountered. Indeed some worked in institutions where there was an appointed head of deep learning. The following quote illustrates that while some were concerned that there was an element of ‘jargon’ to some aspects of how the phrase has been used, the notion was still relevant:

“It is jargon, in a way, but it is a term you are giving to developing that learning at a higher level.” (Comment made on action research facilitation day).

There was a feeling that the use of the term ‘deep learning’ would be enhanced through a more informed position. In the eyes of one action researcher, the current use of the phrase lacks the clarity that they had gained from the combination of a literature review on the subject and through their related action research projects.

“The way we’re looking at it, it holds water. It is a very valid expression of a form of learning, but there will be various people who will identify it as just being a buzzword. There needs some sort of clarity about what it is and what it means, because if there



isn't clarity then people can use it as a throw-away term." (Comment made on action research facilitation day)

In the eyes of this action researcher, having a more informed position would also be a way of tackling doubters or cynics. This clarity was believed, in one case, to come from juxtaposing the notion of deep learning against other forms of learning, specifically surface learning:

"For me, for anyone to develop clarity about deep learning, you have to have a conversation about what surface learning is... Sometimes surface learning is appropriate, whether the motivation is purely to understand, or whether it is strategic to just get through the exams, to just pass." (Comment made on action research facilitation day).

In fact, in this quote, the action researcher emphasises a strategic aspect to learning. However, the implication of the ensuing discussion was that in order for learning to be retained, to become applicable and utilisable by learners, it needs a wider purpose than that limited to learning for examinations. The themes arising from the action research projects are explored below and are exemplified by quotes taken from the action research reports.

### **Embedding skills to enhance deep learning**

ICT can enhance deep learning by improving learners' skills such that they become second nature. The development of skills, such as drawing graphs, can itself be seen as a form of deep learning. However, once these skills are developed to the extent that they become automatically implemented by learners, they can be applied in different contexts and can be used without requiring excessive concentration. This then makes more working memory available to the learner for the subject of their study.

One of the features of learning, thought by action researchers to be deep, refers to embedding skills. The intention is that through practicing these skills, learners become more competent in their use and, therefore, more able to apply them to the subject of their learning. In this respect, learning is deep because learners become sufficiently competent with the skills in question such that using these skills requires little effort and does not distract from the effort given to the subject of study. An example of the way that this feature of deep learning has been interpreted is in the work of Elizabeth Bridgett, who describes her work as follows:

"I interpreted deep learning as internalising skills – embedding skills deep within the brain so they become a toolkit for the student to rely on when necessary." (Elizabeth Bridgett, action researcher).

The intention is that, through the use of various technologies, learners can practice these skills so that the skills then become second nature and an enabler of learning.

However, there is a second way of interpreting this issue, as highlighted in the following quote from Tim Rigler's action research:

"I have found that primarily, there are technological barriers that must first be overcome so that the learners are able access the resources available. Secondly, learners are limited in their use of the myriad resources available to them and some of the few resources that they do use have questionable reliability. Furthermore, when learners are trained in the use of the resources that are available, they do make good use of them and, in this instance, the use of a blog/discussion board greatly improved learner engagement and the use of the resources available." (Tim Rigler, action researcher)

Tim suggests that the use of ICT is itself a skill, one which needs to be developed so that it is embedded and can support, rather than distract from, learning. Tim's view is a positive one. He argues that once ICT skills are developed, they can provide a process to enhance deep learning. In his case, this refers to the use of online blogs/discussion boards to provide a bridge between learning in school and beyond school.

The first of these themes emphasises the deep learning of skills, such that their use becomes automatic and instinctive. Using the skill therefore does not require attention, which can then be devoted to learning the task in hand. This is itself, a learning aspiration. That is, skills are learnt to such a depth that their use is instinctive. This frees working memory for the topic of learning, which would otherwise have been devoted to using the skills in question. The skills to be developed include the use of ICT which, while a general statement, emphasises that ICT is both a topic for learning and a medium through which learning of other subjects can take place. The intention of this type of learning provides the basis from which the skills and concepts developed can be transferred outside the original context in which they were learnt.

### **The application of knowledge and skills in different settings**

The ability to apply skills in different settings other than that in which the skills were learnt is regarded as one of the qualities of deep learning. This is related to the above theme in that, once skills have been embedded, they can be applied to other, often more challenging contexts. ICT provides the opportunity to broaden learners' experience and provide a wider range of challenges for learners.

