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**E-learning
in Science and Design and Technology**
Proceedings of IDATER on-line conference 2005 - 2006

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Contents

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Introduction	2
<i>Lead papers</i>	
BA (Google): graduating to information literacy Tara Brabazon	5
Classroom and chatroom: why school science pupils should discuss practical science work on-line Patrick Fullick	21
E-learning as technology, e-learning as learning Torben Steeg	38
<i>Refereed papers</i>	
A review of the literature concerning website effectiveness: before, during and after use <i>Peter Simmons and Kevin Badni</i>	47
A discussion of constructivist learning in relation to the Development of ideation using a Virtual Reality Learning Environment for Innovation Education in Iceland Gisli Thorsteinsson and Howard Denton	62
Internet Safety issues in English schools Jocelyn Wishart	78
Engagement as the key feature of the successful use of the internet for information Alan Pritchard	87
Using ICT to enhance student understanding of classification Mark Chapple and Gary Simpson	97
The development of a virtual learning environment site to support year one industrial design undergraduates: A case study Howard Denton	114

Curriculum development contributions from practitioners

ICT – a modern solution to the science teaching equation? Jenny Turner	124
Recreating ecosystems in micro worlds Gary Simpson and Mark Chapple	128
A new dimension to Science teaching in the 21st Century Lorraine Ellison	134
Teaching Science Online Michael Walsh	136
The use of search engines in the teaching of classification in Key Stage 3 science Lisa Gammon	146
The Internet supporting an aspect of Designing and Making: a mini case study. Alan Pritchard	152
HTML for Beginners John Kennedy and Christine Turner	155
The Catalytic Oxidation of Ammonia: An Interactive Web-Based Virtual Experiment and Teaching and Learning Resource Christine Turner and John Kennedy	168

E-learning in Science and Design and Technology

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Introduction

A background to IDATER

In 1988 the Department of Design and Technology at Loughborough University launched the first *National Conference in Design and Technology Educational Research and Curriculum Development*. Growing each year, the Conference went international with the first IDATER conference in 1992. This grew to become one of the most significant research conferences in its field and the Conference Proceedings became standard reference sources for those involved in design and technology education research and curriculum development across the world.

From the beginning, the Conference aimed to provide a forum for both practitioners and researchers in the field of design and technology education. This ranged from primary schools, through secondary and higher education. Through the mechanism of Special Interest Groups (sigs) established by conference delegates rather than conference organisers, the emerging research agenda was set.

As part of the IDATER 2000 programme an on-going research seminar was established to discuss international research collaboration and extend the conference beyond a specific annual gathering. At the same time it was acknowledged that rising costs meant that members could not attend in the numbers required for a viable and vigorous international conference. It was, therefore, decided to build upon the IDATER research seminar concept and develop a rolling on-line, e-conference. This book is the hard-copy record of the first of these e-conferences; in this case aimed at *e-learning in design and technology and science*.

By adopting an e-format the Conference was able to offer members several advantages:

- the Conference could run over a longer time frame than a conventional conference;
- delegates had the opportunity to consider, at length, any paper as opposed to a more usual 15 or 20 minutes;
- an international audience could be reached with minimal cost to both presenters and delegates. This, particularly, opened opportunities for practitioner based research;
- a series of conferences with specific foci could be run.

Each e-conference will be opened with a set of invitation papers acting as stimuli for discussion, by authorities in the particular field under consideration. Papers can be submitted for full, double blind refereeing or more simply as curriculum development papers. In addition on-line forums are possible. Each conference will close after a suitable period and all papers will be archived through the Design Education Research Group ([DERG](http://idater.lboro.ac.uk/)) at Loughborough University for free on-line access (<http://idater.lboro.ac.uk/>). In addition a hard copy will be made available, this book being the first in the series.

This publication

This book has 2 roles. Firstly, to bring together up-to-date contributions to the field of e-learning. Secondly, to provide a vehicle for practitioners in the fields of science and design and technology to share good practice.

E-learning is taken to mean any technique which employs ICT-based equipment to facilitate learning. Examples could include web-based materials at either Intra or Internet levels and stand-alone materials used in classrooms such as practitioner generated interactive databases etc.

There are three sections:

- Lead papers from authorities in the field of e-learning;
- Papers which have been subjected to double blind peer review;
- Curriculum development contributions from practitioners (non-refereed).

Lead papers

The first lead paper, ***e-learning as technology, e-learning as learning***, by Torben Steeg explores two themes: Firstly, what we understand about the economic, technical and social impacts of new technologies and how this might relate to the complex range of technologies that fall under the title 'e-learning'. It argues that detailed exploration of the likely impacts of various e-learning technologies is a key task. Secondly, understanding of how learning happens, from a constructivist viewpoint, is used to develop a set of criteria against which e-learning approaches can be judged.

The second lead paper is by Patrick Fullick: ***Classroom and chatroom: why school science pupils should discuss practical science work on-line***. This argues that such discussion may, if suitably managed, lead to increased understanding among pupils of the nature of science. The author also argues that the rapidly increasing use of networked computers (in schools and at home) provides a natural way of doing this.

The third lead paper offers a very important warning to the limits and limitations of Internet-based learning. Tara Brabazon, in ***BA (Google): graduating to information literacy***, argues that the increasing use of the web and search engines such as Google by students is having seriously negative effects on their abilities to develop arguments and take well informed decisions. She points out that while search engines enable the rapid collection of data from web sources, those sources are not, necessarily reliable or appropriate. She notes that 'making students think, rather than assume, and read rather than cut and paste is proving a challenge'. This is a particularly timely warning. The problem is not confined to students; staff may fall into the trap of constructing e-learning materials where there are multiple links and the student need go no further than the virtual boundary of the site.

Refereed papers

Within this section there are six papers. These are presented in the following sequence. Firstly Peter Simmons and Kevin Badni offers a review of the literature on website effectiveness, noting that the impact that websites have is rarely assessed in an educational context. It identifies three distinct phases of effectiveness: before use, during use and after use. The paper uncovers gaps in the research in two areas; primarily a need for further research concerning influence after a website has been used and requirements for ensuring a wide knowledge of the websites existence. The paper also discovers some conflicting ideas of importance between a websites' usability and likeability.

The second paper offers a discussion of constructivist theory relating to the use of a virtual reality learning environment (VRLE) to assist in the teaching of ideation in Icelandic schools (Thorsteinsson and Denton).

The third paper (Wishart) issues a timely warning of safety issues relating to Internet use in schools and is based on an audit of Internet safety practices in English schools.

The fourth paper looks at the way use of the Internet has been promoted by government bodies in the UK. Pritchard shows how the National Curriculum in England includes schemes of work aimed at helping pupils search large databases, the Internet and interpret information. It is noted that levels of engagement in learning can be enhanced using this technology.

The fifth paper provides an example of the use of specific desktop computer based software to enhance student understanding of classification in science lessons. Chapple and Simpson describe using Inspiration, PowerPoint and MicroWorlds to build dichotomous keys and represent the data.

The final refereed paper, by Denton, describes the development and evaluation of a virtual learning environment (VLE) to support conventional studio based design work by undergraduate industrial designers. This VLE was designed and operated on a university intra-net; that is it was accessible only to students of that university, though they could be anywhere in the world. The VLE also offered links to appropriate sites, verified as authoritative by staff, which lay in the wider web based world.

Curriculum development papers

There are eight papers presented by practitioners. The first, by Turner describes her progress as a trainee teacher in terms of learning to use the Internet to support her teaching. The process of professional reflection described is a valuable reminder of the difficulties some staff experience in using these technologies.

Following this there is a set of four papers based in teaching and learning science within schools. Simpson and Chapple describe their experiences incorporating e-learning into a Year 8 ecology study unit. Ellison gives illustrations of good practice in the use of Inter and Intranets in her school. Walsh describes an online approach to teaching a General National Vocational Qualification (GNVQ) science course using digital materials produced by 3E's Multimedia delivered via the Digitalbrain platform. Gammon then describes some of the strategies she uses with search engines and the Internet to provide a more interesting approach to the topic of animal classification.

Pritchard looks at using the Internet to support designing and making activities in schools. He describes how websites can offer pupils different ways of gaining insights into scientific and technical principles relating to design and making and how the National Grid for Learning can support the busy teacher.

Kennedy and Turner provide a useful guide for using HTML in the production of teaching materials. Finally, these authors also present a paper on an interactive web-based virtual experiment as a teaching and learning resource.

Forthcoming publications in this series include Action Research in Science and Technology Education and Technology and Designing.

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BA (Google): Graduating to information literacy

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Academic research involves three steps: finding relevant information, assessing the quality of that information, and then using appropriate information either to try to conclude something, to uncover something, or to argue something. The Internet is useful for the first step, somewhat useful for the second, and not at all useful for the third.

Beth Stafford (1999: 145)

A problem has emerged in my teaching during the last three years that requires attention. As each semester progresses, a greater proportion of my students are reading less, referencing infrequently and writing with little clarity and boldness. There will always be the top twenty five percent of the class who are rigorous and committed scholars in the making. They require little meta-learning, but can operate in models of student-centred teaching and facilitation. Increasingly the middle fifty percent - that require greater guidance, attention and commitment from teaching staff to pass a course - is producing inadequate work. This group writes assignments days before they are due, runs a spelling checker through the document rather than draft it, and relies on the internet for research material, rather than refereed course readings. These problems are not caused by Google. Technology is never the cause of societal problems, inside or outside a university. Instead, the popularity of Google is facilitating laziness, poor scholarship and compliant thinking. It is a panacea for our time-poor students.

This paper conducts a thought experiment. I locate 'a teaching problem,' use literacy theory to understand it, and then offer solutions. I can no longer assume that students enrolled in an Arts degree enjoy reading and writing or are intellectually curious. My goal is to develop an information scaffold, attempting to align my goals and expectations with a student desire for educational achievement.

Google time

Google, and its naturalized mode of searching, encourages bad behaviour. When confronted by an open search engine, most of us will enact the ultimate of vain acts: inserting our own name into the blinking cursor. This process now has a name: googling. It is a self absorbed practice, rather than outward and reflexive process. It is not a search of the World Wide Web, but the construction of an Individual Narrow Portal.

It is important to be completely honest about the internet – let alone the web – being searched by Google. The web is large, occasionally irrelevant, filled with advertising, outdated and increasingly corporatized. It seems appropriate that Google is ubiquitous at the moment when teachers and librarians are overworked and less available to see students. David Loertscher confirmed that

Search engines such as Google are so easy and immediate that many young people, faced with a research assignment, just 'google' their way through the internet rather than struggle through the hoops of a more traditional library environment (2003: 14).

There are consequences for the proliferation of Google, which is the most popular search engine, but not the most effective for all research tasks. AltaVista has more features and search capabilities. Google is also heavily immersed in the English language, which creates a shielded world view and increasing marginalization of indigenous vocabularies. There is a reason for the limited vista of this virtual landscape.

Larry Page, one of the founders of Google, developed the technology while a doctoral candidate in engineering at Stanford. The word Google is derived from the mathematical term googol, a one followed by 100 zeros. This origin is important, as founding ideologies invariably frame the meaning of structures in the long term. The cultural orientation of the search engine was engineering, not education, library, internet or cultural studies. There is a suite of Google products, including the image search, a Usenet discussion service, Froogle – a virtual shopping mall - and a catalogue search. In November 2003, a new software package – the Google desk bar – was released, which allowed the user to access the search engine without opening a new web browser. The software was released for free because of the exposure granted to the logo.

The underpinning technology for Google is PageRank, which is an 'objective' measurement of important web pages assembled by the number of links that point to them. Therefore Google ranks their search results via the number of links and hits to that site. For example, when "Tara Brabazon" is entered into Google, the number one returned search is my Home Page, the site developed (by me) to promote my career. It is an advertisement. The links with less hits, but perhaps more critical information, are far lower on the ranking. My personal web page has so many hits because a link is presented at the bottom of each email I send from my work computer. Not surprisingly, hundreds of curious undergraduates with a bouncy index finger click to their teacher's profile. This is one example from one person. Ponder the more serious consequences when students click onto highly ideological sites that are assessed by popularity, not importance or significance. There are many other ways that this ranking could be assembled. The assumption of Google is that popularity is synonymous with quality. Pop Idol, American Idol and Australian Idol were popular. They did not promote quality singing. Google is the internet equivalent of reality television: popular, fast and shallow.

The success of Google is of such a scale that it is one of the few products and nouns that has transformed into a verb. Googling has become a verb for surfing, following a similar path to Xeroxing and Hoovering. Like these other nouns turned verbs, it is a standardized response to plural and complex problems. Photocopying requires an understanding of copyright law as much as where to insert paper into the Xerox machine. House cleaning requires time, rather than simply the purchasing of a Hoover. These nouns-turned-verbs make us forget about process, structure and obstacles. Googling is a one-size-fits all response to information sharing, and assumes that a user has the literacy to not only utilize the search engine but the interpretative skills to handle the results.

By December 2002, Google indexed three billion web documents, and supported 150 million searches a day. Profitable since 2001, it won the contract to be AOL's search engine and handles 75% of searching traffic (Clyde 2003: 44-45). In 2003,

the Expanded Academic Database, one of the most important full-text databases for education and the humanities in particular, also featured a link to Google at the top of every search page. Teachers and librarians need to encourage refereed research, stressing that Google is the start – not the entirety – of a search. There are major consequences to our students, their future and our educational system if we are apathetic rather than pro-active in the building of an information scaffold, rather than allowing a search engine to define the parameters of effective research.

