

**Is ICT being used to its potential to
improve teaching and learning
across the curriculum?**

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1 Introduction

Under the National Curriculum Orders it is mandatory that schools teach ICT across the curriculum and teachers are under pressure to show how their schemes of work incorporate this requirement.

In its ImpaCT report, the DfES (2002) made a statement about the use of ICT in the teaching of non-ICT subjects:

“There is evidence that, taken as a whole, ICT can exert a positive influence on learning, though the amount may vary from subject to subject as well as between key stages, no doubt in part reflecting factors such as the expertise of teaching staff, problems of accessing the best material for each subject at the required level and the quality of ICT materials that are available.”

The author has observed lessons where ICT has been used in the teaching of another subject and the schools involved could claim to be fulfilling their obligations under the NC Orders. However, the technology was used simply to replicate traditional methods (writing, drawing or getting information from a text book) and failed to exploit the power of ICT in a creative or imaginative way.

These observations led to author to consider whether there were examples of ICT being used in the way that the NC Orders envisage; to enrich the teaching of other subjects, to do things that would be impractical using traditional methods and incorporate both ICT and non-ICT learning objectives.

This paper discusses ways in which ICT can be used creatively and imaginatively to assist in the teaching of non-ICT subjects and why frequently it seems to fail to live up to its expectations.

2 Observed examples of unimaginative use of ICT

In 2004, the author had the opportunity to observe a range of lessons in non-ICT subjects taught in ICT classrooms. Reflections on these observations have suggested that ICT was not being used in an imaginative way to enhance the teaching and learning of the subjects. Instead, the reasons for teaching pupils in ICT classrooms appeared to be:

1. To meet the requirements of the National Curriculum orders to integrate ICT into all NC subjects (Imison and Taylor 2001).

In particular, schools will be very aware of the OFSTED (2002) report, that “non-compliance with statutory regulations remains very high”, with 40% of schools at KS4 and 30% of schools at KS3 failing to deliver ICT across the curriculum. By moving a class into an ICT classroom, the teacher can claim that their subject is meeting their cross-curricular responsibilities.

2. To deal with classroom management issues of difficult sets.

Pupils tend to be less disruptive when working on computers as the computer holds their attention. Pupils working on a computer are less likely to be distracted and often show more enthusiasm for their tasks (Finlayson and Cook 1998). The computer is used as an ‘electronic babysitter’ to occupy disruptive pupils and allow the teacher to spend more time helping well-behaved pupils.

Bonnett et al (1999) also commented on this aspect of pupils engaged in ICT-based activities. In their research, they reported that pupils were generally more highly committed to tasks when working on computers.

With a class containing disruptive pupils, this may be a justifiable objective on its own, if it reduces the disruption in the lesson and enables some of the pupils to learn something.

In the main, the lessons that the author has observed have done little more with the computers than could have been done equally effectively using traditional teaching resources such as pens, coloured pencils and paper.

To illustrate these points, it is useful to describe a couple of examples of lessons where the use of ICT was unimaginative.

Example 1 – Year 9 MFL

The author observed a series of MFL lessons for a low-ability Year 9 class where pupils created PowerPoint slides about topics given to them by the teacher. They had to find or draw pictures of a house showing the different rooms and then label them in French. In subsequent lessons they repeated this task by creating slides that described in French, their typical day, illustrating their words with pictures from the Internet.

There was no evidence of the pupils learning any more French than they had already learned in previous lessons and they used PowerPoint skills that they had already learned in ICT lessons.

A positive aspect of this lesson was that most of the pupils appeared to be on-task, concentrating on the screens and working quietly. However, it was clear that some were, at various points during the lesson, using the computers for things other than the main task set by the teacher. Some were playing games on the Internet or looking at web pages that had nothing to do with the task, whilst others were drawing pictures on Paint that were unrelated to the desired learning outcomes.

