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Computer science for schools – panacea or bandwagon?

Author: Mark Baker, Education Vision Consultancy

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However, all is not looking rosy for the future. Speaking at a recent Microsoft Partners In Learning event in Reading, Ian Livingstone (co-founder of Game Workshop and Life President of Eidos) spoke of how the industry is "crying out for talent", having to turn away business because of a lack of skills and forced to look overseas for recruits to make up the difference. This is a sad state of affairs, given current high levels of unemployment, particularly amongst graduates and young people. In terms of global development rankings, the UK is reported to have fallen from 3rd to 6th place in just two years.

The Hope-Livingstone review found that only 12% of graduates from specialist video games courses managed to find a job in the video games sector within six months of graduating, despite demand from the industry. ICT in schools is seen as failing to produce the skills needed, resulting in mismatches between what schools are producing and what universities want and between what industry needs and universities are producing. Given the scale of the economic opportunities, that should give us all reason to reflect.

One of the remedies that has been proposed is to bring computer science into the National Curriculum, with ICT disparaged by some as being merely for users of technology and just concerned with boring office-type applications. There is a danger that politicians will be seduced by this message and seek to effect a "quick fix" initiative focused around a new subject name and some curriculum changes that will do little, if anything, to improve outcomes.

There is sometimes a very worrying lack of understanding of what ICT is concerned with. One coalition MP was recently reported commenting about his daughter, who produced interesting video material when at home; at school she had to study spreadsheets – by implication a tedious and unnecessary area of focus for Key Stage 3.

The quality of ICT teaching is variable and there is nothing sadder than hearing from learners who find their ICT lessons dull and without challenge. ICT should be and can be an incredibly rich and engaging area of study that offers crucial support to the whole range of human endeavour. The study of modelling and data handling (spreadsheets and databases) and the associated mathematical and analytical concepts requires academic rigour and skills of fundamental importance. ICT can also cover sound and video editing, graphics, design, control, programming, website production and more, thanks to a National Curriculum that recognised the rapid pace of technological change and allowed teachers significant flexibility.

The vision for the subject that underpinned the Secondary National Strategy further promoted richness of content and a vibrant, evolving curriculum. Whilst some valuable developments were initiated, much of this vision remains unfulfilled, but there was a shift to begin to promote the learning of some of the more technical aspects of computing.

All pupils should be exposed to some of these more elemental aspects in order to build their understanding of technology and the underlying concepts and to inspire those who might go on to further specialised study. In the stronger ICT departments this is happening already.

However, we should not forget that most learners will spend their working lives as users of technology and will not need, nor find engaging, protracted study of the maths and science of computing.

Computer science can be incredibly rich, challenging and engaging to a smaller number of pupils. It suffers from being a relatively specialist interest and getting viable class sizes for GCSE and post-16 courses will be an issue for many schools.

Finding sufficient numbers of high quality specialist teachers will be an even greater challenge. Providing appropriate professional development for existing ICT teachers to improve their ability to deliver aspects of computer science and to improve overall teaching quality, will require determination and imaginative solutions, especially following the rapid contraction of local authority curriculum teams.

Secondary schools that are forced to use large numbers of non-specialist teachers to deliver the subject at Key Stage 3 face the biggest hurdles. Whilst GCSE and post-16 courses are normally given priority, this can result in poor experiences in Years 7-9 that drive pupils away from ICT and related areas when choosing examination courses.

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Government should be mindful of the effect of operating in a market-driven qualifications environment. There is huge pressure on attaining excellent examination grades throughout the education system and an expectation that we can go on improving results year after year. The danger is that this comes at the expense of true educational quality.

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The push for teaching computer science as part of the National Curriculum brings a welcome focus on technology and reveals how much support there is, from highly dedicated individuals, for doing the very best we can for our young people. It is crucial that we do not lose the opportunity to reinvigorate the teaching of technology by rushing in to poorly considered, relatively superficial initiatives.

We need strong collaboration between Government, industry and all sectors of education, together with a determination to find long-term, sustainable solutions to issues such as:

- the supply of specialist technology teachers
- continually reviewing and updating what is taught to reflect changes in technology and market opportunities
- reviewing and updating qualifications to maintain rigour and relevance
- properly equipping schools to allow the effective delivery of the curriculum

And perhaps most importantly, improving the professional development of teachers to help them keep abreast of changes, update their knowledge and skills and boost their confidence in new areas of the curriculum, in order to improve the overall quality of technology teaching

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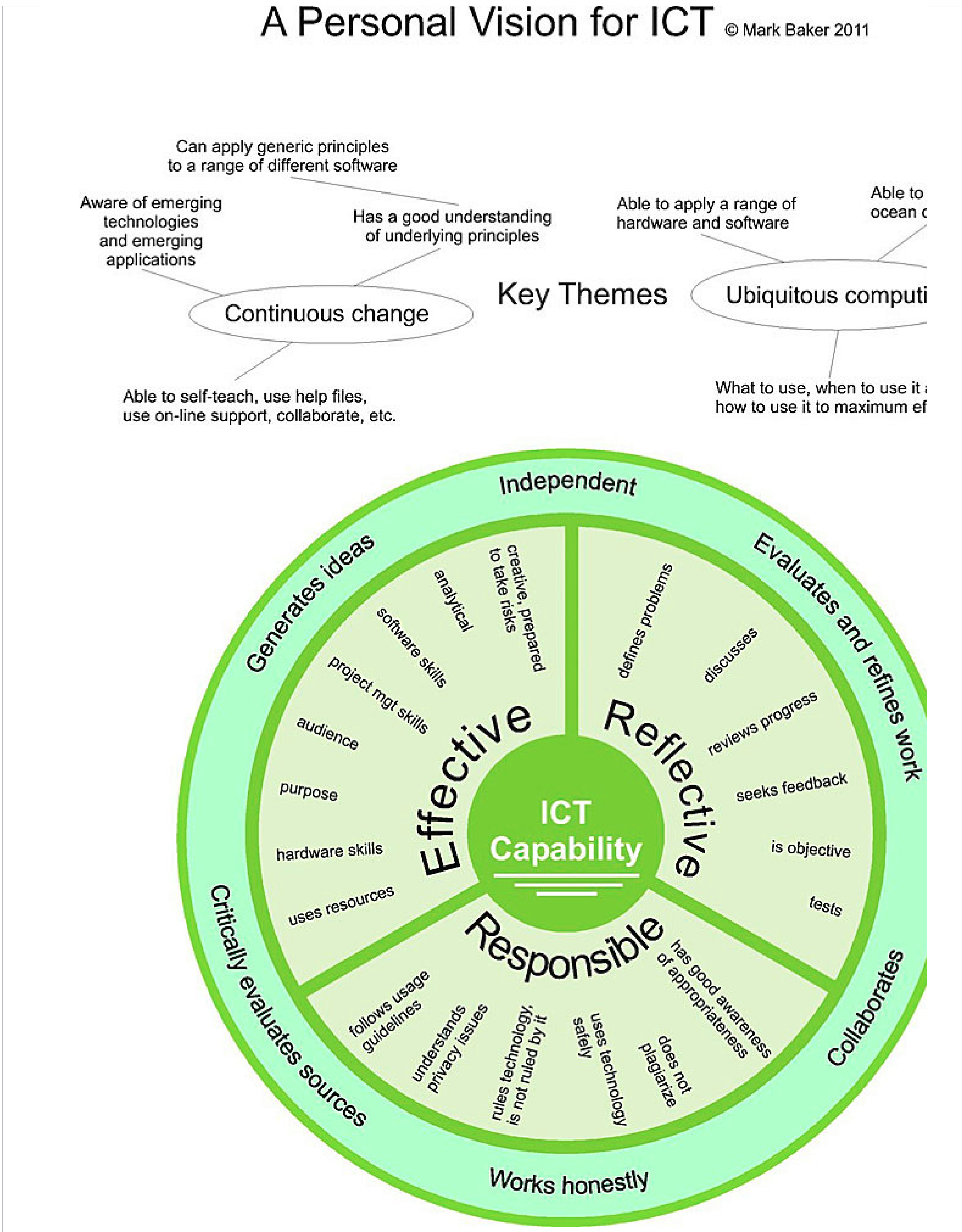

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Mark Baker can be contacted at info@educationvision.co.uk

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Naace
PO Box 6511
Nottingham
NG11 8TN
Phone: 0115 945 7235
Fax: 0870 241 4115
Email: office@naace.co.uk

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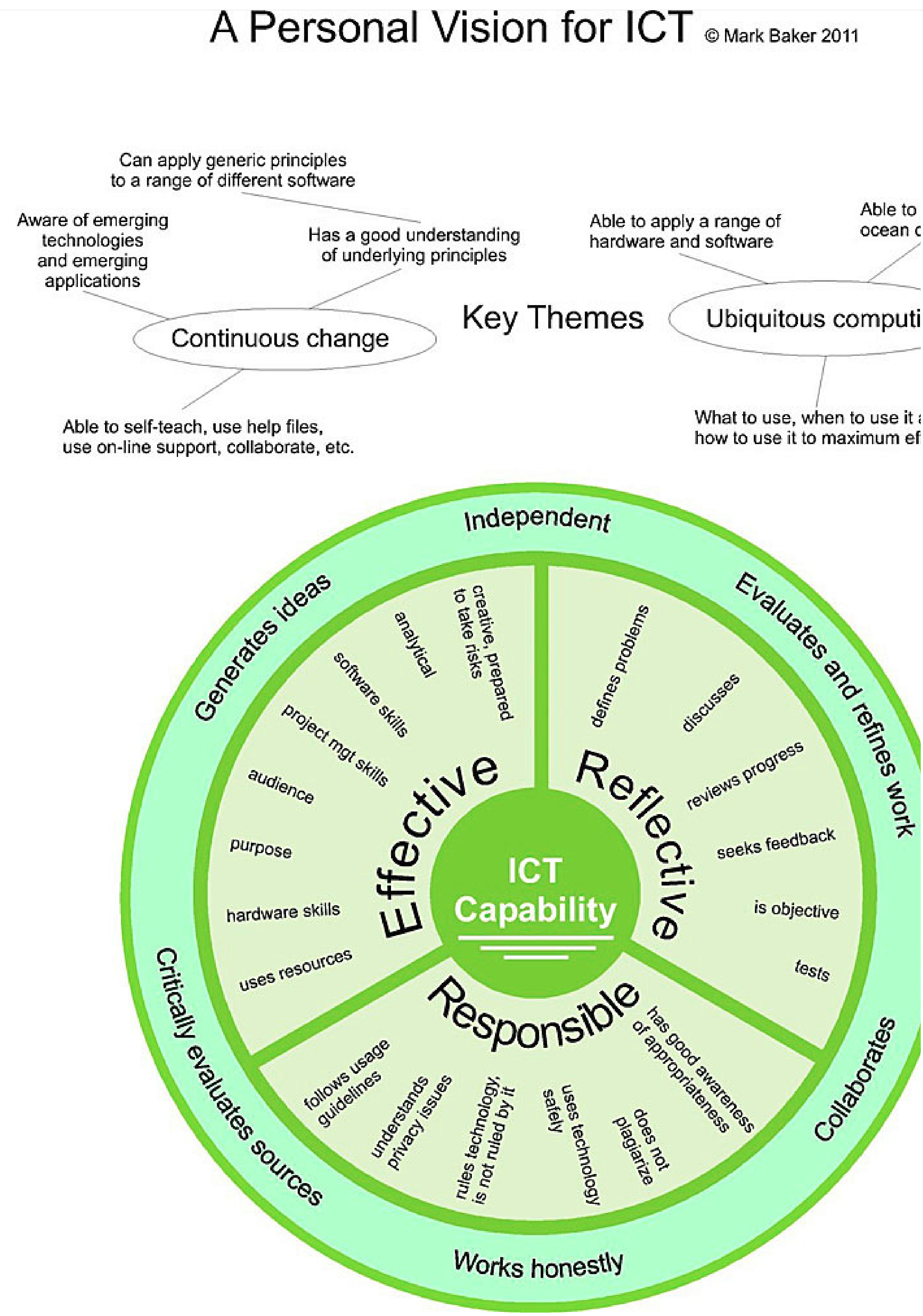

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How do students perceive ICT- what is important to them?

Author: Pete Bradshaw, The Open University

This article is drawn from my PhD thesis which was completed in 2011. The research and analysis was thus done prior to the recent flurry of pronouncements on the future of ICT as a subject, its curriculum and its relation to other subjects. The findings are still pertinent I believe in giving 16-year olds' perspectives of ICT, all of whom were entered for a formal qualification in the subject. It is intended that this is the first of three articles drawn from the thesis – the second will look at perceptions of assessment of ICT and the third the importance that the school, and system context, has on the student view.

One of my key research aims was to critically analyse the ways in which students aged 16 construct their learning of ICT capability in formal and informal contexts. Emerging from this was a clear sense of what they saw as important. The article begins with an overview of this view that students have, or at least had, of ICT. It is followed by a discussion of how the research was undertaken and a presentation of some of the data and its analysis.

Overview

The research clearly showed that students viewed ICT as being primarily a subject that leads onto future utility. This may be manifested either in the use of an ICT qualification as a passport to future success or as being something that develops life skills. The passport, a qualification, is to the next stage of their education or something that is required by employers or universities. This view of the utilitarian nature of ICT could have lead to an interpretation that students perceived the subject solely as one in which learning is restricted to skills. This was not the case. Students reported, for example, on creative aspects of their learning. This includes both skills and knowledge and understanding of creative processes and their application to p[problem solving.

Students construct their view of the content of the ICT curriculum through the lens that determined by the school they attend and the course they are following. This is touched on here but will be discussed more fully in the third article. Their perception of their learning of ICT was enculturated by the formal context of the curriculum and assessment criteria of the specification of the ICT qualification they were taking. When considering which aspects of ICT they regard as important students were more likely to prioritise topics that formed part of their formal education than uses of ICT that were part of their informal, or non-formal, learning. It seemed to be entirely possible for students to have a detailed view of a topic and to see it as important for later life but not to regard it as something that should be in the curriculum.

This tendency to dismiss or undervalue informal or out of-school use is even more emphasised when considering assessment – to be discussed in the second article – but it was a common feature of their responses. An example of such of topic is the use of a diverse set of communication tools. Stduents report sophisticated uses of communications technology, but do not think it is part of the subject ICT. On the other hand where students do value informal uses of ICT these tend to be creative e.g. video editing.

There are also elements here of a different perception of tacit knowledge (Schön, 1983; Eraut, 2000) outside of formal contexts, and practical application. Those aspects of ICT capability learnt in the home or through informal contact with peers and others do not feature as noticeably in the constructs of ICT learning reported by students. Neither do they feature in those aspects of ICT which students consider important. On the other hand the learning of particular skills, and the understanding that goes with them to use software tool effectively, are prominent in what students consider to be important. Thus in the first phase of data collection (see below) knowledge and skills are explicitly part of the construct elicited from the repertory grids. These are complemented and contextualised by the particular pieces of software that feature in the coursework of the qualifications being taken. ICT-based activities that students undertake outside of school – e.g. games, social networking – do not feature despite their significance in surveys that report on use of ICT tools for learning (Crook, 2008; Ofcom, 2011). From this mismatch it could be concluded that as this is how students construct their learning of ICT and this is what is in the specifications, then the specifications are fit for purpose. This is rather contrary to the orthodoxy and the cries for the revision of specifications. It is worth saying also at this point that students did not report that they found the subject boring.

One of the phenomena emerging from the study, however, is that of enculturation. Students report that what is in the specifications is what is important to them. This does not negate the claims made for curriculum and assessment revision. Rather it suggests that students are unable to see beyond the course they are taking and construct their learning, and the subject of ICT, around whatever is presented. Similarly it would tend to indicate that they are unable to see the transformative nature of ICT (Williamson et al., 2005), working instead to the list of exam board requirements. Both 'Working to a list' and '[Following] exam board requirements' were explicit poles of the constructs elicited in the first phase of data collection. Educational commentators and researchers, in contrast to students, are outside of the experience of actually following a course to assessment at 16 and are not constrained by this enculturated view. Further evidence of this came in group interviews where students, when asked what they would include in a new ICT course if they could design one, said they would not make radical changes.

Student perceptions of their own learning in ICT were found to be dominated by the requirements of the course they are following but the same is not true of what constitutes 'being good at ICT'. When asked to think of someone (which may have been themselves) who was 'good at ICT' and what made them 'good', students sometimes referred to things that were drawn the formal learning done in school but they also referred to other aspects of ICT use. These centred particularly on problem-solving and the ability to fix hardware or, in a few cases, to programming. Here students appear to have equated 'good' with open-ended learning and constructionism (Papert, 1980). Often this was phrased in the context of helping others from which one can infer that students had a constructivist, or at least social, view of learning (Piaget, 1973; Vygotsky, 1978; Bruner, 1996; Wenger, 1998; Craft, 2011).

The perceptions of students on learning also have a range of provenances. Thus they are influenced by what others do, as illustrated in the comments above, and by the direction they are given by their schools, teachers and examination specifications. It is noticeable that students do not tend to refer to these influences explicitly. Thus it is not 'doing what is required by the coursework specification/teacher/school' that is reported a being important but "produc[ing] presentation[s], word documents, [and] spreadsheets" (Student response to in questionnaire).

How was the data collected?

The methodological point of view used was set in interpretive tradition. By this is meant that it was the interpretation of the students, filtered through the interpretation of the researcher that is paramount. The particular approach owed much to a 'spiral' technique develop particularly in the understanding on responses in more therapeutic contexts and drew heavily on the work of Conroy (2003) in nursing and on Smith and Osborne (2003). While these contexts and methods may not seem, at first, to have a direct application to education and learners the key feature was that they start with a 'blank sheet'. Respondents, in this case students, interpretations of their world are allowed to come out as far as possible unfettered by questions, surveys or hypotheses. My own viewpoint had to be initially suppressed as much as possible. This is the notion of 'bracketing' that has a long tradition in phenomenological research (see for example Finlay, 2009 for an overview). The data was collected in three phases – repertory grids, questionnaire and interview and each is now described in turn with the emergent results for what students perceived as important in ICT discussed.

Phase 1: Repertory grids

A repertory grid was used the first phase of data collection (Kelly, 1955; Bell, 2011). This method does have prompts but the responses of students are ordered by them rather by the researcher. I gave them free reign to associate any response with any other, and to categorise them in any manner, even if their views seemed at variance with the orthodox view of teachers and 'the system'. I began by asking pairs of year 11 students these questions:

- ICT - what should you know about?
- ICT - what should you be able to do?
- ICT assessment (coursework/exams) - what should be in them?
- If someone is 'good' at ICT, what can they do?
- If someone is 'good' at using technology, what can they do?
- What technology do you use at home and not school?

Once a pair had exhausted all of their answers to the above they were invited to look for two answers that had a characteristic in common and a third which did not share that characteristic. This is the standard process in repertory grid use. As an example one pair had responded 'Make viruses' and 'Make programs' in answering the questions above (you, the reader, can decide which question/s had these answers!). They then said that these two shared the characteristic 'Making things. They selected another of the answers 'Take apart PC' as not sharing that characteristic. Similarly they said that 'Make programs' and 'Recover lost data' shared the characteristic 'Solve problems' whereas '[Knowing how to] merge cells' did not – in their view.

The characteristics identified in this way are known as 'personal constructs' in the theory of Kelly (op.cit.). It is important to restate that these were identified by from the students; they represent their view of the world, however idiosyncratic or simplistic. We might have said that 'Make viruses' and 'Make programs' were examples of 'Programming'. For them they were just 'Making things'. A final aspect of defining these characteristics was to give a name to the 'opposite' characteristic i.e. that represented by the third answer. Using the example above:

- 'Make viruses'/'Make programs' = 'Making things'

- Take apart PC' = 'Knowing things'
- 'Make programs' / 'Recover lost data' = 'Solve problems'
- [Knowing how to] merge cells' ? 'Solve problems'

Notice how the first has a name for the 'opposite' (knowing rather than making) whereas the second was just 'not' the first.

Having identified the constructs, and categories, the next stage was to identify which ones were the most significant. This was done by asking students to associated every one of their answers to as one 'pole' or other of every construct they identified. A statistical process was then applied to look for significance and the most significant constructs noted.

Some of these constructs are similar to each other. For example there are a number which consider working with different types of data: 'Numbers – Words', 'Excel – Powerpoint' and 'Data handling – Messaging'. These constructs could be categorised as 'Working with different types of data'. Such categorisation done by me as a researcher. It overlaid my perception of similarities between constructs onto the student view. This was an integral part of the methodological approach after Conroy (op.cit.). The following categories emerged as the most significant in the student view:

- Using intuition
- Relevance for later life
- Creativity v Set instructions
- Working with different types of data
- Knowledge of processes for efficient working practices
- Knowledge v Skills

This was the end of the first phase of data collection and had generated an overview of things that students associated with ICT, its assessment and the use of technology for learning.

Phase 2: The questionnaire

The first phase of empirical research established the key constructs in student perception. The next stage was to collect more data on these constructs through the views of a wider group of students. A questionnaire was used that would also act as pilot for possible questions to be used in the third and final phase of interviews. The students who responded to the questionnaire were from the same school as those who took part in the repertory grid analysis.

The results of the construct elicitation above informed the questionnaire design. A further source was the subject criteria for GCSE ICT (QCA, 2001) which underpin the assessment framework the majority of these students were engaged in. The responses that relate to how and what students see as important in ICT are now focused on.

Relevance to later life

Students saw more relevance in the subject ICT than they do in its assessment. Of the sample of 44 all but two respondents rated the subject ICT as more relevant than its assessment. 80% of respondents stated that ICT was 'relevant' or 'very relevant' to 'later life or jobs', but only 36% stated that ICT assessment was. Responses to the two questions that focused on this indicated that students feel that ICT assessment is important to later life, but not that it is relevant.

ICT activity and location

Students were asked to state (up to) three things they were good at, or enjoyed doing, with ICT and to indicate whether each was done in school, out of school or both. Responses are grouped into categories, shown here with the most popular first (N=44):

- Communications (21).
- Games (20).
- Internet (17).
- Using Office Applications (17).
- Creative Uses (12).
- Music (9).
- Schoolwork (9).
- Generic Uses (8).
- Computing Type Uses (2).
- Auctions (1).
- Image download (1).

Only one activity was reported by more than two students as being done 'only in school' – this was 'Using Office Applications'. In contrast for activities done only out of school, 'Communications', Games', 'Music' and 'Creative uses' were each mentioned by 15-30% of the respondents. For activities done both in and out of school, 'Internet' was the most often cited followed by 'Games', 'Using Office applications', 'Communications' and generic uses. It would seem, therefore, that the use of Office applications (word processing, spreadsheets, databases etc) is associated with school. This was also seen in the explicit naming of MS Office applications in the construct elicitation activity. They have a significant presence in the coursework tasks, requirements and guidance. It is perhaps unsurprising, therefore, that student perception, and use, of ICT in school is coloured by the experience of focusing on coursework using these tools.

Activities undertaken outside of school

Students were given a set of 13 activities drawn from those used in the research of Crook et al. (2008), complemented by those mentioned in the construct elicitation in the first phase of data collection. They were asked which ones they did outside of school. Activities reported by approximately three-quarters of the sample or more were:

- Keep in touch by social networking sites (82%).
- Upload things to social networking sites (77%).
- Keep in touch by e-mail (75%).
- Computer gaming (73%).

Three of these activities feature communication, corresponding to the findings above. Indeed with the increase in online gaming (Ofcom, 2011), communication is also an important aspect of that activity for many teenagers.