Earlier this year, I was asked to assist two colleagues in a Sydney school. Jacinta Squires and Lee FitzGerald, a high school teacher and teacher librarian respectively, conducted action research on the information scaffold constructed by their students, and the consequences to learning outcomes. They discovered when surveying high school history students that they use Google as a first search, and mobilize the internet ahead of books. They also showed that the students hardly ever read learning outcomes, marking criteria or the library catalogue. Significantly, students also accessed encyclopaedias for gaining information. Squires and FitzGerald's action research is timely and important, but has profound consequences when students make it to university.

Students commence my first year course demonstrating superficial research and comprehension skills, and awkward writing modalities. They presume that if something is written down, then it must be correct. Making students think, rather than assume, and read rather than cut and paste is proving a challenge. Let me display what was submitted to me in 2003. It provides an indication of the problems I am trying to correct. To my embarrassment and horror, here is an example of a bibliography submitted for my 'research paper' at University level.

Reference List:

<http://www.beatlesagain.com/breflib/love.html>

<http://www.beatlesagain.com/breflib/teens.html>

http://ia.essortment.com/historyoftheb_rmdq.htm

<http://www2.canisius.edu/~dierenfb/his389.htm>

<http://www.beatlesagain.com/breflib/teens.html>

I provide students with a course reader of one hundred extracts from books and articles, featuring the most relevant and important material in a subject area. This student has ignored all this material – on popular music, youth culture and fandom for example – to write a paper on the Beatles using a Google search for “Beatles fans.” My comments on this bibliography were clear.

Reference List:

<http://www.beatlesagain.com/breflib/love.html>

<http://www.beatlesagain.com/breflib/teens.html>

http://ia.essortment.com/historyoftheb_rndq.htm

<http://www2.canisius.edu/~dierenfb/his389.htm>

<http://www.beatlesagain.com/breflib/teens.html>

You must never
use internet-based
sources as self-
standing references.

Where are your readings
from the course?

Another example where a student wrote a paper on “Asian gangs” reveals the problem in an even more troubling fashion. Instead of questioning how and why Australian police single out Asian citizens, the student did not deploy this level of interpretation, but merely took information from highly politicized sites.

2020/18/21

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[Accessed 30 October 2003]

Highly racist statements splattered from this bibliography and into the essay, with assumptions expressed about "Asians" being intrinsically violent, tribal and insular. Once more, she inserted "Asian Gangs" into Google and these results emerged. These bibliographies occurred even after I placed the following information in their study guides.

In terms of research material, please remember that I reward a diversity of media in my marking. In other words, I will not be happy if a student constructs an essay on refugees or Kill Bill, taps into Google and constructs a bibliography of sites. The net is an important, diverse database but it also

has major limitations. Your effort in seeking out textual diversity will be rewarded (Brabazon 2003: 9).

Students ignored this warning and utilized the most simple of searches, not even bothering to deploy course readings that had been photocopied for them.

Google standardizes searching at the time when there is a great diversity of both information and users. In a fast food, fast data environment, the web transforms into an information drive through. It encourages a “type in-download-cut-paste-submit” educational culture. A 2001 study reported that 71% of American students relied mostly on the internet for major assignments at school. In this same study, 24% relied mostly on the library and only 4% used both the internet and the library (Lenhart 2001). My aim is to lift that 4% figure so that students are actively moving between the digital and the analogue, the unrefereed web and scholarly databases. Angela Dudfield described this intellectual mobility as “hybrid forms of literate behaviour” (1999).

Google has increased the accessibility of web sites, transforming the landscape of digital information into a manageable formation. It also encourages sound bite solutions that are not researched or theorized. In such an environment, we have to encourage intellectual rigour in an edu-tainment landscape. Google makes searching for information more democratic, but it is also demeaning of the critical and creative thinking involved in well-planned research strategies and refereed scholarship.

Being literate

The future requires no footnotes.
Heather-Jane Robertson (2003:380)

Literacy takes many forms and is saturated with the political interests and investments of myriad groups. My concern with the scale of reading and research deployed by my students opens an envelope of ideas about how literacy is shaped and changed through the digital environment. Such a study is not technologically determinant, but places the internet in a socio-cultural context of education. The problem is not Google. The problem is that I am teaching a cohort of students who are the first generation in their family to attend University, are in part-time work, and do not have either the experience or expectations about the requirements of advanced and internationally-competitive scholarship. My words here must not be taken to suggest that first-generation students should not be admitted to University. My brother and I were the first generation in my family to attend University. I remember the feelings during my first year: panic, confusion and little understanding of teacher’s expectations. However instead of ignoring the set texts, I took the opposite path, reading everything on course lists. This effort was triggered by fear (of failure) and uncertainty about expectations and standards. Crucially though, the proliferation and popularity of the internet and the World Wide Web in education has confirmed that literacy is not an endpoint - a skill to be achieved - but a process of ongoing development and change. Colin Lankshear has shown how reading and writing are social practices that require context to grant meaning. He stated that “literacies are inseparable from practices in which they are embedded and the effects of these practices” (1998: 44). This paper, through the investigation of critical and interpretative literacies in the digital environment, demonstrates that the ability to decode text on a screen does not always create an apparatus to transform information into knowledge. In creating a “New word order,” (Lankshear 1996: 47) there is need to create the participation, building and

translation of information platforms to facilitate conditions conducive to learning and teaching. New 'basics' emerge through the movement from Fordism to (Post) Fordism, aligning with other changes to capitalism and the nation state. The older forms of literacy, based on encoding and decoding, need grafting to higher level comprehension skills. Post-Fordist theorists such as Richard Florida, by acknowledging the casualized and flexible workforce, are translating the languages and imperatives of capitalism by stressing innovation and creativity.

The argument is that creativity is required to foster economic productivity and competitiveness, which then enables (and intertwines) globalization and information technology. For teachers, this social and economic transformation appears to encourage an investment in training and life-long learning. Clearly though, there is much of the old economy in this sexed-up new economy. What I am seeing in my classroom is approximately half of each year's cohort placing education, research and scholarship very low on their list of priorities. Ironically, in the midst of the knowledge economy, students are less creative, innovative and dynamic. Dick Hebdige stated that,

With the public sector, education, the welfare state – all the big, 'safe' institutions – up against the wall, there's nothing good or clever or heroic about going under. When all is said and done, why bother to think 'deeply' when you're not being paid to think deeply? (1988: 167)

Hebdige published these words in 1988. His analysis is even more shockingly accurate in the 2000s and provides a context for student behaviour. They are writing Fordist essays: mass produced papers with standardized search engines. Supposedly, an education geared for an assembly line is inappropriate in the midst of a 'creative' Third Way. When Tony Blair stressed the changes to the economy in his 1997 election campaign, he concurrently placed education (education education) as his top three priorities (Coyle: 2001, 46-54). The reason was clear: knowledge is not only something to teach or share, but exploit. Literacy theorists need to monitor these changes in language, work patterns and technology. If the knowledge economy is to be more than a slogan of the Third Way political agenda, then a negotiation of critical literacies must be granted primary attention.

The difficulty is that most literacy debates focus on student 'problems' in reading and writing, and the methods used to 'correct' or 'solve' these problems. A culture of blame and guilt is established. For example, the front page of The Australian's Higher Education Supplement on April 21, 2004 screamed the headline "Phonics at core of new literacy war" (Cooper: 2004, 21). This newspaper article presented (again) the controversial split between a whole language approach, which encourages students to use context and visual clues to 'decode' the meaning of words, and phonics, which relies on decoding words by breaking them into syllables. What the story did not stress was how different students learn in distinct ways. 'Testing' is seen to track or represent 'learning.' But testing and learning are different cultural formations. Invariably meta-skills – such as an awareness of what is not being asked in a test and why - are difficult to assess, but usefully arch beyond formal education. Further, there is no discussion of the framework in which this literacy war is being waged. Luke placed this debate in context.

This may be the story of literacy education in the late 1990s. It is not a story about the triumph of method but a story about government cutbacks and institutional downsizing, about shrinking resource and taxation bases, and about students and communities, teachers and schools, trying to cope with

rapid and unprecedented economic, social and technological change (1998: 301).

Instead of placing attention on ahistorical 'national standards,' with little attention to technological change or resourcing, literacy teaching and learning needs to be situated within economic and political conditions. The past can never be an indicator or method to evaluate current literacy standards as demographic changes through immigration, and political critiques such as through feminism, have radically altered the meanings and appropriateness of teaching, learning and curricula development. Capitalism is changing: literacies morph in response. An important part of this discussion is a recognition that 'acquiring' literacies rarely occurs solely in an educational institution, but reinforces the skills and ideologies taught in the home (Gee 1991: 9). Formal education is a place to practice already existing knowledge and abilities. The different approaches to literacy development – such as whole language, phonetics, genre pedagogy and critical literacy – also need to monitor the relationship between young people, poverty and literacy. Too often encoding and decoding text is a marker of intelligence, rather than (only) an opportunity to learn and practice encoding and decoding.

In such difficult times, when we are frequently teaching undergraduates who have no idea why they are at University and are ill-prepared for the rigour of scholarship, teachers can become desperate and vulnerable to the promises of technology. Student enrolment figures are increasing with the desire – initiated by Tony Blair but providing a model for Australia – to have half the cohort of young people in tertiary education (Teichler 2003: 171-185). Standards of achievement for our students are changing, and forcing teachers each day to ask about the acceptable parameters of research, writing and scholarship. The movement to mass participation has emerged concurrently with a decline in public funding for Universities. Internet-mediated communication seems an ideal solution to overcrowded tutorial rooms. However (well funded) research has failed to find concrete, verifiable and positive correlations between computer-mediated education and student achievement (Cuban 2001: 178).

Critical literacy is an ambiguous but important phrase, confirming that discussions of literacy must move beyond print-based representations and into how texts are building blocks of identity. There is a gulf between competency-base literacy – encoding and decoding – and critical literacy, which – to cite Macken-Horarik – "problematizes the relationship between meaning making (reading and writing) and social process" (1996: 75). She argues that critical literacy is not an 'add on' to literacy debates, but requires a mastery of everyday, applied and theoretical knowledges before moving to a reflexive negotiation of a knowledge area, text or language (Macken-Horarik 1998: 77).

Mary Macken-Horarik's Model of Literacy

Everyday	Applied	Theoretical	Reflexive
Diverse and open ended	Attaining a particular expertise	Gain disciplinary knowledge	Negotiation of social diversity
Confluent with spoken language	Use of spoken and written words to enable activity	Production and interpretation of epistemic texts	Probing assumed and specialized knowledge systems
Moving through roles and relationships in the family and community	Skill-based literacy	Situated in educational learning environments	Finding alternatives
Personal growth literacy		Specialized literacies	Challenging commonsense
		Assimilating and reproducing knowledge	Meaning determined through diverse media
			Critical literacy

Table based on Mary Macken-Horarik (1998:78).

The question is if – and then how – internet-mediated information encourages or facilitates the movement from the everyday to the critical. Google searches use conversational language and gather superficial information about many topics. By Macken-Horarik's definition, there is little encouragement to gain dense or deep expertise through applied, skill-based critical literacy. Further, with Google hits ranked by popularity rather than interventionist librarianship, disciplinary knowledge and expertise in methodology and epistemology is lacking. Seeing alternatives and negotiating social diversity is difficult to initiate with the majority of websites in English, and the saturation of Google in national languages.

It is necessary to focus time and attention on the building of an information scaffold, to orient students into the world of the text, so that they are able to evaluate Google searches – and websites generally – by moving outside the digital environment and into other media. To obtain this goal, Macken-Horarik recommends teaching strategies that facilitate “explicitness” (1998: 82). The aim of this process is to give students – and citizens – the ability to move texts into diverse contexts and observe how meanings change. For example, when does political resistance become terrorism? How does the justification of violence change when the guns and bombs are moved from Iraq to the United States of America? All (Googled) truths must be granted a history.

Explicitness in method is required to establish an “enacted curriculum” (Wyatt-Smith 1999: 29-35), rather than constructing (another) list of assessment criteria unread by students. There will never be a single way to teach literacy. Learning is a fragile process. In such an environment, pinpointing emancipatory education is difficult. Critical literacy remains an intervention, signaling more than a decoding of text, or a compliant reading of an ideologue's rantings. Operational literacy – encoding and decoding - is a cultural practice of reproduction. Critical literacy requires the production of argument, interpretation, critique and analysis.

Building an information scaffold

One of the best disguised escapes from anxiety is the escape into information.

Hugh Mackay (1993: 226)

Obviously, I have a problem to solve in my assessment structures. After surveying literacy theories, I realize that there is a mismatch between my expectations of research and scholarship and what my students believe is University-level work. I have assumed that operational literacy would inevitably lead to cultural and critical literacy. Google has facilitated a quick and simple 'method' for completing their assignments, assuming that they can answer complex questions about Gramscian hegemony or theories of textual poaching as easily as finding their old school friends. I must change the assessment to actually mark their ability to find diverse sources and interpret them. It is important that I commence this process at first year level.