Most of the pupils spent more time of the appearance of their presentation rather than the content. Pupils were observed spending most of the lesson playing with different backgrounds, colours, fancy fonts and pictures and producing very little text in French.

These lessons did not involve using ICT to produce anything that could not have been done using traditional resources of pens and paper. The learning objectives for the MFL curriculum could have been met without using ICT although the presentation quality of the output would not have been as good and the pupils may well have been less motivated to complete the task and behave well.

Example 2 – Year 8 history

This was a Year 8 history lesson in which pupils were required to produce a report about Lord Nelson. The teacher directed the pupils to a single website that contained images and text about Lord Nelson and told them to use Word to create their report.

Most pupils used the same picture and simply cut and pasted blocks of text from the web page into their report without demonstrating any understanding of the content. Very few rewrote the information in their own words and it is unlikely that many gained any understanding about the subject matter they were supposed to engage with. There was no evidence of independent learning and the lesson did not meet the curriculum objective of “finding things out”. There was nothing in the lesson that pupils could not have achieved using a textbook and pens and paper, except for the addition of a photograph in their report. The teacher commented that they were a difficult class and at least they were quiet in the lesson. This was due in part to the fact that many of the pupils finished copying and pasting enough text to fill a single page very quickly and then spent the rest of the lesson playing games on the Internet.

Both these examples illustrate poor uses of ICT in teaching other subjects. In neither case was ICT used to enhance the teaching and learning in the lesson. All of the activities could have been done using non-ICT resources. Sutherland et al (2004) echo these findings in their description of an ICT-based history lesson in a secondary school:

“The teacher gave little or no help in how to manage the collaborative and history-related aspect of the work. It may well have been that an assumption was made that the computer would act as the third voice, the ersatz teacher...students would either know what to do or be motivated to find out.”

3 How can ICT be used effectively to enhance the teaching and learning of non-ICT subjects?

3.1 Objectives of using ICT

Having described some examples of poor use of ICT in teaching, it is important to discuss how ICT can and is used effectively for teaching and learning. There is a considerable amount of research describing how ICT is being used very effectively in schools.

DfES (2003a) sets out the objectives for effective use of ICT in teaching and learning as:

- *“broadening horizons with more opportunities for creative expression;*
- *flexibility to study where, when and how best suits individual needs and preferences;*
- *increased motivation through learning that stimulates and stretches;*
- *wider access to learning and participation;*
- *sensible choices about when, when not and how to use new technology to enhance, enrich and extend learning.”*

It goes on to suggest that:

“ICT can make a significant contribution to teaching and learning across all subjects and ages. It can engage and motivate children and young people and meet individual learning needs” (DfES 2003a).

Cox (1997) also lists a series of benefits of using ICT in lessons:

- *“increased commitment to learning tasks;*
- *enhanced enjoyment and interest in learning and the subject;*
- *enhanced sense of achievement in learning and pride in the work;*
- *increase in self-directed learning and independence;*
- *enhanced self-esteem leading to expectations of achieving goals.”*

Becker (2001) documented a study of over 4000 teachers in the USA and suggested the following objectives of using ICT in lessons:

- *“getting information and ideas;*
- *expressing self in writing;*
- *mastering subject skills just taught;*
- *learning computer skills; and*
- *analysing information.”*

These studies confirm what the author has observed about the positive impact that ICT can have on pupils' learning, including:

- increased motivation to stay on-task, behave better and produce higher quality output;
- produce higher quality work;
- learn more independently and at their own pace;
- do things they cannot do using traditional methods and resources;
- do more work and work more quickly; and
- integrate several subjects into project-based activities.

3.2 Increased motivation

Many studies describe the motivating effect of using ICT in schools and the author has observed the positive effect it can have on students' attention and effort in class. Trimmel and Bachman (2004) studied the impact of introducing laptops into classrooms and one of their conclusions was that: "information technology has a positive impact on school attendance and learning interest". The DfES (2003) drew on a number of research projects to support its statement that: "ICT can play an important role in motivating pupils and encouraging them to engage in learning, within and beyond the classroom".