The least reported activities of those presented were:

- Write a blog (27%).
- Edit Wikipedia or other wikis (18%).
- Upload images to a website e.g. Flickr (14%).
- Use social bookmarking sites del.icio.us, Digg, Reddit (9%).

The last three mention specific websites. Facebook and MySpace were also mentioned as examples of the social networking sites cited as the most frequently undertaken activities. The other reference to a particular website, YouTube, was cited by just under half (47%) of the respondents. There is evidence here, perhaps, of the importance of brand. The social bookmarking sites from Crook et al. (op.cit.) do not have a brand image of which students are aware.

This question also provided opportunity for free text response. The most frequently mentioned activities given in this response were those that involved downloading – music, films and, perhaps seriously or perhaps rebelliously, pornography. The figures here were small however – 9% or respondents mentioning downloading music or films.

Characteristics of someone who is 'good at ICT'

This free text question was predicated on the basis that if assessment is to be fit for purpose then it should recognise and reward those who are 'good at ICT'. The question then was to gain students' perceptions of what was meant by good in this context.

The questionnaire prompted for up to three characteristics. Some students mentioned three, others mentioned one or two, some mentioned none. Twelve students did not respond to this question. The text in the responses was analysed for themes - table 1 summarises these:

Themes	Students	Mentions
Creative	10	12
Generic	14	23
Programming	6	7
Technical	18	26
Office	4	6
Games	1	2
Research	3	3
Communication	3	3

Table 1. What identifies someone as 'good' at ICT?

Many of the responses were generic, for example 'works (types) fast', 'knows what they're doing'. Such responses could be applied to any aspect of learning or assessment and are not ICT-specific. If these are discounted the two most frequently mentioned characteristics of 'being good at ICT' were those associated with technical capability and with creativity. These were mentioned by 18 and 10 people respectively with 26 different mentions of technical prowess (students could give up to three responses and some gave three examples in the same category).

Examples of the responses for 'technical' capability included 'They can solve common problems with computers', 'They know what each part does', and [They] build, fix and maintain computers. Indeed, fixing a computer was the most often cited attribute. For 'creative' capability, responses included '[They] can produce multiple media on a computer', '[They can] create a website' and 'They can use Sketch[y] Physics and [create] really good designs'. Perhaps allied to both the technical and creative attributes, and at their intersection, is programming. This was mentioned by six students in response to this question. This supports the free text responses where programming was the most frequently mentioned activity that should be assessed. It would also seem from the response to this question that students value those of their peers who understand how a computer works and can be creative with, or program, it. Where they see these attributes they conclude that someone is 'good at ICT'.

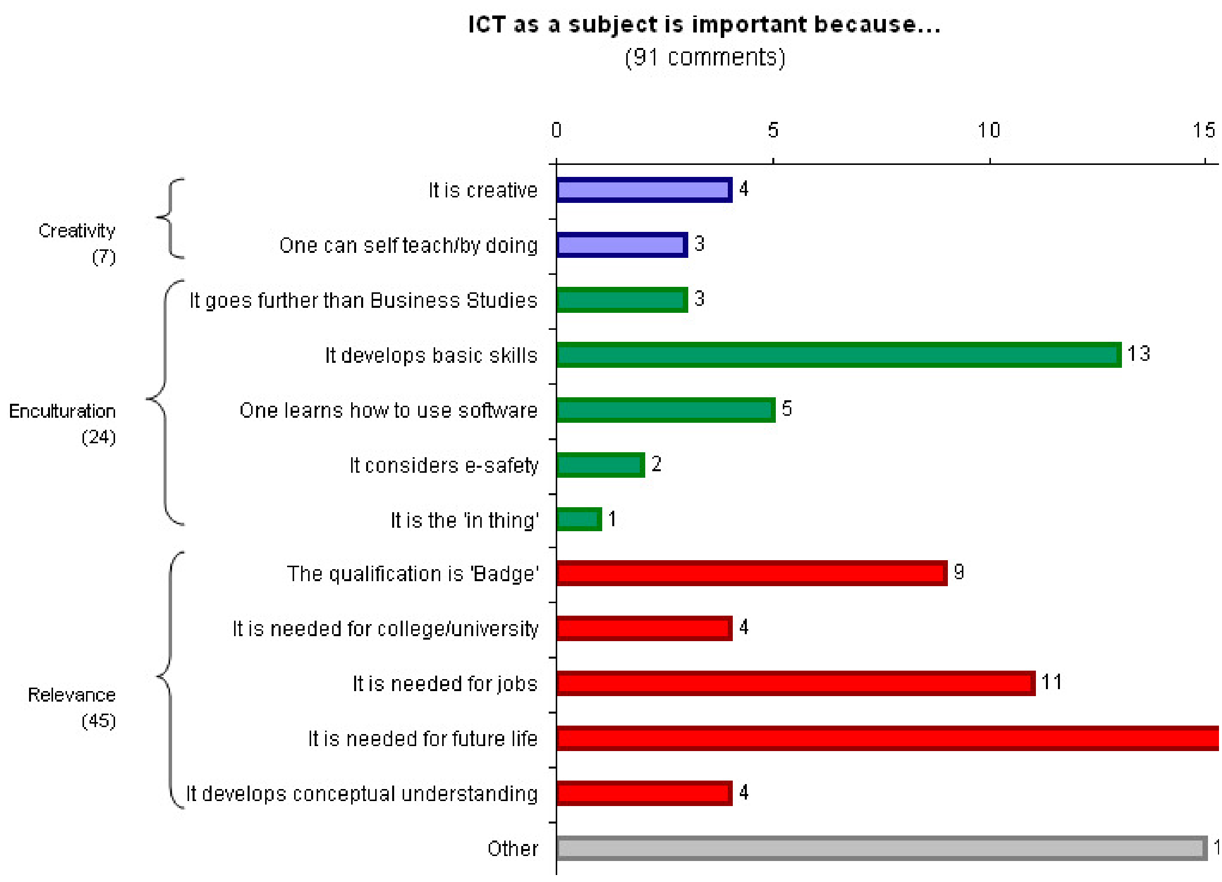
In summary the interpretation of the data from the questionnaire reveal four emergent items that categorize students' perception of what is important in ICT:

- Relevance – of ICT for later life, answers which show the subject as utilitarian.
- Creativity – answers that focus on problem-solving or on the creation and editing of products.
- Tools – answers which focus on the use of tools.
- *ommunications – answers which show that ICT is often about communication (confirming the 'C' in ICT after Stevenson, 1997).

Phase 3: The semi-structured interviews

The final empirical phase, the semi-structured interviews is now discussed. The design of the questions for these interviews followed on from the findings to date. The previous section reported on the findings from the data collected in the second phase, the questionnaire. These in turn built on those from the first, construct elicitation, phase. A series of individual interviews was undertaken in each of five sample schools chosen for spread of geography, type of school and ICT qualification. Interviews were done with five students in each school and then the group as a whole.

In the analysis of the interviews, 91 comments were identified that indicated an importance of ICT to the students. These could be clustered into three themes of creativity, relevance and enculturation with sub-themes as shown in Chart 1:



The most striking thing from the students' responses, supporting the very initial comments in the repertory grid, was the predominance of views that came from the school and the specification. As before comments around Microsoft office gave a very clear boundary to their view of what ICT might be. Aspects of creativity were reported much less.

Creativity – or at least that aspect which is literally creating something was given some prominence by a significant minority of respondents. This product focus is also most often accompanied by a linkage to the world of work and is seen in the emergence of the phenomenon of 'relevance'. It was often something that students thought was an indication of what indicated that someone was 'good at ICT'.

When talking about what they do in ICT and how they perceive the subject and its assessment, students overwhelmingly reported the requirements of the specification by what they produce and the tools which they use in the production e.g. posters, websites, spreadsheets and databases. Less explicit in their response was consideration of knowledge and understanding or reference to processes. What is produced is a key element of the evidence for coursework. Thus the students' view of importance is coloured by the systemic view and the needs of assessment. These will be returned to in subsequent articles.

Pete Bradshaw can be contacted at p.r.bradshaw@open.ac.uk

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Naace
PO Box 6511
Nottingham
NG11 8TN
Phone: 0115 945 7235
Fax: 0870 241 4115

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The impact on learning of wireless networks

Author: Roger Broadie, Broadie Associates Ltd.

A number of schools are installing wireless networks with high bandwidth, for high numbers of computers, that is maintained when computers are roaming. This study looks at the pedagogies they are using to generate significantly better learning.

The nature of the study

The schools were polled as to their reasons for needing high density, high bandwidth wireless that is maintained while roaming. Individual conversations were then had with teachers to explore their answers in more depth. This identified teaching approaches being adopted that make it possible for learning to be more effective than in traditional approaches.

The teaching approaches the schools are adopting is characterised by the development in the schools of independent learning by pupils, with the pupils taking greater responsibility for their work, working much more socially and collaboratively than has been traditional in classrooms, and using a far wider range of ICT-based tools, and range of media in producing work.

The effectiveness of this new pedagogy is judged, by the teachers in these schools, to promote pupils' learning much more strongly than pedagogy that is more teacher-directed and involves more individual work and less social collaboration.

Analysis of the collaborative enquiry-based learning that is being adopted suggests that this is producing significantly better learning because, in working on the topics the teacher sets and scaffolds work on:

- pupils are creating their ideas of how to progress their work on the topic faster, and with greater breadth and depth through collaborative enquiry, than they would otherwise do if thinking and researching individually.
- pupils are more engaged with this kind of work, particularly when supported and enabled by personal computer devices, Internet access and use of rich media, resulting in a higher work rate and greater concentration.
- this greater engagement is leading pupils to use their own time to find out about and to teach themselves knowledge and skills.
- the collaborative approach is leading naturally to continuous peer discussion and assessment (informally as well as formally) through comparison of ideas and work, which is motivating pupils to achieve better progress in developing their work.
- the increased breadth and depth of enquiry, and the higher engagement in the work pupils are producing, are leading to higher quality final work being presented for summative assessment.
- the greater speed in developing ideas and the higher quality pupil output that is produced are providing higher starting points and more time for the teacher to work with the pupils in developing higher order thinking, providing further challenge and in stretching pupils to extend and improve their work.
- the result is significantly better and deeper learning in the same elapsed time, with the teachers able to dedicate more of their time to higher level interventions.

Comparison of new and previous pedagogies

It is possible to characterise learning as a process of the learner posing themselves increasingly demanding questions that challenge what they know; questions that they proceed to answer in the work they produce. For example, in creative writing a pupil might challenge themselves to make a sentence better, and ask themselves "what techniques are there to make a sentence better", then "will technique A work better than technique B for this sentence", "what determines which technique will work better" and so on – similarly for any subject or topic.

Comparing how this is achieved in a teacher-led class without personal Internet access and without pupils being able to communicate and collaborate out of class, with how it can be achieved when pupils have these opportunities:

Individual learning and work

- The teacher sets an initial challenge and provides pointers as to what the pupils should consider in tackling the challenge.
- The pupil decides individually how to go about their work. Their creativity in doing this is based on examples the teacher has provided and any they personally know of or find. The degree of creativity depends only on their innate creativity.
- The pupil's drive in doing the work comes only from their own current level of drive and teacher encouragement.
- The review of their work and how to improve it is then guided by the teacher, with comparison of their work with that of others only being introduced after they have produced their version.

Collaborative learning and work

- the teacher sets an initial challenge and provides pointers as to what the pupils should consider in tackling the challenge.
- The pupils have initial ideas about how to go about their work and share these with others, stimulating better initial ideas.
- The process of doing their work is iterative, their creativity in doing this being based not only on examples the teacher has provided, and any they personally know of or find, but also on how they see their peers tackling the work. The degree of creativity is extended by pupils wanting to produce ideas that differ from those of their colleagues, leading to more diversity of ideas.
- The pupils' drive in doing the work comes not only from their own current level of drive and teacher encouragement, but from the social and competitive desires to impress their peers.
- The review of their work and how to improve it happens several times in the creative process with constant comparison with what others are doing, before review by the teacher.

Possible arguments against adoption of collaborative approaches to work are that:

1. Pupils are relying on ideas from others rather than creating their own,
2. Time spent discussing with others could be better spent on individual creative thought.

The counter arguments, which are the experience of the schools studied are:

1. A culture can easily be developed in which pupils seek and enjoy the success of having colleagues like their ideas, or of being able to suggest better ideas to their friends. Part of this culture is losing the fear of getting things wrong, through an ethos led by the teacher that poor work is the start of improved work. Pupils are therefore likely to be more creative and courageous in putting forward ideas.
2. The higher engagement driven by working collaboratively leads to pupils working faster and using time that they would not previously have dedicated to work, including personal time as well as more intensive use of time in lessons. The actual time spent on individual thought is therefore increased.

It was notable in discussions with the teachers that they have actively developed a culture amongst their pupils that encourages explicit awareness of learning and of the quality of work, such that discussion between pupils becomes valuable in raising the quality of work.

There was also discussion of whether use of the technology, while currently driving higher engagement, might cease to be motivating as it becomes more commonplace. While this study cannot make definitive statements about this, there were two strong themes in all the conversations:

- the use of rich media and the increased conversations about their work seem to help pupils understand and learn much more effectively than through study of purely textual or verbal explanations. This could be a human factor that will persist even when use of mobile technology and wireless networks is commonplace.
- the motivation that comes from working collaboratively is obviously enabled by technology and the wireless network, but appears to be a fundamentally human motivation, independently of technology that will hence persist.

Conclusion

The conclusion of the study is that the benefits to learning offered by personal Internet-connected computer devices, operated in a high performance wireless network environment, are best gained by changing pedagogy to promote independent collaborative learning, and that this can produce improvements in learning in a school that are lasting and significant.

Roger Broadie can be contacted at roger@broadieassociates.co.uk

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The schools involved were:

Bolton Community College
Costello Technology College
Newent Community School
New Line Learning Academy
Sedburgh School
St John the Baptist Primary School
Uckfield Community College

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Naace
PO Box 6511
Nottingham
NG11 8TN
Phone: 0115 945 7235
Fax: 0870 241 4115
Email: office@naace.co.uk

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The Principles of Educational Robotic Applications (ERA): A framework for understanding and developing educational robots and their activities

Author: Dave Catlin, Valiant Technology Ltd and Mike Blamires, Dept of Education, Canterbury Christ Church University

Abstract

The original educational robots were the Logo Turtles. They derived their rationale from constructionism. How has this changed? This paper postulates ten principles that underpin the effective utilisation of robotic devices within education settings. We argue that they form a framework still sympathetic to constructionism that can guide the development, application and evaluation of educational robots. They articulate a summary of the existing knowledge as well as suggesting further avenues of research that may be shared by educationists and designers. The principles also provide an evaluative framework for Educational Robotic Applications (ERA). This paper is an overview of the ideas, which we will develop in future paper.

Introduction

Logo combines philosophy, educational theory, artificial intelligence, cognitive science, developmental theory, neuroscience, robotic engineering and computer science. It emerged in the 1960s when most of these disciplines were still in their infancy. Post modernism, logical positivism, phenomenology and deconstructionism were disrupting age old philosophical positions.Turtles, the first breed of educational robot, emerged as part of Logo and shared its intellectual grounding particularly its constructionist approach to education. While the intervening years have seen significant developments in the underpinning sciences, little has been done to review their overall and collective impact on the way we use educational robots.

While never becoming extinct, real Turtle robots faded into the background as researchers almost exclusively worked with virtual robots. This is changing. Writing in the Scientific American, Bill Gates predicted “robots will be the next hot field” (Gates 2006). Certainly, this rise in popularity has started to appear in education. Consequently a review of the intellectual and practical basis relating to our use of educational robots becomes urgent. This paper is the result of that review. We propose that ten Educational Robotics Applications (ERA) Principles summarise the value of robots and robotic activities in any educational context.

We start by making a set of simple claims why we think these Principles are of value. We follow this with a description that references some of the supporting evidence and conceptual grounding. In order to provide some degree of ‘future proofing’ and to make the postulates independent of the type of robot, we have kept the descriptions as abstract as possible. Where contextual instances help to clarify our meaning we have used examples.

Although we call these Principles we are aware of their hypothetical nature. Over the coming years we expect research activity will gradually confirm, change, delete or find evidence that will steadily transform the postulates into verified principles. We finish the paper with a brief introduction to the e-Robot project which aims to accomplish this validation process.

Introducing the ERA Principles

The Principles are not stringently independent ideas. They form a holistic set of values that integrate in different combinations. For example Personalisation Engagement and Equity share an affinity. Personalisation also resonates with the Practical, Curriculum and Assessment, and the Pedagogical Principles.

The use of robots involves the interaction of students, teachers and technology. We have grouped the Principles under these headings more to assist their recall than an exacting effort of categorisation.

Why the ERA Principles?

The Principles present a framework that:

1. Explains:
    a. How robots help students learn
    b. The benefits of educational robots to teachers

2. Offers a check list for those who want to:
    a. Design educational robots
    b. Develop activities that use educational robots
3. Helps justify the investment by schools in robotic technology
4. Suggests underlying cognitive and developmental processes
5. Provides researchers with a set of claims to evaluate

Technology		
	1	Intelligence
	2	Interaction
	3	Embodiment
Student		
	4	Engagement
	5	Sustainable Learning
	6	Personalisation
Teacher		
	7	Pedagogy
	8	Curriculum and Assessment
	9	Equity
	10	Practical

Table 1 The ERA Principles

Intelligence

Educational Robots can have a range of intelligent behaviours that enables them to effectively participate in educational activities.

An exploration of this principle needs to explain what we mean by:

1. Intelligent behaviour
2. Effective participation

For our purpose we recognise intelligence as belonging to a spectrum of behaviours focused on intentional goals (Sternberg 1985, Stonier 1997, Freeman 2000, Sternberg et al 2008). This means the robot need only possess task specific intelligence, which targets explicit learning objectives, rather than a general ability to act in unstructured situations. In this sense educational robots need to help students acquire specific knowledge, provoke them into thinking, help to develop skills or provide them with experience of situations and knowledge structures that mirror useful thinking patterns. They provide students with opportunities to use their knowledge in problem solving and engage in knowledge transfer, generalise concepts and develop their social skills.

Currently deep-down in their microchips, educational robots are based on what Winograd and Flores termed Western rationalistic tradition (Winograd and Flores 1986). These represent powerful thinking patterns capable of supporting many useful educational applications. Logo is an example. When a version of it is internalised into a robot's core behaviour it dictates what the robot can and cannot do. As technology and our understanding of educational robotics develop we expect to find new "core" behaviours capable of supporting different learning experiences.

Effectiveness contains the notion of efficiency, which we take to mean improvement. That is, students grasp ideas faster; get a better understanding of concepts, etc. This is relative. We grasp the idea faster than if we used some other method. It depends on which student and which method and what works well for one student may not work so well with another. Effectiveness also depends on the skill and experience of the teacher. Teachers teach: the technology is a tool to help – not replace them. Not every teacher will exhibit the same aptitude for using educational robots, irrespective of their general teaching skill. Whereas an adept, well trained teacher will achieve brilliant results, a robot will not make up for teaching deficiencies.

Generally, the measure of effectiveness is statistical. In most applications, with most students and most teachers, we expect intelligent robots will enhance educational achievement. If a robot does this for just one student it is valuable. The need for the statistical verification is economic: it is hard to justify the cost of a robot system for singular teaching successes.

Interaction

Students are active learners whose multimodal interactions with educational robots take place via a variety of appropriate semiotic systems.

Working with robots is an active learning process, which is generally more effective because it is multi-modal. Interaction always involves the use of a semiotic system. Semiotics is usually defined as thescience of signs (Halliday 1978). Crystal (1999) offers a more appropriate definition, which captures the heart of any educational enterprise:

> *Semiotics: The study of signs and their use, focussing on the mechanisms and patterns of human communication and on the nature and acquisition of knowledge.*

Signs evoke meaning through culture and context. For example in the West the colour red implies danger whereas in China it means good luck. However, the "value" (meaning) of the sign changes according to its use. So for example a red cross suggests medical help. Education is about learning the signs and signifying practices of our culture.

Logo is a semiotic system. We communicate our ideas to a robot by manipulating Logo symbols (commands) according to rules (programming syntax). The robot provides feedback through its movement – a sort of mechanical "body language". We can use this "body language" schema to understand other semiotic systems. For example if we place a robot on a number line and make it move by manipulating symbols (numbers and operation signs) using the rules (addition, subtraction, multiplication and division) students can explore the semiotic systems of numbers and arithmetic. Consider the equation (+4) – (-3) = (+7). Students are normally taught to solve this problem by remembering a meaningless rule like two minuses are a plus. Using the robots students use their visual, kinaesthetic and spatial modalities to develop mental models of negative number arithmetic. Importantly, they learn through understanding (NCTM, 2000 and Bransford, et al 2000). They see that on the number line to get the robot from (-3) to (+4), the robot has to travel (+7). This emphasises the meaning of the number system, particularly the relationships between positive and negative integers and the idea of subtraction as "difference".

Up until now robots have been dumbstruck[1]. Yet, natural language is humanity's major semiotic communication system. Valiant's new Roamer is changing that. The basic robot has a very powerful speech capability. This opens up many tantalising possibilities. For example by incorporating Logo's list processing ability, we can explore embedding in the robot the language ideas explored by Golenberg and Feurzeig (1987). In Incy Wincy Spider, an Early Years comprehension activity (Valiant 2009), Roamer sings out the verses of a nursery rhyme. The students realise the robot has "got it wrong" and their task is to teach it to get the verses in the right order. They do this by pressing the keys representing the "action" of the rhyme.

The Incy Wincy activity involves sequencing, a precursor to programming, which has been the primary way we interact with educational robots. If we transform the phrase "human communication" used in Crystal's definition of semiotics to the more apposite "Human Computer Interface" (HCI) and Human Robot Interface (HRI) we open exciting new possibilities. Forerunners of this technology are already finding their way into toys (Bartneck and Okada, 2001). And the work of some researchers on sociable robots (Brazeal 2004, Dautenhahn 2007) shows the possibility of very natural interactions between student and machine. For example AnthroTronix used Roamer as a basis for their Cosmobot robot. They have developed an interactive glove through which children can operate the robot through American Sign Language. The Principle also embraces the idea of tangible computing, which involves students purposeful construction of environments that control the behaviour of the robot.

How can this assist education? Vygotsky's concept of "tools" is a fertile starting point. The influential Russian psychologist proposed that just as we used tools to impact our external environment we need tools to modify our behaviour. Semiotics was the foundation of these 'mental tools' by which Vygotsky meant language (Wertsch 1985). Clearly robots represent physical tools which Papert, borrowing ideas from Winnicot (1971), called "transitional objects" or "objects to think with" (Papert 1980). Activity Theory (Leontiev 1978, Davydov and Radzikhovskii 1985, Engeström 1987, 1999) grew out of Vygotsky's work. This theory orientates us to a world of objects and our mental interactions with them. Some work on this has been done in relationship to Activity Theory and HCI (Nardi 1996). It is our contention that extending this work into educational robotics will provide a deeper understanding and offer new perspectives on the Interactive Principle.

Logo Turtle robots formed the prototype educational robot system. Logo offered new ways for students to develop mathematical, computational, geometric and scientific skills (Cuoco 1990, Kyngos 1992). From the initial conception of Logo (Feurzeig, et. al. 1967) to the existence of effective educational applications took many years and a great deal of research (Papert et. al.1971 to 1981). As new robotic and HCI/HRI technologies emerge they will need to undergo the same process, but gradually we will see an increase in the capability of robots to support teachers and help provide valuable learning experiences.

Embodiment

Students learn by intentional and meaningful interactions with educational robots situated in the same space and time.