The first time I attempted to embed and assess an information scaffold in my curricula was successful. At that time, my strategy was prescriptive rather than flexible. In 2002, I wrote the curriculum for a course titled Repetitive Beat Generation, which I taught with Professor Steve Redhead based on his book of the same name (2000). It was an upper-level undergraduate course, small in number and competitive in entry requirements. Only the best and brightest gained admission. Before writing a research essay, students were required to submit an annotated bibliography.

Annotated Bibliography

There are strict requirements on this component of the exercise. Students must include at least thirty sources. Each source is accompanied by a 20-50 word description, showing how they are to be used in the project.

Of these thirty sources,

At least twelve must be refereed articles and books, split evenly between the two categories. Students must therefore learn how to use databases, such as the expanded academic database. Come and see Tara – she will show you how these operate. Please note: these books and articles must be non-fiction.

There must be at least five references from popular music.

There must be at least one film or television programme.

There must be at least five web sites.

There must be at least two magazine or newspaper articles.

There must be at least two novels or collections of short stories.

This is obviously a difficult exercise, but it is important for students to increase their research capabilities, and develop analytical skills in a wide array of media (Brabazon 2002: 21).

The results from this highly regulatory assessment were innovative, considered and balanced. The essays derived from this bibliographic exercise were of the highest standard I have seen in my academic career. Most of the students in the group then went on to honours and postgraduate work. Two students left the course, unable to complete this assignment. Although I was unaware of it at the time, I created a scaffold for learning which slowed the research process, creating time for reflection and planning.

This year, in my upper level course, Cultural Difference and Diversity, I attempted this process again – not for the undergraduates, but for the honours version of the course. I made the Essay Outline and Annotated Bibliography worth only 10% of the overall mark, in case the assessment was not successful.

Essay Outline and Annotated Bibliography (10%)

Length: 1500 words (a combined and maximum limit for the two parts)

Due date: Monday, April 19, 2004

This assessment is aimed at helping students develop their main essay. The assignment has two parts.

(A) Essay Outline

A topic for the main essay must be presented, alongside both a clearly crafted question and thesis statement. Ensure that you present the structure of the paper. Also, display what you believe will be the strengths and problems you may confront in researching this paper.

(B) Annotated Bibliography

Present at least 10 references, with a short description of how these sources will contribute to your paper.

This assignment worked extremely well and the feedback from students was excellent. They found that the project crystallized their main essay and confirmed the research material available to them. The task for me is to now translate these earlier successes – in a specialist and competitive upper-level undergraduate course and an honours course respectively – into a first year course.

In previous versions, my first year course Introduction to Cultural Studies featured four modes of assessment.

Prior Assessment Structure for Introduction to Cultural Studies

1. Textual Analysis (20%)
2. Main Essay (40%)
3. Take-home exam (30%)
4. Tutorial participation (10%)

For 2004, I have removed the textual analysis, which assesses students' ability to understand and apply semiotic terms, and replaced it with a project tethered to the main essay, which assists students in building an information scaffold

Current Assessment Structure for Introduction to Cultural Studies

1. Essay Justification and Annotated Bibliography (20%)
2. Main Essay (40%)
3. Take-home exam (30%)
4. Tutorial participation (10%)

The form of this new assessment, when considering the directives of critical literacy theory, needs to be overt with assumptions unmasked. The following assignment reveals how I have worded the question in their study guides.

1. Essay Justification and Annotated Bibliography

Due Date: At any point of the semester, as long as it is submitted by the end of week nine (October 1, 2004)

Weighting: 20% of the course

Word Length: 1000 words

This assignment prepares students for writing their main paper. You therefore must decide on the topic for the main essay before completing this first exercise.

You must do the following.

STAGE ONE

Present your chosen question, justifying your choice and identifying any problems – in terms of material, interpretation or argument - that you foresee. Outline the primary theorists and major argument of the essay: that is, the point you are trying to prove. This section will be between 400-600 words in length. Write in full sentences and paragraphs. If I see a bullet point, then I will kill myself and/or the student responsible for this affront to scholarly writing.

STAGE TWO

It is expected that students will use between 10 and 20 sources from the Reader for the Main Essay. Therefore this second stage for your first assignment focuses on students finding sources **OUTSIDE THE READER**. Students are required to locate **TEN FURTHER SOURCES** and write between 20 and 40 words on each, explaining their relevance to the project. This explanatory paragraph creates an 'annotated bibliography,' rather than simply a 'bibliography.'

The ten sources must be of the following type.

- Two scholarly monographs. (Please note: a monograph is a book. Ensure that the text is produced by a recognized scholarly publisher, such as a University Press.)
- Two print-based refereed articles. (Refereeing is the process whereby a journal sends out an article to scholars in the field to assess if it is of international quality and rigour. Students know that articles are refereed because the inside cover of the journal lists an editorial board, and the process of review will be outlined. Examples of refereed journals include the Cultural Studies Review, The International Journal of Cultural Studies, Media International Australia, Cultural Studies and Continuum. These are all available in the Murdoch University Library. Other refereed articles are also accessible through full-text, refereed databases of the Library.)
- One web-based refereed article. (Students must ensure that the site they use – such as M/C or First Monday – is a refereed online journal. Again, you will find that the journal lists an editorial board and states that it is refereed.)
- One web-site that is non-refereed (that is an online article from publications such as Online Opinion, Arts Hub, a blog or fan club site)
- One magazine or newspaper article.
- One track or album of popular music
- One advertisement (from radio, television, magazines or the online environment), an item of fashion, food product or sporting equipment.
- One television programme or film.

Remember - after each source is listed - students must then write 20-40 words about the text, including why it was selected for the project.

The aim of this exercise is to teach students how to find information and how to assess the relevance of research. Once completed, this material becomes the further reading for the main assignment. When writing the main essay, students simply intertwine these sources with the set course reading. Your research for the main essay is done!

You are learning something new. Do not be frightened. CHALLENGES ARE GOOD. Your brain is growing.

You are not on your own. Tara is happy to help in any way, explaining the nature of information and source material. Do not hesitate: come and see me – or email me – with any queries.

The word length for both parts of this project is a combined maximum of 1000 words

While I am not yet content with the precise wording of this assignment, it does address the problems that have worried me in the last few years. Expectations about reading and research are revealed, and the 'unspoken assumptions' about University education are presented. Further, for those students without these knowledges about finding research material, I have constructed an information scaffold so that they know what is required, and if they do not then they must ask me.

This process aims to make students think about the quality of information and how it is structured. It slows their research process and creates space for critical literacies. Speed searching blurs the distinction between data, information and knowledge. Through the convergence of technology, communication and entertainment, we are losing the capacity (and/or time) to evaluate material. There is an abundance of information, but what is scarce is the right information in an appropriate context. Evaluating the quality of web and print sources requires training and skill development. Often forgotten is the rigorous refereeing process that formulates the production process for books and articles. While some material on the web is refereed, generally the pieces are short and the arguments less developed.

I have realized through the last three years that I will have to teach my students how to gather and interpret information. I had made suppositions about education, libraries, reading and writing and assumed these ideas were understood by my students. Obviously that was an arrogant presumption. Curricula must be reframed to ensure that students can make meaning from a textual environment. For the next few years, in each of the courses I now write, the aim will be to develop interpretative capital, linking form and content.

Student users must approach web searching with thought and consideration. Two words in Google is not an endpoint of the research process. Planning for searches creates electronic and intellectual expectations. It also commences critical thinking and interpretation before slamming into an information glut. This rational and ordered approach to information management is distinct from the random, emotive and conversational mode of searching through Google. Finding old high school friends through Google is fine. Conducting research for high school using the same

method is inappropriate. The key is not how many hits are returned from a search, but how many were relevant, current and live sites.

While web use for academic research is increasing, the quality of sources varies tremendously. Students are confusing quality and quantity information. The triviality of the material found means that we too often become enthused with access to sites and do not ask why we needed access this material in the first place. The key skill that most of us need to learn – which is facilitated by the expertise of librarians – is how to manage and balance print and electronic resources. Collection management is even more important in an internet-mediated environment than outside of the digitized realm. Richard Sayers realized that “our challenge is to convince the techno-faddists and economic rationalists that Google is still not yet one of the seven wonders of the modern world” (2003: 410). It is rare for technologies to destroy each other. Google is a disruptive, not destructive, technology. Newspapers, radio, television and the internet co-exist. Books did not die with the internet. Offices and schools are not paperless. Google will only be one stop in a long journey through research and scholarship.

Some of the best modes of teaching do not begin with the presentation of information. The difficult decision for me to make through this process of curricula revision is to relinquish the ‘testing’ of content, via the first semiotics-based assignment. While I believe that it is important that students gain detailed knowledge about cultural studies, it is also now necessary that they be ‘encouraged’ to read more widely and with consciousness. Teaching form rather than content allows students to be active participants in the building of an information scaffold, facilitating the creation of critical literacies. That objective is as much a part of cultural studies as textual analysis.

As our first lesson in schools and universities, must teach, test and re-teach how to assess the quality of all information. I now encourage students to ask five preliminary questions.

1. Who authored the information?
2. What expertise does the writer have to comment?
3. What evidence is used?
4. What genre is the document: journalism, academic paper, blog, polemic?
5. Is the site funded by an institution?

Asking students to answer these questions is a way to limit the free range of searching on the internet. They must pause, reflect and think. These questions foster recognition that finding information is not necessarily convergent with understanding information. Without such critical pauses, the inclusion of the internet into the school and university curriculum may ensure access to information, but does not promote the development of critical thinking, wide-ranging research, high quality writing and innovative interpretations. Google’s popularity does not facilitate or encourage the discipline and structure that many of our students require. The technology itself is not to blame, but the poor funding of schools and universities – and the low credibility granted to teachers and librarians – is at fault. The difficulty is that information – through Google – is seen to be both abundant and cheap. The abilities required to assess this information are more difficult and costly to obtain. If my first year students can understand the meaning and purpose of refereeing and recognize that not all sources are equivalent, then I have been successful.

There remains a gulf – a wide and expansive canyon – between principles and practice. I am not sure how my students will respond to this change in assessment.

The historian in me is worried that if I remove overt assessment/checking of their semiotic ability then they will be unable to complete the main essay which requires this knowledge. But my desire – at least for one semester – is to attempt an intervention in poor research methods and broaden students' reading. Providing students with tools does not mean that they are used. Hoping that students will magically read widely without the building of an information scaffold is an intellectual relic of an earlier age.

If this paper has an agenda, then it is the importance of techno-skepticism. The skill and techniques of well trained teachers and librarians are required in this information age to block students from googling their way through a degree. Until their testamur reads Bachelor of Arts (Google), such interventions will be required.

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Biography

Tara Brabazon is an Associate Professor in Media, Communication and Culture at Murdoch University and Director of the Popular Culture Collective (<http://www.popularculturecollective.com>). Her research interests include internet studies, sport, popular music, creative industries initiatives, city imaging, multiculturalism and education. She has published three books, Tracking the Jack: A retracing of the Antipodes, Ladies who Lunge: celebrating difficult women and Digital Hemlock: internet education and the poisoning of teaching. A fourth book, Liverpool of the South Seas: Perth and its popular music, is released by the University of Western Australia Press in October 2004. A fifth book, From Revolution to Revelation: Generation X, Popular Memory, Cultural Studies is published by Ashgate in November 2004. She is a previous winner of a national Australian Teaching Award for the Humanities. For further information please refer to <http://www.brabazon.net>(.) Contact Tara via t.brabazon@murdoch.edu.au(.)

e-learning as technology, e-learning as learning

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Abstract

This paper explores two main themes: Firstly, it examines what we understand about the economic, technical and social impacts of new technologies and examines how this might relate to the complex range of technologies that fall under the title 'e-learning'. It argues that detailed exploration, using foresight methods, of the likely impacts of various e-learning technologies is a key task.

Secondly, understanding of how learning happens, from a constructivist viewpoint, is used to develop a set of criteria against which e-learning approaches can be judged. The paper concludes by applying the principles developed to the case of e-learning in electronics within D&T.

Key words

E-learning, learning, ICT, new technology, impact, D&T, electronics simulation software, microcontrollers

Biography

Torben Steeg is a freelance consultant in education, specialising in curriculum development, evaluation and research in Design & Technology, Information and Communication Technologies (ICT), Science and Mathematics. He is also an Honorary Research Fellow in the University of Manchester Faculty of Education where, until January 2004, he was Subject Leader for the PGCE D&T course, supported the development of students' understanding of ICT use across all PGCE courses and taught on the MEd in ICT course. He is external examiner for the PGCE and KS2/3 D&T courses at Liverpool John Moores University. Research interests include the interactions between D&T, ICT, Science and Mathematics, the use of the Internet in schools and, within D&T, systems thinking, control technologies and the uses of ICTs to support learning. He works with the Nuffield D&T Project and is a member of the editorial boards for the IEE's 'Electronics Education' and DATA's 'Journal of D&T Education'. He is also a member of DATA's ITE Advisory Group and an accredited trainer for Pro/DESKTOP and for the ECT initiative. Previously he taught D&T, Control Technology, Science and IT before moving to the University of Manchester, initially to work with the Technology Enhancement Programme.

e-learning as technology, e-learning as learning

This paper explores two main themes: Firstly, what we understand about the impact of new technologies and how this might relate to e-learning as the application of a range of new technologies. Secondly, our understanding of how learning happens and what the implications might be for 'e-learning'. The paper concludes with a brief application of the issues raised to a particular instance of e-learning.