Bonnett et al (1999) undertook research into the use of multimedia software to produce a learning resource about drugs. Pupils were allowed to choose their own content and presentation styles and two main benefits accrued from this:

"the opportunity to choose how they communicate will increase pupils' motivation to do so; and second, by selecting modes of representation they may develop an understanding of how photographs, drawings, text and sound may contribute to the meaning-making process whilst taking part in that process themselves."

In this study, the authors believed that providing pupils with choices would motivate them to think about the options available to them and select the most appropriate media for their audience and purpose.

The authors reported that the subject and ICT objectives were achieved. The ICT objectives were useful in their own right as it is a key element of the ICT curriculum that pupils learn how to present multimedia information in a

professional way (DfEE 1999). However, some of the teachers commented that that it “was no different to traditional methods in supporting the subject learning the subject-learning objectives” (Bonnett et al 1999).

Most students enjoy working on computers and if it a novelty rather than the norm then that makes it even more motivating. However, whilst student enjoyment is an important factor in education, adherence to the curriculum is even more so and therefore, careful planning is an essential element of teaching with ICT.

3.3 Produce higher quality output

The author has observed that the quality of pupils’ work produced on ICT is generally of a much higher quality than if it is hand-written. Homework reports frequently are annotated with images and screen shots to explain what they have done and are embellished with fancy fonts and word-art titles. Whilst this may not improve the substance of what is produced, it does demonstrate that pupils care about what they are producing and put considerable effort into its appearance. “Using ICT improves the quality of pupil’s work”. Watts and Lloyd (2004).

Ellis (2004) studied students working in multi-media and confirmed the motivating aspect of ICT, in particular with reference to lower ability pupils:

“the teachers...also felt that some students – frequently characterised as low-achieving boys – has managed to work at a level and to produce outcomes that were of a higher quality than usual.”

A good example of ICT being used imaginatively to create high quality output is where pupils in a Geography lesson used PowerPoint to create animated presentations of the way that volcanoes erupt (NCaction 2004). The pupils had to create a series of pictures of the stages of an eruption, scan them into the computer and then animate them using PowerPoint. It would have been possible to show pupils an animated sequence of a volcanic eruption, but by getting them to make one themselves, they learned a great deal about the way volcanoes behave, and also how to use PowerPoint to create animated sequences.

3.4 Learn independently

It is commonplace for schools to use the Internet as a research tool to allow students to find their own information. John and Sutherland (2004) describe the way in which the Internet can be used in Geography to develop a “digital earth” concept to enhance pupils’ understanding of many aspects of the subject. The Internet is often used to augment textbooks at much lower cost, for example, a secondary school Art class uses the Internet extensively for research and gathering ideas, and even for interacting directly with contemporary artists via their websites (BECTA 2001).

3.5 Do things that cannot be done using traditional methods

BECTA (2001) discusses the use of specialist hardware and software by pupils involved in Art projects. They use digital cameras to capture original images that are used as the basis for paintings or digitally manipulated to create new and interesting effects.

This school also uses digital scanners to explore the light filtering properties of different plastics, net curtains and film negatives. The use of digital technology

allows students to experiment much more than would be possible with traditional techniques given the amount of curriculum time available. As one teacher pointed out, “technology takes out all the donkey-work. Students can find out instantly whether an idea will work – before they embark on a huge production”.

Furthermore, students with disabilities or who lack the manual dexterity to perform well in Art or Music can produce high quality work using a computer. Given that teaching is about giving pupils opportunities to succeed, providing them with tools to produce high quality work can deliver very positive results.

DfES (2003a) suggests that ICT can be used effectively in Science to show video sequences of things that are hard to explain or visualise. For example, animated sequences could be used to show how water molecules behave as temperature changes alter the state of the water from ice, through liquid water to steam.