We propose that by interacting with physical robots students can have positive educational experiences. And in a special caveat the claim extends to positive experiences that at a minimum are qualitatively different to those with virtual robots. While 30 years of practical work in schools has shown that thousands of teachers share this intuitive view, there is little hard data to verify the claim. Such evidence is contradictory, flimsy or does not target embodiment (Mills et al 1989, Gay 1989, Syn 1990, Weaver 1991, Mitchell 1992, Betts 1997, Adolphson 2005).

Our proposition does not critique the value of educational software. Instead, we aim to affirm the potential of physical robots. Our claim is built on a theoretical framework that has two strands:

1. Work by various authors in the areas of embodied cognition, AI and robotics
2. The original body syntonic claims of Seymour Papert (1980a) Embodiment in cognitive science claims three things:

- Mind has evolved, not as a machine, but as an integrated element of an organism embedded in a society and in a physical temporal world.
- Mind and body are intimately intertwined. They form an 'adaptive system' – that works together to survive and thrive as their environment changes.

- Most embodied cognitive processes are subconscious.

The concept of embodiment is rooted in biology (Muratana and Verela 1987). Despite this some writers have applied the term to software (Franklin 1997). Others argue that bodies are essential to cognition (Pfeifer and Scheier 1999). A survey (Ziemke 2001) looks at what kind of body is required. We restrict our meaning to living entities (students/teachers) and physical robots.

Embodiment is about how we engage with the world, extract and share meaning through our interaction with it and the objects it contains (Dourish, 2003). It is self evident that this applies to robots. But does it apply to virtual robots? It could; however, engagement is not with the "real world" and interaction is not with "real artefacts". What appears on the screen is, at the very least, someone's conceptual interpretation of the real world. Here we use the term real, in the way a thirsty man would view a real glass of water compared to a virtual glass of water.

Berthelot and Salin (1994) found that lack of experience with meso and macro space restricted elementary school students' ability to cope with micro space[2]. We have seen students confused by the forward command moving a virtual turtle upwards on the computer screen. Going forward across the floor is the same for student and robot. This is the core of Papert's body syntonic idea: students can 'play turtle'. They can project themselves out of their ego centric mind, 'stand in the shoes' of the robot and directly perceive the world from its perspective.

Exploring the idea of embodiment could lead to new understandings about educational robots. Consider the proposal that maths is not an objective science, but that it arose out of the various 'image schema' derived from repetitive embodied experiences (Lakoff and Nunez 2001). These pre-linguistic entities provide a source for linguistic metaphors like 'source – path – goal', which sympathises with the attributes of mobile educational robots. Although this theory is controversial (Gold 2001, Madden 2001) many maths educators believe the work has merit (Schiralli and Sinclair 2003, Tall 2003). We believe that further research into embodiment will aide our understanding of educational robotics.

Engagement

> *Through engagement Educational Robots can foster affirmative emotional states and social relationships that promote the creation of positive learning attitudes and environments, which improves the quality and depth of a student's learning experience.*

In 1992 Classic Roamer debuted in America when a Chicago teacher tried it with a second grade student who normally never engaged in school work. He decided to make Roamer turn "all the way around". So he programmed it to turn 8, which made it turn 8 degrees. He was shocked at this small movement. He was also captivated and went on to experiment with 1, 2 and 3 digit numbers. He subconsciously gained experience of equivalency and after 45 minutes discovered 360 was the "magic number". Thirty years of ad hoc observations of students using robots has shown this is not an uncommon example of the Engagement Principle. Educational robots and their activities have a propensity for capturing students' attention.

Engagement is a far richer and apposite concept than the ubiquitous, "makes learning fun". For example work done at CNEFI[3] in Paris used Roamer to change the attitude of an adolescent who had been 'brain damaged' in an auto accident (Sarralié 2002). The student had lost the ability to do simple arithmetic. He was very aggressive towards the teachers trying to restore his competency. Eventually, they gave him a Roamer activity, which necessitated him performing basic calculations. The robot task captured his attention, helped him realise his incapacitation and made him amenable to working with the teachers. It is fair to say that fun was not a part of this experience, but engagement was very much in evidence.

While many children seem to possess a natural fascination for robots, this is simply an advantageous starting point. What Bruner (1966) called the "will to learn" is a factor in sustaining engagement. Teachers can motivate students, help develop interests and trigger their curiosity (Hidi and Renninger 2006, Keller 2000 and Arnone and Small 2010). We claim that educational robotics provide skilful teachers with many ways of achieving these conditions.

Engagement involves the relationship a student forms with the robot. The classic ideas on transitional objects (Winnicot 1971, Leslie 1987) all relate to the cognitive processes of young children. Recent work has shown that:

1. Our relationship with physical objects also involves emotional and social experiences
2. The experience is not restricted to young children
3. Robots fall into a new category between inanimate object and living thing

Sherry Turkle cites evidence of children talking about their experience with Sony's robot dog Aibo as if it was one of their toys, yet they interact with it as though it were a real puppy (Turkle et al 2006). She classifies robots as "relational artefacts" and splits them into Rorschach and evocative types. Like the Rorschach test, aka ink blo tests, Turkle shows that student responses to the robots mirror underlying issues in their life and reveal their strategies for dealing with their concerns. She describes the evocative aspect as philosophical: something that makes people think (Turkle 2007). Papert's famous anecdote about his childhood experience with gears is an example of an evocative object at work (Papert 1980b). Not in the cognitive sense that the young Papert acquired a mental model that years later would help him understand equations; it was the wider philosophical effect that inspired his extraordinary career.

Engagement is about capturing a student's attention. In our Chicago anecdote the student became absorbed in the turning problem. We mentioned his subconscious experience of equivalence, something the curriculum did not require him to learn for another two years. This is an example of the "natural" learning of mathematics Papert so earnestly advocates. It is also an example of an intuition, which is an intrinsic element of the engagement principle.

No one taught the Chicago student equivalence. Yet he happily "unthinkingly" used these concepts. This is the crux of a definition of intuition: immediate apprehension by the mind without reasoning (Allen 1990). This definition gives intuition a disreputable reputation. Some psychological studies make no distinction between intuition and guessing (Myers 2002). Comparative philosopher Hope Fitz combines Eastern and Western traditions to offer an alternative view. She sees intuition as an integral process of the mind, which is grounded in sub conscious memories and experiences. While it is linked to reason, the act of insight does not involve reason (Fitz 2001).

Insights are not accidents. Our subconscious accounts for most of our mental activity (Bragg et al, 2008). It is through attention that we build and access our intuitive knowledge. Poincare (1905) described the process in terms of creative mathematics. He deliberately immersed himself in anything relating to a problem. He relied on his intuitive skills to channel insights into his conscious mind. Discussing this idea Papert (1978 and 1980) suggests this process is not restricted to a mathematical elite. We go further and speculate that is not restricted to mathematics. It empathises with the ideas of expert knowledge discussed by Bransford et al (2000), the psychological studies on implicit learning (Goschke 1997) and perhaps the more sensational and speculative assertions made by advocates of accelerated learning (Jensen 1995). Our claim is that through engagement in robot activities students develop their intuitive understandings.

Sustainable Learning

Educational Robots can enhance learning in the longer term through the development of meta-cognition, life skills and learner self-knowledge.

School is not just a place for the acquisition of knowledge and skills.It plays an important part in the personal development of students. The English National Curriculum (2010) specifically states the need to help students acquire communication skills, the ability to work with other people, to present ideas and to be confident.

The way we use educational robots automatically engages students in situations where the opportunity exists to develop these skills. For example, the Robotic Performing Arts Project (Catlin 2010) illustrates an opportunity for students to develop their cognitive, social, personal and emotional skills in an authentic learning situation.

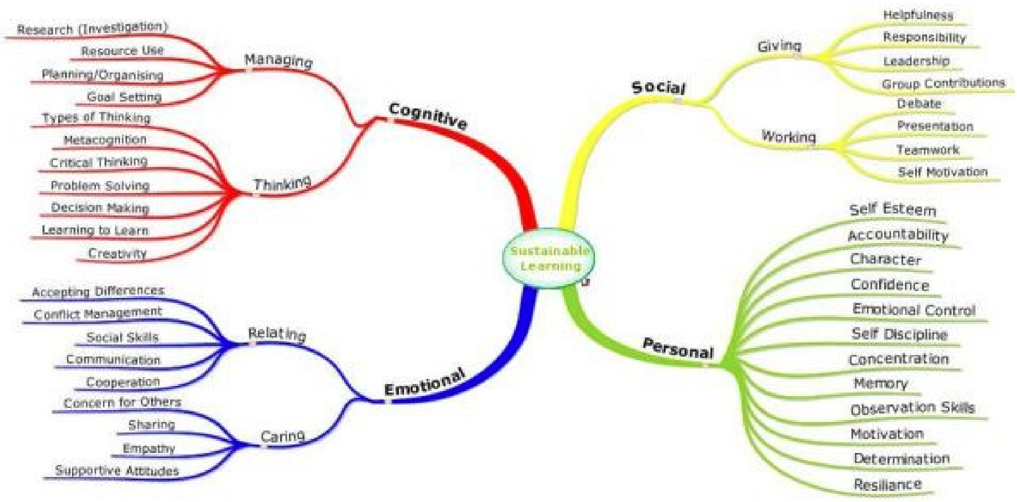

Fig.1 Mind map of typical sustainbale learning criteria relevent to educational robots - adapted from Iowa 4H Program (2010)

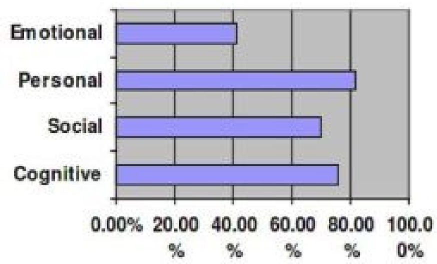

Fig. 2 Involvement of sustainable criteria in a sample of 30 Classic Roamer activities

Pedagogy

The science of learning underpins a wide range of methods available for using with appropriately designed educational robots to create effective learning scenarios.

A central question in our project is what pedagogy justifies our belief that robots have a role in education? In the development of Logo, Papert synthesised ideas of Artificial Intelligence and the constructivist approach to education. That is, we understand the world by constructing mental models from our experiences. We assimilate or accommodate new experiences into our existing concepts or we accommodate them by modifying our existing ideas. Logo and Turtle robots provided experiences in a way that brought students into direct contact with some powerful and important ideas, particularly in mathematics.

Is this the only way we can or should view the educational process? We have already cited the potential insight we might gain from a review of Vygotsky and Activity Theory. While there are differences in these and other ideas, there are also many similarities. What clearly emerges is not some definitive truth about the way we learn but more of an orientation. This is starting to become known as the science of learning. Papert talks about the spirit of Logo and that life is not about “knowing the right answer”, but getting things to work. We need to adopt this pragmatic approach and let the science of learning inform and sometimes inspire our development of educational robots and their activities. Ultimately our judge of success is not whether we have a consistent developmental framework, but whether we can connect learning science and the technology with successful classroom practice.

Another aspect of pedagogy is a set of strategies that help us to create and analyse educational robotic activity. An analysis of work with Valiant’s Turtle and Classic Roamer has identified 28 different methods for using educational robots (Catlin 2010a).

Catalyst	Demonstration	Games	Presentations
Challenges	Design	Group Tasks	Problem solving
Conceptualisation	Engagement	Inductive thinking	Projects
Cooperation	Experimentation	Links	Provocateur
Creative	Experience	Modelling	Puzzles
Curriculum	Exploration	Memorisation	Relational Artefact
Deduction	Focussed Task	Pacifier	Transfer

Table 2: Pedagogical tools for educational robots

Most activities employ several strategies. For example a Roamer Activity called Robot Rally Race (Valiant 2009) starts with a challenge to find the fastest route, involves experimentation while the students try to find out how fast the robot travels over different terrains, and uses this statistical data in a focussed task to calculate the fastest way from start to finish. Table 2 is not a closed list. We expect to find other tools as the power of robots grows – for example Valiant’s work on robotics and storytelling is likely to yield some new approaches.

Curriculum and Assessment

Educational Robots can facilitate teaching, learning and assessment in traditional curriculum areas by supporting good teaching practice.

Most formal education takes place in schools. The “local” community decides what the students should learn and typically demand “proof” of achievement. While the curriculum and assessment methods vary between different communities there are many similarities. If educational robots are to make a significant impact they must be able to address the two items that concern teachers the most:

1. Teaching the curriculum
2. Assessment and testing

The Curriculum and Assessment Principle includes the phrase "good teaching practice". How does this affect how a teacher teaches? Does it alter their traditional role as a dispenser of knowledge and what do educational robots have to contribute to this situation? These questions lead us to consider and develop another of Vygotsky's innovative ideas: the Zone of Proximal Development (ZPD) defined as what the learner can do alone and what they can do with assistance (Vygotsky 1978). We predict the ZPD concept will develop to embrace technology in general and intelligent robots in particular. The characteristic of this model is that the teaching and learning experience will be more flexible than the Logo model of student teaching the robot or the teacher dispensing knowledge. It will be a dynamic model allowing any of the participants to be a teacher or a student.

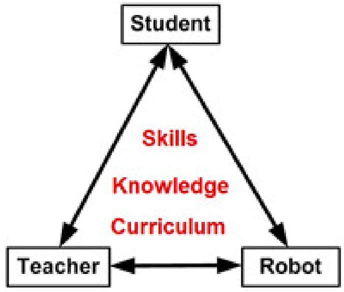

Fig. 3 The dynamic relationship between teacher, student and robot shows that the learning and teaching interactions are bi-directional.

This proposition assumes that educational robots can be applied broadly across the curriculum. Turtle robots were tightly linked with mathematics and Roamer, Lego and other robots have made clear links with STEM (Science, Technology, Engineering and Maths) subjects in general. However, it is clear that robots are not restricted to these domains. In 1992 Harrow schools in the UK ran a district wide robotic art project. Students had to make Roamer into animated sculptures of fantastic insects. Perhaps more surprisingly is the use of robots in the study of moral and social values (Bers and Urrea 2000). Currently Valiant is developing a library of between 200 and 300 free and commercially available Roamer K-12 activities in all subjects. Some of these, like the fantastic insects, are major projects; others like the Incy Wincy activity are completed in a lesson. The potential for activities far exceeds what a school could use in a balanced approach to teaching.

Formative assessment is a crucial part of effective learning environments particularly when it forms an unobtrusive element of an activity (Bransford et al 2000b, Black and Wiliam 2006). Feedback is embedded in robotic goal orientated action. Robots inherited this trait from Logo. Students propose an interim solution and then decide if it is satisfactory or whether they need to and/or how to make improvements. This makes formative assessment a natural part of this dynamic interactive process.

Personalisation

Educational robots personalise the learning experience to suit the individual needs of students across a range of subjects.

Ellwood Cubberley, a contemporary of John Dewey and Dean of Education at Stanford urged we view schools as factories in which the children were raw products to be shaped and fashioned to meet the demands of twentieth-century civilisation (Cubberley 1916). His rhetoric got worse: "the business of schools was to build its pupils according to specifications laid down" and this required "continuous measurement of production to see that it is according to specification, the elimination of waste…" Contrast this with the educational aims stated in the UN Charter for the child. It charges nations with developing the child's personality, talents and mental and physical abilities to their fullest potential (United Nations 2001). Robots support the UN child centred vision.

1. Self Expression	Educational robots are tools that allow students to explore ideas and express their understanding in personal creative ways.
2. Flexible Use	Robots are adaptable to the needs of the teaching situation (see Practical Principle) and the needs of the individual student.
3. Differentiation	Robot activities find a natural level of difficulty. They support the constructionist principles and recognise that students build their own understandings in their own ways. They support struggling learners and challenge gifted students.
4. Learning Styles	Robots engage in multiple modal experiences: • Kinaesthetic • Visual • Spatial • Auditory • Tactile

Table 3: Ways educationla robots support the Personalisation Principle

These ideas are familiar to constructionists and have drawn their fair share of criticism. Let's deal with some the most common. Students setting goals does not lead to lower standards or the study of irrelevant topics. While students make the choices, good constructionist teachers "rig the deck". They motivate and encourage students. In fact once ignited students' imagination usually outstrips the activity objectives and pushes beyond expectations. This is not about achieving par; it is about the excellence beyond that. In a Classic Roamer task the students had to make a robot dog. Suddenly it needed "a wagging tail". How to do this was far beyond the teacher's skill and knowledge level, but not beyond her teaching skills. The students found a solution - a rubber tube that wagged furiously as Roamer wiggled its bum!

Equity

Educational robots support principles of equity of age, gender, ability, race, ethnicity, culture, social class, life style and political status.

Before we can understand how robots help with equity we need to understand some of the issues involved. Equity means giving students an equal chance for a good education. Or does it mean giving them a fair chance? It turns out that equity is very hard to define, and how you define it affects how you deal with it (Ainscow et al 2006). Equal chance for example could mean making sure that each school has the same level of funding, resources, quality of teaching, etc. A fair chance would perhaps look at compensating for disadvantages.

Society can only determine a curriculum culturally entailed in favour of the mainstream of the community. For anyone who belongs to a cultural group that is not part of the mainstream, and whose sub group would produce a different curriculum, they have to make more effort to achieve academic success. There are those who argue such a curriculum represents a lingua franca for a society (Hirsch 1988). If minority students want to fully participate in main stream culture, they need to overcome cultural barriers. Though in practice mainstream-culture eventually changes because of input from minority participants (Lave and Wenger 1991).

Inequity arises from things like unequal funding (Kozol 2005), lack of qualified teachers, high quality materials, equipment and laboratories (Darling-Hammond 2005), overcrowded classrooms (Ferguson 1991) and poor quality teachers (Dreeben 1987).

Research and classroom practice show that minority pupils perform better when teaching is filtered through their own cultural experiences and frames of reference (Gay 2000). We claim:

1. Robots are tools that allow students to express themselves from their cultural perspective
2. The creative nature of robot activities makes them amenable to cultural modification

Because most societies have a tradition of artificial life (Simons 1986), robots have the potential to be culturally acceptable. Most cultures have developed the art of puppets and many technically advanced cultures created automaton of arious types. Robots are another manifestation of this tendency. The mechanisms behind robots as transitional and relational objects make robots potentially tools through which children can express themselves. In a study of Huli children in Papua New Guinea, anthropologist Laurence Goldman (1998) concluded:

> *In their "as-if vignettes", pretenders are constructing, experiencing and implementing their models of the world, models that are always culturally encumbered and inflected.*

This is the same mechanism Valiant has observed with students of indigenous cultures like the Maori, Australian Aborigines and some Native American peoples using Roamer. Students project their imagination into artefacts. With robots these imaginations come to life and enable students to express themselves in a way that reflects their heritage and situatedness in the modern world. They can connect their heritage with technology in their terms.

A robot teacher recently appeared in a Japanese school (Demetriou 2009). Saya, a humanoid invention of Professor Hiroshi Kobayashi, took the class register. Work at Carnegie Mellon with the robot Asimo is exploring and perfecting a robot that can read to students (Mutlu et. al. 2006). At a cost of $1M Asimo is a long way from classrooms, but it does imply that technology can "make up" for the poor quality of teachers. This argument is already well advanced with cognitive tutors (Woolf et al 2001, Koedinger, 2001). We do not subscribe to this view. Some very early research showed that technology together with teachers working with students got better results than students learning with teachers or technology alone (Dalton and Hannafin, 1988). This is very old research, but we suspect it still has validity. We believe that as robots become more adaptive and capable of providing sustained, uninterrupted interactions with the students, the teachers will be able to concentrate on working in ways that have greater impact on a student's learning. This demands higher teaching skills not lower. It helps make teachers more effective.

Practical

> *Educational robots must meet the practical issues involved in organising and delivering education*

in both formal and informal learning situations.

We often see approaches to education produce spectacular results in research or other controlled circumstances, followed by limited success or even outright roll-out failure. While we believe robots and ERA compliant activities will make a positive educational contribution, careful implementation and management is necessary if a school is to take full advantage of what robots offer. The Practical Principle considers this on two levels:

1. Systemic Implementation
2. Classroom Practicality

The Classic Roamer had a 95% penetration of UK Primary schools. This does not mean schools are getting the most out of them or using them regularly. Taking care of systemic changes issues will help people get the most out of robots. The following comments apply at the level of classroom, school, school district or even whole country.

Vision	+	Buy In	+	Skills	+	Resources	+	Plan	=	Change
Vision	+	Buy In	+	Skills	+	Resources	+	Plan	=	Confusion
Vision	+		+	Skills	+	Resources	+	Plan	=	Resistance
Vision	+	Buy In	+		+	Resources	+	Plan	=	Fear
Vision	+	Buy In	+	Skills	+		+	Plan	=	Frustration
Vision	+	Buy In	+	Skills	+	Resources	+		=	Vacillation

Table 4 Elements of change adapted from Thousand and Villa (1995)

Table 4: Summarises the elements required to make systemic change and what happens when an element is missing. Schools or districts wishing to integrate robots into delivering the curriculum need to address each of these issues. We propose the ERA Principles will help people develop an understanding and vision of how robots can be used.

At the moment most people think school robotics means students building robots. This type of activity is in fact a subset of the more general use of robots. Most teachers would not deem it practical to have to build the robot to engage in the Chicago Activity. For teachers to buy-in to using robots they must perceive their value outweighs the effort in dealing with the logistics and the preparation process. We are not trying to imply that there should be no applications that involve engaging in technical activity, but there needs to be activities that can be "ready to go in minutes" and do not require technical expertise. This does not mean the robots need to be crude. You do not need to be technically savvy to use sophisticated technology like a TV.

We do not feel that robotics will receive the kind of investment inskill training that has been expended on ICT (technology). Therefore it is essential that training is in-built into the activities: a sort of just-in-time and on-the-job approach. This was not feasible a few years ago but with the advances in online training and quality of open source platforms like Moodle it is now possible. Where teachers do go on training courses, online systems will act as support when they return to the hubbub of the classroom.

1	Individual work
2	Group work
3	Whole class learning
4	Home schooling
5	Learning support
6	Gifted programmes
7	SEN Interventions
8	Project work
9	Play
10	Games
11	Competitions
12	Collaborations

Table 5: One aspect of a robot's practicality is its ability to be used in many different teaching scenarios.

Budgets are always tight in schools – particularly if the school does not have a "vision". However, it can help if robots integrate with equipment schools already have.

So many times we have seen robot projects, particularly events like out of school competitions, generate huge amounts of enthusiasm. When the students go back to school that energy dissipates into the mundane. With proper planning teachers can use these events to boost the student's interest in regular lessons. Pupils cannot learn from using a robot alone. It is one element in a complex process. Well planned use of robots will ensure that the student has an opportunity to link their robotic experiences with formal aspects of the curriculum.

Conclusions

The ERA Principles represent the issues surrounding educational robotics. While this paper presents a quick survey of some of the pertinent arguments and hints at some of the evidence, it is clear that a lot of research is necessary to advance the subject. For many the research strictures dictated by NCLB's[4] positivistic approach to research is nonsense. However, there was a point to it. Many whims have been perpetuated onto schools. Our disagreement with NCLB lies with the rejection of the normative and interpretative research methodologies (Cohen and Mannion 1994). Perhaps this is not surprising because many of these techniques are ideal for studying the use of robots in schools. We also believe that what passes for longitudinal research is too short term. A three year research program would have missed the effects of Papert's gear experience. It is our intention to set up the e-Robot project which will aim to gather research information from an online community. The aim of this is to start to gather and collate the research necessary to develop the ERA Principles.

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Endnotes

1 The Tasman Turtle and some toys like Furby had limited speech capabilities.

2 Micro Space is the space accessible without moving: things on your desk – the computer screen. Meso Space is on a room level and Macro is wide open spaces - something you journey through.