The impact of new technologies

It has been common for some years now to use the letter 'e' as a prefix to signal a familiar activity being carried out using electronic technologies and, in particular, Information & Communication Technology (ICT). E-mail, e-commerce, e-gambling, e-books, e-banking and, of course, e-learning are familiar examples and the purveyors of each new 'e-' prefix seem keen to imply two things;

- 1 That the transfer of the activity from the physical to the electronic domain is unproblematic;
- 2 That this transfer will fundamentally, and for the better, transform the activity.

Fostering such feelings towards these new technologies presumably makes sense from the perspective of those promoting them; they may view potential users as potentially conservative in their habits and, in particular, cautious about transferring activity from a known realm to one that is unfamiliar and intangible. Often the imperatives for change are financial so that moving people onto new systems as quickly as possible is highly motivated by economics.

However, both of the above claims are generally challengeable. Transfer of an activity from one domain to another is unlikely to be completely unproblematic and, while this transfer may indeed transform the activity, whether this transformation is 'for the better' or not relies upon value judgments and questions of 'better for whom?'. Moreover, the two implications contain the seeds of a contradiction; is it likely that a transformation of the way an activity is carried out will be unproblematic? On the whole it seems likely that the more fundamental the transformation the more likely it will be that unforeseen problems will develop in the process of transfer.

E-mail is an example of an electronic technology familiar to many people (but by no means at all to all people, even in supposedly 'wired' societies such as the UK). Is the transfer to e-mail from other, paper-based, forms of communication unproblematic? The answer has to be 'no'. Brief consideration of e-mail as a technology reveals problems in the economic, technical and social arenas.

A fundamental economic problem is clear; access to e-mail is predicated on access to costly and technically complex Internet infrastructure and technology. It is easy to forget in the affluent North, as we juggle our phones, and decide whether to communicate by SMS, fax, e-mail, instant messaging, blog, or voicemail, that in some areas of the world access to a phone remains a luxury. Even in richer countries there is concern about the 'digital divide' between those who do have easy access to Internet technologies and those who don't.

Those who do have economic access to the required technologies may still find that e-mail is not necessarily a straightforward technology to master. Internet technologies, and, I believe, computer technologies generally, remain immature technologies; by this I mean that they are neither intuitive to use nor technically robust. The majority of e-mail

users in the UK rely either on technical support at their workplace to set up and maintain a reliable e-mail service or on pre-installed or automatically installed (e.g. from a CD-ROM) services to set up e-mail (but not maintain it) on their home computers. The problem, for the majority of non-technical users, with the latter is that the very necessary maintenance to keep a modern PC running effectively is expensive. The experience of most PC owners is that performance and reliability degrades over the first six to twelve months – and this affects access to e-mail.

For those with effective access, e-mail has had a significant social impact. It transpires that, although e-mail appears to have similar aims to traditional postal mail, the differences are such that people generally approach the business of e-mailing others quite differently. It will take a longer perspective than we yet have to identify the full ramifications of this, but we can identify some issues that seem important now, while accepting that the landscape is still changing. These include:

- An increase not only in the actual speed of communications but also in our expectations of speediness in response to our own e-mails.
- Huge growth in the number of communications we have to deal with every day. This is compounded by;
- Not only spam (deliberate mass junk e-mail) but volumes of irrelevant e-mail because it cost nothing to send an e-mail to multiple recipients, which leads to;
- A growth in the time spent simply managing e-mails. In particular managers who used to delegate paper mail to secretaries have often kept hold of their e-mail management.
- The use of e-mail as the commonest pathway for viruses and similar software into computers, requiring;
- A need to constantly update computer software to prevent viral infection of computers.
- A blurring of the work/leisure boundary as e-mail, along with other new technologies, has made it easier to work not just at home but on most forms of transport as well.
- A terseness in communication urged partly by the speed of the technology but also by the volumes of e-mail that need to be processed.
- Concerns about privacy, as Government lays down rules about the number of years that e-mails must be stored for (even when users have deleted them from their own computers). Interestingly, it remains inconceivable that a Government should attempt to impose the same rules on paper communications; it seems that with e-mail they have because they can.
- Embarrassment as rashly worded e-mails are instantly sent leaving no opportunity to reflect and revise; as e-mails are sent to the wrong people, or to groups of people instead of individuals; or as assumed to be private e-mails are circulated round the world – because it costs nothing to do so.
- There has been a reduction in face-to-face meeting of colleagues in workplaces as a quick email replaces a walk and a chat.

Clearly there are also social benefits that e-mail has brought – or people wouldn't persist with its use in the face of the issues noted above. These benefits are not listed here, as the aim has been to illustrate how a reasonably simple technology is having a significant social impact on the lives of many people in ways that were neither desired nor predicted (nor probably predictable) by the inventors of early e-mail systems and

are not welcomed by e-mail users today. It's noteworthy that e-mail has not done away with the postal service (or, yet, internal paper mail in most companies); rather it has added another layer of communication that complements (or in the worst cases duplicates) other communication channels such as the letter, the memo, the phone and the fax.

As an aside, it is interesting that SMS (texting), which can be characterised as a highly mobile 'e-mail lite', has been phenomenally successful despite being a feature of mobile phones that was, initially, neither planned nor advertised for consumer use. In this case there was no single prior activity that texting has replaced; rather, as with e-mail, a range of prior technologies have been sidelined some of the time. More importantly, texting has created a novel method of communicating that satisfied previously unrecognised communication desires or needs and enabled new, less planned, ways of living day-to-day life, so transfer of an activity from one domain to another has been less of an issue. As with e-mail there are access issues arising from economic factors, but the economic threshold for access is substantially lower as is the competence threshold for operation, while, because phones are simpler devices, their technical maturity is higher than that of desktop computers. Nevertheless I'm sure that a list of undesirable social outcomes could be drawn up, not least by teachers.

Why all this discussion of e-mail in a paper on e-learning? Because e-mail is a technology that is reasonably well understood and familiar, with an apparently straightforward aim (communication) whose social impact is becoming evident to us. Consideration of the issues surrounding e-mail in the economic, technical and social arenas serves as useful warm-up to thinking about the relationship between learning and e-learning. In contrast to e-mail, e-learning can be based on a wide range of technologies that few understand well and that are rapidly developing, has an aim that is acknowledged to be complex to achieve (learning) and is likely to have social impacts that, though difficult to fully predict, will probably be of deeper significance than the impacts of email.

Perhaps one useful outcome from this conference might be the detailed exploration, using foresight methods, of the likely economic, technical and, in particular, social impacts of various e-learning technologies. It is the nature of impact predictions that they are guesses into the future; many will be familiar with famous predictions from the world of computing such as that of Microsoft's Bill Gates in 1981 that "640K ought to be enough computer memory for anyone" or the prediction from Popular Mechanics magazine in 1949 that "Computers in the future may weigh no more than 1.5 tons.". Whatever the risk of looking foolish in the future, we are not absolved from the responsibility of examining carefully the potential impacts that the new technologies we introduce into education might have.

Learning and e-learning

Learning is generally agreed to be relatively permanent change in the behaviours, capabilities, thoughts, or feelings of an individual that results from experience. The basis of learning is change in the neural structure of the brain that is still not well understood, although neuroscience research is currently making rapid progress in uncovering aspects of how learning happens.

E-learning is exactly the same; that is to say the end result of e-learning is learning because change in the brain has occurred. The 'e' in e-learning simply indicates that a relatively novel medium (ICT) is being used to support learning. It is e-learning as opposed to book-learning, or lecture-learning, or field trip-learning, or practical

experience-learning. In the same way, the end result of e-mail (a written communication delivered to a recipient) is the same as postal mail or hand-delivered mail, even though the process of delivery and the form of the communication is rather different.

Two things make e-learning both more interesting and more complex than the raft of other 'e-' technologies. The first of these is the question of how learning is actually encouraged to happen – not in the neuroscientific sense but in terms of cognitive psychology; that is, the methods by which learning can be most effectively stimulated. The second is the increasing power of the underlying computer technologies to both simulate the repertoire of teaching approaches that can stimulate learning. There is potential, in this simulation, to improve the quality of at least some of these teaching approaches.

Cognitive psychology is an active and somewhat contested field of endeavour. However, in a broad constructivist view of learning, a range of features of learning are generally agreed that can be summarised as:

- Learners construct their own models of the world from their experiences in it.
- The resulting mental constructs are highly individual.
- These mental constructs are robust.
- Social interaction plays a significant role in the construction of mental models.
- Thinking about how you think (metacognition) can improve learning.

Such a model of how learning happens has some key implications for how teaching should be organised. These can be outlined as:

Teachers ought to elicit not just what pupils know before embarking on teaching, but the context of that knowledge in the pupil's worldview.

However, this elicitation is not straightforward. Asking a pupil to articulate their knowledge will not necessarily result in them saying what they actually believe (research on undergraduate physicists' understanding of physics concepts has shown that it is quite possible to answer physics exam questions correctly and gain a place on a university physics course while maintaining scientifically incorrect understandings of fundamental GCSE level concepts). Where pupils do accurately report their understanding they are unlikely to be able to describe the mental constructs in which these are held.

Many teachers are having some success in using tools such as mind or concept maps to help them elicit pupils' prior knowledge. Some subject teachers (e.g. of Maths or Science) can make use of quite detailed research-based information on the range of prior concepts that pupils are likely to have at particular ages. It is likely that the majority of teachers rely on their training and subsequent experience to inform them of the likely subject constructs that pupils will bring to particular topics.

Teaching based simply on the transmission of knowledge is unlikely to result in change in these robust mental constructs. Rather, teaching requires the creation of situations that allow pupils to actively develop or re-order their mental constructs. A wide range of these 'active' learning approaches have been developed and are in wide use in schools. Their use has also been incorporated into national initiatives such as the KS3 Strategy.

In some cases, successful re-ordering of mental constructs may require the creation of 'cognitive conflict'; the deliberate setting up of situations to reveal flaws in existing mental constructs.

The inherent robustness of mental constructs means that change may require pupils to have multiple opportunities to experience cognitive conflict spread over long periods of time. For example a 'spiral' curriculum is designed so that subject matter is revisited a number of times during a key stage with increasing cognitive demand and in a widening range of contexts.

The individuality of pupil's mental constructs is fundamental to the need for differentiated teaching. Differentiation, like active learning, is well explored field, but high quality differentiation remains a demanding expectation for teachers operating in the traditional 1:30 setting.

Social engagement is central to the construction and reordering of mental constructs. Pupils need a lot of opportunity to engage with active learning in settings that encourage talk; in pairs and groups, in informal and formal settings, to each other as well as the teacher (or other subject authority).

One of the most strongly expressed findings of the APU's work on D&T was that:

"There are few things in life that are certain, but one of them is that the occasional use of paired and/or small group activities, and the use of short but structured discussions, will enormously help pupils to make progress in their work"

The engagement of pupils in metacognition has been shown to make a significant difference to their learning. In recent years a range of projects have provided materials for schools to encourage metacognitive activity, including some that are focussed specifically at Science and at D&T classrooms. Metacognition is also a key strand in the KS3 Strategy. Yet amongst all this activity it is not clear that work in D&T, in particular, is used as matter of course to engage children in thinking about how they think.

A summary of the lessons from cognitive psychology provides an interesting set of criteria against which we might judge any approach to e-learning:

- 1 Does it support learning through concrete experience?
- 2 Does it encourage active engagement with the subject matter?
- 3 Does it support the elicitation of prior understandings?
- 4 Does it allow for the fact that progression is not necessarily sequential?
- 5 Does it allow work in a range of contexts?
- 6 Does it support metacognitive activity?
- 7 Does it provide opportunities for pupils to 'talk' so that learning is embedded, for example within small groups or large groups, one-to-one, or to oneself (for example in a process diary)?

To pick a bad example for submission to these criteria, an e-learning approach that was particularly fashionable in UK schools the 1990s was the Integrated Learning System (ILS). This was very close to what we now call a Managed Learning Environment (MLE), some 10 years later, the main difference being that ILSs were built on proprietary technology rather the 'open' Internet technologies used by modern MLEs. The model for teaching proposed for ILS systems was that a group of pupils would sit, individually, at a computer screens, wearing headphones (as instructions were given both as text and voice) and responding to questions provided by the computer system. An ILS fails on criteria 1, 4, 6, 7 and only weakly meets criteria 2 (the engagement is active within the limitations of on-screen activity), 3 (many ILS systems have a system of establishing the level at which a pupil is working, but this is based on what the individual can do on-screen and is not able to probe understanding in any deep sense), and 5 (most ILS systems provide a range of on-screen contexts). Not surprisingly, the

extensive evaluations of ILS systems carried out in the UK concluded that they were only effective (if at all) when firmly embedded within 'traditional' teaching approaches or, to use a current idiom, within 'blended' learning. More damning was that the evaluations found it hard to establish significant learning gains at all, which must have a disappointment to the schools that spent tens of thousands of pounds on dedicated servers, dedicated computer suites and software licences with, it must be said, a great deal of encouragement from UK Government agencies. It is, presumably, safe to assume that no-one in these Government agencies undertook an initial evaluation of the software's potential against learning criteria such as those above before encouraging schools to purchase.