DfES (2002a) describes a GCSE Design project where students had to plan and design a three-dimensional model. They used software to test aspects of their design that greatly reduced the amount of time required and provided much more flexibility which would have been “beyond them because of limitations in skills or the materials used, or would be impractical in a crowded GCSE timetable.”

3.6 Do more work

ICT enables high quality output to be produced at a speed that cannot be matched using traditional methods and resources. Teaching applications such as graphing packages in Mathematics, multimedia authoring software and data analysis packages in Geography and Science all allow students to work much faster than if they had to do the tasks manually.

Morgan and Tidmarsh (2004) studied the work of a Geography teacher using ICT in her lessons. They describe the advantages of using ICT as a tool to increase the breadth and speed of learning, increasing the efficiency of both teacher and students. ICT was used to gather, analyse and present information and the teacher described her use as: “great for cutting down time where you want to analyse information”.

3.7 Integrate subjects into projects

The author observed a Gifted and Talented project across a variety of subjects where the ICT suite was made available for their exclusive use in producing the outputs and undertaking the research about the countries that were allocated to them. The cross-curricular nature of the project enabled the pupils to put their subject knowledge into context and they produced very high quality work.

Abbott et al (2001) describe a number of excellent examples of cross-curricular use of ICT in multi-disciplinary projects:

“The computer has been the mechanism by which...students have been able to create new and exciting poems, posters, leaflets and newspapers in English, Dance, Music, Art, Drama, Science, History and Geography, all related to an on-going theme.”

This approach is described by Russell (2001) as “multiple integration” where students work on a single project across a range of subjects and use ICT to gather and process information and produce the final output. The benefits of this approach include:

- the work done in all lessons is set in a context that encourages cross-fertilisation of skills across subjects; and
- teachers plan and work collaboratively, facilitating skills transfer across subjects.

4 What are the difficulties of successfully using ICT in other subjects?

Given all the positive research described in section 3 it would appear that schools are being very successful and imaginative in integrating ICT across the curriculum. However, many researchers believe that the success stories are isolated and that the norm in most schools is very different. Dale et al (2004) commented that: “the use of ICT in teaching and learning remains only partially understood and inconsistently practiced in schools.”

This section looks at some of the key factors that prevent schools from successfully delivering excellent and imaginative lessons using ICT. These factors include:

- lack of confidence of teachers in using ICT;
- lack of detailed planned into how ICT can be used to enhance the teaching and learning;
- technical problems and shortage of computers in classrooms;
- more opportunities for pupils to get off-task;
- the wealth of facilities in many applications can be confusing and cause pupils to lose sight of the primary learning objective;
- pupils may be able to produce the desired outcome using ICT but may not understand the processes involved. This is known as the ‘black-box’ syndrome;
- timetabling difficulties; and
- the need for teachers to change their pedagogy.

4.1 Teachers' confidence in ICT

Becker (2001) noted that teachers' expertise in ICT was an important factor in its successful use in lessons: "the ways that teachers have their students use computers are certainly affected by their own level of technical expertise". He established in his earlier paper (Becker 2000) that there is a clear correlation between teachers' knowledge of ICT (as well as a constructivist theory of teaching and the availability of ICT in the classroom) and the frequency and effectiveness of software use in teaching.

This finding was confirmed by OFSTED (2004), which pointed out that: "teachers'...knowledge remains the key to the most effective practice".

Dillon (2004) also supports this view:

"The representations of software of many non-specialist teachers are idiosyncratic, fragmentary and transient with imperfectly learnt links and false assumptions" and that "these teachers are concerned that the skills of their students are more advanced than their own."

It is hardly surprising that teachers are reluctant to experiment with ICT if they are concerned that their students' knowledge is greater than their own.

DfES (2003a) highlights the way in which the UK Government is attempting to overcome this obstacle to increasing the use of ICT in schools. The current strategy is termed 'e-confidence' and has "high levels of staff competence and confidence" as a key objective.