A second, related, feature of deep learning is that skills and knowledge can be applied in different contexts, once they become learnt at a deep level. For these skills to become usable in different settings, learners should have a good grasp of the knowledge and a high level of competence in using the particular skills. The quote from Elizabeth Bridgett continues as follows:

"[Learners] appeared to be perfectly competent when it came to understanding and using skills in isolated contexts, for instance, when asked to find the distance

between two points or the gradient of a line. However, [when this was asked] more indirectly, or required them to use this skill in problem-solving, the skill seemed not to be there.” (Elizabeth Bridgett, action researcher)

The transferability of skills and knowledge is, therefore, also regarded as a feature of deep learning as both an aspiration and as a process. This was a feature of learning recognised by Jo Battison, another action researcher, in direct reference to the teaching of ICT.

“The concept of deep learning was deemed to be the ways in which information was accepted and stored by learners. [It also included] whether [learners] were able to use that information or learning across the other subjects being covered on their course.” (Jo Battison, action researcher)

The aspiration here is that the learner should have a sufficiently coherent grasp of the knowledge or skill in question such that they can apply it outside of the context in which it was learnt. Learning within context is not sufficient to achieve deep learning. Deep learning results in knowledge that can be applied. There is a creative aspect to this that emphasises the learner being able to manipulate knowledge in response to differing contexts. But, this also refers to bridging between the student’s home and their studies, as emphasised by the following quote from Wee Hoe, an action researcher exploring the potential for using games as a part of learning:

“The results of such an approach enabled learners to transfer knowledge and skills gained in one learning experience to other situations through personalisation of learning process. This personalisation involved the transformation of role from passive recipient of knowledge to active inquirer of every facet of the learning process.” (Wee Hoe, action researcher)

Linking between the context for learning and other settings has three main relationships to deep learning. First, this is an aspiration of deep learning. That is, learning can be considered to be deep once learners are able to apply that learning to different settings and different problems. This can be achieved once the embedding of learning covered in the theme above has been achieved. The second interpretation of linking learning between contexts refers to the connection between the learner’s life outside and inside the educational institution. Thus, deep learning is learning which has a wider relevance than that required for their studies and has some relationship with their wider lives. The third feature of the contextual settings for learning refers to the use of learning strategies that require students to make links between learning and the application of that learning in different contexts. In other words, deep learning can be encouraged by adopting strategies which encourage learners to apply their knowledge and skills in different ways and in different settings.

The application of ICT to support transferable learning, therefore, needs to link between learners’ studies and their home life. It needs to support learners in making links between their uses of ICT within and beyond their studies. The attempt by

action researchers in this project, through the use of gaming as an educational resource, aspired to create that link. This principle also refers to the skills learned and knowledge acquired in different subjects and ensures a connection between them through common, but varied and flexible uses of ICT. There is, however, also an element of practice and the skills development associated with it. The strength of ICT is that it can provide a multiplicity of ways in which particular concepts can be experienced and in which skills can be developed. This broadens the experience of learners and provides the opportunity to develop a multifaceted perspective on the same concept. It thus enriches and embeds such concepts, an issue covered in the discussion of the use of immersive 3D environments, a project conducted by Ian Courtenay.

Finally, this contextual consideration of deep learning implies that due account is given to learners' existing skills and knowledge and that this is recognised in the learning strategies used. One particular example of this was seen in the project conducted by Jo Battison, a further education ICT lecturer. Her project intended to recognise the high level of competence that her students had in some of the uses of ICT. She then built that recognition of learners' competence into her own use of ICT. This requires a focus on the individual. This was interpreted by action researchers as relating to independence, self-directed and personalised learning.

### **The association between independent and deep learning**

Deep learning implies that learners take ownership of the content and process of their learning. This requires learners to be able to reflect on how they learnt and the scope to direct how and when they work. ICT has the potential to offer learners the opportunity to access materials and work at times of their own choosing. This is especially the case with the use of learning platforms. However the use of learning platforms should take into account the nature of communications technology already experienced by learners.

The phrase 'deep learning' is also associated with the extent to which individuals engage with the concepts and skills being learnt. That is, while the setting for learning is social and support is provided by education professionals, the knowledge and skills acquired are regarded as being deep when learners' can recall them easily and accurately. These skills can be applied in different contexts in creative ways, other than those through which they were learnt.

At the heart of this issue, there is an expectation about the development of the individual. Thus, one of the distinguishing factors of deep learning is that the student comes to 'own' and appropriate what has been learnt to such an extent that they are able to manipulate that learning and creatively apply it. This is the process of personalisation described as an aspiration by Tom Pole, an action researcher who explored the potential for developing deep learning through the use of ICT in teaching maths.