I hope that another outcome from this conference might be the detailed analysis of various learning technologies against the kinds of constructivist learning criteria outlined above.

An example of e-learning

New technologies can drive curriculum change as much as the desire to do new things in the curriculum can drive the development of new technologies. When these forces operate in concert there can be overwhelming pressure to both adopt the new technology and to transform the curriculum in the light of this technology.

The teaching of electronics in D&T is in the process of such a transformation in the UK. New technologies that allow a great deal of design and development work to be done on computers rather than with physical components are working in concert with the desire to open up electronics to a much wider section of the pupil population. Specifically, two key e-learning technologies are:

Electronics simulation software

This allows circuits to be simulated and validated on the computer screen. Systems based approaches for those new to electronics and component based approaches for more advanced users are available. It is now possible to design a circuit on screen, test and validate its operation using the computer, automatically transfer this design into printed circuit board (PCB) design software and then use the PCB software to create files that will drive CAM (computer aided manufacture) machinery to produce and drill the circuit board. All the pupil has to do in the physical world is solder the components into place.

Microcontrollers

These are low cost (around £1) computers on a chip, containing processor, memory, and input and output control. These are the devices that now populate and control a wide range of everyday electronic devices from kettles onwards. One particular version, the PIC, is proving particularly popular in UK schools. A wide range (around 10) of competing approaches to programming PICs now exists, from high level, iconic, software environments running on a PC to small handheld programmers and even the use of mobile phones. When programmed using high level software, programs can be simulated and validated within the software environment before being committed to the PIC. The PICs in use in schools can be reprogrammed many times and, in some of the available approaches, they can be programmed while they remain in the circuit they are controlling.

In an electronic circuit a PIC replaces all of the 'processing' elements of the circuit; all that is required in the circuit is provision for input and output signals to be connected to the chip and powered appropriately. Thus the resulting circuits are

compact.

Not only do PICs allow pupils to work in contemporary ways with electronics, they eliminate many of the things that are obstacles to pupils' success in component based electronics; complex PCBs that are difficult to trace faults on, the need to understand a wide range of components, the increasing cost of a circuit as operational complexity rises.

Here are two new e-learning technologies that have rather different emphases but that are both contributing to new approaches to electronics teaching in which electronics design is moving from the physical to the 'virtual' realm.

We have established two sets of questions that can be asked of these e-learning technologies, one set relating to their possible economic, technical and social impacts and a second set relating to the way they might support learning. The table summarises, very briefly, some possible responses to these questions.

Impacts

Economic	<p>Costs of software and supporting hardware. Could be disparity in access to the technology.</p> <p>Possible economic impact of greater numbers of pupils leaving school with an interest in electronics design and manufacture. But also an issue of whether the skills gained through new approaches provide a suitable foundation for progression in the subject.</p>
Technical	<p>Generally shifts the technical demand from lower to higher levels in the system. E.g. with PICS there is a move from a design focus on the operation of individual components to a focus on how the system as a whole should operate.</p> <p>Less focus on handling individual components could reduce confidence in practical aspects of the subject while increasing overall confidence in ability to 'do' the subject.</p> <p>Effect on confidence if infrastructure failures leave pupils' work irretrievable. Confidence in the software is highly dependent on the simulation provided being an accurate simulation of the physical entity.</p>
Social	<p>Greater numbers of pupils engaging with the subject leading to electronics developing a different social image.</p> <p>Technical development is pushing change in examination specifications.</p> <p>Greater success with electronics leading to higher self esteem growing out of mastery of a 'difficult' subject.</p> <p>Understanding of the scope of what electronics can achieve more widespread socially leading to greater demands for useful devices.</p> <p>Reduced ability to mend own products due to lack of practical skills – or raised ability to mend own products due to greater confidence in understanding how electronic devices work.</p>

Quality of learning supported	
Support of learning through concrete experience?	Experience is not of concrete objects in the physical sense, but the manipulation of circuit symbols or program elements is a concrete experience that provides concrete feedback. Pupils have the freedom to try out their own designs with instant response from the simulation and no risk of damage to anything in the physical world.
Encouragement of active engagement with the subject matter?	The simulation environments have been designed to encourage active engagement with the subject matter, not least because designs can be instantly tested and refined.
Support for the elicitation of prior understandings?	The software environments have been designed so that scenarios can be pre-designed by the teacher; these can be used for elicitation purposes.
Allowance for progression that is non-sequential?	There is no model of progression built into the software; the approach to progression is dependent on the teacher.
Allowance for work in a range of contexts?	Design can be undertaken in any relevant context, but work is always contained in a software environment. Experience with real components is probably required to broaden the contextual experience.
Support for metacognitive activity?	Not explicitly built in, but the environments are ripe for teacher metacognitive intervention.
Provision of opportunities for pupils to 'talk'?	Not explicitly built in, but the environments are sufficiently rich that pupil talk will be supported by the environment if encouraged by the teacher.

On the above analysis, these environments seem to generally pass the learning tests set up and the potential impacts identified are generally benign or manageable. On the basis of this analysis it would be reasonable to recommend this form of e-learning to teachers. But teachers of electronics have, of course, already recognised the pedagogic quality of these new approaches to teaching electronics, if only intuitively; simulation software and PICs are already an ICT success in D&T departments.

Which leaves us with the lesson that, whatever analyses are done on e-learning effectiveness, the voice and the choice of the teacher needs to carry significant weight in funding decisions that relate to e-learning. Teachers, after all, generally really do know best.

A review of the literature concerning website effectiveness: before, during and after use.

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Abstract

There is a need for effective websites to help to integrate sustainable development principles into design and technology education. This paper describes current sustainable design initiatives in education which aim to achieve this integration of sustainability principles. Despite large investment into information communication tools such as websites, the impact that these websites have within education is rarely assessed. This paper outlines the key areas of the broad topic of 'website effectiveness' according to literature in this area. It also investigates the comprehension of website effectiveness within this context, and identifies three distinct phases of effectiveness: before use, during use and after use. The paper uncovers gaps in the research in two areas; primarily a need for further research concerning influence after a website has been used and requirements for ensuring a wide knowledge of the websites existence. The paper also discovers some conflicting ideas of importance between a websites' usability and likeability.

Keywords

Sustainable design, effectiveness, websites, impact, decisions, usability

Introduction

The response by businesses and designers to sustainable development and more specifically sustainable design, has evolved over the past few years. Initially industry sought to reduce environmental impact through 'end of pipe' techniques in the 1980s. The emphasis later shifted to look at cleaner manufacturing processes that address issues of less waste and pollution. Currently the focus now resides in a 'cradle to grave' approach looking at environmental, social and economic aspects throughout a product's lifecycle (Bhamra 2004). The design of products, and the education of designers, has therefore become integral to the movement's success.

Sustainable Development has become a prominent part of design and technology education. Schemes such as Design for the Environment Multimedia Implementation (DEMI) (Clare 2001) led by Goldsmiths College (University of London), Practical Action's Sustainable Design Award (SDA) (Capewell and Norman 2003) and Sustainable Technology Education Project (STEP) have all been championing the movement.

Bhamra (2004) identifies the current position of sustainability as combining technology, culture and nature, the success of which relies on the effectiveness, innovation and creativity of its implementation. Furthermore Bhamra (2004) identifies five significant features that aid the progression to sustainable design:

initial and sustained motivation; communication / information flow; whole-life thinking; hands-on environmentally conscious design; positioning in the world. (Bhamra 2004: 564)

Sustainable design websites relate to various aspects of the features identified by Bhamra (2004). In design and technology education sustainable design websites are

often used as key communication tools for students to refer to, and it is their effectiveness that will be focused on. The internet could be seen as an appropriate tool for educating young people as they represent a significant part of the population of internet users (Wu 1999). According to FIND/SVP, 30% of people who use the internet are between the age of 18 and 29, and 42% of internet users hold degrees.

Sustainable design websites and their success may be determined by analysing how effective they are at communicating the information, *before use*, *during use* and *after use*. In this context, the sustainable design education websites all aim to inform young designers of the issues and to help influence their design decisions by giving them access to information on more sustainable methods. Effectiveness, in this instance, could be deemed to be when a student uses one of these more sustainable methods, acting from the website information available. Perhaps effectiveness could be defined as thinking about the issues in a different way after being inspired sustainability i.e. considering sustainability issues in their design work without necessarily employing the sustainable methods. Website effectiveness may be better assessed in the context of people changing their behaviour rather than taking an action. The websites may not have an immediate affect on the user but trigger the issues at a future point in their work or everyday lives, it is this influence that is difficult to pinpoint.

The effectiveness of sustainable design websites in conveying and communicating information is therefore an important focus area. It takes a greater priority when you consider sustainable design as an evolving area that designers struggle to prioritise. Generally website assessments fail to consider all of the areas of website effectiveness and therefore it is very difficult to define. Most website assessments are focussed on usability or are assessed for aesthetical value but whether the websites are effective in communicating is left to chance. There is little prior art for which this research can be based. Any hypothesis must therefore derive from the research undertaken and defining website effectiveness is therefore imperative for the study to progress. How can effectiveness be judged? Is it judged by a designer gaining an understanding of the relevant issues or an attempt by the designer to resolve these issues? Or is it that a demonstration of effective sustainable design practice is the criterion for success? The word 'effectiveness' can be extremely broad, for example a website may be considered effective by simply getting a user to access the site, or return to it. The understanding of effectiveness could also be judged on how much influence it has on the user. The focus of this study concentrates on sustainable design education websites which are used by sustainable design initiatives as a tool to inform and inspire various aged students.

Sustainable design initiatives

The Sustainable Design Award (SDA) is run by charitable organisation Practical Action. They aim to 'help bring issues of sustainability into mainstream designing and making at AS and A2 level' (Capewell 2004). Communication has proved a vital component in the development of the scheme to both teachers and students through different forms of media, from handbooks to teaching sessions and a dedicated website. From training days to key one to one inputs in schools, the SDA scheme aims to raise the profile of sustainability to the designers of the future. The website has become an integral part of that education. The Sustainable Design Award website (www.sda-uk.org) averages around 13,700 visits a week (MediaHouse 2006), the majority from academic servers. The SDA website has become a practical way of communicating sustainable design

information directly to students. This website, and others like it, could be seen as being a key information resource tool for design and technology education. DEMI has also been a notable scheme that is 'responding to the need for sustainable development curriculum within and throughout undergraduate design programmes' (Clare 2001). It has similar aims to the SDA but is run solely as a website resource aimed at older students, predominantly undergraduates. DEMI was developed by a consortium of several academic institutions including Goldsmiths College, Falmouth College of Arts, Surrey Institute of Art and Design, the University of Brighton and the Design Council. They aim to bring together sustainable development issues and debate, whilst providing key information for students. Sustainable Technology Education Project (STEP) is a sustainable design scheme aimed at key stage 3 and 4 students. STEP is produced by Practical Action and is funded by the Department for International Development (DFID) and the European Commission. STEP 'aims to increase young people's awareness of sustainable technology, enabling them to recognise the economic and environmental impacts of the technology they choose' (Capewell 2003).

Website effectiveness

In order to establish a consensus of what is considered to be website effectiveness, an extensive literature review was carried out to draw together several ideas of effectiveness. In the past 'practitioners and researchers have proposed different criteria for effective Website design based on common sense, intuition, and rules-of-thumb, effective Website design focusing on the quality of the information it provides has rarely been studied' (Katerattanakul and Siau 1999).

In this instance website effectiveness covers a range of areas from content to usability. Initial research studies into usability and effectiveness have proved useful in establishing a firm understanding of the key areas. Theoretical studies of the effectiveness of the internet is sparse for two main reasons; it is a relatively new research area and people are still finding their way, secondly the people at the forefront researching this area are unlikely to sit back and reflect on developments (Day 1997: 109). The brainstorm in Figure 1 shows the key areas of effectiveness as loosely based on texts by Durham 1999, Nielsen 1993, Mayhew 1999 and Preece 1993. It illustrates the wide-ranging areas that make up effectiveness in this context.