4.2 Planning the use of ICT

Much of the research highlights the need to plan carefully the use of ICT in lessons. Sutherland et al (2004) sum this up as: "ICT alone does not enhance learning. How ICT is incorporated into learning activities is what is important."

Abbott et al (2001) also stress the importance of detailed lesson planning when using ICT and that pupils must be encouraged to understand the process involved rather than simply focusing on the output.

Some teachers use ICT as a way of encouraging independent learning skills. However, this still needs to be planned and supervised with the teacher directing the pupils' activities and output:

"there is a risk that using ICT-based learning may make it too easy to hand over too much responsibility to the pupils themselves, with the hope that as long as the pupils are occupied in front of the computer there is always a chance that they might manage their own learning process."

Jedeskog and Nissen (2004)

It is possible that highly motivated pupils may take responsibility for their own learning and meet the desired learning outcomes, but it is unlikely to be a successful strategy with the majority of classes.

ICT is only an effective tool in the hands of an effective teacher, and not a panacea in its own right. It would seem that a prerequisite for success is the subject knowledge of the teacher and their ability to weave the use of ICT into the existing curriculum:

“Decisions about the geographical educational benefits of ICT need to be firmly based in an understanding of the aims and purposes of Geography teaching” (Morgan and Tidmarsh 2004).

BECTA (2001) suggested that success comes when teachers use applications that open up new ways of working. It acknowledges that this takes planning and imagination, but suggests that the results can be “spectacular”.

4.3 Technical reliability

It is important to acknowledge that ICT can have technical problems and contingency planning is necessary to ensure that alternative strategies are in place. Sutherland et al (2004) describe a situation in a school where the ICT was particularly unreliable and this led to lower attainment among high ability pupils:

“Students lost so much time when the computers would not work at all that the high attainers working on the computers produced work of a much lower standard than usual and were demotivated.”

As computers become more sophisticated and the range of software used by schools continues to increase, schools must recognise the need to employ more and higher quality technical staff. With pressure on budgets and competition from the commercial sector for the best staff, it is becoming increasingly difficult for schools to attract and retain technical staff with the appropriate skills and experience.

4.4 Students being off-task

Another frequently observed problem with ICT in general and the Internet in particular is that it provides many more opportunities for pupils to get off-task.

Jedeskog and Nissen (2004) describe a lesson in which:

“They (the pupils) are at the same time working with school tasks, sending emails, choosing new music from their MP3 files, looking at a home page and they are chatting. When I get nearer, they very rapidly (and skilfully!) change to the school task.”

“Internet activities demand a commitment of time, energy and attention that must be traded off with other activities that a teacher might pursue.” (Wallace 2004).

This view is supported by the author’s own observations. In classes where the Internet is being used, it is essential to keep a close eye on the students to ensure that they remain on task. This is not always possible in mixed ability classes where pupils are working at different rates and require disproportional amounts of assistance.

4.5 Facility overload

The author has observed that pupils often focus on the facilities provided by the application rather than the expected outcome and the learning objectives. For example, pupils will spend the majority of a lesson experimenting with different colours and backgrounds and have no time left to create the required content. BECTA (2003) suggested that it is important that pupils are given an initial design brief so they know what they are aiming towards and begin the process with something simple so that they can build up their confidence in using the tools available rather than playing with all of them all at once. Watts and Lloyd (2004)

observed this problem in relation to the use of the Espresso package: “Is too much energy being expended in ‘play’ as opposed to being ‘on task’?”

The Internet is used extensively in schools as a research tool, but a major problem is the wealth of material available, a lot of which is biased and unreliable. Leach and Moon (2000) describe a situation where a student produced a paper about how the Holocaust did not happen because of what he read on a website. This shows why it is necessary for teachers to be very aware of what the Internet is being used for and to ensure that the information used is unbiased and from reliable sources. Graham and Metaxas (2003) also raise this as a concern in their paper about the impact of the Internet on critical thinking. Their description of the way that students are unable to detect bias or determine between fact and advertising raises serious concerns for teachers that allow their students to find their own information with little or no guidance. Also, students spend huge amounts of time searching for information and comparatively little time analysing and processing the information.