3 CNEFI - Centre National d'Etude et de Formation pour l'Enfance inadaptée" (CNEFI) - National Centre of Study and Training for children with special needs)

4 No Child Left Behind – President Bush's view on education which insisted that schools only used researched supported teaching methods

Naace
PO Box 6511
Nottingham
NG11 8TN
Phone: 0115 945 7235
Fax: 0870 241 4115
Email: office@naace.co.uk

Naace

The Principles of Educational Robotic Applications (ERA): A framework for understanding and developing educational robots and their activities

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Author: Dave Catlin, Valiant Technology Ltd and Mike Blamires, Dept of Education, Canterbury Christ Church University

Abstract

The original educational robots were the Logo Turtles. They derived their rationale from constructionism. How has this changed? This paper postulates ten principles that underpin the effective utilisation of robotic devices within education settings. We argue that they form a framework still sympathetic to constructionism that can guide the development, application and evaluation of educational robots. They articulate a summary of the existing knowledge as well as suggesting further avenues of research that may be shared by educationists and designers. The principles also provide an evaluative framework for Educational Robotic Applications (ERA). This paper is an overview of the ideas, which we will develop in future papers.

This paper was first published at Constructionism 2012.

Introduction

Logo combines philosophy, educational theory, artificial intelligence, cognitive science, developmental theory, neuroscience, robotic engineering and computer science. It emerged in the 1960s when most of these disciplines were still in their infancy. Post modernism, logical positivism, phenomenology and deconstructionism were disrupting age old philosophical positions.Turtles, the first breed of educational robot, emerged as part of Logo and shared its intellectual grounding particularly its constructionist approach to education. While the intervening years have seen significant developments in the underpinning sciences, little has been done to review their overall and collective impact on the way we use educational robots.

While never becoming extinct, real Turtle robots faded into the background as researchers almost exclusively worked with virtual robots. This is changing. Writing in the Scientific American, Bill Gates predicted “robots will be the next hot field” (Gates 2006). Certainly, this rise in popularity has started to appear in education. Consequently a review of the intellectual and practical basis relating to our use of educational robots becomes urgent. This paper is the result of that review. We propose that ten Educational Robotics Applications (ERA) Principles summarise the value of robots and robotic activities in any educational context.

We start by making a set of simple claims why we think these Principles are of value. We follow this with a description that references some of the supporting evidence and conceptual grounding. In order to provide some degree of ‘future proofing’ and to make the postulates independent of the type of robot, we have kept the descriptions as abstract as possible. Where contextual instances help to clarify our meaning we have used examples.

Although we call these Principles we are aware of their hypothetical nature. Over the coming years we expect research activity will gradually confirm, change, delete or find evidence that will steadily transform the postulates into verified principles. We finish the paper with a brief introduction to the e-Robot project which aims to accomplish this validation process.

Introducing the ERA Principles

The Principles are not stringently independent ideas. They form a holistic set of values that integrate in different combinations. For example Personalisation Engagement and Equity share an affinity. Personalisation also resonates with the Practical, Curriculum and Assessment, and the Pedagogical Principles.

The use of robots involves the interaction of students, teachers and technology. We have grouped the Principles under these headings more to assist their recall than an exacting effort of categorisation.

Why the ERA Principles?

The Principles present a framework that:

1. Explains:
   a. How robots help students learn
   b. The benefits of educational robots to teachers
2. Offers a check list for those who want to:
   a. Design educational robots
   b. Develop activities that use educational robots
3. Helps justify the investment by schools in robotic technology
4. Suggests underlying cognitive and developmental processes
5. Provides researchers with a set of claims to evaluate

Technology		
	1	Intelligence
	2	Interaction
	3	Embodiment
Student		
	4	Engagement
	5	Sustainable Learning
	6	Personalisation
Teacher		
	7	Pedagogy
	8	Curriculum and Assessment
	9	Equity
	10	Practical

Table 1 The ERA Principles

Intelligence

Educational Robots can have a range of intelligent behaviours that enables them to effectively participate in educational activities.

An exploration of this principle needs to explain what we mean by:

1. Intelligent behaviour
2. Effective participation

For our purpose we recognise intelligence as belonging to a spectrum of behaviours focused on intentional goals (Sternberg 1985, Stonier 1997, Freeman 2000, Sternberg et al 2008). This means the robot need only possess task specific intelligence, which targets explicit learning objectives, rather than a general ability to act in unstructured situations. In this sense educational robots need to help students acquire specific knowledge, provoke them into thinking, help to develop skills or provide them with experience of situations and knowledge structures that mirror useful thinking patterns. They provide students with opportunities to use their knowledge in problem solving and engage in knowledge transfer, generalise concepts and develop their social skills.

Currently deep-down in their microchips, educational robots are based on what Winograd and Flores termed Western rationalistic tradition (Winograd and Flores 1986). These represent powerful thinking patterns capable of supporting many useful educational applications. Logo is an example. When a version of it is internalised into a robot's core behaviour it dictates what the robot can and cannot do. As technology and our understanding of educational robotics develop we expect to find new "core" behaviours capable of supporting different learning experiences.

Effectiveness contains the notion of efficiency, which we take to mean improvement. That is, students grasp ideas faster; get a better understanding of concepts, etc. This is relative. We grasp the idea faster than if we used some other method. It depends on which student and which method and what works well for one student may not work so well with another. Effectiveness also depends on the skill and experience of the teacher. Teachers teach: the technology is a tool to help – not replace them. Not every teacher will exhibit the same aptitude for using educational robots, irrespective of their general teaching skill. Whereas an adept, well trained teacher will achieve brilliant results, a robot will not make up for teaching deficiencies.

Generally, the measure of effectiveness is statistical. In most applications, with most students and most teachers, we expect intelligent robots will enhance educational achievement. If a robot does this for just one student it is valuable. The need for the statistical verification is economic: it is hard to justify the cost of a robot system for singular teaching successes.

Interaction

Students are active learners whose multimodal interactions with educational robots take place via a variety of appropriate semiotic systems.

Working with robots is an active learning process, which is generally more effective because it is multi-modal. Interaction always involves the use of a semiotic system. Semiotics is usually defined as the science of signs(Halliday 1978). Crystal (1999) offers a more appropriate definition, which captures the heart of any educational enterprise:

Semiotics: The study of signs and their use, focussing on the mechanisms and patterns of human communication and on the nature and acquisition of knowledge.

Signs evoke meaning through culture and context. For example in the West the colour red implies danger whereas in China it means good luck. However, the "value" (meaning) of the sign changes according to its use. So for example a red cross suggests medical help. Education is about learning the signs and signifying practices of our culture.

Logo is a semiotic system. We communicate our ideas to a robot by manipulating Logo symbols (commands) according to rules (programming syntax). The robot provides feedback through its movement – a sort of mechanical "body language". We can use this "body language" schema to understand other semiotic systems. For example if we place a robot on a number line and make it move by manipulating symbols (numbers and operation signs) using the rules (addition, subtraction, multiplication and division) students can explore the semiotic systems of numbers and arithmetic. Consider the equation (+4) – (-3) = (+7). Students are normally taught to solve this problem by remembering a meaningless rule like two minuses are a plus. Using the robots students use their visual, kinaesthetic and spatial modalities to develop mental models of negative number arithmetic. Importantly, they learn through understanding (NCTM, 2000 and Bransford, et al 2000). They see that on the number line to get the robot from (-3) to (+4), the robot has to travel (+7). This emphasises the meaning of the number system, particularly the relationships between positive and negative integers and the idea of subtraction as "difference".

Up until now robots have been dumbstruck[1]. Yet, natural language is humanity's major semiotic communication system. Valiant's new Roamer is changing that. The basic robot has a very powerful speech capability. This opens up many tantalising possibilities. For example by incorporating Logo's list processing ability, we can explore embedding in the robot the language ideas explored by Golenberg and Feurzeig (1987). In Incy Wincy Spider, an Early Years comprehension activity (Valiant 2009), Roamer sings out the verses of a nursery rhyme. The students realise the robot has "got it wrong" and their task is to teach it to get the verses in the right order. They do this by pressing the keys representing the "action" of the rhyme.

The Incy Wincy activity involves sequencing, a precursor to programming, which has been the primary way we interact with educational robots.If we transform the phrase "human communication" used in Crystal's definition of semiotics to the more apposite "Human Computer Interface" (HCI) and Human Robot Interface (HRI) we open exciting new possibilities. Forerunners of this technology are already finding their way into toys (Bartneck and Okada, 2001). And the work of some researchers on sociable robots (Brazeal 2004, Dautenhahn 2007) shows the possibility of very natural interactions between student and machine. For example AnthroTronix used Roamer as a basis for their Cosmobot robot. They have developed an interactive glove through which children can operate the robot through American Sign Language. The Principle also embraces the idea of tangible computing, which involves students purposeful construction of environments that control the behaviour of the robot.

How can this assist education? Vygotsky's concept of "tools" is a fertile starting point. The influential Russian psychologist proposed that just as we used tools to impact our external environment we need tools to modify our behaviour. Semiotics was the foundation of these 'mental tools' by which Vygotsky meant language (Wertsch 1985). Clearly robots represent physical tools which Papert, borrowing ideas from Winnicot (1971), called "transitional objects" or "objects to think with" (Papert 1980). Activity Theory (Leontiev 1978, Davydov and Radzikhovskii 1985, Engeström 1987, 1999) grew out of Vygotsky's work. This theory orientates us to a world of objects and our mental interactions with them. Some work on this has been done in relationship to Activity Theory and HCI (Nardi 1996). It is our contention that extending this work into ducational robotics will provide a deeper understanding and offer new perspectives on the Interactive Principle.

Logo Turtle robots formed the prototype educational robot system. Logo offered new ways for students to develop mathematical, computational, geometric and scientific skills (Cuoco 1990, Kyngos 1992). From the initial conception of Logo (Feurzeig, et. al. 1967) to the existence of effective educational applications took many years and a great deal of research (Papert et. al.1971 to 1981). As new robotic and HCI/HRI technologies emerge they will need to undergo the same process, but gradually we will see an increase in the capability of robots to support teachers and help provide valuable learning experiences.

Embodiment

> *Students learn by intentional and meaningful interactions with educational robots situated in the same space and time.*

We propose that by interacting with physical robots students can have positive educational experiences. And in a special caveat the claim extends to positive experiences that at a minimum are qualitatively different to those with virtual robots. While 30 years of practical work in schools has shown that thousands of teachers share this intuitive view, there is little hard data to verify the claim. Such evidence is contradictory, flimsy or does not target embodiment (Mills et al 1989, Gay 1989, Syn 1990, Weaver 1991, Mitchell 1992, Betts 1997, Adolphson 2005).

Our proposition does not critique the value of educational software. Instead, we aim to affirm the potential of physical robots. Our claim is built on a theoretical framework that has two strands:

1. Work by various authors in the areas of embodied cognition, AI and robotics
2. The original body syntonic claims of Seymour Papert (1980a)

Embodiment in cognitive science claims three things:

1. Mind has evolved, not as a machine, but as an integrated element of an organism embedded in a society and in a physical temporal world.
2. Mind and body are intimately intertwined. They form an 'adaptive system' – that works together to survive and thrive as their environment changes.
3. Most embodied cognitive processes are subconscious.

The concept of embodiment is rooted in biology (Muratana and Verela 1987). Despite this some writers have applied the term to software (Franklin 1997). Others argue that bodies are essential to cognition (Pfeifer and Scheier 1999). A survey (Ziemke 2001) looks at what kind of body is required. We restrict our meaning to living entities (students/teachers) and physical robots.

Embodiment is about how we engage with the world, extract and share meaning through our interaction with it and the objects it contains (Dourish, 2003). It is self evident that this applies to robots. But does it apply to virtual robots? It could; however, engagement is not with the "real world" and interaction is not with "real artefacts". What appears on the screen is, at the very least, someone's conceptual interpretation of the real world. Here we use the term real, in the way a thirsty man would view a real glass of water compared to a virtual glass of water.

Berthelot and Salin (1994) found that lack of experience with meso and macro space restricted elementary school students' ability to cope with micro space[2]. We have seen students confused by the forward command moving a virtual turtle upwards on the computer screen. Going forward across the floor is the same for student and robot. This is the core of Papert's body syntonic idea: students can 'play turtle'. They can project themselves out of their ego centric mind, 'stand in the shoes' of the robot and directly perceive the world from its perspective.

Exploring the idea of embodiment could lead to new understandings about educational robots. Consider the proposal that maths is not an objective science, but that it arose out of the various 'image schema' derived from repetitive embodied experiences (Lakoff and Nunez 2001). These pre-linguistic entities provide a source for linguistic metaphors like 'source – path – goal', which sympathises with the attributes of mobile educational robots. Although this theory is controversial (Gold 2001, Madden 2001) many maths educators believe the work has merit (Schiralli and Sinclair 2003, Tall 2003). We believe that further research into embodiment will aide our understanding of educational robotics.

Engagement

> *Through engagement Educational Robots can foster affirmative emotional states and social relationships that promote the creation of positive learning attitudes and environments, which improves the quality and depth of a student's learning experience.*

In 1992 Classic Roamer debuted in America when a Chicago teacher tried it with a second grade student who normally never engaged in school work. He decided to make Roamer turn "all the way around". So he programmed it to turn 8, which made it turn 8 degrees. He was shocked at this small movement. He was also captivated and went on to experiment with 1, 2 and 3 digit numbers. He subconsciously gained experience of equivalency and after 45 minutes discovered 360 was the "magic number". Thirty years of ad hoc observations of students using robots has shown this is not an uncommon example of the Engagement Principle. Educational robots and their activities have a propensity for capturing students' attention.

Engagement is a far richer and apposite concept than the ubiquitous, "makes learning fun". For example work done at CNEFI[3] in Paris used Roamer to change the attitude of an adolescent who had been 'brain damaged' in an auto accident (Sarralié 2002). The student had lost the ability to do simple arithmetic. He was very aggressive towards the teachers trying to restore his competency. Eventually, they gave him a Roamer activity, which necessitated him performing basic calculations. The robot task captured his attention, helped him realise his incapacitation and made him amenable to working with the teachers. It is fair to say that fun was not a part of this experience, but engagement was very much in evidence.

While many children seem to possess a natural fascination for robots, this is simply an advantageous starting point. What Bruner (1966) called the "will to learn" is a factor in sustaining engagement. Teachers can motivate students, help develop interests and trigger their curiosity (Hidi and Renninger 2006, Keller 2000 and Arnone and Small 2010). We claim that educational robotics provide skilful teachers with many ways of achieving these conditions.

Engagement involves the relationship a student forms with the robot. The classic ideas on transitional objects (Winnicot 1971, Leslie 1987) all relate to the cognitive processes of young children. Recent work has shown that:

1. Our relationship with physical objects also involves emotional and social experiences
2. The experience is not restricted to young children

3. Robots fall into a new category between inanimate object and living thing

Sherry Turkle cites evidence of children talking about their experience with Sony's robot dog Aibo as if it was one of their toys, yet they interact with it as though it were a real puppy (Turkle et al 2006). She classifies robots as "relational artefacts" and splits them into Rorschach and evocative types. Like the Rorschach test, aka ink blot tests, Turkle shows that student responses to the robots mirror underlying issues in their life and reveal their strategies for dealing with their concerns. She describes the evocative aspect as philosophical: something that makes people think (Turkle 2007). Papert's famous anecdote about his childhood experience with gears is an example of an evocative object at work (Papert 1980b). Not in the cognitive sense that the young Papert acquired a mental model that years later would help him understand equations; it was the wider philosophical effect that inspired his extraordinary career.

Engagement is about capturing a student's attention. In our Chicago anecdote the student became absorbed in the turning problem. We mentioned his subconscious experience of equivalence, something the curriculum did not require him to learn for another two years. This is an example of the "natural" learning of mathematics Papert so earnestly advocates. It is also an example of an intuition, which is an intrinsic element of the engagement principle.

No one taught the Chicago student equivalence. Yet he happily "unthinkingly" used these concepts. This is the crux of a definition of intuition: immediate apprehension by the mind without reasoning (Allen 1990). This definition gives intuition a disreputable reputation. Some psychological studies make no distinction between intuition and guessing (Myers 2002). Comparative philosopher Hope Fitz combines Eastern and Western traditions to offer an alternative view. She sees intuition as an integral process of the mind, which is grounded in sub conscious memories and experiences. While it is linked to reason, the act of insight does not involve reason (Fitz 2001).

Insights are not accidents. Our subconscious accounts for most of our mental activity (Bragg et al, 2008). It is through attention that we build and access our intuitive knowledge. Poincare (1905) described the process in terms of creative mathematics. He deliberately immersed himself in anything relating to a problem. He relied on his intuitive skills to channel insights into his conscious mind. Discussing this idea Papert (1978 and 1980) suggests this process is not restricted to a mathematical elite. We go further and speculate that is not restricted to mathematics. It empathises with the ideas of expert knowledge discussed by Bransford et al (2000), the psychological studies on implicit learning (Goschke 1997) and perhaps the more sensational and speculative assertions made by advocates of accelerated learning (Jensen 1995). Our claim is that through engagement in robot activities students develop their intuitive understandings.

Sustainable Learning

> *Educational Robots can enhance learning in the longer term through the development of meta-cognition, life skills and learner self-knowledge.*

School is not just a place for the acquisition of knowledge and skills.It plays an important part in the personal development of students. The English National Curriculum (2010) specifically states the need to help students acquire communication skills, the ability to work with other people, to present ideas and to be confident.

The way we use educational robots automatically engages students in situations where the opportunity exists to develop these skills. For example, the Robotic Performing Arts Project (Catlin 2010) illustrates an opportunity for students to develop their cognitive, social, personal and emotional skills in an authentic learning situation.

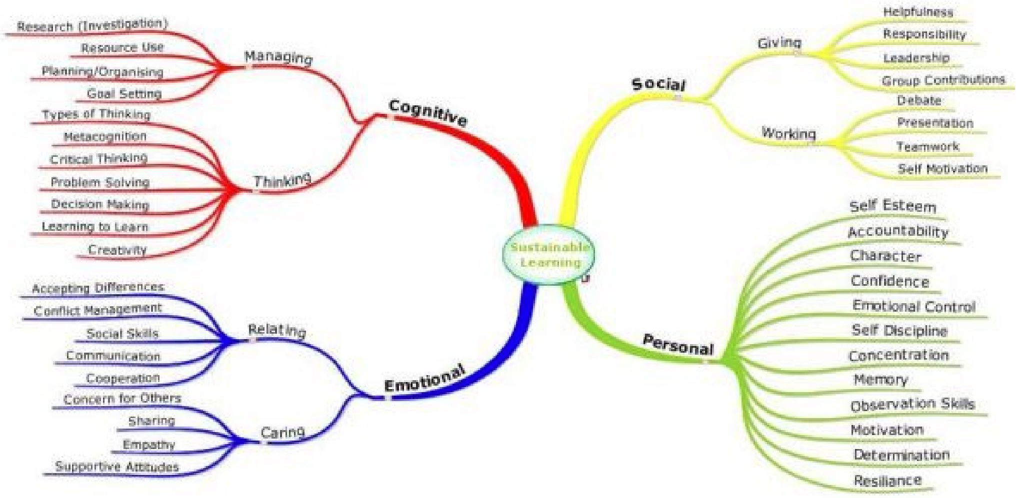

Fig.1 Mind map of typical sustainbale learning criteria relevent to educational robots - adapted from Iowa 4H Program (2010)

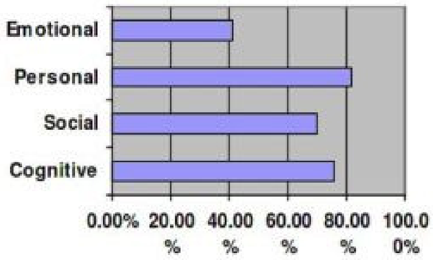

Fig. 2 Involvement of sustainable criteria in a sample of 30 Classic Roamer activities

Pedagogy

The science of learning underpins a wide range of methods available for using with appropriately designed educational robots to create effective learning scenarios.

A central question in our project is what pedagogy justifies our belief that robots have a role in education? In the development of Logo, Papert synthesised ideas of Artificial Intelligence and the constructivist approach to education. That is, we understand the world by constructing mental models from our experiences. We assimilate or accommodate new experiences into our existing concepts or we accommodate them by modifying our existing ideas. Logo and Turtle robots provided experiences in a way that brought students into direct contact with some powerful and important ideas, particularly in mathematics.

Is this the only way we can or should view the educational process? We have already cited the potential insight we might gain from a review of Vygotsky and Activity Theory. While there are differences in these and other ideas, there are also many similarities. What clearly emerges is not some definitive truth about the way we learn but more of an orientation. This is starting to become known as the science of learning. Papert talks about the spirit of Logo and that life is not about "knowing the right answer", but getting things to work. We need to adopt this pragmatic approach and let the science of learning inform and sometimes inspire our development of educational robots and their activities. Ultimately our judge of success is not whether we have a consistent developmental framework, but whether we can connect learning science and the technology with successful classroom practice.

Another aspect of pedagogy is a set of strategies that help us to create and analyse educational robotic activity. An analysis of work with Valiant's Turtle and Classic Roamer has identified 28 different methods for using educational robots (Catlin 2010a).

Catalyst	Demonstration	Games	Presentations
Challenges	Design	Group Tasks	Problem solving
Conceptualisation	Engagement	Inductive thinking	Projects
Cooperation	Experimentation	Links	Provocateur
Creative	Experience	Modelling	Puzzles
Curriculum	Exploration	Memorisation	Relational Artefact
Deduction	Focussed Task	Pacifier	Transfer

Table 2: Pedagogical tools for educational robots

Most activities employ several strategies. For example a Roamer Activity called Robot Rally Race (Valiant 2009) starts with a challenge to find the fastest route, involves experimentation while the students try to find out how fast the robot travels over different terrains, and uses this statistical data in a focussed task to calculate the fastest way from start to finish. Table 2 is not a closed list. We expect to find other tools as the power of robots grows – for example Valiant's work on robotics and storytelling is likely to yield some new approaches.

Curriculum and Assessment

Educational Robots can facilitate teaching, learning and assessment in traditional curriculum areas by supporting good teaching practice.

Most formal education takes place in schools. The "local" community decides what the students should learn and typically demand "proof" of achievement. While the curriculum and assessment methods vary between different communities there are many similarities. If educational robots are to make a significant impact they must be able to address the two items that concern teachers the most:

1. Teaching the curriculum
2. Assessment and testing

The Curriculum and Assessment Principle includes the phrase "good teaching practice". How does this affect how a teacher teaches? Does it alter their traditional role as a dispenser of knowledge and what do educational robots have to contribute to this situation? These questions lead us to consider and develop another of Vygotsky's innovative ideas: the Zone of Proximal Development (ZPD) defined as what the learner can do alone and what they can do with assistance (Vygotsky 1978). We predict the ZPD concept will develop to embrace technology in general and intelligent robots in particular. The characteristic of this model is that the teaching and learning experience will be more flexible than the Logo model of student teaching the robot or the teacher dispensing knowledge. It will be a dynamic model allowing any of the participants to be a teacher or a student.

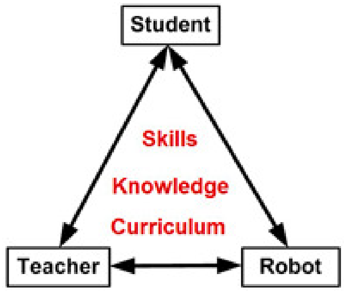

Fig. 3 The dynamic relationship between teacher, student and robot shows that the learning and teaching interactions are bi-directional.