“We hoped that by making the whole curriculum available to students they might be able to develop independent working skills and eventually become better or ‘deeper’ learners. The main thrust of our thinking was that learners who take responsibility for their own learning by choosing the resources and activities they want to use, will need to also reflect on the links between different areas of mathematics and will therefore gain a greater appreciation of the whole of the subject. Furthermore, they will be forced to use the maths in a number of unfamiliar situations, rather than just in the limited number they may have met in lessons.” (Tom Pole, action researcher)

A common feature of the projects undertaken by action researchers was the form of independence outlined by Tom in this quote. There were a number of features involved in supporting the development of this approach through the use of ICT. These included the use of learning platforms, sometimes employing the added interactivity associated with Web 2.0 technologies. However, as noted by Tim Rigler, this form of interactivity was not especially well used by students. Instead, the use of learning platforms was focused on giving students the opportunity to engage with learning materials in ways that they felt were appropriate to them, thus encouraging more student self-direction and more flexible opportunities for students to decide where and when to work. Additional applications of ICT, with the intention of enhancing independence, were not necessarily directly associated with the qualities of the particular technology in use. Rather, these applications were associated with the way in which these technologies were applied as a part of an overarching pedagogic strategy employed by the tutor, a subject explored in a later section.

### **Providing opportunities for deep learning**

As well as providing a medium or stimulus for learning, ICT can also influence the climate of educational organisations. This influence means that ICT does not necessarily need to be the activity through which learning is stimulated to enhance deep learning. Examples of this include the use of ICT to conduct tasks that might otherwise have distracted learners. In this way, ICT can be a motivational influence, leading to learners becoming more engaged and hence, enabling more productive learning environments.

The action researchers have shown that the use of ICT need not be directly related to the learning outcomes of students to be influential in encouraging deep learning. In one instance, for example, a range of handheld gaming devices were introduced into maths lessons. The intention was to develop learners’ maths competence. However, this seemed to have no noticeably different impact on learning than written exercises with the same aspiration. In practice, the handheld devices became tools that the learners enjoyed using. This had a marked effect on student’s attitude to their studies and on the climate of the classroom. In particular, there was an impact on behaviour. Thus, by influencing the climate for learning, ICT had made it possible for students to learn the concepts being covered in their classes. In doing so, it enhanced the possibilities for deep learning to be achieved.

The projects of action researchers did not always work out as planned. However, this did not necessarily mean that such projects were not able to inform an understanding of how ICT has the potential to promote or encourage deep learning. The following quote is one such example in which Elizabeth Bridgett outlines a project which had a varied response from students.

“The use of ICT did not always seem to enable deep learning to take place in the way that I had initially envisaged. A large proportion [of learners]... were using it as a trial and error tool and removing themselves from the thinking process. Others took a good deal of time to become familiarised with the programmes. However, it was really encouraging to see some of the students using the ICT in a really positive way. Perhaps they were not using ICT to embed the learning, but they were certainly using it to free up their working memory. They were using it as a student would use a calculator in a shape and space problem – to concentrate on the problem in hand and not get bogged down in the nitty-gritty. They were also beginning to use it as a different way of approaching problems. Rather than giving up, or asking for help, some pupils began to see the ICT as a foothold into the problems.” (Elizabeth Bridgett, action researcher)

In this case, students had engaged differently with the software being tested. Only the minority had used it in the way intended. However, there were benefits for learners that might not necessarily have been commensurate with the aspirations of the action researcher. Using the ICT influenced the ways in which students worked and through which, opportunities were created (by making one aspect of the process easier) for deep learning to take place. This emphasises a second point, which is associated with a number of the themes explored here, that deep learning is complex. It takes time and can be correspondingly difficult to assess.

### **The difficulty of assessing deep learning**

The motivations that underpin deep learning are seen as being broader than learning purely for exams. Furthermore, the scope of deep learning makes it difficult to assess, in particular as it is concerned with making links between a range of different concepts and skills and the application of those in different contexts. However, the use of ICT as a strategy to encourage deep learning is believed to enhance the assessed work of learners.

As suggested above, the transferability described as being a critical feature of deep learning was regarded, by action researchers, as relating to a wider purpose than the acquisition of accreditation or performance in assessment.