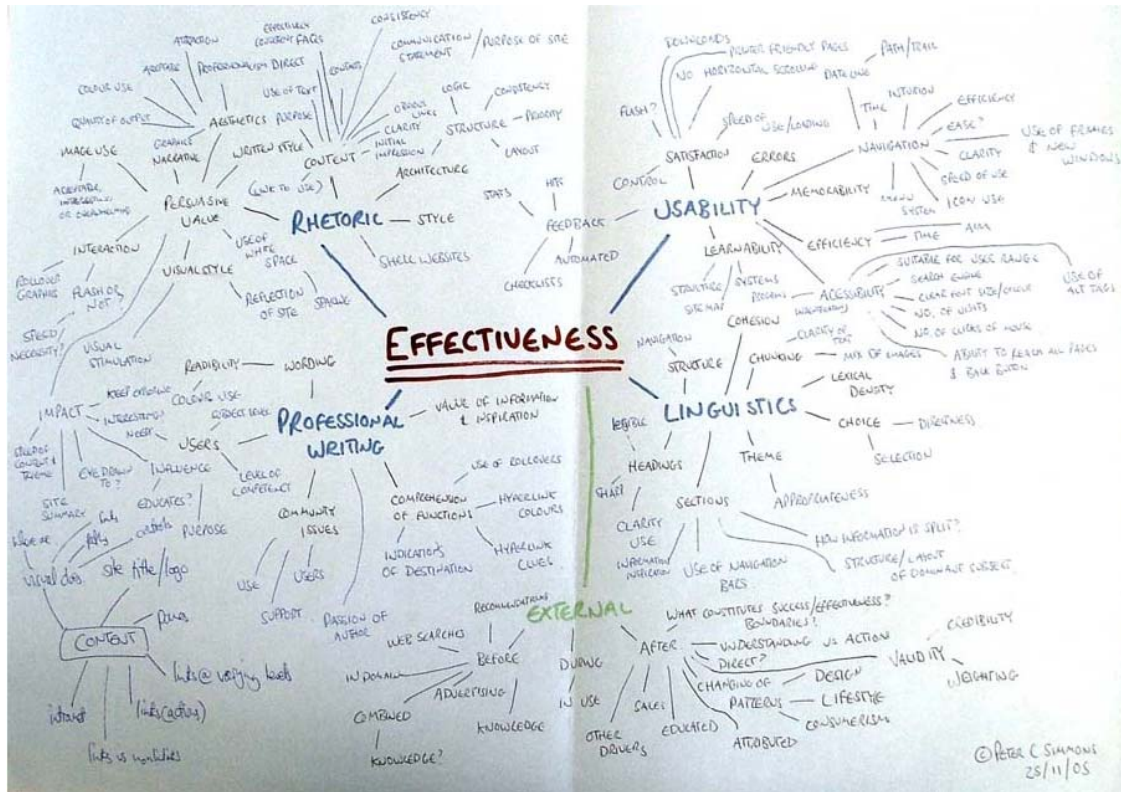


Figure 1: A brainstrom concerning the meaning of website effectiveness

(Durham 1999, Nielsen 1993, Mayhew 1999 and Preece 1993)

Table 1 highlights the phases of use and the specific authors in the literature review that address that particular area. The table used the brainstrom shown in Figure 1 as a basis for classification into specific phases of website use. The phases have been identified as before use, during use and after use. Under each of these phases the topics are split into distinct 'effectiveness' sub-headings. 'Before use' for example can be broken down into five; revisits to a website, recommendations to the website, advertising to attract you to the website, website searches and appropriateness of the domain name. Under each of the categories references have been cited to different authors. The table helps to show the amount of literature on each subject under each of the subheadings, for example the table shows a lot of literature on the 'during use' phase, more specifically usability. Table 1 is particularly useful in indicating areas of research and for illustrating gaps in the research. These gaps are highlighted with cross-hatching. The table shows that there is little literature into 'before use' areas; revisiting, advertising and the domain names of websites. It could be assumed that most research into website effectiveness focuses on when the user has actually reached the website rather than focusing on issues of marketing. It also shows that 'after use' there is little information on the influence or impact of these websites. This would further support the notion that website effectiveness is rarely assessed in terms of having some impact or outcome. It is this area that is integral to a websites success and could be used to justify money being spent on websites such as those like SDA, STEP and DEMI.

It is apparent that a greater knowledge of how the websites influence is needed to determine the success of websites and the worth of the investment put into them. A greater understanding of their existence is also an area that may need focusing on. With a topic such as sustainability, awareness of the issues and access to information is essential to progress the movement. Websites can often be relied upon to deliver that awareness and ultimately the influence. Given this scenario, these areas of low literature coverage, take greater importance in relation to a websites' success.

BEFORE WEBSITE USE					
Revisiting	Recommendations		Advertising	Searches	Domain name
	Rathswohl 2002			Bauer and Scharl 2000	
DURING WEBSITE USE					
Cognitive psychology	HCI	Usability	Linguistics	Rhetoric	Likeability
Mayhew 1999 Preece 1993 Day 1997 Durham 1999 Spool 1999	Mayhew 1999 Preece 1993 Katerattanakul and Siau 1999 Durham 1999 Wu 1999	Preece 1993 Nielsen 1993 Dumas and Redish 1993 Brajnik 2000 Spiliopoulou 2000 Durham 1999 Spool 1999 Olsina et al. 1999 Bauer and Scharl 2000 Katerattanakul and Siau 1999	Durham 1999 Bauer and Scharl 2000	Durham 1999 Olsina et al. 1999 Bauer and Scharl 2000	Day 1997
AFTER WEBSITE USE					
Patterns	Usability reviews		Web sales	Influence	Likeability
Spiliopoulou 2000	Brajnik 2000 Rathswohl 2002 Spool 1999 Olsina et al. 1999 Bauer and Scharl 2000		Spool 1999 Schubert and Selz 2001		Day 1997

Table 1: Classification of literature found in relation to website use

Most users fall into the category of surfer or information retriever (Preece 1993). According to Preece (1993) 'surfers' simply browse websites not looking for anything specific just clicking on items of interest. 'Information retrievers' tend to look for specific information and are therefore it is difficult for websites to meet the needs of both user groups. As organisations have little controls over who visits their website, unless it is password protected, it could be assumed that both types of user have access to the information. Websites can be seen as a communication tool and therefore their composition can be viewed in the same manner. Day (1997) argues that websites, like

other communication tool, possess an explicit purpose, coherent structure, and a relevant conclusion (relevant conclusion implying an achievement or outcome). Website effectiveness, placed in this context, would seem reliant on the judgements of the website user. According to Day (1997), websites are judged not on how they work, more on if they work.

A website works because the people it serves like it. (Day 1997: 109)

The factors that make a website likeable may be considered as part of the effectiveness story. Likeability is part of both during use and after use phases. Can a website be effective without it being likeable? Does an effective website focus on each of the areas of effectiveness equally? When considering a websites' entire design, Day (1997) argues it is more about doing the right things well.

In the context of learning about Websites, it is not sufficient to just read the literature about website design and effectiveness; in addition, students must actively form their own informed attitudes about website quality. (Rathswohl 2002 :1312)

Websites require a level of user interactivity. If you also consider their varying formats, for a fair assessment of a websites' effectiveness, the website would need to be used. Conclusions can then be gathered from set assessment tools or a more subjective assessment of the websites' effectiveness during use.

...when websites are meant to teach or provide information, the task of effective Web page design can be considered from an instructional design point of view, an aesthetic point of view, or a psychological point of view... (Katerattanakul and Siau 1999)

Katerattanakul and Siau (1999) identify three areas that educational websites can be classified; instructional, aesthetic and psychological. These judgements need to be considered when deciding what makes a website effective. Instructional would imply a website that informs the user of specific information. Aesthetical mean a website that has graphical appeal to the user. Psychological would look more to the ease of use and how things are displayed structurally to help the user find the information they require. It could be argued that websites become effective when they meet the goal of what the website is trying to achieve. Sustainable design schemes aim to inform, inspire and motivate, and so their corresponding websites they could be considered as effective if they achieve these aims.

The phases of website effectiveness

After an extensive literature review was carried out, three clear phases of effectiveness were identified as before use, during use and after use. The review went further than just concentrating on criteria that '...typically relate to a website's design and layout, content and navigation features' (Rathswohl 2002). The review intended to expand these areas, to allow for a wider spectrum of criteria that relates to different phases of a websites' use.

Before use

Before use, takes into account the time before reaching the website and the possible paths that may have led you to the website. This section outlines the main contributory

factors to reaching a website. To most website designers the approach to finding a website is not a major consideration, concentrating on when the users actually use the website rather than how they got there. After all, the majority of websites dealt with in this study belong to companies who have other departments for marketing and technical support. It was felt that the before use aspect of effectiveness should be reviewed with the main focus being on the other phases; during use and after use. The areas of before use include:

- revisiting a website;
- recommendations from colleagues or leaders in the field;
- advertising;
- website searches;
- chance, the appropriateness of a domain name.

A revisit to a website may indicate that the site has been successful as you are returning to the site. Although a revisit may also be viewed as a failure, as the user may not have been successful using the website the first time. Recommendations from colleagues or leaders in the field may be considered as a measurement of success, as one would presume the website had been of some value to the recommender. Advertising and marketing of a particular website may also lead you to a website, but it could be argued that this is effectiveness of the advertising rather than the website itself. The same conclusion could be drawn from website searches. It could be argued that website searches show popularity but the position of a website on a list of search results can also be bought. The other possibility is that the website was discovered by pure chance. This may indicate more the success of the appropriateness of a domain name rather than helping establish its effectiveness.

It is important to recognise that on a basic level websites cannot be effective unless the user finds it. A website cannot be effective if it is not used. It may be argued that the 'before use' measures are little to do with website effectiveness, only how strong the advertising is to attract the user to the website. In analysing what should be considered as website effectiveness, Rathswohl points to criteria that 'typically relate to a website's design and layout, content and navigation features' (Rathswohl 2002). This would relate more to use of the website itself rather than the success of trying to reach it.

During use

During use is a huge area when assessing a websites' effectiveness. The key areas identified under 'during use' are:

- cognitive psychology (visual perception, information processing, attention, memory, learning, models);
- human-computer interaction (physical, experience, psychological, socio-cultural and user interaction);
- usability (navigation, accessibility, feedback, errors, learnability, memorability, satisfaction, throughput, flexibility and attitude);
- linguistics (sections, chunking, structure, theme, headings);
- rhetoric (persuasive value (interaction, style, aesthetics), architecture, shell sites, content (obvious links)).

Cognitive psychology

Cognitive psychology 'is the study of human perception and cognition' (Mayhew 1999: 2), it relates to how a task is carried out and the capabilities of the user involved to

process/interpret the information needed to complete this task. Preece (1993) outlines two main ways of improving the design; providing knowledge about expectations of do's and don'ts, and identifying potential problems. Preece (1993) believes cognitive psychology is built up of various factors discussed in detail below: *visual perception, information processing, attention, memory, learning and mental models*.

Visual perception

People's visual perception of objects gives a three dimensional appearance, with website design; text, graphics, animation and video can help this. Many design aspects relating to computer interface design relate directly to website design for example is it: legible, distinguishable, comprehensible, uncluttered and meaningful structure to assist the visual appearance of the website. Even the organisation and presentation of tables can influence people's decisions as to the time spent on a specific page.

Information processing

Information processing means a response to look at a certain part of the screen, or performing an action as a direct result. Stages outlined by Preece relate to the encoding of the information, comparing this to other representations in the brain, deciding upon a response and then carrying out an action. 'Our ability to remember things, therefore, is closely linked to the way in which they are initially encoded' (Preece 1993: 26). This ability to remember things has become a theoretical foundation on which cognitive psychology is often based.

Attracting attention

Grabbing people's attention is a vital, yet often overlooked quality of a website. Often we have so many other things around us, keeping the attention of the user is a difficult task. This is referred to as selective attention. How a website is going to attract this attention needs to be addressed, with the correct information given to the user at a specific time. Important information needs to be prominent, the structure is therefore crucial. The ability to allow users to multi-task but ultimately come back to the website flexibly (Preece 1993). Determining factors of this relate to the presentation of information, various visual and auditory cues, and partitioning of pages and their flow.

Memory

Memory is an integral part of all our actions in everyday life but the level of memory varies considerably. Some tasks on computer systems are more complex than others and take longer to learn. Preece believes determining factors such as names and icons that are meaningful and reflective can often improve this memory level. Improved menu structures with clever design names could be seen as an area where this is beginning to get exploited.

Learning

Learning to use a computer requires active involvement (Preece 1993: 29). Preece also identifies five key aspects of learning:

- learning through doing;
- learning by active thinking – understanding the system;
- learning through goal and plan knowledge – having an aim to the use;
- learning through analogy – familiar concepts;
- learning from errors – feedback from making mistakes.

Mental models

Often mental models of ourselves interacting with products are formed and can provide a basis for predicting or explaining our interactions. This mental model tends to reflect previous experience, interactions and behaviour patterns. It is therefore important to create a design that enables the 'user to develop a suitable mental model' (Preece 1993: 31).

Human-computer interaction

The way that users interact with their computers whilst using computer programs or websites can indicate factors that lead to improvements. Successfulness in conveying information or areas that are easy to use can indicate an effective human-computer interaction. There are many parallels between computer programs and websites in relation to their effectiveness. The aim is to produce a computer based output which safely, effectively, efficiently and enjoyably communicates a certain subject area. Well-designed computer outputs with good usability (Preece 1993) can be seen to improve performance of a workforce, improve quality of life and make the world a safer more enjoyable place to live in, these three areas can also be applied to website design.

A focus on efficiency of tasks allows for information to be accessed directly for an improvement of products exterior and interior. Efficient use of sustainable design websites will hopefully help to result in a better world for current and future generations through an improved knowledge of sustainable principles. Human-computer Interaction requires a knowledge of the user, a knowledge of the purpose, an understanding of when and where it will be used, and also what is actually technically feasible (Preece 1993).

Preece also goes on to outline four key factors relating to users which is particularly relevant to this study:

- physical – height, weight, left/right handed, dexterity, visual acuity, health and fitness;
- experience – knowledge of the task they want to do and computer use;
- psychological – adventurous or timid state of mind, ability to learn, memory;
- socio-cultural – background, upbringing, educational attainment, age, race, gender, ethnicity.