This proposition assumes that educational robots can be applied broadly across the curriculum. Turtle robots were tightly linked with mathematics and Roamer, Lego and other robots have made clear links with STEM (Science, Technology, Engineering and Maths) subjects in general. However, it is clear that robots are not restricted to these domains. In 1992 Harrow schools in the UK ran a district wide robotic art project. Students had to make Roamer into animated sculptures of fantastic insects. Perhaps more surprisingly is the use of robots in the study of moral and social values (Bers and Urrea 2000). The Robotic Performing Arts Project™ (Catlin 2010, Valiant 2012) illustrate the type of project that can connect with any subject at any level. Currently Valiant is developing a library of between 200 and 300 free and commercially available Roamer K-12 activities in all subjects. Some of these, like the fantastic insects, are major projects; others like the Incy Wincy activity are completed in a lesson. The potential for activities far exceeds what a school could use in a balanced approach to teaching.

Formative assessment is a crucial part of effective learning environments particularly when it forms an unobtrusive element of an activity (Bransford et al 2000b, Black and Wiliam (2006). Feedback is embedded in robotic goal orientated action. Robots inherited this trait from Logo. Students propose an interim solution and then decide if it is satisfactory or whether they need to and/or how to make improvements. This makes formative assessment a natural part of this dynamic interactive process. A recent study of AfL Methods emphasise this affinity (Catlin 2012). In principle AfL codifies good teaching practice. Its what "good teachers" do instinctively. Educational robots provide the opportunity for AfL methodologies to flourish. At the same time, AfL gives teachers the tools to clarify to both students and themselves as well as other interested parties, what learning actually takes place.

Personalisation

> *Educational robots personalise the learning experience to suit the individual needs of students across a range of subjects.*

Ellwood Cubberley, a contemporary of John Dewey and Dean of Education at Stanford urged we view schools as factories in which the children were raw products to be shaped and fashioned to meet the demands of twentieth-century civilisation (Cubberley 1916). His rhetoric got worse: "the business of schools was to build its pupils according to specifications laid down" and this required "continuous measurement of production to see that it is according to specification, the elimination of waste…" Contrast this with the educational aims stated in the UN Charter for the child. It charges nations with developing the child's personality, talents and mental and physical abilities to their fullest potential (United Nations 2001). Robots support the UN child centred vision.

1. Self Expression	Educational robots are tools that allow students to explore ideas and express their understanding in personal creative ways.
2. Flexible Use	Robots are adaptable to the needs of the teaching situation (see Practical Principle) and the needs of the individual student.
3. Differentiation	Robot activities find a natural level of difficulty. They support the constructionist principles and recognise that students build their own understandings in their own ways. They support struggling learners and challenge gifted students.
4. Learning Styles	Robots engage in multiple modal experiences: • Kinaesthetic • Visual • Spatial

	• Auditory • Tactile

Table 3: Ways educationla robots support the Personalisation Principle

These ideas are familiar to constructionists and have drawn their fair share of criticism. Let's deal with some the most common. Students setting goals does not lead to lower standards or the study of irrelevant topics. While students make the choices, good constructionist teachers "rig the deck". They motivate and encourage students. In fact once ignited students' imagination usually outstrips the activity objectives and pushes beyond expectations. This is not about achieving par; it is about the excellence beyond that. In a Classic Roamer task the students had to make a robot dog. Suddenly it needed "a wagging tail". How to do this was far beyond the teacher's skill and knowledge level, but not beyond her teaching skills. The students found a solution - a rubber tube that wagged furiously as Roamer wiggled its bum!

Equity

> *Educational robots support principles of equity of age, gender, ability, race, ethnicity, culture, social class, life style and political status.*

Before we can understand how robots help with equity we need to understand some of the issues involved. Equity means giving students an equal chance for a good education. Or does it mean giving them a fair chance? It turns out that equity is very hard to define, and how you define it affects how you deal with it (Ainscow et al 2006). Equal chance for example could mean making sure that each school has the same level of funding, resources, quality of teaching, etc. A fair chance would perhaps look at compensating for disadvantages.

Society can only determine a curriculum culturally entailed in favour of the mainstream of the community. For anyone who belongs to a cultural group that is not part of the mainstream, and whose sub group would produce a different curriculum, they have to make more effort to achieve academic success. There are those who argue such a curriculum represents a lingua franca for a society (Hirsch 1988). If minority students want to fully participate in main stream culture, they need to overcome cultural barriers Catlin and Robertson 2012). Though in practice mainstream-culture eventually changes because of input from minority participants (Lave and Wenger 1991).

Inequity arises from things like unequal funding (Kozol 2005), lack of qualified teachers, high quality materials, equipment and laboratories (Darling-Hammond 2005), overcrowded classrooms (Ferguson 1991) and poor quality teachers (Dreeben 1987).

Research and classroom practice show that minority pupils perform better when teaching is filtered through their own cultural experiences and frames of reference (Gay 2000). We claim:

1. Robots are tools that allow students to express themselves from their cultural perspective
2. The creative nature of robot activities makes them amenable to cultural modification

Because most societies have a tradition of artificial life (Simons 1986), robots have the potential to be culturally acceptable. Most cultures have developed the art of puppets and many technically advanced cultures created automaton of various types. Robots are another manifestation of this tendency. The mechanisms behind robots as transitional and relational objects make robots potentially tools through which children can express themselves. In a study of Huli children in Papua New Guinea, anthropologist Laurence Goldman (1998) concluded:

> *In their "as-if vignettes", pretenders are constructing, experiencing and implementing their models of the world, models that are always culturally encumbered and inflected.*

This is the same mechanism Valiant has observed with students of indigenous cultures like the Maori, Australian Aborigines and some Native American peoples using Roamer. Students project their imagination into artefacts. With robots these imaginations come to life and enable students to express themselves in a way that reflects their heritage and situatedness in the modern world. They can connect their heritage with technology in their terms.

A robot teacher recently appeared in a Japanese school (Demetriou 2009). Saya, a humanoid invention of Professor Hiroshi Kobayashi, took the class register. Work at Carnegie Mellon with the robot Asimo is exploring and perfecting a robot that can read to students (Mutlu et. al. 2006). At a cost of $1M Asimo is a long way from classrooms, but it does imply that technology can "make up" for the poor quality of teachers. This argument is already well advanced with cognitive tutors (Woolf et al 2001, Koedinger, 2001). We do not subscribe to this view. Some very early research showed that technology together with teachers working with students got better results than students learning with teachers or technology alone (Dalton and Hannafin, 1988). This is very old research, but we suspect it still has validity. We believe that as robots become more adaptive and capable of providing sustained, uninterrupted interactions with the students, the teachers will be able to concentrate on working in ways that have greater impact on a student's learning. This demands higher teaching skills not lower. It helps make teachers more effective. This is the same mechanism Valiant has observed with students of indigenous cultures like the Maori, Australian Aborigines and some Native American peoples using Roamer. (Catlin, Smith and Morrison 2012).

Practical

Educational robots must meet the practical issues involved in organising and delivering education in both formal and informal learning situations.

We often see approaches to education produce spectacular results in research or other controlled circumstances, followed by limited success or even outright roll-out failure. While we believe robots and ERA compliant activities will make a positive educational contribution, careful implementation and management is necessary if a school is to take full advantage of what robots offer. The Practical Principle considers this on two levels:

1. Systemic Implementation
2. Classroom Practicality

The Classic Roamer had a 95% penetration of UK Primary schools. This does not mean schools are getting the most out of them or using them regularly. Taking care of systemic changes issues will help people get the most out of robots. The following comments apply at the level of classroom, school, school district or even whole country.

Vision	+	**Buy In**	+	**Skills**	+	**Resources**	+	**Plan**	=	**Change**
Vision	+	**Buy In**	+	**Skills**	+	**Resources**	+	**Plan**	=	**Confusion**
Vision	+		+	**Skills**	+	**Resources**	+	**Plan**	=	**Resistance**
Vision	+	**Buy In**	+		+	**Resources**	+	**Plan**	=	**Fear**
Vision	+	**Buy In**	+	**Skills**	+		+	**Plan**	=	**Frustration**
Vision	+	**Buy In**	+	**Skills**	+	**Resources**	+		=	**Vacillation**

Table 4 Elements of change adapted from Thousand and Villa (1995)

Table 4: Summarises the elements required to make systemic change and what happens when an element is missing. Schools or districts wishing to integrate robots into delivering the curriculum need to address each of these issues. We propose the ERA Principles will help people develop an understanding and vision of how robots can be used.

At the moment most people think school robotics means students building robots. This type of activity is in fact a subset of the more general use of robots. Most teachers would not deem it practical to have to build the robot to engage in the Chicago Activity. For teachers to buy-in to using robots they must perceive their value outweighs the effort in dealing with the logistics and the preparation process. We are not trying to imply that there should be no applications that involve engaging in technical activity, but there needs to be activities that can be "ready to go in minutes" and do not require technical expertise. This does not mean the robots need to be crude. You do not need to be technically savvy to use sophisticated technology like a TV.

We do not feel that robotics will receive the kind of investment inskill training that has been expended on ICT (technology). Therefore it is essential that training is in-built into the activities: a sort of just-in-time and on-the-job approach. This was not feasible a few years ago but with the advances in online training and quality of open source platforms like Moodle it is now possible. Where teachers do go on training courses, online systems will act as support when they return to the hubbub of the classroom.

1	Individual work
2	Group work
3	Whole class learning
4	Home schooling
5	Learning support
6	Gifted programmes
7	SEN Interventions
8	Project work
9	Play
10	Games
11	Competitions
12	Collaborations

Table 5: One aspect of a robot's practicality is its ability to be used in many different teaching scenarios.

Budgets are always tight in schools – particularly if the school does not have a "vision". However, it can help if robots integrate with equipment schools already have.

So many times we have seen robot projects, particularly events like out of school competitions, generate huge amounts of enthusiasm. When the students go back to school that energy dissipates into the mundane. With proper planning teachers can use these events to boost the student's interest in regular lessons. Pupils cannot learn from using a robot alone. It is one element in a complex process. Well planned use of robots will ensure that the student has an opportunity to link their robotic experiences with formal aspects of the curriculum.

Conclusions

The ERA Principles represent the issues surrounding educational robotics. While this paper presents a quick survey of some of the pertinent arguments and hints at some of the evidence, it is clear that a lot of research is necessary to advance the subject. For many the research strictures dictated by NCLB's[4] positivistic approach to research is nonsense. However, there was a point to it. Many whims have been perpetuated onto schools. Our disagreement with NCLB lies with the rejection of the normative and interpretative research methodologies (Cohen and Mannion 1994). Perhaps this is not surprising because many of these techniques are ideal for studying the use of robots in schools. We also believe that what passes for longitudinal research is too short term. A three year research program would have missed the effects of Papert's gear experience. It is our intention to set up the e-Robot project which will aim to gather research information from an online community. The aim of this is to start to gather and collate the research necessary to develop the ERA Principles.

Dave Catlin can be contacted at dave@valiant-technology.com and Mike Blamires at mike.blamires@canterbury.ac.uk

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Endnotes

1 The Tasman Turtle and some toys like Furby had limited speech capabilities.

2 Micro Space is the space accessible without moving: things on your desk – the computer screen. Meso Space is on a room level and Macro is wide open spaces - something you journey through.

3 CNEFI - Centre National d'Etude et de Formation pour l'Enfance inadaptée" (CNEFI) - National Centre of Study and Training for children with special needs)

4 No Child Left Behind – President Bush's view on education which insisted that schools only used researched supported teaching methods

Naace
PO Box 6511
Nottingham
NG11 8TN
Phone: 0115 945 7235
Fax: 0870 241 4115
Email: office@naace.co.uk

Naace
Insider Research: investigating learning platform development in the classroom

Author: Jim Fanning, Tideway School

When the DfES Harnessing Technology e-strategy and Learning Platform guides were published in 2005 it's probably not surprising, given the perceived 'newness' of the technology, that there was little reference to research or practice. The 2008-09 academic year was the first one in which a local authority approved learning platform was introduced to Tideway School. This article describes a doctoral research study carried out in the school that sought to explore the following questions in relation to the classroom use of that technology:

Introduction

When the DfES Harnessing Technology e-strategy and Learning Platform guides were published in 2005 it's probably not surprising, given the perceived 'newness' of the technology, that there was little reference to research or practice. The 2008-09 academic year was the first one in which a local authority approved learning platform was introduced to Tideway School. This article describes a doctoral research study carried out in the school that sought to explore the following questions in relation to the classroom use of that technology:

1. Does the use of a learning platform in the secondary school classroom support approaches to personalised learning?
2. Does teacher understanding of personalisation influence the way the technology is used?
3. What skills do teachers require to use the platform to support their teaching?
4. Is there evidence that anytime-anywhere learning begins to take place and does this blur the boundaries between learning in and out of school?

Background

In 2005 the DfES Harnessing Technology e-strategy and platform advice booklets were published, introducing teachers to learning platforms and linking them to personalisation. Harnessing Technology emphasised the changing nature of teacher-student relationships, learning beyond the classroom and peer collaboration through networking. The Learning Platform booklets mapped out various reasons for adopting a platform including support for student achievement, reducing teacher workload and improving communication. In 2006 BECTA published its functional requirements for the technology. Mandatory features included online assessment, customisation of the web interface to student preferences, access to the platform outside school, a student portfolio and a discussion forum and messaging facility.

Context

Tideway was a secondary school of 650 students aged 11-16. It became a Specialist Technology College in September 2003 and was re-designated in 2007 with a school mission statement:

> *"To provide success and challenge for all through technologically enriched learning that prepares young people for participative and enterprising citizenship in the twenty- first century."*

Fifty teachers were employed in the school. A few staff had been involved in New Opportunities Fund (NOF) training through the Open University and had used the First Class virtual learning environment (VLE), although when questioned they had little recollection of that technology apart from a 'fuzzy' memory of access issues. Two members of staff had recently completed a Masters qualification and used a VLE on those courses. Seven members of staff had qualified as teachers within the past three years and had experience of using a VLE at university for accessing course details, files and shared diaries. In interviews the majority said that, although they had used the VLE to support their studies, their course syllabus had made little reference to the use of learning platforms in the classroom or e-learning pedagogy.

Every classroom in the school was equipped with a desktop computer and interactive whiteboard. There were three dedicated computer suites in the school, along with a smaller number of mini-suites, equipped with up to 6 PCs for small group work. There was also a learning resource centre for larger group work, equipped with networked PCs. Every member of staff had their own school laptop. The student: PC ratio was 3:1. A questionnaire conducted during the research period asked teachers to rate their technical skills in the use of ICTs. The vast majority - 93% - described themselves as confident users of classroom technologies, who knew where to seek help if they required it.

Methods

At the start of the process a formal research agreement, based on British Educational Research Association (BERA) guidelines, was drawn up. Presentations were made to staff and students and data was collected in a range of ways, including questionnaires, lesson observations, and interviews, field notes from informal discussions and observations, as well as data from the learning platform.

Findings

1. Does the use of the platform support approaches to personalised learning?

Where the platform supported classroom teaching the following findings emerged:

The assessment tool on the platform was used mainly for summative purposes. Such use was found more commonly at Key Stage 4 than Key Stage 3. At Key Stage 4 this tended to emulate end of Key Stage/GCSE style assessment tests. Past exam papers were also uploaded to the system and available for students to download, complete and upload back to the teacher for marking.

Where there was evidence of formative assessment the application most used was the forum. Forum use was most commonly found in project or cross-curricular work that extended into a series of lessons, over a number of weeks. Those departments that rated their implementation of Assessment for Learning (AfL) highly were more likely to be the ones where online formative assessment opportunities were present.

Where resources had been uploaded to the system the vast majority were not differentiated. History was one of the few departments to explore the provision of differentiated resources and those series of lessons were taught by one of the technology teachers. Where differentiated resources had been created for a flexible learning project teachers had to rely upon network support staff to design them. Only one department, ICT, had experimented with differentiation by task. Where the platform had been used in lesson time there was evidence that this had an impact on one-to-one and one-to-small group support as it allowed teacher time to be more effectively targeted.

Where collaboration took place it was in the form of students working in pairs to support each other’s learning as opposed to completing a task that had been broken down into individual responsibilities. It was only in the year after the data collection had taken place that a number of major cross-curricular collaborative projects began to be delivered.

Where staff were using the platform most tended to focus on the application of one tool, for example the forum or the wiki. There were few examples of subject areas using platform applications in an integrated way.

2. Does teacher understanding of personalisation influence the way the technology is used?

Where there was a departmental culture, a ‘way of doing things’ or a belief in aspects of the personalised learning agenda this was reflected in the ways in which the technology was being used.

Formative assessment opportunities were most obvious in Design & Technology lessons. That subject area had self-assessed its implementation of AfL as ‘very good’. Collaborative working was described by D&T teachers as a key component of their face-to-face teaching. The bulk of the Year 7 lessons in the school were taught by a small number of teachers. They described collaborative planning, teaching and learning as essential features of the teacher and student experience and this was also reflected in the online lessons taught by those teachers. The Head of Science believed that summative assessment and the tracking of student progress were key elements of personalised learning and this was reflected in the summative assessment opportunities on the platform in this subject area.

The use of the platform reflected very much the culture of a department and the beliefs of individual teachers. The ICT subject area was the only one to experiment widely with the full range of tools and web designs to support learning, suggesting that where skill’s and pedagogic understanding complemented each other use of the technology developed beyond replicating existing practice.

3. What skills do teachers and students require?

In a school survey 35 % of teachers said that a lack of technical skills was a barrier to platform adoption. Whilst the majority was able to describe the different components of the learning platform, data from the system showed that only a small range of applications or tools were being used. The training package provided by the platform provider was based on the skills necessary to set up a web page, populate it with content and establish tools such as a wiki and forum. The local authority supported this package of training, although it was assumed that each school would have its own platform administrator who would be taught a higher level of technical skills relating to aspects such as access rights. Throughout the research period only a minority of staff showed competence in these technical skills, whilst a majority relied upon support from a network assistant to programme the platform.

Where an application was being used by a member of staff, irrespective of whether they had set this up themselves or relied upon technician support, in most instances they were not aware of any model of pedagogic practice upon which to base their teaching with the application. For example, established practice in the use of forums describes the emergence of threaded conversations and the skills required to weave and summarise.

Whilst the platform provider and local authority drew a distinction between the technical skills of teaching and non-teaching staff, the reality is that working practices are not so easily defined. In the research school the network manager stated that:

> *"Teachers need to take some responsibility for being able to allocate passwords that students have forgotten, create files in a format that can be accessed by those who do not have the applications we use in school and set up group and individual permissions to use particular features within the platform. Those areas are the ones that students most commonly complain about and the ones that disrupt lessons most as we try to provide immediate support where the platform is being used."*

The staff questionnaire conducted for this research suggested that the majority of teachers felt confident in the use of school technologies, without seeking technical support. The technologies they were using however required fairly basic computing skills, whereas the intricacies of the platform demanded a more detailed technical knowledge of specific applications and their programming. Some teaching staff resisted training in these areas, stating that this was a responsibility of the network support team.

There is an assumption amongst many professionals that since the current generation of students have been born and brought up with Internet technologies, they somehow understand how to use those technologies in a way that many teachers do not. In Tideway all students had received training in use of the technical aspects of the platform in ICT lesson time. This included logging on, uploading and downloading files, taking surveys and contributing to forums, wikis and blogs. A school learning platform code of practice was used to instruct them in appropriate use of the communication tools and school sanctions that would be imposed for those failing to follow guidelines. What was not explained to students were the ways in which use of the platform might change classroom teaching and learning. The students who took part in forum work appeared to lack not the technical the skills but rather the learning skills required of that environment.

4. Is there evidence that flexible learning begins to take place and does this begin to blur the boundaries between learning in and out of school?

If flexible learning means access to learning resources that had been used in the classroom, to support learning, at a time and place outside the normal school day, then there was evidence that this was already happening, through the use of email or within department specific online services. For example the Mathematics Department used a service called MyMaths to set homework.

Through the learning platform:

- In GCSE History there was evidence that students accessed classroom materials out of school hours, although these students tended to be from the group of high achievers. Support was not synchronous and tended to be limited to making available what had been taught in lesson time;
- ICT lessons and access to them reflected much the same practice as in History;
- A D&T forum used to support Year 9 lessons was accessed by the member of staff on an evening and week-end basis;
- Forums to support GCSE revision in English had been set up by the Head of Subject but were used by a small minority of students.

Implications

Throughout the research period there was no evidence that students were willing to forgo the teacher as the 'significant other' in their learning experience. Student interviews consistently highlighted a preference for the immediacy of feedback and detailed discussions that were a feature of the physical classroom. Working practices in the pilot schemes for local authority virtual schools, funded by UK central government, managed by local authorities, focusing entirely on online teaching and targeted at secondary students with special needs, suggest the importance of a physical presence in the teaching of that age range. As with mainstream education however there is as yet little research into the model of teaching and learning provided by virtual schools. These observations and the findings of this thesis signify a need for a model or theory of use that will successfully blend both the physical and the remote online learning experience.

The inclusion of a student and a parent voice is noticeably absent from most research into VLE use. During the data collection for this study a number of statements were recorded from interviews with Key Stage 4 students:

- We want to use Facebook, Flickr, MSN and YouTube. You ban these in school and want us to use your learning platform. It is about teacher control and convenience isn't it?
- Why would I want to use a school platform when social networking sites are more exciting?
- Parent access is about me being checked up on and nothing to do with me being responsible for what I do.
- It is not my own personal learning space if I can't control who is able to view it.

In terms of these student statements there is little indication that the 'net generation' feels in any way empowered by the implementation of a school VLE. Indeed a core theme or concern is the way in which the technology is perceived as a monitoring and controlling tool. This is a particular concern given, as stated earlier in this article, those aspects of platform practice that can blur the lines between school and home, between the public and the private.

Future Development

The overall findings from this school based research suggested that where skills, pedagogy and structures complement each other, then use of the platform leads to a change in teacher or classroom practice. Where one element is absent then the technology tends to replicate or support existing practices. Based on this the following development framework has been adopted in Tideway School to support the introduction of technologies associated with online learning.

The skills that are identified are by no means comprehensive. They reflect current use of the system by teachers as evidenced by this research and also research findings from a wider group of teachers canvassed by a BECTA sponsored research project. For the purposes of this model I would argue that teachers, as the main directors of learning, should develop a range of technical skills in the applications they use within the learning platform. It is only through the acquisition of these skills that they can adapt their own model of pedagogy to online learning opportunities.

It has been argued that e-learning theories tend to be an adaptation of existing theories that relate to face-to-face teaching and learning. Some platform applications however require a specific understanding of the pedagogical approach that makes best use of their features. Salmon's model of e-learning does represent a way of working with online communities that has been widely used and adapted. Within the proposed framework a teacher understanding of such approaches has been highlighted as essential to effective use of the platform.

Lastly, school structures have been identified as a key element within this model. By structures I mean classroom practices such as the three-part lesson and features such as the timing of lessons, the school timetable and the pattern of teacher work practices.

This proposed model is a work in progress. It requires further investigation in both the research school and further afield, but it does provide a framework within which to both implement and evaluate platform use. While the framework focuses on the teacher, it could also be adapted to investigate and evaluate both student and parent use of the technology.

In terms of future development, what is unclear is the impact of little central government direction in respect of technology in education. There were clear targets in the DfES 2005 e-Strategy for personalised learning spaces for every student. Since the election of a coalition government in 2010 that direction has become unclear. At the time of writing the Department for Education (DfE) had yet to issue advice regarding the use of learning platforms.