“Deep learning, on the other hand, is promoted as a desirable strategy, since it leads to an understanding of content rather than, for example, simply remembering it to reproduce in an assessment.” (Amanda Lumb, action researcher)

While improvement or high achievement was an understandable aspiration of many action researchers (see for example Michael Mayes’ project), and was an outcome

which would be commensurate with enhancing deep learning, the actual assessment of deep learning (both as evaluation of the action research projects in question and as a judgement of education outcomes) was believed to be problematic.

“It has to be accepted that assessment is difficult. Formal assessment during the process could constrain the students and interfere with deep learning. Also, deep learning cannot be gauged from looking at the video. The media itself will interfere with judgement. Peer assessment of the video also presents a major issue... because as competition developed between the teams, one team published and the other, feeling intimidated, prevaricated and failed to publish. Deep learning is evidenced by the thinking that goes into the making of the video, not its final publishing. Is this any different than trying to judge the success of a school trip to a theatre? No, both are enriching experiences, outside of the classroom, providing opportunities to engage in higher order thinking.” (Graham Pemberton, action researcher).

This further emphasises the importance of the setting for learning. In this case, it was the effect that unintended competition had on the completion of the task. The challenge, as described by Graham Pemberton, is to recognise the extent, form and content of learning, which is so personalised as to remain hidden to casual observation or instrumental methods of measurement. Thus, achieving deep learning is not just a case of choosing the right technology for the right purpose, but of the overarching culture of learning fostered in the educational organisation. It includes the learning environment in question, its relationship with the wider world of the learner, and brings all of these together through the pedagogical approach of the tutor and the use of ICT within this.

### **The importance of the overarching pedagogical approach in the use of ICT**

ICT provides a broad range of strategies to enhance learning. A consistent theme of this research was the importance of being strategic about using ICT. This is in the context of having a broader learning strategy, in which ICT is likely to play a significant part, but is not the only approach adopted.

A consistent theme of this work is that while ICT has the potential to enhance learning, such that it becomes deep, this is most likely to be achieved when the use of ICT is set within an overarching pedagogical approach.

“ICT is a tool and it is down to teachers and learners how this tool can be used to their advantages, but this is not always straightforward.” (Larissa Sidor, action researcher)

Two features of having a pedagogic approach were related to promoting learner independence. The first was related to the development of metacognitive skills, through which learners develop their understanding of how they learn and how their learning can be judged. This did not refer to particular applications, but was based

around developing an approach in which students could access learning resources at times appropriate to them and in ways that matched their own aspirations. Jo Battison argued that this was an important stimulus to ensure that the materials provided on the learning platform were varied and included the range of materials that students themselves would have encountered in their own use of ICT.

For others, the use of ICT was based around the completion of projects. In these cases, the pedagogic approach adopted was intended to support the development of organisational skills in addition to the technical ICT skills required to produce and publish videos online. In this use of ICT, implemented by Graham Pemberton, the use of technology was not the learning outcome. Equally, it was not the facilitator of learning in the way that the maths games described by Michael Mayes would require learners to practice their skills. Rather, it was the medium through which students could communicate their learning, requiring them to engage in a sustained project with the video as the outcome. That is, the process of producing the video, which constituted the ICT component of their work, required students to develop their understanding of the topic. They had to do this to such an extent that they could communicate what they were learning coherently and to then manage the project with the video as the end product. Graham reflected on the importance of building these activities into approaches that were suitable for the group in question, providing more opportunities for the types of independence needed by high ability students and with more structure for lower ability students.

“The balance between a closely bound brief and an open-ended brief has to be decided by the teacher. In this project, the students were academically strong and mature and able to respond to the open nature of the task. They were able to keep focused on the topic and...want to explore it from different points. With a weaker and less mature group, it would be more appropriate to give them a tighter brief such as creating a story-board with milestones and check points.” (Graham Pemberton, action researcher)

There is, however, a word of caution from one action researcher, who believes that the potential of ICT can lead to its use or implementation without giving due consideration to the overarching pedagogical approach (of which it is just one part).

“There seems to be a very high risk of ‘putting the cart before the horse’ in allowing ourselves to be beguiled by the undeniable possibilities of ICT applications. [The danger is to do this] without really thinking through what we are trying to achieve. Consequently, [we then] develop elaborate solutions to poorly defined problems with, unsurprisingly, less than optimal outcomes.” (Richard Simpson, action researcher)

While ICT is believed to provide a great deal of potential for transforming educational approaches and enlivening the learning experiences of students in ways consistent with deep learning. It is also a tool for students and practitioners alike. In order to ensure the best use of ICT, in ways appropriate to encouraging deep learning, its use needs to be considered within an overarching pedagogical approach. This



approach should encourage student self-direction, sustained engagement with learning resources, the application of knowledge and skills outside the immediate setting and further application of that knowledge and skills outside of the initial conceptual area to which this learning was related.