These four factors need to be addressed when assessing the users of the sustainable design websites. The credentials for each of these will be noted for each user allowing for a comparison. When assessing website effectiveness the human-computer interaction factors (physical, experience, psychological, socio-cultural) will help to determine the role of the user and if the users' background influences the effectiveness of sustainable design websites.

User interface

The user interface to an interactive product such as software can be defined as the languages through which the user and the product communicate with one another. (Mayhew 1999: 1)

Wu (1999) concludes that this interaction can be classified in three forms: between user

and messages, between humans and machines, and between senders and receivers. Interaction can be seen as a key area of effectiveness, in terms of the three forms identified by Wu, it is the communication between the user and the website in general terms. Mayhew (1999) outlines several key factors that determine the outcome of user interface success:

- cognitive, perceptual and constraints of people;
- special and unique characteristics of the intended user population in particular;
- unique characteristics of the users' physical and social work environment;
- unique characteristics and requirements of the users' tasks, which are being supported by the product;
- unique capabilities and constraints of the chosen software and/or hardware and platform for the product.

Mayhew (1999) outlines the benefits of more usable interface designs to both users and the business:

- increased profitability;
- decreased user training time and cost;
- decreased user errors;
- increased accuracy of data input and data interpretation;
- decreased need for ongoing technical support;
- greater profits due to more competitive products/services;
- decreased overall development and maintenance costs;
- decreased customer support costs;
- more follow-on business due to satisfied customers.

Use of controls, colour, fonts, format, terminology, interaction pointers, and wording of messages online are all vital to successful interface design.

...too large a volume of information may make it difficult for consumers to access... (Katerattanakul and Siau 1999)

Katerattanakul and Siau (1999) conclude that the volume of information is also an important factor when designing a website. Too much information can hinder a user trying to access the specific information they need as often the specific information becomes diluted or confused. The layout of that material can also determine how easy the information is to access. Information targeted at a certain audience can be more effective than large quantities of information.

Usability

Usability concerns how a product meets the needs of the user. According to Dumas (1993) the determining factors are; the time it takes to complete a task and how easy it was to complete it. Usability considers what task the user is trying to complete; researching, purchasing a product, downloading software, and also what the aim of the site is. Nielsen outlines 5 attributes of usability (Nielsen 1993: 26):

- *learnability*: how easy it is for the user to learn;
- *efficiency*: how productive will the user become;
- *memorability*: how easy is it for the user to remember;
- *errors*: how many errors does the user commit? Can they recover;
- *satisfaction*: how pleasant is it for the user to use?

Preece discusses three other aspects alongside learnability as being essential to usability testing, these are (Preece 1993):

throughput: tasks accomplished, speed of tasks and errors made;

flexibility: ability of the user to adapt to a new system;

attitude: positive attitude given to the users as they grow in confidence using the system.

These usability issues outlined by Nielsen (1993) and Preece (1993) can be seen as the key features for assessing the effectiveness of a website. It is imperative however that usability remains a part of a bigger picture. This study does not wish to just address a websites' usability, but rather its overall effectiveness. Several usability tests were carried out on the websites both automated and manual with an aim to assess usability, and also to reduce the number of websites in this study.

...when designing websites or applications, ease-of-learning goals are often more important than ease-of-use goals (Mayhew 1999: 139)

Mayhew points out that many users will not visit a website daily and that ease of navigation and updated content must be considered as 'very important qualitative goals' for websites. Mayhew goes further stating that quantitative issues surrounding system response time and its impact on user performance.

After use

Another phase of website effectiveness can be seen as 'after use', this concerns how a website affects a user after they have visited the website. The key areas identified under 'after use' are:

- change in patterns (design, lifestyle or consumerism)
- usability reviewed (validity, credibility and weighting);
- web sales and education value;
- direct or indirect influence.

In order for effectiveness of a website to be assessed, a key area has to be its influence. This could be seen in terms of a change in pattern of behaviour. More specifically a change concerning design decisions, lifestyle or consumption. The phase 'after use' also comprises of a websites' usability to assess its validity, credibility and weighting, all of which could be judged upon user decisions that follow. This may include a review of the statistics generated whilst the website was being accessed. A reflection of success could also relate to website sales and a users' education. Is an action needed to demonstrate a success; is effectiveness more related to an understanding of the issues? If the website has conveyed information then that is one measure of success. This issue would hinge on whether that was the aim of the website. If money had been invested with an aim to change peoples' perception then the investment may be deemed a failure. With an issue such as sustainability the issue of success becomes more significant if schemes are reliant on the website as a tool to motivate change. For the sustainable design schemes included in this study they aim to educate and re-educate people and the onus would then be on the user to act.

Likeability factors

Likeability is an important aspect of website effectiveness. Day's (1997) assertions into website effectiveness are based on an idea that all effective websites are likeable and that non-effective websites are not. This would appear to be more dependant on the particular aim of each website individually. Surely websites can be effective in conveying information without a need necessarily to be liked by their user. If the aim was to create a website that was likeable, perhaps then it could be considered as an 'effectiveness' consideration.

Attitude towards a website is important. Attitude is formed upon cognitive information, emotional information and aims to address behavioural intentions (Day 1997). It is important to highlight that the majority of users do not wish to understand the technology behind a website, but simply to know if the website works. When you consider likeability in this context it holds greater significance.

Day (1997) identifies the following contributory factors as key parts of what makes a website likeable:

- quality: dynamic quality (refers to websites acting in response to an action) and static quality (quality is not interactivity dependant);
- customer focus: specific to user;
- purpose: creator/audience driven, not based on sales or hits;
- content: responsive to expectations and behaviours;
- structure: logical and customer-based;
- housestyle: integrity (consistency) and clarity (layout, assists and comprehension);
- action: communication of purpose and result.

Website effectiveness summary

5 Website effectiveness summary

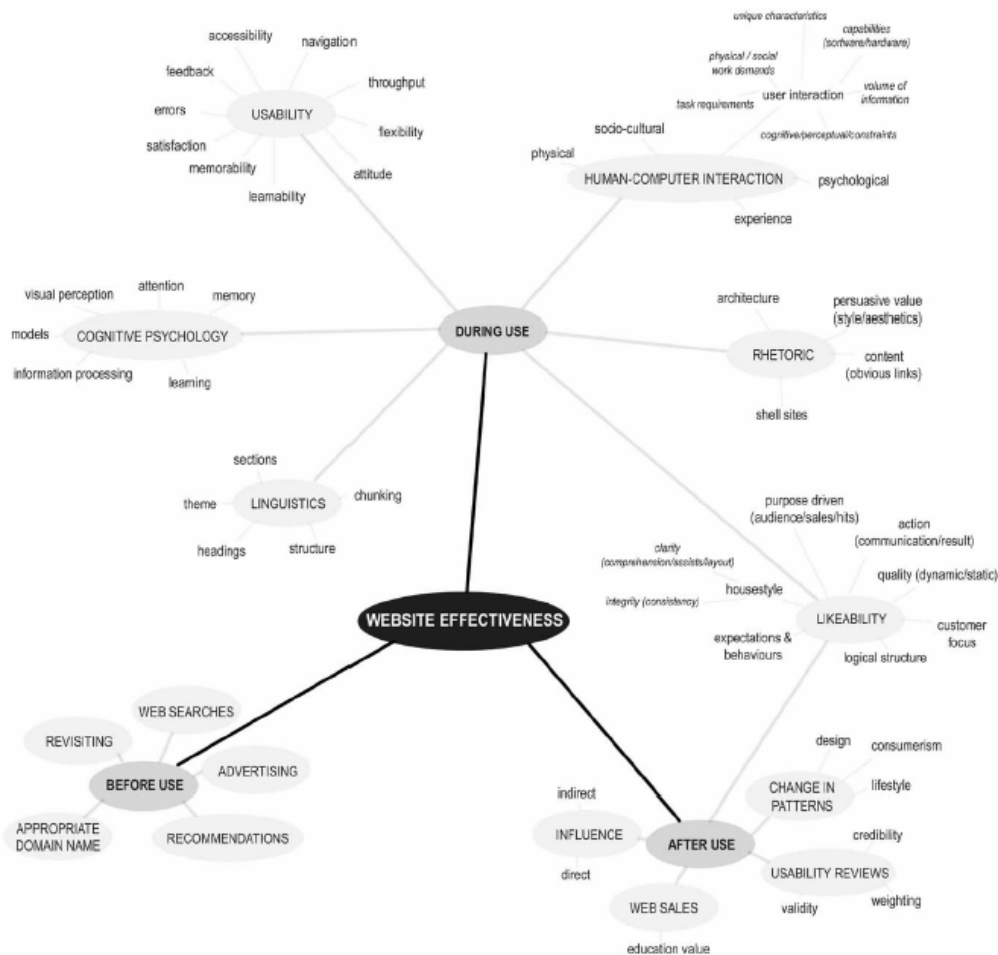


Figure 2: A summary of the issues relating to website effectiveness

In summary, the word effectiveness has a vast array of specific areas. From the literature three phases emerged in which effectiveness could be judged in this study. These concerned 'before', 'during' and 'after' use as shown in Figure 2. The figure shows the various aspects of website effectiveness research so far. The main part of this research will focus on tasks in the 'during' and 'after' use parts to see how websites can influence their designing. 'Before' use would only become prominent in selecting the websites to use, but most of the specific categories under this heading related more to its advertising and marketing strategy rather than how effective the actual website is. The websites selected hope to educate, and as a result, influence a decision taken in designing having used the website. The literature indicates a lack of material in tracing the influence of websites. This is surely a critical area of a websites' success and also its effectiveness in teaching, informing, inspiring and learning. It is in this context that the websites will be assessed.

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A discussion of constructivist learning in relation to the development of ideation using a Virtual Reality Learning Environment for Innovation Education in Iceland

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Abstract

Innovation Education (IE) is a new subject area in Icelandic schools. The aim of the subject is to train students to identify needs and problems in their environment and to develop solutions: a process of ideation. This activity has been classroom based but now a Virtual Reality Learning Environment technology (VRLE) has been designed to support ideation. This technology supports online communications between students and teacher and enables them to develop drawings and descriptions of their solutions. The VRLE is network based and the students work online in the school with their ideas in real time.

As this learning environment is new it is important to explore and evaluate its use and value. This paper describes the basic IE pedagogical model and the subsequent development of the VRLE. These are discussed in relation to constructivist learning theories. The paper also contains contemplation about future research to develop the pedagogical understanding for using VRLE to support the development of ideation skills inside of the innovation process.

Keywords: Innovation Education, ideation, pedagogy, Virtual Reality Learning Environment, constructivism, Computer Supportive Collaborative Learning.

Introduction

This paper describes the Innovation Education model developed within the Icelandic education system and particularly the development of a Virtual Reality Learning Environment (VRLE) designed to support it. These developments are discussed in relation to learning theories, particularly the constructivist perspectives.

Firstly the background to these developments are described. The pedagogy underpinning IE is described and a model of this form of teaching and learning is presented. Secondly constructivist theory relating to generic VRLEs is discussed, including the concept of Computer Supported Collaborative Learning (CSCL). Third the theory is related to the specific Icelandic IE VRLE and a second model of teaching and learning is presented as a contribution to discussion. Finally, consideration is put in the picture about future research to develop the IE pedagogical understanding further.

Background to Innovation Education in Iceland

Innovation Education (IE) was a curriculum development project which originated in Iceland in 1991. This project focussed on conceptual work; searching for needs and problems in the student's environment and finding appropriate solutions or applying and developing known solutions (Thorsteinsson 2002, Gunnarsdottir 2001). IE was aimed at general education, rather than design type subjects. In 1996 Iceland University of

Education coordinated a three year European Union funded project Practical use of Information Technology and Open and Distance Learning in Innovation Education (InnoEd), which took place between 2002 and 2005. This took the original IE work and introduced computer-based technologies in order to develop new ways of supporting students work in IE classes. A major output of the InnoEd project was the development of a virtual reality learning environment (VRLE) in which children could interact, communicate, and host their innovation education work.

The pedagogy of Innovation Education

Innovation Education (IE) is defined as an innovative school activity. It has pedagogical values, in the context of general education and is part of the Icelandic National Curriculum (1999). IE is based on conceptual work which involves searching for needs and problems in the student's environment and finding appropriate solutions or applying and developing known solutions (Denton and Thorsteinsson 2003). Zhuang et al. (1999) described innovation as either:

- an invention which may be considered completely new;
- an improvement of an existing product or system; or
- a diffusion of an existing innovation into a new application

Developing students' ideation skills is the main emphasis of the pedagogy of IE (Gunnarsdottir, R. 2001). By strengthening individuals' ideation in a general educational context they are meant to be better able to deal with their world and take active part in society.

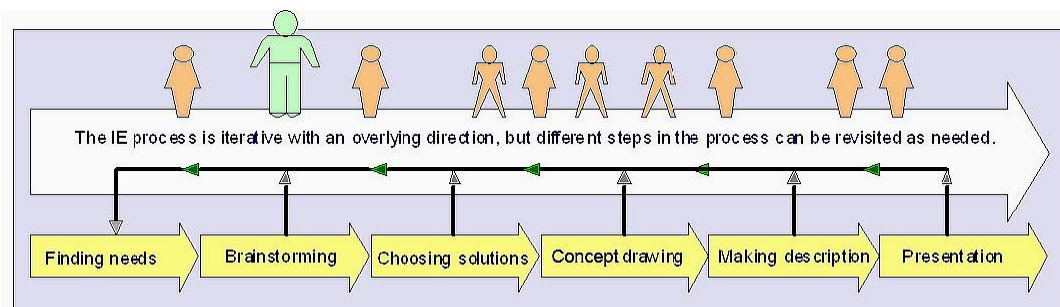


Figure 1: Ideation within the IE working process.