The coalition government also undertook a series of actions in relation to national research. BECTA, the organisation responsible for regulating, supporting and promoting learning platform adoption, was abolished. BECTA was the single biggest sponsor of large scale, longitudinal research into learning platforms in the UK. In a landscape dominated mainly by case studies and those promoted by individual platform suppliers, where large-scale research such as that supported by the Wolverhampton LA is the exception, it is unclear who will fill the gap. It has been suggested that innovations take 10 years to get from idea to mass adoption. Where central government support or funding is not available or has been reduced such longer term research may not be possible, especially in an education system that is dominated by the political cycle of five-year elections. The coalition government also announced new criteria for the awarding of research grants, including proof that such research has a social or economic impact.

The future development of learning technologies and virtual learning environments in England and Wales may therefore rely more upon local as opposed to national initiatives.

Note: Jim Fanning is Assistant Headteacher at Tideway School in Newhaven, East Sussex. This research was carried out as part of an Educational Doctorate (EdD) at Sussex University. The full text of the thesis upon which this article is based can be found at www.learningplatforms.info

Jim Fanning can be contacted at jf@tidewayschool.org

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Email: office@naace.co.uk

Naace
Claiming e-readers and e-books for learners

Author: Sandie Gay and Tina Richardson, National Institute for Adult Continuing Educatio (NIACE)

Sales of e-readers soared in the UK over the 2011 Christmas period with over 1m units being bought as gifts and now, nearly a third of Britons own an e-reader. But how can this technology be harnessed in schools?

Sales of e-readers soared in the UK over the 2011 Christmas period with over 1m units being bought as gifts (YouGov survey[1])and now, nearly a third of Britons own an e-reader(Wiggin's Digital Entertainment Survey[2]). Sales of e-books outstripped those of hardcopies with publishers such as HarperCollins reporting downloads of 100,000 e-books on Christmas Day (2011) alone[3].

As always, with new technologies, particularly those within the financial reach of learners and learning providers and showing much promise, pre to post compulsory teachers have been dipping their toes in to find out how best to harness this technology to help their learners - schools with a view to seeding a love of reading in reluctant pupils, further education facilitating the development of literacy skills in adults and higher education[4] keen to ensure sufficient copies of essential texts can be made available as well as lessen the burden of having to carry heavy texts for all students through offering e-book versions. Lifelong learning is being supported by community libraries too, offering lenders pre-loaded e-readers on short loan[5].

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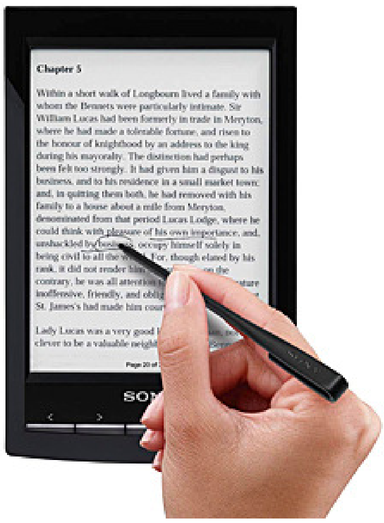
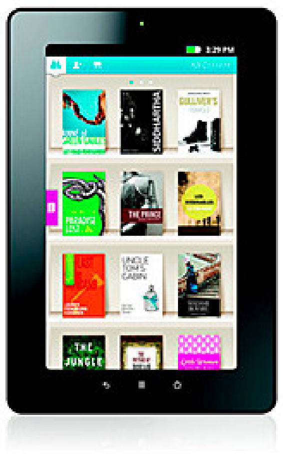
However, it's not as easy as you might expect with the complexities of e-book formats already befuddling even the most techno savvy teachers, not necessarily because they don't understand the underpinning design technology, although this can be like wading through treacle sometimes, but because they don't understand why it should be the way it is. So, it seemed timely for NIACE[6] to commission a guide for adult learning providers considering investment in this technology. The guide is focussed on adult learning and literacy development; however, many of the benefits and issues can be transposed across all of the sectors. Some learning providers have already started to investigate the use of e-readers and e-books and have highlighted valuable benefits but also a number of issues of use in the learning environment. From our research, it has been difficult to write a sentence without having to qualify it with 'using this e-reader or that one' with e-books 'in this format' or 'in that format with or without ...' etc, etc.



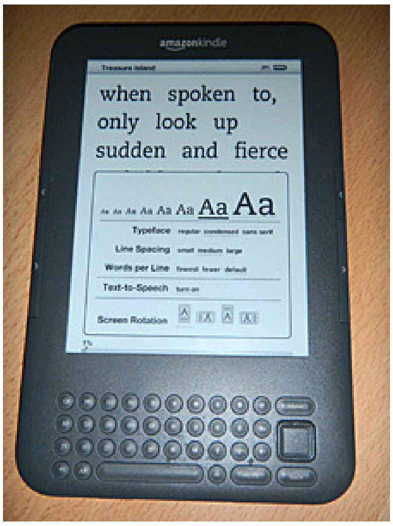
There are, basically, four types of devices on which e-books can be read. Firstly, using a dedicated e-reader and who hasn't heard of the best selling Amazon's Kindle? There are, of course, others including the Sony Reader, first launched in 2006, the Kobo e-readers available in the UK from 2011, a year after Amazon launched its third generation Kindle Keyboard in the UK in July 2010 (two years after release in the US), and many, many others. E-books can also be read on tablets, the most popular being Apple's iPad (72% of 640,000 tablets gifted according to the YouGov survey) as well as on a computer or laptop using an e-book app or browser depending on the file format of the e-book. Dedicated e-readers are just that – e-readers with none of the distractions of multifunctional tablets or computers e.g. emails, surfing, playing games - so a big bonus to ensure learners are focussing on the task at hand. However, if you are up for the higher investment, multifunctional tablets provide other functionalities e.g. emails, surfing, gaming etc which can be creatively used to support learning too. The fourth option is the newly emerging hybrid e-readers with the e-ink displays but also provide a better web-browsing experience for emails and surfing, colour and play multimedia such as audio (Kindle Touch) and video (Kobo Vox), thus giving you an in-between choice for cost and functionality. So, there's one balance that needs to be worked out – which to go for? If you plump for the dedicated e-reader because of its many benefits including portability, cost, glare-free reading, capacity and long battery life, then which one?



Which is where the complexities come piling in and not only in the functions available on the physical readers themselves but also concerning the e-books that can be read on them. There are, again basically (without going through complicated workarounds or conversion using other specialist software such as Calibre), three main formats for e-books: the proprietary format, the biggest selling of which is Amazon's .AZW which can be read only on a Kindle e-reader or Kindle app, the open standards format i.e. .EPUB which can be read on most of the other e-readers or e-book reading apps or Adobe's PDF (portable document format) which can be read on all of the e-readers and apps. E-books for the Kindle can only be bought from Amazon (although, at the time of writing, sale through a partnership with Waterstones was being worked out), which is not necessarily a big problem as it has a huge list (over 865,000 at the last count[7]) and are competitively priced.

However, e-books in the EPUB format can be bought from all the other e-book stores including Apple's iTunes and the file can be transferred and read on any of the devices apart from the Kindles (see note re conversion above). Sony claims that its e-book store holds over 2m e-books and iTunes currently have over 150,000 and increasing all the time. E-books that are created as PDFs, for example many of the classics, Shakespeare, Bronte, Twain etc, which are out of copyright and so available for free, can also be read on all devices including Kindles. So, secondly, factor in your choice of e-book format.

Accessibility – could do better



The availability of e-books and e-readers has been a boon for learners with visual impairments and others who have difficulties reading print, allowing them to access books at the same time as everyone else rather than wait for a large print version or audio book to be released (take a look at some of the YouTube clips by visually impaired or blind adults and children extolling the virtues of e-readers [8]). This is because, thanks to the rapidity of creating the digital format, the e-book is being launched along with the printed version (why wouldn't you?) as well as the accessibility features built into the design of the e-readers and e-book reading apps. On the majority of e-readers, text size can be enlarged, font style, line spacing and screen orientation changed to suit; e-book reading apps have these and also have a number of text/background contrast options. One of the great features that the Kindle and some other e-readers offer is the Text to Speech (TTS) function with a built in voice engine which can read the text to you – always supposing that this feature has been enabled with the permission of the book's author. Therein lies another conundrum.

Digital Rights Management (DRM) is a way of variously locking the digital format of a book to protect the rights of the author. For example, e-books can be coded to dictate how many devices a copy of the e-book can be read on, for how long, whether the format can be converted from one to another or whether the text-to-speech is enabled or not. In many instances, the latter is disabled to prevent damaging sales of the audio book (read by a real person). A lawsuit threat in the States has led Amazon to encourage authors to give permission for TTS to be enabled for reading on its Kindles and also release a special Kindle app with accessibility plug-in. The app has a special voice engine for the text, whether or not TTS has been enabled, and works with the owner installed screen readers on the PC (MAC version not yet available) for other parts like the menus. This has been allowed as the app is seen as assistive technology rather than a software application[9]. Whilst this goes some way towards addressing the issue, this is not altogether without its problems (described in more details in our NIACE guide to be published in October). DRM also allows libraries[10] to buy short term use licences for books, text books, journals and magazines as duration can also be coded in but difficulties in cross-platform operability is limiting for the customer and so is an issue - if the borrower happens to own a Kindle, they cannot read their borrowed e-book on it. Additionally, some school and college libraries[11] have had their fingers burnt with the confusion over the legal position of adding one purchased copy of a book on several Kindles; whilst, this might be allowed for up to six devices for private customers depending on the permissions given by the author and coded into the DRM, it seems it's not allowed (or possibly it is, although we cannot get Amazon to provide a definitive response) for learning providers or public libraries. In the States, Amazon has agreed a lending solution with 11,000 libraries[12] but this has yet to come to the UK.

Some PDF files are also protected by DRM via the Adobe Content Server. Adobe originally created this format to ensure the

original layout was retained so writers could be sure that each page viewed would look exactly the way they intended including the placement and layout of any associated images. In order to do this, secure coding is added to prevent editing of the content which, unfortunately, also means a significant impact on the reading experience as the reflow of text (where the words wrap according to the line length – think of how text is typed into a word processing application and wraps to each line if the font size is increased or more words are added into the sentence) is affected when read on an e-reader and so entailing difficult scrolling on the screen. DRM protected PDFs can be read on Adobe's own software and app, Acrobat Reader and Digital Editions and some other e-readers and apps (e.g Sony Reader) – notably not all (Kindle!), thus adding another layer of complexity to the decision making process. There can be other access problems with PDFs, such as text grouped with images, navigation and chapter links, all of which can be addressed if realised when creating the e-book in this format. Most learning providers will also want to load their e-readers for their learners with their own handouts and other information documents for their learners. This is entirely possible on all the e-readers and alternative multifunctional
devices, usually in the PDF format. But, as described above, unless care is taken when the PDF is created, many of the added value functions of e-readers and e-books can be lost (more details will be in the guide). Alternatively, of course, it's possible to convert them to a EPUB format e-book from documents using a number of software tools freely available or if using Kindles, by sending them to Amazon for conversion to the Kindle format for them to appear on the device.

Voicing your demands

There are a number of campaigns to raise awareness of some of these issues and put pressure on e-reader manufacturers and publishers. The Royal National Institute of Blind People (RNIB), the Right to Read Alliance and JISC TechDis are vociferous in this area and are working with publishers and e-reader manufacturers in the UK and there are various organisations in the US such as the Reading Rights Coalition, also looking at rights of all readers. With the current strong focus on e-readers and e-books, we suggest now is the time for learning providers to voice their requirements and make demands of the
industry for the benefit of learners, whilst manufacturers and developers are still interested and before they move onto the next big technological thing, although, it seems, this won't be for a while yet[13]. If they don't add their voices to the campaigns and make a noise now, they will miss the boat and if manufacturers don't take notice, they will be missing a trick in securing this significant market. JISC TechDis[14] has produced guidance for publishers with recommendations on good practice and working together towards more accessible e-book standards[15]. JISC TechDis has also created a Lookup Publishers site[16] that allows you to search for publishers carrying books in your chosen format but, more importantly, to submit a request to publishers to create an accessible e-book of a printed version if one doesn't already exist. Amazon is doing the same by inviting you to add your e-book request via a link under each book it sells which doesn't have a Kindle format, but of course if you were a cynic, you might think this is simply helping the giant monopolise the market further; on the plus side, it is very competitive in its pricing. For our focus on adult literacy development, research has found that there are very few titles in e-book format for the 5m or so adults in the UK needing to improve their literacy skills, so whilst we're at it, let's get more e-books produced for adult learners at different levels making investing is this technology a win-win
for everyone. By the way, lobbying the publishers does work, as shown by Newcastle City Learning who have been able to persuade Readwell Road publishers to produce their series of books for adult literacy learners as e-books[17].

What do we want?

- Cross-device operability of e-books
- Easier and cost-effective purchasing and management of e-books and e-readers for learning providers
- Accessibility considered at all stages of e-book and e-reader production
- Suitable e-books for adult literacy learners

When do we want it? Now!

Please see the NIACE Publication pages: http://shop.niace.org.uk/ebooks-for-adult-learning.html for details of NIACE's guide, written for teachers of adult literacy and curriculum managers, to be published in October 2012.

Sandie Gay can be contacted at sandie.gay@gmail.com and Tina Richardson can be contacted at t.a.richardson@staffs.ac.uk

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4 http://www.library.manchester.ac.uk/academicsupport/ereaders/
5 http://www.staffordshire.gov.uk/leisure/librariesnew/gnosalllibrarytolaunche-readerloanservice.aspx
6 National Institute for Adult Continuing Education: www.niace.org.uk

7 http://www.ebookreaderguide.com/2011/03/13/kindle-nookcolor-ipad2-sony-overdrive-which-ebookstore-has-most-ebook-titles/
8 http://www.youtube.com/watch?v=16krEX-4UJ4&feature=related
9 http://www.amazon.com/gp/feature.html?ie=UTF8&docId=1000632481
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RSS What is RSS?

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Advancing Education
Computer Education
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Naace CPD
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Naace
Claiming e-readers and e-books for learners

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Author: Sandie Gay and Tina Richardson, independent specialists and consultants for the National Institute for Adult Continuing Education (NIACE)

Sales of e-readers soared in the UK over the 2011 Christmas period with over 1m units being bought as gifts and now, nearly a third of Britons own an e-reader. But how can this technology be harnessed in schools?

Given they are a technological gadget, e-readers are even more popular with the not so young than even the young[1]. So how can this technology be harnessed to support learning?

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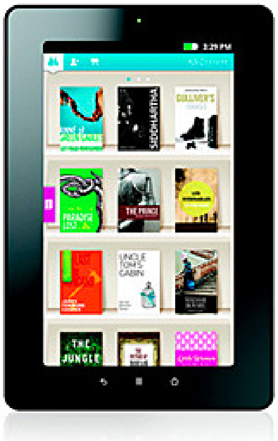

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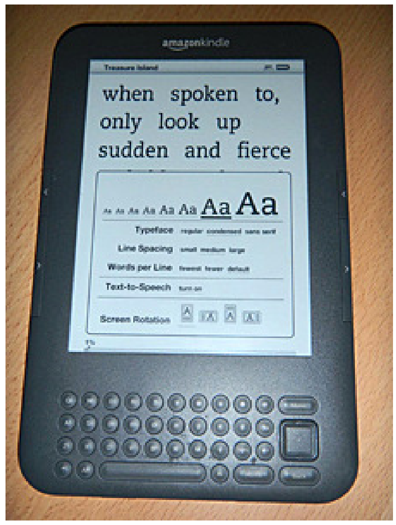
Accessibility – could do better



The availability of e-books and e-readers has been a boon for learners with visual impairments and others who have difficulties reading print, allowing them to access books at the same time as everyone else rather than wait for a large print version or audio book to be released (take a look at some of the YouTube clips by visually impaired or blind adults and children extolling the virtues of e-readers [9]). This is because, thanks to the popularity of the digital format, the e-book is being launched along with the printed version (why wouldn't you?) as well as the accessibility features built into the design of the e-readers and e-book reading apps. On the majority of e-readers, text size can be enlarged, font style, line spacing and screen orientation changed to suit; e-book reading apps have these and also have a number of text/background contrast options. One of the great features that the Kindle and some other e-readers offer is the Text to Speech (TTS) function with a built in voice engine which can read the text to you – always supposing that this feature has been enabled with the permission of the book's author. Therein lies another conundrum.

Digital Rights Management (DRM) is a way of variously locking the digital format of a book to protect the rights of the author, publisher and vendor. For example, e-books, created in any format, can be coded to dictate how many devices a copy of the e-book can be read on, for how long, whether the format can be converted from one to another or whether the text-to-speech is enabled or not. In many instances, the latter is disabled to prevent damaging sales of the audio book (read by a real person). A lawsuit threat in the States has led Amazon to encourage authors to give permission for TTS to be enabled for reading on its Kindles and also release a special Kindle app with accessibility plug-in. The app has a special voice engine for the text, whether or not TTS has been enabled, and works with the owner installed screen readers on the PC (MAC version not yet available) for other parts like the menus. This has been allowed as the app is seen as assistive technology rather than a software application[10]. Whilst this goes some way towards addressing the issue, this is not altogether without its problems (described in more details in our NIACE guide to be published in October).   DRM also allows libraries[11] to code their books, text books, journals and magazines for short term use but difficulties in cross-platform operability is limiting for the customer and so is an issue - if the borrower happens to own a Kindle, they cannot read their borrowed e-book on it. Additionally, some school and college libraries[12] have had their fingers burnt with the confusion over the legal position of adding one purchased copy of a book on several Kindles; whilst, this might be allowed for up to six devices (registered to the same account) for private customers depending on the permissions given by the author and coded into the DRM, it seems it's not allowed (or possibly it is, although we cannot get Amazon to provide a definitive response) for learning providers or public libraries. In the States, Amazon has agreed a lending solution with 11,000 libraries[13] but this has yet to come to the UK.

Unfortunately, like happened with digital music, piracy of e-books is growing as individuals try to pick the locks. We absolutely respect the rights of copyright holders, publishers and vendors of e-books but it would be good if the rights of learners can be heard and their needs and those of providers trying to facilitate learning be met.

Voicing your demands

There are a number of campaigns to raise awareness of some of these issues and put pressure on e-reader manufacturers and publishers. The Royal National Institute of Blind People (RNIB), the Right to Read Alliance and JISC TechDis are vociferous in this area and are working with publishers and e-reader manufacturers in the UK and there are various organisations in the US such as the Reading Rights Coalition, also looking at rights of all readers.

With the current strong focus on e-readers and e-books, we suggest now is the time for learning providers to voice their requirements and make demands of the industry for the benefit of learners, whilst manufacturers and developers are still interested and before they move onto the next big technological thing, although, it seems, this won't be for a while yet[14]. If they don't add their voices to the campaigns and make a noise now to help inform and shape future development, they will miss the boat and if manufacturers don't take notice, they will be missing a trick in securing this significant market. JISC TechDis[15] has produced guidance for publishers with recommendations on good practice and working together towards more accessible e-book standards[16]. JISC TechDis has also created a Lookup Publishers site[17] that allows you to search for publishers carrying books in your chosen format but, more importantly, to submit a request to publishers to create an accessible e-book of a printed version if one doesn't already exist. Amazon is doing the same by inviting you to add your e-book request via a link under each book it sells which doesn't have a Kindle format, but of course if you were a cynic, you might think this is simply helping the giant monopolise the market further; on the plus side, it is very competitive in its pricing. For our focus on adult literacy development, research has found that there are very few titles in e-book format for the 5m or so adults in the UK needing to improve their literacy skills, so whilst we're at it, let's get more e-books produced for adult learners at different levels making investing is this technology a win-win for everyone. By the way, lobbying the publishers does work, as shown by Newcastle City Learning who have been able to persuade Readwell Road publishers to produce their series of books for adult literacy learners as e-books[18].

What do we want?

- Cross-device operability of e-books
- Easier and cost-effective purchasing and management of e-books and e-readers for learning providers
- Accessibility considered at all stages of e-book and e-reader production
- Suitable e-books for adult literacy learners

When do we want it? Now!

Please see the NIACE Publication pages: http://shop.niace.org.uk/ebooks-for-adult-learning.html for details of NIACE's guide, written for teachers of adult literacy and curriculum managers, to be published in October 2012.

Sandie Gay can be contacted at sandie.gay@gmail.com. Tina Richardson can be contacted at t.a.richardson@staffs.ac.uk

About the authors

Sandie Gay is a qualified FE teacher with adult literacy specialism. She currently works as an e-learning facilitator at Staffordshire University and as the Manager for Evidencing Skills and Qualifications at the Institute for Learning. In the latter role, she has developed extensive knowledge of FE initial teacher training and teaching qualifications. She has a strong background in e-learning and use of digital technologies for learning and teaching and many years experience as staff development trainer in a variety of contexts, including as e-guide trainer for the National Institute for Adult Continuing Education (NIACE) and her current role at Staffordshire University. At the university she has become experienced in supporting technology supported learning in higher education programmes, particularly using Blackboard as a virtual learning environment.

Tina Richardson is a teacher educator and the manager of the Professional Development Centre at Staffordshire University, which delivers Subject Specialist Qualifications in adult literacy, numeracy and ESOL (English for Speakers of Other Languages) to teachers in the Lifelong Learning Sector. Previously she managed and also taught on the Skills for Life provision at Stafford College. Tina has a Master's in Computing and is currently undertaking a doctorate in education.

Endnotes

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8 http://www.ebookreaderguide.com/2011/03/13/kindle-nookcolor-ipad2-sony-overdrive-which-ebookstore-has-most-ebook-titles/
9 http://www.youtube.com/watch?v=16krEX-4UJ4&feature=related
10 http://www.amazon.com/gp/feature.html?ie=UTF8&docId=1000632481
11 http://www.guardian.co.uk/government-computing-network/2011/apr/14/public-library-ebook-service-grows-cilip-lincolnshire
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16 http://www.jisctechdis.ac.uk/resources/detail/goingdigital/Towards_Accessible_e-Book_Platforms_Research
17 http://www.publisherlookup.org.uk/
18 http://www.excellencegateway.org.uk/node/20459

Naace
PO Box 6511
Nottingham
NG11 8TN
Phone: 0115 945 7235
Fax: 0870 241 4115
Email: office@naace.co.uk

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My Big Campus – A Core Cog in Our Learning Environment

Author: Adam Hodgess – Learning Technology Manager, Lipson Community College

In January 2011 Lipson Community College made the decision to implement the Lightspeed Total Traffic Control (TTC) solution for the college network. This system allows for a much greater, more granular control of internet filtering.

In preparing young people to be responsible and capable citizens we understand that this can only be done by presenting real world scenarios and challenges. It is therefore important that our students have access to a range of materials and are educated in making the right choices in the use of these resources.

One fundamental resource is the internet and until recently following the implementation of TTC, we found our staff and students very restricted in accessing materials purposefully. We know how important it is to safeguard our students against harmful online content but similarly we know what powerful learning tools can be accessed via the internet.

Implementing the TTC system struck an excellent balance for the college, not only opening up access to more services as we required, but also providing a much higher quality monitoring solution. More effective tools to track issues that may be related to safeguarding could now be used to provide support and assistance proactively. Daily monitoring of search criteria ensures that students are aware of responsible searching and the college can provide a wider platform for access as a greater level of trust has been established.

Lightspeed Systems with TTC has radically changed the ability for staff and students to access teaching and learning tools they need upon demand. In itself it has made a significant impact on the colleges ICT systems.

Lightspeed didn't stop there. As a proactive company and one which clearly believes in the empowerment of the learner, their next phase was to create a platform that linked TTC with an online environment. With the clear aim of providing learning resources in a format which mirrors that of beneficial electronic tools in the real world, the team set about developing a new collaborative network.

In May 2011 Lipson Community College was introduced to My Big Campus (MBC) and a radical journey began.