## Conclusions and wider emerging themes

A key message arising from this study is that, despite the rhetoric, there is still a great deal of uncertainty surrounding the understanding, interpretation and implementation of deep learning. However, the data draws attention to a number of recurring issues that we have grouped around four areas:

- Perspectives on the nature of deep learning
- Perspectives on the potential for ICT to enhance deep learning
- Perspectives on wider issues
- Areas of further research.

### Perspectives on the nature of deep learning

Practitioner action researchers in this project felt that deep learning was both a phrase that they had encountered and a concept that had relevance for their work. The interactions of deep learning with their practice that seemed to have most relevance are summarised below:

- Deep learning is not achieved through a simple focus on examination performance.
- Deep learning involves learners developing a sufficiently comprehensive grasp of concepts that can be applied to different contexts.
- Deep learning involves learners developing their skills such that their use becomes instinctive and supportive of conceptual learning.
- Deep learning takes times and is cumulative.
- Deep learning is based around learners' individual development, thus it is associated with independent learning.
- Deep learning involves making links.

### Perspectives on the potential for ICT to enhance deep learning

In addition to making comments in reference to deep learning, action researchers identified a number of implications of the use of ICT to enhance deep learning.

These are:

- ICT can provide an approach through which learners can experience concepts from multiple perspectives and in ways that would not have been possible otherwise.
- The use of learning platforms provides learners with the chance to engage with learning materials online and so take charge of the timing of their own learning.
- The use of ICT can change the culture and climate of educational organisations, such that there is greater potential for deep learning.

- The functional use of some applications provides the opportunity for learners to devote their efforts towards interrogating the broader concepts in hand and not in being bogged down in the minutiae of tasks.
- The use of ICT must be seen in relation to the overarching pedagogic approach.
- Learners do not necessarily have to be highly competent in using ICT, but they must learn the skills necessary to make the best of technology. This is one feature of a deep learning approach that employs ICT.

### **Perspectives on wider issues**

- Deep learning has to be considered in the context of the wider reform of the curriculum and assessment currently taking place in 14-19 education and training.
- The practitioner still has a key role to play in developing a range of skills. There is a need for staff development programmes to enable practitioners to take advantage of the opportunities provided by deep learning.
- Deep learning relates closely to the broader personalisation agenda. This is because it implies that learners take control of their own learning and develop their perspective and resulting understanding of subjects being studied.

### **Further areas of research**

Given the relatively small scale and time-constrained nature of this particular project, many of the action research projects we have described provide a starting point for further research. The opportunity to carry out further research into the use of particular ICT applications and the development of ICT provides a number of areas for potential research. In particular, in-depth longitudinal research over a sustained period of time is needed. A number of other potential areas for further research have also been identified:

- Deep learning, ICT and assessment
- The use of learning platforms in promoting learner independence
- Deep learning and ICT in particular subject areas
- Deep learning and ICT pre-14.
- The impact of the introduction of Diplomas on the use of ICT with deep learning.

## References

Atherton, J S (2005), 'Learning and Teaching: SOLO taxonomy', [online] UK.  
[www.learningandteaching.info/learning/solo.htm](http://www.learningandteaching.info/learning/solo.htm)

Becta (2008), *How technology supports 14-19 reform: an essential guide*, Becta.  
[feandskills.becta.org.uk/download.cfm?resID=31532](http://feandskills.becta.org.uk/download.cfm?resID=31532)

DCSF (2005), *14-19 Education and Skills White Paper*, HMSO.  
<http://publications.dcsf.gov.uk/default.aspx?PageFunction=productdetails&PageMode=publications&ProductId=CM+6476&>

Entwistle, N (2000), 'Promoting deep learning through teaching and assessment: conceptual frameworks and educational contexts', TLRP Conference, Leicester.

Leitch, S (2006), *Prosperity for all in the global economy: world-class skills, final report*, HMSO.  
[www.hm-treasury.gov.uk/leitch\\_review\\_index.htm](http://www.hm-treasury.gov.uk/leitch_review_index.htm)

QCDA (2008), *The Diploma and its pedagogy*, QCDA  
[www.qcda.gov.uk/19933.aspx](http://www.qcda.gov.uk/19933.aspx)

Simms, E (2006), *Deep Learning-1: A new shape for schooling*, Specialist Schools and Academies Trust.