This observation is consistent with the findings of Jedeskog and Nissen (2004) that: “there appears to be no time to synthesise (information): ‘to do’ gets more attention than ‘to understand’.”

4.6 The ‘black-box’ syndrome

The ‘black-box’ syndrome is where pupils produce the output required by the teacher, but may have little idea of how it was produced and consequently are unable to apply the skill to similar situations. An example of this is the ‘Wordplay’ application described by Ashurst (1986). This package allows pupils to enter types of words that are used by Wordplay to create poems. Ashurst concludes that it is an effective tool to “encourage children not only to use language but how

to think about they use it". However, the author is sceptical about whether pupils truly learn about language constructs, or whether they just enjoy making funny-sounding poems without knowing why different types of words appear in certain places.

Another example is the use of 'GraphSight' in Mathematics teaching. Although pupils are able to plot complex lines from mathematical equations, it is not believed that this necessarily promotes understanding of the relationship between the equations and the lines they produce. Using traditional methods, pupils have to plot the points on graph paper and should be able to predict where they might go next and what might happen to the line if the equation were altered. Although 'GraphSight' allows lines to be plotted easily, teacher intervention is still needed to explain the shapes of the lines.

The author has observed what Dale et al (2004) call the "Encarta syndrome" where pupils simply download chunks of material without reading it or understanding the concepts within it. When asked to discuss their findings or use the information in classwork, they are unable to do so. Many pupils seem to think that simply finding the information is sufficient without realising that it is vitally important to process and understand it. "Pupils mainly use their time at school searching for and collecting information but not elaborating and evaluating information" Jedeskog and Nissen (2004).

4.7 Timetabling difficulties

Incorporating ICT across the curriculum requires careful timetabling and cooperation among departments. Sutherland et al (2004) point out that in Science in particular, it may not be possible to move practical classes to ICT

suites because of health and safety considerations or to site computers in Science laboratories because of space constraints.

In other subjects, the times when the ICT suites are available may not suit the schemes of work planned by the teachers. Consequently, much more cross-curricular and departmental planning is required than most schools have been used to in the past.

4.8 Changing pedagogy

Teachers have to accept that the widespread use of ICT in schools is having an impact on teaching pedagogy and requires a significant rethinking of approach. Becker (2000) describes the two main teaching methods and their effect on the way in which ICT is used in lessons:

- Traditional transmission instruction assumes that pupils will learn through teacher explanation or reading from texts. Skills are learnt through practicing each skill in a sequence prescribed by the teacher.
- Constructivist instruction assumes that understanding comes from relating new ideas to the learner's prior beliefs. Skills acquisition comes in an unstructured way as new skills are used as required to solve practical problems.

He concludes that when ICT is used in lessons, the constructivist approach is more likely to lead to successful outcomes. Furthermore, his study showed that teachers with the most constructivist philosophies tend to use computers more often and in a more challenging way both in their classrooms and as users themselves.

5 Conclusions

The research about the use of ICT in teaching and learning is contradictory. Some studies highlight excellent and imaginative examples of ICT in lessons, whilst others are more sceptical and confirm that the author's observations are not isolated incidents.

ICT can provide a vast range of facilities and resources in one place that are accessible to all pupils at the same time. It can overcome shortages of textbooks and other resources that would hold back the achievement of learning objectives.

ICT provides almost limitless facilities for pupils to express themselves. For example, multimedia packages provide far greater facilities than most schools could reasonably be expected to provide using traditional resources. Indeed, the output produced by the pupils using traditional resources can often be suggested by the resources that the teacher makes available and stifle pupils' imagination.

Pupils are motivated to produce high quality output using ICT. Many pupils decorate their work with borders, images and fancy fonts largely because the software enables them to do so. Only a very few pupils decorate their work in these ways when it is hand-written.