Collaboration and cooperative learning are at the centre of the way we teach and learn at Lipson Community College. With this in mind the ability for our staff and students to access a platform anywhere, anytime to continue to use resources and ask questions is an asset and is quickly becoming an essential tool.

The concept of a Virtual Learning Environment (VLE) that allows us to present a host of resources and open up access to learning far beyond the classroom, is not a new concept but one that has developed a great deal with the advancement of online technology. The college has championed the concept of this type of learning through another product but felt that this no longer served the needs of our community.

The introduction of My Big Campus at the college heralded a major change in how open this platform was for development and little there was to learn to maximise its potential. MBC has capitalised on the work done by global leaders in social networking such as Facebook. The growth of Facebook has been enabled by its intuitive layout and navigation along with powerful collaboration tools, which have grown in simplicity to create and then give control to the user.

Lightspeed systems have followed a similar roadmap in the creation of MBC. A simple user interface has been designed that enables different users the rights to manipulate areas of the platform as required. This in essence removed the need for a complex back end administration console as control is already with each of our developers (every member of staff!).

The college officially launched MBC with initial introduction training to all staff in September 2011. Since then we have seen a greater and more profound development of online collaboration and cooperative learning than we had seen in the entire life of the previous platform (approx. 5 years).

Our staff are empowered by the simplicity to create new groups, assign tasks, receive work and have a continued dialogue throughout a course. The speed at which this can be achieved is incredible and has been one of the prime reasons for the products growth.

Our students and our staff are familiar with Facebook and social networking and therefore it made perfect sense to work with a platform that offered the same types of services but directly aimed at education. Lightspeed systems only offer the MBC product to schools and colleges. In this we are now part of a global community of users that all have the same purpose, to improve teaching and learning through a collaborative forum.

We have already begun to work with a host of different schools, mainly in the state of Wisconsin, USA. Here we have worked with a district administrator who has access to over 23,000 MBC users, all eager to work on a range of projects.

As a hosted service this offers the college the backup of a full development team and removes the need and concerns relating to having one single on site developer. The MBC team are extremely receptive to ideas and concepts that will enable the product to continue to meet the needs of our college community.

We believe that no one product fulfils all of our needs in the aim of developing a Managed Learning Environment (MLE). This MLE's task is provide access to a range of teaching and learning resources along with interoperable content creation tools and meaningful tracking and reporting systems to ensure staff, student and parents are always informed.

Whilst it is accepted that not all of our college population will have access to a computer in the home or internet connectivity, we can ensure that additional access to these resources is made available, before, during and after the college day. Through this process we aim to help develop highly skilled, motivated individuals that use new technologies with purpose now and in the future.

For more information go to http://www.lightspeedsystems.com/

Naace
PO Box 6511
Nottingham
NG11 8TN
Phone: 0115 945 7235
Fax: 0870 241 4115
Email: office@naace.co.uk

Naace
Just 'GooGol' it: is Web 3.0 the answer to information overload?

Author: Steve Ingle, Associate Lecturer and Doctoral Researcher, University of Cumbria

This short paper presents a brief review of the literature and debate around the notion of Web 3.0 and its potential implications for students, educators and our teaching practice.

Google was named as a play on the word 'googol'; a mathematical term for the number represented by the digit 1 followed by 100 zeros, 10100. The use of the term reflected Google's original aim to organise a seemingly infinite amount of information available on the web (Google, 2012). As the amount of internet available data has expanded exponentially since Google's conception in 1997, are we now at the stage when 'just googling it' no longer provides a manageable solution to our search for relevant and useful information?

One possible response to the information overload now faced by many students and academics is the ongoing development of 'Web 3.0', or the so called Semantic Web.

> *'If the Semantic Web lives up to its promise, intelligent tagging technology will enable educators and students to spend less time searching and sifting through information overload and more time thinking and participating.' (Ohler, 2010)*

This short paper presents a brief review of the literature and debate around the notion of Web 3.0 and its potential implications for students, educators and our teaching practice.

What is different in Web 3.0?

When exploring current definitions of Web 3.0, it is useful to remind ourselves about the conditions for, characteristics of and services of Web 2.0. The shift from the early days of the read-only web to a more social, read-write web has been realised through a range of technical developments in recent years, coupled with a rapid expansion in internet connectivity. The latest market intelligence report from the UK communications regulator (Ofcom, 2011) confirms that the majority of UK homes are now connected to the internet (25 per cent in 2000, 76 per cent in 2011). Add to this greater levels of device ownership, increases in bandwidth, new mobile technologies and enhanced data storage capacities and it is not hard to see how the development of a more sophisticated and interactive web has been facilitated. Crook (in Selwyn, 2008) identifies how these conditions have led to both a dramatic growth in the number of internet users (engagement) and the visualisation of exchange and networking practices; two distinctive factors that influence and define Web 2.0.

> *'Web 2.0 is the network as platform, spanning all connected devices. Web 2.0 applications are those that make the most of the intrinsic advantages of that platform: delivering software that gets better the more people use it... going beyond the page metaphor of Web 1.0 to deliver rich user experiences.' (O'Reilly, 2005)*

In terms of services, Web 2.0 is often defined as an umbrella term which encompasses more recent internet applications that facilitate social interaction, such as podcasting, video sharing, wikis, data mash-ups, virtual societies, social networking, blogging and online gaming (Pang, 2009; Selwyn, 2008; Anderson, 2007). Web 2.0 characterised a significant shift in the democratisation of the internet, from a web largely controlled by those skilled in coding and website authoring, to a platform which allows any user not only to read but to actively create, shape and collaborate with the web - anytime, anyplace. The shift from so called Web 1.0 to 2.0 did not materialise overnight but as a result of continued technological advances which demand a dynamic web that shapes and is shaped by its users. The popularity of such applications is clear e.g. with Facebook and YouTube.

This continued and rapid evolution has led some to debate how the next generation of the web will be defined. Web 3.0 is often considered to be the 'Semantic Web', a term accredited to the web's original creator Tim Berners-Lee (Anderson and Whitelock, 2004), who envisaged a world where computers would become capable of analysing all the data on the web: content, links, and transactions between people and computers. Semantic can be defined as 'meaning', with a Semantic Web allowing computers to read, 'understand' and make meaning out of information that matters to a specific individual, as opposed to simply displaying information (Morris, 2011; McEneaney, 2011). The Semantic Web includes software agents capable of intelligent reasoning in order to locate and combine data from many sources, to produce and deliver more logical solutions to user tasks. Ontologies are created through the use of metadata, to encode a specific area or domain of knowledge, combing the vocabulary, semantic relationships and rules of logic. Put simply, this data integration converts display only information to meaningful data, allowing the semantic search engine to conduct 'intelligent' searches, and return information which is pertinent to the user (Ohler, 2008; Devedzic, 2007; Yu, 2007; Ghaleb et al, 2006). One developing example, which uses data to present 'solutions' to user queries can be seen in WolframAlpha (www.wolframalpha.com), described as a 'computational knowledge engine'. It is useful to explore and consider the response to a simple search in this type of 'smart engline', for example: 'the calories in 1 bowl of corn flakes + a latte', compared with the 778,000 results provided by Google. Which interface provides the most useful response?

As well as a change in the coding, data integration and presentation of information, Green (2011) suggests that Web 3.0 is also about a shift in how we interact with the internet, including the mobile and the immersive web. The rapid increase in use of internet-connected mobile devices, such as smartphones and tablets; has facilitated a more seamless use of the web as we move from home, to work, to school or university, to the park. Ofcom (2011) reports that nine out of ten people now own a mobile phone (36 per cent in 2000, 91 per cent in 2011), with over a quarter of adults (27 per cent) and almost half of teenagers (47 per cent) owning a smartphone and around 28 per cent of UK adults using their mobile phones for internet access. The intelligence report also identifies a high level of reported 'addiction' to the use of their mobile devices, with 37 per cent of adults and 60 per cent of teens admitting they are highly addicted, including over a fifth of adult and nearly half of teenage smartphone users admitted using or answering their handset in the bathroom or toilet.

We are now ever more able to access and interact with the web on the go, from blogging on the train, checking emails in the bank queue, even shopping online whilst burning calories in the gym. It is no surprise that researchers and practitioners have been quick to explore the pedagogical potential of mobile devices for learning (m-learning), with considerable ongoing debate (see Parry, 2011; Traxler and Wishart, 2011; Attewell et al, 2010). The 2012 New Media Consortium Horizon Report (Johnson, Adams and Cummings, 2012) describes the six emerging areas of technology most likely to have a significant impact on higher and K-12 (high school) education. Both reports identify mobiles apps and tablet computing as technologies most likely to enter mainstream teaching and learning use within the next 12 months, and reinforces the ongoing debate for educators.

> *'The future our students will inherit is one that will be mediated and stitched together by the mobile web, and I think that ethically, we are called on as teachers to teach them how to use these technologies effectively.' (Parry, 2011)*

The immersive nature of the developing web can also be seen in the growing use and popularity of virtual worlds, augmented reality and 3D environments (Green, 2011). Second Life (http://secondlife.com) is perhaps the most well known social virtual world, offering opportunities for real-time collaboration and social construction of understanding, creativity and immersive interaction for over 20 million users (Ellis and Anderson, 2011; Ferguson, 2011; Dalgarno and Lee, 2010). Unlike immersive virtual reality (VR), which draws the user away from the real world and onto the screen, augmented reality (AR) enhances the real world experience through combining an overlay of computer generated materials with physical objects in real time (Yuen, Yaoyuneyong and Johnson, 2011; Zhou, Duh and Billinghurst; 2008). Accessed through smartphones, PDAs and tablet devices, AR applications (Apps) aim to simplify the user's life by bringing virtual information to enhance and augment their perception, interaction with and understanding of the world around them (Yuen at al, 2011; Carmigniani et al, 2011). Although AR has been around for some time, educational applications are yet to mainstream. Yuen et al (2011) provide a useful overview and five directions for the use of AR in education, identifying: AR books; AR gaming; discovery-based-learning; objects modelling and skills training as areas where AR can have a positive pedagogical impact.

How might Web 3.0 impact on learning?

Whether we take a narrow or broad view of a Web 3.0 definition, it is reasonable to consider the current and potential implications that internet developments are having, and will have, on teaching, learning and assessment. As Ohler (2010) suggests, intelligent tagging technology may enable educators and students to spend less time searching and sifting through seemingly limitless information and more time thinking and participating, online or offline.

> *'For many of today's undergraduates, the idea of being able to conduct an exhaustive search is inconceivable. Information seems to be as limitless as the universe. And research is one of the most difficult challenges facing students in the digital age' (Head and Eisenberg, 2010)*

Automated, intelligent searching may also address some of the issues around digital literacy and information management often found with current internet searches. Many teachers, tutors and trainers will have experienced the frustration of students typing in their assignment titles into a search engine expecting to find the relevant information in a few simple clicks! Personalisation and customisation are potential key benefits, where only information which is relevant to the learner, based on their learning needs, learning behaviours, location, identity and characteristics, is presented through the filtering capabilities of the Semantic Web (Porter, 2012; Green, 2011; Devedzic, 2006). Learners may benefit from knowledge construction, as searches through the Semantic Web use linked data to return a media rich personalised report, including relevant lecture notes, resources, videos, journal articles, blogs, TV programmes, social networking contributions (Ohler, 2008).

The increasing ubiquity of mobile learning, including tablet computing, coupled with augmented reality applications may also provide further opportunities for a customised and more personalised approach to education. By enhancing the user's skills and senses through an augmentation of the real environment with virtual information, AR may provide access to capabilities and resources for a more efficient, less stressful and independent mode of learning for those wishing to study their own pace (Yuen et al, 2011; Carmigniani, 2011). For example integrating, combing and overlaying multimedia content with traditional paper-based materials (such as handouts or assignments) may help some learners to assimilate and construct a better understanding of new information or tasks (see Weiser, 1991 in Chen, Teng, Lee and Kinshuk, 2011; Mayer, 2001).

Conceptions of the semantic web and augmented reality have been around for some time however and their development into the mainstream is yet to be realised. A number of barriers and concerns exist, not least the scale of tagging and coding of information into ontologies of domain specific knowledge. Who will decide how and what information is tagged, will this be 'accurate' and will anyone bother? Berners-Lee (in MacManus, 2009) suggests that one potential reason for the slow take up of Semantic Web protocols is that search providers may prefer information to remain chaotic.

> *'Search engines had typically not been keen on the Semantic Web - maybe you could argue that their business is making order out of chaos, and they're actually happy with the chaos. And if you provide them with the order, they don't immediately see the use of it'. (Berners-Lee in MacManus, 2009)*

Ohler (2010) identifies how the unavoidable imposed bias and perspectives of those coding information into the Semantic Web could mean the 'rewriting of the world as we know it' through a subtle but global 'rendering of reality'. Concerns have also been raised around information security and privacy as our personal preferences and online behaviours are tracked and used to filter the responses to our future information needs (Anderson and Whitelock, 2004).

Possible considerations for practice

In version 3.0, the web can be viewed as evolving to adapt to humans, rather than the adapting that we have done to computers. In some respects, Web 3.0 is already here; when we shop online, we are often presented with a series of 'personalised' recommendations based on our previous purchases and searches. When using online music services, our existing tastes and preferences are used to suggest new media that might also be to our taste. Should we be considering the benefits of Web 3.0 developments for education and our role as educators? Armstrong (2009) highlights the crucial link between the developing technologies of Web 3.0 and literacy, and proposes five critical strategies for teachers and students in preparing for tomorrow's world: the need to become fluent in different registers for reading, writing and communicating in multiple worlds; to become fluent in switching or multitasking; to build on the transferable knowledge of the past; to create and collaborate constantly; and to conceive of work and play as seamless.

More practically, perhaps as educators we also need to reconsider our own role in developing students' digital literacy skills, including their critical discrimination and management of online information. Reflecting on our own digital literacies, do we have sufficient technical skills and knowledge in order to genuinely consider the pedagogical benefits that mobile learning, applications and immersive technologies can provide for our learners? If we don't, can we continue to survive by just 'Googling it'?

Steve Ingle is an associate lecturer and doctoral researcher at the University of Cumbria. He is currently completing a PhD in technology mediated learning, with a focus on the pedagogical impact of augmented reality in vocational education. He can be contacted at steve.ingle@cumbria.ac.uk

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PO Box 6511
Nottingham
NG11 8TN
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Naace
Pioneering web conferencing across Scottish schools

Author: Adobe

In 2007, Education Scotland (formerly known as Learning and Teaching Scotland) worked introduced Glow - the world's first national intranet for Scottish education. It was set up to help break down geographical barriers and work alongside Curriculum for Excellence to build capacity and ensure a first-class education for Scotland by providing a platform where Scottish Schools across all 32 local authorities could share best practise, teaching tools and lesson plans.

In 2007, Education Scotland (formerly known as Learning and Teaching Scotland) worked with RM to introduce Glow - the world's first national intranet for Scottish education. It was set up to help break down geographical barriers and work alongside Curriculum for Excellence to build capacity and ensure a first-class education for Scotland by providing a platform where Scottish Schools across all 32 local authorities could share best practise, teaching tools and lesson plans.

In order to encourage collaboration between schools and make resources more equal for schools that didn't have enough money to bring in their own guest speakers, schools across the country can use Glow's web conferencing capabilities - known as Glow Meet. This functionality means teachers, students and stakeholders can interact in a virtual classroom using video, audio and a shared whiteboard. It also provides a platform that schools across Scotland can use to share guest speakers, watch national events and collaborate on events and projects.

Although Glow Meet was well received in the education community, Education Scotland wanted the web conferencing functionality to be supported by more up-to-date technology which would allow sessions to be recorded rather than students and teachers being restricted to watching them at a specified time. As such, in March 2011, Adobe Connect was chosen to be the web conferencing supplier for Glow Meet, offering teachers better flexibility and accessibility.

Encouraging flexible learning

Glow Meet has broadcast a wide range of 'National Meets' since its launch, ranging from theatre group performances at schools, to national events such as the Edinburgh Book Festival and programmes giving career advice to students. Teachers and students can access these by logging into a virtual classroom and also use instant messaging to interact with other schools and speakers attending the sessions.

The introduction of Adobe Connect for Glow Meet has meant these sessions are now much more flexible and accessible for teachers and students as the instant recording element of the software allows each 'National Meet' to be recorded and watched again or at another time that is more convenient. Each session also saves the questions and answers asked via instant messaging, so anyone that couldn't make the original time can still have access to all the same information.

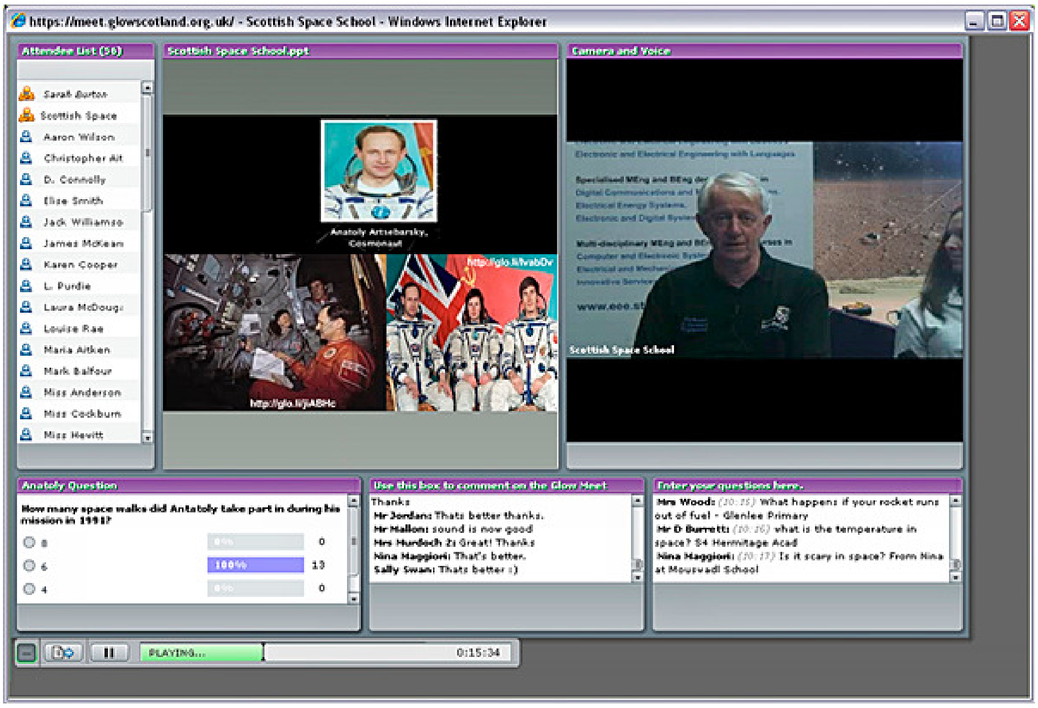
For teachers this means they can save programmes and events of interest and then show them in an appropriate lesson rather than basing lessons around the time the event is screened. Likewise for students, the use of Connect means they can now refer back to relevant events, programmes and clips and use them when doing school work and revision to help them produce more informed work.

For added convenience, Adobe Connect Mobile allows teachers and students to access Glow Meet whilst they are on-the-go from a variety of mobile devices so they don't have to be restricted to a classroom or computer at home.

Andrew Brown at Education Scotland comments: "Moving to Adobe Connect has made things far simpler for our users - one click to launch, and a nice clean simple environment that doesn't get in the way of the learning. An added bonus is having the material available afterwards for people to view again! I used to be impressed by the concept of a classroom without walls – now we're beginning to understand the potential of a classroom without a clock."

GLOW TV

Following the successful roll-out of Adobe Connect for Glow Meet, Education Scotland was keen to enhance the service



further using the instant record feature. As such, it worked with RM and Adobe to develop Glow TV - a central place in Glow where all previous Glow Meet sessions recorded by Adobe Connect can be hosted. Launched in the autumn term of 2011, Glow TV allows students and teachers to access all previous Glow Meet sessions from one archive location rather than having to request links to previous sessions or remember to save them while the sessions are still live.

In addition, Glow TV also includes a packed schedule of programmes and events, allowing students and teachers from across Scotland to add their own programmes, plan what they would like to access and sign-up for forthcoming events through an easy-to-use drop down list. Historically students and teachers had to complete a registration form for every event they wanted to take part in. The new system saves time and allows teachers to see what events are coming up so they can incorporate this into lesson plans.

Programmes on Glow TV are anything from ‘Meet the author’, where schools hold virtual Q&A’s with well known authors over Adobe Connect; to Gaelic lessons; to live streaming from events such as Scottish Opera. It also produces career advice programme ‘World of Work Wednesdays’ which film local people employed in a specific field speaking about what they do on a day-to-day. basis. This allows students to get an engaging insight into what careers are available to them when they leave school.

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Implementing Switched on ICT

Author: Mrs Homewood, Leader for ICT, Engayne Primary School

A report on the implementation of Rising Stars SOICT units of work at Engayne Primary School.

In October I decided to take the bold move, as Leader for ICT, and put the SOICT units of work into my teachers' hands and see what they do. Give them complete freedom about which they choose to do first. At an ICT Leaders meeting, where we were discussing SOICT, my idea was met with comments such as *"How will you make sure they don't just choose units they can do on Powerpoint?" "What if they get rid of old units which they should be doing and don't replace them with like-ones?" "All year groups will end up doing the same thing."*

Most other leaders were implementing the full scheme straight away, ditching all other ICT planning, or they were using the units in only one year group at a time to pilot and roll out slowly. They really didn't like the unpredictability of my method…. however… I didn't like the idea of going to each of my year groups and telling them what they would be doing. I knew I would be met with opposition and "buts". I also didn't want to tell my ICT technicians – who were extremely busy with other jobs, that I needed new software installed and hardware checked for all the new units of work.

So what was my plan to avoid chaos?

I approached my staff at a staff meeting in October, shared with them all the positive aspects of the new SOICT units of work and gave out the packs. I told them that between October and Easter (Aut 2, Spr 1 or Spr 2) they had to choose as a year group one unit of work to complete. I was giving them the freedom to throw out any old unit of work they hated and the children found boring. They had to choose a unit from the new scheme which they felt they could manage, linked with some other learning they were doing and used software which we already had in school – if possible. The initial rumblings around the staff room were positive and eager. So I quickly added that if they enjoyed one unit, they were free to do another!

Of course, this isn't the end of the story. In January I spoke to them again, reminding them that they had to complete one unit. I also highlighted that we had an enterprise week coming up in March and that some year groups may find a good unit to link to that work. I then sent round a link to a survey monkey questionnaire of 10 questions which evaluated the unit they had completed. You are welcome to view the survey here: http://www.surveymonkey.com/s/GC28QQV (please do not submit a reply though!) I told them all that the responses to this survey would inform my next move with the units of work.

So far, compared to all other ICT staff meetings I have done (and there have been many!), I have received a more positive response to SOICT than anything else. Teachers are keen to try something new and are happy to be given the freedom to find their own links to other subjects and be creative. Yes, eventually I will probably adopt the whole scheme of work and may have to do some training for some year groups for some of their more unusual units of work, but until then we are becoming more varied and exciting in our ICT teaching, without me needing to prod everyone and that is a good step forward!

Mrs Homewood is Leader for ICT and Year 4 class teacher at Engayne Primary School and. Engayne is an ICT Mark accredited school and won runner up in Leadership & Management category of the 2009 ICT Excellence Awards.