## **Appendix 1: Technical note, project methodology**

The literature review was conducted around a series of key search terms. In addition to the academic sources, a number of practitioner materials were used. The action researchers were given access to the literature review and encouraged to contribute to the final version.

The action research aspect of this project was managed from the Warwick Institute of Education. This brought together a group of practitioners, all of whom were teachers of 14-19 year old students. The aim was to explore how ICT was, or could be, used to enhance deep learning. This group were provided with copies of the developing literature review and maintained links with a named academic working as a part of the research team at Warwick. They also met together at seminars hosted by the University of Warwick. At these seminars, they shared progress with each other, with academics working on the project, with representatives from Becta and with representatives from other organisations, including the University of Bristol. These seminars were held at strategic points during the action research process, which is described in more detail later in this document. These seminars were also intended to stimulate dialogue within the action research group. Areas of dialogue included, where the term deep learning had been encountered, the ways in which it was being used and the relevance of this phrase to practitioners. These discussions were recorded and are also referred to below. Action researchers are in the process of completing individual reports that have been used to inform the writing of this report. A total of thirteen reports are being written in relation to this aspect of the project. These, it is hoped, will be published online as one of the project outcomes.

### **Key aims**

The project developed a multi-disciplinary, mixed-method approach to answer the following research questions:

- What knowledge and skills do learners need in order to be effective deep learners now and in the future?
- What technology-enabled practices and structures in the 14-19 context support these goals and how do they do this?
- Which practices accelerate the learning gains afforded by technology in the 14-19 setting and in what way? What are the causative links between the practices, the learning gains and the technology, if any?

In particular, the Warwick part of the project carried out two substantive pieces of work, the literature review and the action research.

### **Literature review**

The literature review aimed to establish perspectives on the skills and knowledge which, it is predicted, students will require in their future career. It also aimed to further explore and operationalise (for other aspects of this research) the dimensions

of deep learning and its relationship with educational structures and practices. This was further enhanced with an exploration of publications exploring the interaction between ICT and learning, in particular, identifying publications which provide examples of the impact that the specific uses of ICT have on 14-19 student learning. This served two main purposes. The first was to produce a document that summarised literature around the themes of influential ICT uses, deep learning and anticipated future workforce requirements. The second was to identify exemplary applications of ICT that could then be related to the action research group and, potentially, applied in their trials.

## **Action research**

The action research group, with guidance, administered common research instruments to explore students' perspectives of the impact of the technologies in use.

The final research approach trialled technologies and associated deep learning strategies in practice. Because of the limited duration of this project, they were initial trials, but it is hoped that this study will lead to further work. The aim of these trials was to give a group of practitioners the opportunity to engage with this research and to conduct their own pieces of practitioner action research. This action research was concerned with applying and testing out, especially innovative areas of ICT use. The selection of the technologies tested was managed in consultation with the group in reference to their experience and to the literature review.

These action research studies also included an element of student engagement as student voice was adopted as one of the collaborative principles of this work. The aim of these action research projects was to attempt to identify the influence of particular technologies and the ways in which they are used in student learning in relation to the concepts of deep learning derived from the literature review.

## **Organisation and management of action research projects**

The action research aspect of this project was managed by the University of Warwick Institute of Education. This project brought together practitioners working with students aged 14-19 and who had an interest in developing their pedagogical practices in the use of ICT. These practitioners were not necessarily already highly competent in the use of ICT (although one was a course coordinator for ICT). Enthusiasm was believed to be more significant than competence and the action researchers who took part taught a range of subjects and had a range of ICT competence.

These action researchers were brought together through several events hosted at the University of Warwick. This split the action research into four main phases as follows:

- Identification of an issue to explore.

- Reconnaissance – this includes phases during which participants explored the issues related to deep learning and ICT and examined existing practices in their working context that could inform their understanding.
- Action - as a result of learning from Stages 1 and 2, action researchers implemented a plan of action intended to use ICT to influence deep learning among their learners.
- Evaluation - this was often concurrent with Stage 3 and was the phase during which the effects of the intervention were examined.

Throughout this project, action researchers were treated as co-researchers. As a result, these action researchers will be cited as authors in a future report in their own right. In addition to reporting on a practice-based inquiry of their own, these action researchers also worked together as a collaborative inquiry group. They developed their understanding of deep learning and ICT through discussion with each other and with other invited guests (including academics and representatives from Becta). These discussions were recorded and constitute a source of data in their own right.