Use of ICT can enhance learning, but not simply because it is used instead of traditional methods. As John and Sutherland (2004) point out, "ICT alone does not enhance learning; rather it is the ways in which ICT is incorporated into the various learning activities that is of fundamental importance".

Somekh et al (2004) are even more sceptical: "Teachers of other subjects were less sure that ICT had any real effect, and some teachers thought it had had a negative effect on literacy and numeracy".

Teachers have to adapt their teaching styles when using ICT in lessons to adopt a more constructive approach (Becker 2000). The independent learning aspect of ICT suggests that teachers should become less directive and adopt a more 'coaching' and discursive approach (Bonnett et al 1999).

There is sufficient research to suggest that ICT can have a very positive and beneficial impact on teaching and learning and that this is the case in many classes. However, in order to achieve success, teachers need to ensure that they:

- are competent in the hardware and software to be used;
- plan their lessons as thoughtfully as they would do when using traditional methods;
- adapt their teaching styles to support the way in which pupils work on computers;
- monitor carefully what pupils are doing to ensure they stay on-task; and
- be aware of the breadth of facilities and information that ICT provides and ensure that students are given clear direction as to the process and desired outcomes of the learning activities.

Much of the literature reviewed by the author supports the view that ICT can have a significant and positive impact on teaching and learning if it is planned and used to enhance and enrich the lesson objectives and not simply as a way of fulfilling the NC Orders or keeping unruly classes occupied.

The teacher will always have an important role in the classroom, no matter how advanced the technology gets. Students require attention, praise and discipline and their learning needs to be set in the context of a curriculum that builds on prior knowledge and exposes them to new concepts and skills; something that ICT cannot do on its own.

The overall conclusion from this document is summed up by Becker (2000), who rightly challenges Cuban's view that ICT is "largely incompatible with the requirements of teaching":

"Under the right conditions – where teachers are personally comfortable and at least moderately skilled in using computers themselves, where the school's daily class schedule permits allocating time for students to use computers as part of class assignments, where enough equipment is available and convenient to permit computer activities to flow seamlessly alongside other learning tasks and where the teacher's personal philosophies support a student-centred, constructivist pedagogy that incorporates collaborative projects partly defined by student interest – computers are clearly becoming a valuable and well-functioning instructional tool."

References

Abbott, C., Lachs, V. and Williams, L. (2001) Fool's gold or hidden treasure: are computers stifling creativity? *Journal of Educational Policy*. 16(5). 479-487.

Aldrich, F., Rogers, Y. and Scaife, M. (1998) Getting to grips with "interactivity": helping teachers assess the educational value of CD-ROMS. *British Journal of Educational Technology*. 29 (4). 321-332.

Ashurst, J. A. (1986) Using the computer program 'Wordplay' with third year junior children. In: Wray, D. and Potter, F. *Evaluating and using language and reading software*. Ormskirk: UKRA. pp 78-83.

Becker, H. J. (2000) Findings from the Teaching, Learning and Computing Survey: Is Larry Cuban right? *Revision of a paper written for the January 2000 School Technology Leadership Conference of the Council of Chief State School Officers, Washington D.C.*

Becker, H. J. (2001) How are teachers using computers in instruction. *Paper presented at the 2001 meetings of the American Educational Research Association*.

BECTA (2001) *A report on the use of ICT in Art and Design*. Coventry: BECTA

BECTA (2003) *What are presentation technologies?* Coventry: BECTA.

Bonnett, M., McFarlane, A. and Williams, J. (1999) ICT in subject teaching: an opportunity for curriculum renewal? *The Curriculum Journal*. 10 (3). 345-359.

Cox, M. J. (1997) *The effects of information technology on students' motivation. Final report*. London: Kings College and NCET (National Council for Education Technology).

DfEE (1999) *The National Curriculum for Information and Communications Technology*. London: DfEE.