Find out more about Switched on ICT from Rising Stars at www.switchedonict.co.uk

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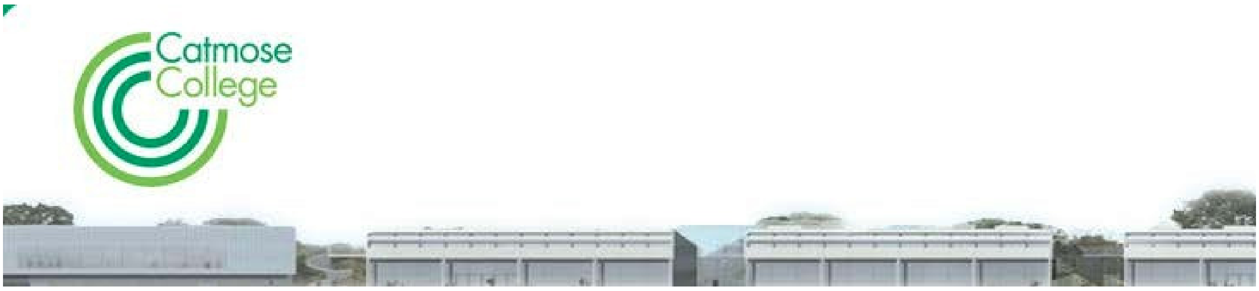
Catmose College Radiowaves Case Study

Author: Beth Smith, College Librarian, Catmose College



In the past year, an amazing transformation has taken place within the lives of certain students at Catmose College. They have become involved with Radiowaves either as part of their elective programme, out of pure interest or through their involvement in the BBC News School Report which we upload onto our Radiowaves station.

Developing Confidence and Literacy

As part of their involvement, some have become more confident, released their inhibitions, somehave enhanced certain life skills like leadership, team-working as well as journalistic and literacy skills. One of our students has developed as a sports journalist and his reports are now being featured on the BBC News School Report webpage, with a reward trip to spend some time in the sports news room at TV Centre. Another student, who is not academic in any way and can be slightly troublesome, has been transformed when putting him behind a camera.

Radiowaves has helped many of our students overcome shyness through their reporting on different stories. This shyness has now become confidence and pride and has also given them a focus which is then transferred into their other classes. The reporters at our school have embraced the Radiowaves technology with enthusiasm; they go about their reporting tasks with diligence and minimum supervision. They are creative in their approach and have built up quite a following of readers/viewers/listeners, both within the school and beyond.

The Radiowaves reporters are developing 'life' skills which gives them the confidence that they need for the school community they are in, higher education and the world of work in the future.

Motivating through Social Media

Our College has embraced social media and embedded the use of the Radiowaves platform into our curriculum. As a college, we are happy for our students to use this media as it is fully moderated both by college and Radiowaves staff, and we know it is safe for our students to use. Students undertake work and then upload it to their own personal page, which they can personalise. The work can be in varied media and this can include written, audio, video and photographic examples. We love the fact that our students can create work that can then be viewed by their peers, our staff, other members of Radiowaves and also any one accessing the World Wide Web. We have a number of reports that have been viewed over 4000 times and this creates a huge sense of achievement to our students.

Using Radiowaves can be a great motivational tool. I would love to be able to share my sense of joy when I log onto the website sometimes and see the reports that have been created or the interaction that is taking place using the comments system. Here at Catmose, we have a number of SEN students who have signed up for Radiowaves as part of our elective program. In particular, one student has poor communication skills but he is now writing reports on his favourite subject and placing comments onto the work of others. This gives me, and the other staff who work closely with him, huge satisfaction.

Radiowaves and our multimedia equipment is used in many different ways within college. Some subjects are using Radiowaves to ‘display’ their students work to the greater community and others as a way of peer and self assessment.

Curriculum Feedback

The head of Sports said, “Radiowaves has been of great value throughout sport. Team Captains have given verbal match reports and inter-school fixtures and events have been reported on by reporters. The use of Radiowaves has helped to raise the profile of Sport at the college and given valuable and deserved recognition to those who have participated.”

“The use of Radiowaves in the English curriculum has been a particular help to me as an English

teacher because students are able to hear their poetry. If we did this without a resource like sound recording equipment, it would be like doing theory work with no practical. Practical in this context is essential because it helps students understand how they are being persuaded by the use of rhetorical techniques."

"The Humanities Department decided to use some Year 7 History topics to examine how Radiowaves could best be used. One successful venture was the recording of a lesson on the Domesday Book, which was used by other members of the Department for training purposes as well as encouraging students to approach their learning in innovative ways. The Department found that students enjoyed the different learning experience, participated better as learners and were more prepared to assist in and assess each other's learning. The use of interviews has also encouraged students to question and promote each other's progress. Substantial further use is intended of the Radiowaves facility in the coming terms."

As well as being used by the curricular team, it is also being used during tutorial time and part of our elective (extra curricular) programme. The students are very enthusiastic about the ways that they can use the equipment and the website.

Quote from an English teacher and form tutor "*Well I can say that Radiowaves has been a useful way to reward tutorial work, to celebrate anniversaries and students. I have found it very encouraging to have staff comment on their poetry published on Radiowaves*".

Supported Service

Using Radiowaves within college is a safe way that all our students can interact with Social Networking and Web 2.0, whilst improving their literacy, writing and communication skills.

We need a safe, moderated area that our students can upload their work to which is motivational, exciting and provides them with satisfaction of a job well done. The students love it as they are in control (subject to work being approved), the staff love it as the students can work creatively, parents love it as they know that their children are working safe online and our SLT love it because they know that our students are gaining so much from the experience.

If I have a problem, I have a named person to whom I can go to who will do their best to answer my query. There is also a teacher's forum where we can interact with other moderators and gain answers from them or even just share ideas. The students also have the 'Mole' who is a member of the Radiowaves team who answers the reporter's queries.

Last year, we were asked to speak about our use of Radiowaves at three educational Shows and at two of these, we had Radiowaves staff in attendance. The time and effort that they gave to our students was exceptional, and this was really appreciated from me as a member of college staff.

Examples of students' work on Radiowaves:

Our station:
www.radiowaves.co.uk/catmosecollege

http://www.radiowaves.co.uk/story/137648/title/Day4part2BergenBelsenConcentrationCamp

This is incredibly moving as the students talk about being in a place like Bergen Belsen. Our students now watch this as part of their history lessons as students are more likely to listen to their peers and their experiences than teachers.

http://www.radiowaves.co.uk/story/155975/title/SirMatthewPinsentlaunchesSchoolSearch
I was asked to arrange for reporters to interview Sir Matthew Pinsent as part of the BBC's launch of the Olympic World Dreams school search.

http://www.radiowaves.co.uk/story/219118/title/toptipsfromtheexperts
As a result of our reporter Colester writing reports on the Ashes for BBC News School report website, he was invited to BBC TV Centre to see behind the scenes at the BBC Sport website. This report includes the interviews he and DJ Staff did with the BBC staff journalists.

Beth Smith can be contacted at office@catmosecollege.com

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Somerset Visualiser Project - Experiences and outcomes

Author: Amy Blackmore, Somerset County Council

The Somerset Visualiser Project involved nearly eighty primary and middle schools across Somerset. All schools were invited to have the use of a visualiser for a term from one of three leading manufacturers – Aver, Elmo and Genee. They were asked to explore its use with their learners across the school.

Background and aims of the Project

The Somerset Visualiser Project involved nearly eighty primary and middle schools across Somerset. All schools were invited to have the use of a visualiser for a term from one of three leading manufacturers – Aver, Elmo and Genee. They were asked to explore its use with their learners across the school in order to support them in achieving the following aims:

- Exploring visualiser technology
- Evaluating the impact on learning
- Gaining knowledge about purchasingComparing models and functionality

This report focuses on the outcomes of the use of visualisers in the Project schools, exploring how visualisers assist teaching and learning and how they might be taken up by other schools for whole-class and small group teaching. In addition, it addresses how schools are now more informed about visualiser technology and how they can make decisions about which models are suitable for their needs.

Summary

From the findings of the Project, we have learned that:

- Teachers who used the visualiser effectively said it became part of their everyday classroom practice and could be used 'intuitively' to complement and enhance existing teaching practice.
- Teachers were able to demonstrate and model intricate skills to all learners at the same time, with the models in the trial also featuring a recording facility so the process could be played back to consolidate learning.
- Teachers reported that the pace of lessons was improved as learners' work could be shared instantly – the increased pace helped with learner engagement and motivation as learners wanted to share and receive feedback from the teacher and their peers.
- Teachers also expressed the opinion that using visualisers helped the speaking and listening skills of learners who shared objects and learning.
- Learners said that they enjoyed seeing real objects and processes in real time, without having to use simulated activities or using tools that did not replicate what they would be using in their actual learning.
- Teachers said that they felt that they understood what a visualiser could bring to the classroom and had an increased understanding of the key features they would be looking for when purchasing a model.

Technological context – what is a visualiser?

The visualisers used in the Somerset Visualiser Project were the Aver CP155, Elmo L1-ex and Genee 2100.

Aver CP155

Elmo L1-ex

Genee 2100

The models were chosen because of their broad similarity in price (between £350-£500) although there were some differences in functionality between the models.

At a simple level, a visualiser is a digital device that connects to a projector and can also (but does not have to) connect to a computer. The visualiser has a camera and light source, and objects or books can be placed underneath the camera to be projected onto a large screen. In most models, the camera can also turn to focus on objects that are on a wall or not directly underneath the camera. Turning the inbuilt light on or off can also improve the clarity of the image, which can be captured – either on the computer, or in most models to an internal drive or SD/USB drive – and then annotated using existing whiteboard software or the visualiser' s own software.

Visualisers enable the teacher to share a variety of resources with the whole class on a screen where all have the same visual access. Small or precious objects can be displayed and zoomed in on to share close-up detail, and learners can place their work underneath the camera to share with their peers at any time during the activity, Real texts – not just 'big books' – can be enlarged and annotated, increasing teachers' flexibility when using resources. Teachers can also model skills that otherwise could involve challenging classroom management situations or the use of simulated software.

Methodology:

All schools in Somerset were invited to participate in the Project with the prospect of having a visualiser for a term to meet the Project's aims (as summarized above). Seventy-five primary schools and five middle schools responded to the invitation and were invited to eight introductory events across the county. These events were organized by the Local Authority and supported by one of the three manufacturers.

The introductory event shared the aims of the pilot and the manufacturer gave basic training on how to use the model, including connectivity and software. At the end of the event, the representative teacher took a visualiser back to their school. Some schools expressed an interest but were unable to attend an event, so a visualiser was delivered to them directly.

Teachers were encouraged to participate in a Fronter room where they could download user guides, comment on a forum and view examples of children's work. They were also sent a weekly update email which shared some of the good practice that was taking place during the Project. Feedback was collected through visits to schools, discussions with teachers and learners, and informal email conversations. In addition, three schools were asked to work with all three visualisers to compare their functionality in the classroom. As all the models in the Project fell within the midrange price bracket, it was felt that schools may be looking at these models when considering purchasing and a comparison of features and functionality may be useful,

Discussion: Impact on teaching and learning

- **Effective interaction:** Teachers reported that they were able to interact with their learners in a different way when using the visualiser – not only were they facing the learners during whole-class activities, but they were able to invite learners to come and share their own learning, which led to increased motivation, achievement and engagement. "When they know there"s a chance of sharing their work, they want to do the best they can and they"re listening more to instructions so they improve the presentation of their writing."
- **Effective use of resources:** Teachers were able to share a single resource across a large group of learners. Small books could be enlarged to become big books; a delicate or precious artefact could be shared with the class and looked at in different ways through the use of the flexible arm and movable camera. "We were able to share a wasp"s nest that one child bought in from home – they were able to see it in far more detail than if we had just handed it round."
- **Real-life opportunities:** Teachers said that they had enjoyed using the visualiser to give their learners 'real-life' learning rather than using simulations, For example, teachers could demonstrate handwriting joins using a real book and real pen rather than a whiteboard simulation on a vertical surface. They could also model how to use classroom

equipment such as protractors and watercolour paints, knowing that the learners would be using the same equipment when working independently. “I know that some of my pupils can"t make that connection between what they see in Smart Notebook and what they do with their own book. Using the visualiser removes that barrier to learning as we"re all using the same tools.”

- **Time-saving:** Teachers reported that they were able to give feedback to learners far more quickly and were also able to cut down on the time they spent making resources. “I used to spend breaktimes scanning work that we"d just done so they could see it on the board for assessment. Now I can show it straightaway and it can change the direction of the lesson for some children as they can see what others are doing."
- **Cost-cutting:** Some teachers said that they had reduced the quantity and frequency of photocopying for learners as they were able to display resources clearly on a large screen. “It"s so much easier to write something once and show it to everyone.”
- **Inclusion for all:** All children were able to see the image on a large screen, and teachers reported that some children whose concentration was poor were more willing to look at objects or work when it was on a screen. “It"s giving everyone the same access to materials, but what it really does is engage children who are used to looking at things on a screen. I"m not saying that"s the right thing to do, but it meets their needs.”
- **Modelling skills:** Many teachers used the visualiser to model difficult processes such as cutting, sewing or folding in real time. They could then be recorded for playing back later, in order to consolidate the process. ‘We were making origami boats and I recorded the process, and then played it on a loop as the children were making their own boats. They quickly realised that they could watch me on the screen and copy it themselves at their own pace.”
- **Pace of lessons:** Teachers who used the visualiser effectively said that the visualiser was ‘always out and always on’ – it became part of the classroom toolkit and could be used at any point, for any purpose. “Once I became used to the software, I used it all the time to share what the children had done – not just during a plenary but when someone had used a great word, or done a great picture – it really helped spark the other children up and had more impact than me stopping them and telling them.”
- **Enhancing existing practice:** Teachers said that when they used a visualiser, it was enhancing rather than replacing the teaching that they would normally do: “It makes you much more flexible in how you can teach – for example, you could use Crocodile Clips software to explore how to make an electrical circuit. Some children love that. But you can also use real equipment and be more adventurous in how you work.”
- **Giving depth to the curriculum:** Some teachers used the visualiser to create stop- motion animations with learners working in small groups and timetabling the visualiser. They reported that using a visualiser to create animations, rather than using a webcam or digital camera, led to better quality animations – both in image quality and finished product - with less camera movement and more images taken. “Children could think about the story they were trying to tell and the process of collaborating to make an animation. They didn"t have to worry about the technology as using the visualiser made the process much easier for them.”
- **Getting the most from the visualiser:** One school used the time-lapse feature in their visualiser to create an animated feature of a germinating bean – the teacher said that this would have been harder to achieve with other technology, and he valued being able to use a single piece of equipment to meet more than one requirement. Another teacher said: “I don"t use a scanner anymore, I always use my visualiser. I don"t use my webcam, I use my visualiser. And I know that I always have a good quality digital camera in my classroom, because I have my visualiser – and that"s in addition to everything else it does with my laptop and my whiteboard.”

Discussion: Impact on learners:

- **Effective engagement:** Learners said that they were more able to see objects and text under the visualiser, and that they enjoyed being able to present using the visualiser themselves. “We use it for show and tell and I can bring in pictures from home to put under the visualiser. I brought my bridesmaid bouquet in so that everyone could see it but I didn"t want them to touch it in case it was damaged.”
- **Raising motivation:** Several children said that they were encouraged to improve their work as there was a chance it could be displayed for all to see on the large screen. “It makes me want to do better because I know that my teacher might put it under the visualiser.”
- **Range of opportunities:** Teachers were able to provide enhanced opportunities to learners by using the visualiser. For example, several teachers used the visualiser to show a live image of minibeasts – or in one instance, a grass snake – and allow the children to zoom in and record the creatures before returning them to their habitats. “I"ve never seen a grass snake before and I wouldn"t have wanted to get close to it, but it was really good seeing it under the visualiser and it made me less scared of it.”

Other outcomes:

The comparison of different models of visualiser allowed teachers to consider what was important to them when purchasing new hardware. Teachers recognised that investment in hardware was now a luxury rather than an expectation, and that they needed to be more informed about a) what they wanted to achieve; b) what solution would meet their needs and c) where to go for support and training.

Of the three schools approached to conduct a comparison study, two submitted a report. They both said that of the models they used, they considered the following factors of most importance to teachers when considering purchase:

- How sturdy is the visualiser for everyday classroom use? – “We found that we needed to test the build quality of the visualisers as some were easy to knock and the children could pick bits off them.”
- What is the quality of the image like? – ‘You need to see the image in action as sometimes the specifications can be misleading"
- How does the software integrate with existing whiteboard software? – “I"ve spent ages learning how to use Smart Notebook effectively – I don"t necessarily want to have to learn how to use a whole new toolbar when I"m using my whiteboard.”
- How easy is it to save, store and access images? – “Having an SD card or USB slot was so useful as we could move images around more easily, and we valued the option of being able to save from the software into different directories without having to put filenames in each time.”

These teachers felt that schools needed to consider how they would plan for staff training and supporting less confident teachers, and that this should be part of the procurement process when approaching a reseller – schools should enquire what package of support they could expect with their purchase. They also said that schools should ensure that visualisers became an essential part of everyday teaching and learning, otherwise the investment was not going to prove worthwhile.

> *"Although it was a significant investment for us to purchase a visualiser for every classroom, it was a decision that has proved to be very successful as they are used by all of our teachers as part of their daily routine, making the discussion of pupils" work, displaying of texts, observation of objects and demonstrations of skills effortless, and thus enhancing the teaching and learning experience for all.”*

Transferability and sustainability:

After the Project, schools were offered the option to purchase their visualiser at a reduced cost. Most (51 out of 80) schools chose to purchase and a number of schools also purchased units for other classes in the school. The following observations were made on future planning for visualiser use:

- Schools need to ensure that all staff are trained in effective use and all staff subscribe to the idea of the visualiser as enhancing rather than replacing practice.
- If one visualiser is being used across a school, it is far less likely to have the same impact as if most teachers have regular and sustained access. This may lead to a lack of confidence in the visualiser and its potential for enhancing learning.
- Without training and support from a reseller or manufacturer, visualisers are less likely to be used – schools need to plan a programme of training and negotiate with the supplier to provide support.

Thoughts and reflections:

The Somerset Visualiser Pilot provided schools with an opportunity to explore a new technology in a time when they may be making hard decisions about ICT development and investment. The British Educational Suppliers Association (BESA) reports that primary school budgets for ICT hardware are likely to be on average £1000 less per school, with a reduction of £4000 in the average secondary school. (BESA "ICT Provision and Use 2010/11"). Futuresource Consulting, who observe trends in educational investment, have projected that by 2011, one in three classrooms will have a visualiser (Futuresource press release, June 2010) – this has a potential conflict with a recent Guardian Education survey, which claims that 45% of teachers claims they have enough hardware, but now need to know how to use it effectively (Guardian Education poll, June 2010). Clearly schools who make an investment in visualisers need to know what they’re getting and how they will be supported in ensuring their investment has a positive impact on the classroom experience.

Teachers have told us that there is huge potential for enhancing teaching and learning with a visualiser. The breadth, richness, and diversity of learning opportunities that they can offer has been clearly identified during the Project, as has the need for effective training and a support network to share experiences and outcomes.

Amy Blackmore can be contacted at AYBlackmore@somerset.gov.uk

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Fax: 0870 241 4115
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Transforming lives through learning

Reference code: Steljes/SMART Technologies

Author: Paul Heinrich

"SMART Board™ interactive whiteboards have revolutionised the classroom experience of our students by helping to make learning more personalised, more interesting, and more relevant to their future working lives." Hilary Bond, Director of Quality & Innovation, West Herts College

"West Herts is an outstanding college that provides high quality education and training," says its latest Ofsted report from April 2010. *"Teachers plan lessons very well to meet individual learners' needs and use a wide variety of teaching methods to motivate and engage learners."* Since then, the college has moved from its old Edwardian and 1960s buildings into a superb new £75 million main building in the centre of Watford, equipped throughout with the latest technology and state-of-the-art facilities to deliver an even better learning experience. The college's goal is to prepare its students effectively for their future working lives by exposing them to the technology they will need – and SMART Board interactive whiteboards are playing a leading role in bridging the divide between classroom and workplace.

West Herts College has an excellent reputation for providing high quality vocational and advanced professional courses to students of all age groups across a wide range of disciplines. There are currently around 12,500 full-time or part-time students in Further, Higher and Adult Education across its three campuses in Watford and neighbouring towns. The college specialises in developing workplace and personal skills to give its younger students a strong head start in their chosen careers, and the new facilities are already having a major impact: "The perception is that young people all have fantastic IT skills, but it's often quite limited to narrow social media applications," says Hilary Bond, Director of Quality & Innovation, West Herts College. *"The combination of SMART Boards and other technologies helps show students how to use IT skills in a working environment and focuses on how they do their work, how they present it, and how they assess other people's work."*

Everywhere you look the new buildings are equipped with the latest technology that wouldn't be out of place in the business world, from state-of-the-art TV and recording studios to fantastic theatre facilities and performance rooms. This blurring of the traditional distinctions between learning and workspaces is one of the college's most striking features. As well as the more familiar classroom settings, SMART Board interactive whiteboards can also be found in the fully equipped hairdressing and beauty salons and are used in a variety of imaginative ways across all campuses and departments to engage learners. In the fashion department learners can follow practical video demonstrations as they learn new techniques, and in social care they can take part in interactive quizzes on the parts of the human body. Trainee beauticians can practice their eyelash extension skills on the whiteboard before trying them out on their customers, and hairdressers can plan their styles and follow online instructions.

"We've tried different makes of whiteboard at our various campuses, and SMART Board interactive whiteboards have proved far superior because of their interactivity and ease of use," says Hilary Bond. "*Some of the others were so complicated that teachers stopped using them or never even switched them on!"* The technology-rich new buildings presented a steep learning curve for the college's 500 or so full-time and part-time teachers: *"They had to get to grips with the SMART Boards very quickly,"* Hilary continues. *"Some were coming from no technology to high technology in a single jump!"*

To accelerate the learning process, an ILT facilitator was appointed for each department and received initial training from Steljes, the authorised representative for SMART Technologies in the UK. The training had to take account of the fact that the ILT facilitators themselves had varying degrees of IT skills, and needed to be tailored accordingly. "Timing was a crucial issue, as we wanted everyone to be familiar with the new technology before the new buildings opened in September 2010," Hilary explains. "The ILT facilitators then cascaded out their training in SMART Boards, laptops and other technology to all the teachers in their departments. This was done over three training days in August 2010 that everyone had to attend."

Over 1,000 training sessions have been delivered to date, and a series of toolkits for beginner, intermediate and advanced levels continues to be rolled out across the college. ILT facilitators also cascade tips, ideas and best practices at regular departmental meetings, and teachers are continuing to push back the boundaries of how they are used. Learners can submit their work online via the Virtual Learning Environment, for example, and the marking is done on the SMART Board using voice tags. The student can then open up the tags to hear what the teacher has said. *"We're really pleased with the SMART Board interactive whiteboards,"* Hilary continues. *"Every teacher is using them and has enjoyed exploring what they can do, but that's just the tip of the iceberg. The capacity and potential of SMART Boards is immense, and there's a lot more functionality we can use!"*

While it's too early to measure the tangible effects on results, it's clear that the array of interactive learning technology at West Herts College is having a beneficial impact. "We encourage a blended learning environment here, and when the use of interactive technology is appropriate to the lesson we've seen that students are definitely more engaged," concludes Hilary. "SMART Board interactive whiteboards have revolutionised the classroom experience of our students by helping to make learning more personalised, more interesting, and more relevant to their future working lives."

"We've tried different makes of whiteboard at our various campuses, and SMART Board interactive whiteboards have proved far superior because of their interactivity and ease of use," Hilary Bond, Director of Quality & Innovation, West Herts College.

Naace
PO Box 6511
Nottingham
NG11 8TN
Phone: 0115 945 7235
Fax: 0870 241 4115
Email: office@naace.co.uk