DfES (2002) ImpaCT 2. *The impact of Information and Communications Technology on pupil learning and attainment*. Nottingham: DfES.

DfES (2002a) ImpaCT2. *Learning at home and school: case studies*. Nottingham: DfES.

DfES (2003) *The big pICTure: the impact of ICT on Attainment, Motivation and Learning*. Nottingham: DfES.

DfES (2003a) *Fulfilling the potential – transforming teaching and learning through ICT in schools*. Nottingham: DfES.

Dillon, P. (2004) Trajectories and tensions in the theory of Information and Communications Technology in education. *British Journal of Education Studies*. 55(2). 138-150.

Ellis, V. (2004) Negotiating contradictions: teachers and students making multimedia in the secondary school. *Technology, Pedagogy and Education*. 13(1). 11-27.

Finlayson, H. and Cook, D. (1998) The value of passive software in young children's collaborative work. In Monteith, M (ed.) *IT for learning enhancement*. Exeter: Intellect.

Imison, T. and Taylor, P. (2001) *Managing ICT in the secondary school*. London: Heinmann Educational Publications.

Jedreskog, G. and Nissen, J (2004) ICT in the classroom: is doing more important than knowing? *Educational and Information Technologies*. 9 (1). 37-45.

John, P. D. and Sutherland, S. (2004) Teaching and learning with ICT: new technology, new pedagogy? *Education, Communication and Information*. 4 (1).

Leach, J. and Moon, B. (2000) Pedagogy, information and communications technology and teachers' professional knowledge. *The Curriculum Journal*. 11 (3). 385-404.

Leah, G. and Metaxas, P. T. (2003) "Of course it's true; I saw it on the Internet!": critical thinking on in the Internet era. *Communications of the ACM*. 46 (5). 71-75.

McFarlane, A. (2003) *Learners, learning and new technologies*. ICEM-CIME Annual Conference, Granada.

NCAction (2004) *Samples of pupil's cross-curricular ICT work*. Available at: <http://www.ncaction.org.uk> [accessed on 12 December 2004]

OFSTED (2002) *Information and communications technology in secondary schools*. OFSTED subject reports series 2001/02 HMI 819. London: OFSTED.

OFSTED (2004) *Information and communications technology in secondary schools*. HMI 1980. London: OFSTED.

Russell, T. (2001) *Teaching and using ICT in secondary schools*. London: David Fulton Publishers. 75-76.

Somekh, B., Woodrow, D., Barnes, S., Triggs, P., Sutherland, R., Passey, D., Holt, H., Harrison, C., Fisher, T., Flett, A. and Joyes, G. (2002) *Final report on the rollout of the NGfL programme in ten Pathfinder LEAs*. Nottingham: DfES Publications.

Squires, D. and McDougall, A. (1994) *Choosing and using educational software: a teachers' guide*. London: The Falmer Press.

Sutherland, R., Armstrong, V., Barnes, S., Brawn, R., Breeze, N., Gall, M., Matthewman, S., Olivero, F., Taylor, A., Triggs, P., Wishart, J., and John, P (2004) Transforming teaching and learning: embedding ICT into everyday classroom practices. *Journal of Computer Assisted Learning*. 20. 413-425.

Trimmel, M. and Bachman, J. (2004) Cognitive, social, motivational and health aspects of students in laptop classrooms. *Journal of Computer Assisted Learning*. 20. 151-158.

Wallace, R. M. (2002) *Technology and science teaching: a new kind of knowledge*. TIME Conference, Battle Creek MI. Available at: <http://www.msu.edu/course/cep/953/readings/WallaceTimeFinal.pdf> [accessed 28 December 2004]

Wallace, R. M. (2004) A framework for understanding teaching with the Internet. *American Educational Research Journal*. 41 (2). 447-488.

Watts, M. and Lloyd, C. (2004) The use of innovative ICT in the active pursuit of literacy. *Journal of Computer Assisted Learning*. 20. 50-58.