The IE process is a simple way to teach ideation skills. The flowchart shows the fundamental steps in the innovation process as it has been promoted. Ideation skills are used at all stages of the IE innovation process.

Students learn through the innovation process within the overall IE pedagogical framework which is managed by the teacher;

1. Finding the needs.
2. Brainstorming.
3. Finding the initial concept.
4. Ideation drawings or modelling to develop the technical solution.
5. Making a description of the solution as addition to the drawing.
6. Presentation.

Ideation is at the core of the IE pedagogical framework. The IE process is iterative with an overlying direction leading from ‘finding needs’ to ‘presentation of solutions’. Innovation has to do with the usefulness of ideas and/or how they can be implemented as solutions to problems encountered in daily life.

In Innovation Education, students use knowledge and information from different sources, as appropriate, to find solutions. This comprises the search for solutions to needs and problems encountered in their own environment. This mirrors Vygotsky (1978) on the zone of proximal development (see below). Students work with their own concepts, but must learn to use the ideation processes needed to bring their idea into being; gaining what is are now known as Creative Relevant Skills (Gunnarsdottir 2001).

Gunnarsdottir’s (2001) research has shown two main pedagogical processes when students take part in Innovation Education. These are acquiring Creative Relevant Skills and the Ideation process. The Creative Relevant Skills are defined in the teaching material of IE as knowledge and skills that are important for the students to learn in relation to the development of ideas. This includes learning relevant concepts, how to register needs and problems identified at home, brainstorming techniques and to make drawings and descriptions of developed solutions.

Ideation is a concept derived from Guilford (1950) and used as a name for a pattern of interactions that forms when a person works on and produces an idea or invention. Ideation is defined in the Oxford Dictionary (2005) as “The faculty or capacity of the mind for forming ideas; the exercise of this capacity; the act of the mind by which objects of sense are apprehended and retained as objects of thought”. Within IE ideation is interpreted further to become a learner skill in relation to innovation.

Gunnarsdottir’s research shows that these two processes need to be in balance during IE lessons (2001:25). She suggests that if the teacher’s role is overwhelming then the students tend to stop using their experience and little creative work will happen. In addition, it appeared an important factor that the students interacted with each other to stimulate the evolution of skills and knowledge within the lessons. This balance and the central processes are explained in figure 2. (Gunnarsdottir 2001).

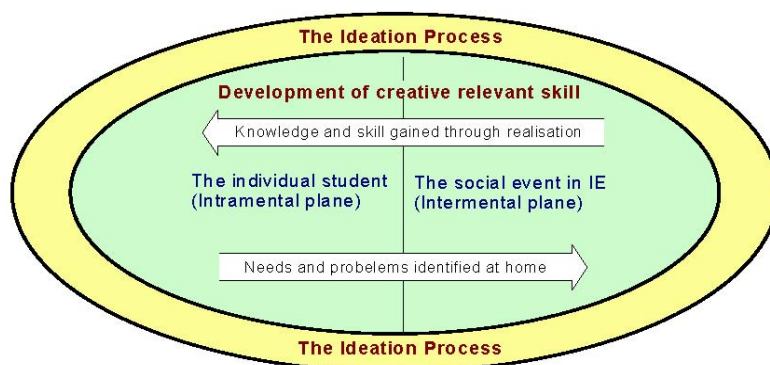


Figure 2: Pedagogical model for IE developed from Gunnarsdottir 2001

Gunnarsdottir, therefore, sees two pedagogical processes: creative relevant skills and the ideation process. However, this author considers that to describe ideation as a process implies a relatively defined and linear approach which is not an accurate

description of ideation as used in IE. Better to describe two pedagogical processes as ideation skills and innovation processes. This enables a view of ideation as a set of skills used in different ways and at different stages within the IE innovation process. Innovation includes the generation of ideas, alternatives, and possibilities (Smith 2001). Innovation is a form of problem solving that begins with the feeling that change is needed and ends with a successful implementation of an idea (Smith 2001). Creativity is considered a quality a student brings to the process which leads to and includes, the idea generation (Gurteen 1998). Innovation Education therefore is defined as a creative school activity, based on the innovation process. Idea generation and the development of ideation skills take place throughout the innovation process.

A VRLE to support ideation

A specific VRLE was designed to enhance ideation via collaborative learning support in IE classes and thus offer individual and social educational opportunities. This development was based on work by Thorsteinsson 1998, Thorsteinsson 2002, Gunnarsdottir 2001, Osberg 1994 and Bricken 1991, Jonassen 2000. Collaborative learning is an term for approaches in education that include joint intellectual effort by students or students and teachers (O'Donnell, et.al. 2006). Groups of students work together looking for understanding, meaning or solutions or in creating a product. Collaborative learning activities can include collaborative writing, group projects, and other activities. Collaborative learning has taken on many forms for example Computer Supported Collaborative Learning (CSCL). CSCL has emerged as a new educational paradigm among researchers and practitioners in several fields, including cognitive sciences, sociology, and computer engineering (Crook, 1994).

The VRLE aimed to offer multimodal communications to strengthen ideation within the innovation process. Of specific interest was the method of ideation used. The IE process is not seen as a rigid model but as a useful basis for ideation work and therefore could be regarded as a tool to facilitate ideation (Gunnarsdottir 2001).

Constructivist theory relating to generic VRLEs

Bricken (1990) theorises that immersive applications of VRLE's are a 'very powerful' educational tool for constructivist learning. The hidden curriculum of VRLE's could be: "make your world and take care of it. Try experiments, safely. Experience consequences, then choose from knowledge" (p. 2). Bricken (1990) and Osberg (1994) has also theorised about VRLEs as a tool for experiential learning, based on Dewey's, Vygotsky's and Piaget's ideas. According to Bricken, a VRLE can teach active construction of the learner's environment. As the VRLE is a computer-created reality it is physically safe for the students and can be used for establishing a basis for different education experiences that would both be impossible and not safe in the physical world. The specific VRLE version is also closed for visitors from outside of the system, with access code and password protection and the users can not be disturbed in their work.

Piaget and Vygotsky (Bricken, 1991; Bricken & Byrne, 1993) introduced the constructivism theory in educational sciences. Central to the vision of constructivism is the view of the learner as "active" and their mental structures are formed, elaborated, and tested, until a satisfactory structure emerges. The Piagetian perspective implies that interaction in groups can create the cognitive conflict and disequilibrium that leads an individual to question his or her understanding and try out new ideas. Vygotsky (1978) illuminated the role of opposition and equilibration in learning. He was interested

in the role of inner speech, the learning of concepts, the role of the adult and as well as learners' peers, as they conversed, questioned, explained, and negotiated meaning. Constructivists who favour Vygotsky's theory suggest that social interaction is important for learning because higher mental functions such as reasoning, comprehension, and critical thinking originate in social interactions and are then internalised by individuals. Children can accomplish mental tasks with social support before they can do them alone. Thus, cooperative learning provides the social support and scaffolding that students need to move learning forward (Woolfolk, 2001, p. 44).

According to Slavin (2000) Vygotsky's theories have been utilised as support to instructional classroom-based methods that underline cooperative learning, project-based learning, and idea finding. Two key principles are important for cooperative learning. Firstly, children learn through cooperative interactions with adults and peers. In cooperative projects children are exposed to their peers thinking processes, knowledge and skills. This cooperation can strengthen the learning outcome as well as misunderstandings. Vygotsky (1978) noted that successful problem solvers talk themselves through difficult problems. In cooperative groups, children can 'hear' this inner speech loudly and this helps them to solve their problems through their approaches. The second key concept (see above) is the idea that children learn best concepts that are in their zone of proximal development. The zone is formally defined as: "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers." (Vygotsky, 1978, p. 86). When children are working together, each child is likely to have a peer performing on a given task at a slightly higher, cognitive level, exactly within the child's zone of proximal development. The "zone of proximal development" (ZPD) is the location where learning occurs. This concept has been the focus of several educational research groups (Edwards 2001) that underline the importance of learning as a collaborative process. It is also suggested that computers can be used as media to provide new contexts in which this collaborative learning might take place (e.g. Newman, Griffin & Cole, 1989).

According to Vygotsky (1978), the zone of proximal development is the difference between what a student can do alone and what he/she can do through supportive collaboration. There are implications for cooperative-learning situations in an IE class in relation to this theory (Gunnarsdottir 2001) and according to Bricken (Bricken, 1991; Bricken & Byrne, 1993) the use of a VRLE in conventional classroom may support such situations (Thorsteinsson and Denton 2006). The initial stage of the IE innovation process starts in the student's own environment, when they identify needs and problems at home. In the school classroom, they communicate with the co-students and the teacher and expose to each other thinking processes throughout their communication during the innovation process. This part of the IE school activity brings the students closer into their zone of proximal development and is one of the characteristics of the IE pedagogical model. According to this, the use of the IE VRLE technologies could be seen as a constructivist-learning tool based on CSCL processes (Lehtonen, Page, & Thorsteinsson, 2005).

For constructivists, learning is not the result of development; learning is development (Fosnot, 1996). Teaching strategies using social constructivism include teaching in contexts that might be personally meaningful to students, negotiating taken-as-shared meanings with students, class discussion, and small-group collaboration. Emphasis is

growing on teachers using different ways to maintain dialectic tension between teacher guidance and student-initiated exploration, as well as between social learning and individual learning. According to the Piagetian perspective, interactions in groups can create a cognitive conflict and disequilibrium that can lead an individual to question his or her understanding and try out new ideas.

Bricken (1991) describes VRLEs as experiential and intuitive as they can offer a shared context that provides interactivity. They can also be set up for individual learning styles (Winn 1993). VRLEs can also support group projects and discussions, field trips, simulations, and concept visualisation. Bricken argues that within the limits of immerse VRLE system functionality, it is possible to create anything imaginable and then become part of it.

Bricken (1991) also speculates that in VRLEs, students can actively inhabit a spatial multi-sensory environment through the VRLE immersion. Students are both physically and perceptually involved in the experience; they get a sense of being within a virtual world. Bricken suggests that VRLEs allow natural interaction with information. Learners are allowed to move, talk, gesture, and manipulate objects and systems intuitively, within the limitations of the system being used.

According to Bricken, VRLEs might be highly motivational: they can have a magical quality. "You can fly, you can make objects appear, disappear, and change. You can have these experiences without learning an operating system or programming language, without any reading or calculation at all. But the magic trick of creating new experiences requires basic academic skills, thinking skills, and a clear mental model of what computers do" (Bricken, 1991, p. 3). Understanding multiple perspectives is both a conceptual and a social skill; virtual reality might enable learners to practice different skill in ways that cannot be attained in the physical world. However, in a longer term, the VRLE world might become ordinary for the students and they loose their motivation.

VRLEs offer a shared experience for many participants. Bricken theorises that VRLE's provide a developmentally flexible, interdisciplinary learning environment. A single interface provides teachers and trainers with a variety and supply of virtual learning materials.

However, there are lot of critical issues and considerations concerning the use of a VRLE technology in education. A VRLE technology contribution to conventional school education means extra cost for the school, as the school has to buy the software used and all the equipment needed. However, most schools have modern computers that can run such technology. A desktop VRLE, using only the conventional screen, keyboard, mouse and speakers is also a cheaper solution than VRLE technology that needs expensive head-mounted 3D glasses or haptic equipment.

VRLEs do not lack in powerful emotional stimulation but these limitations might be one of the reasons it is necessary to use them in the context of conventional school environment instead of being only used in the context of open and distance education, on an individual bases. In the classroom, the students have a degree of closeness to each other and the teacher. Our brain does much more than just process pictures and noises. It integrates all our sensory inputs to make us believe in a persistent, solid world that contains other people besides ourselves who may have intentions toward us. We might even have special brain circuits for interpreting other people's facial

expressions. Nothing we see is emotionally neutral; it is either good or bad for us and as such in our memory. Our brain interprets the world we see around us and calls up on our memory in order to give our vision an emotional content. Just like a VRLE technology, the brain can visit its database to change the world from inside, in addition to perceiving the one outside.

Using the VRLE inside the conventional classroom in the context of constructivist learning through CSCL is meant to minimise the cognitive load students often experience in a traditional teaching and learning context (Schneider 1996). The students' autonomy and freedom to make their own choices about their projects is highly respected by the teacher (Thorsteinsson 2002). The VRLE offers students' access to the Internet and makes them able to communicate with the world outside of the school. At the same time, they are communicating with themselves, each other, and the teacher. Using the VRLE in the classroom brings a multi-channel learning (MSL) support to the IE classroom. The students can access different sources of information. They have to choose and use the information channels that support the development of their ideas and close the ones that are not supportive. They can also get interrupt by entertainment material and taken away from their work. These possibilities are clearly a way to support constructivist learning through Computer Supportive Collaborative Learning but requires self-discipline and a strict supervision from the teacher.

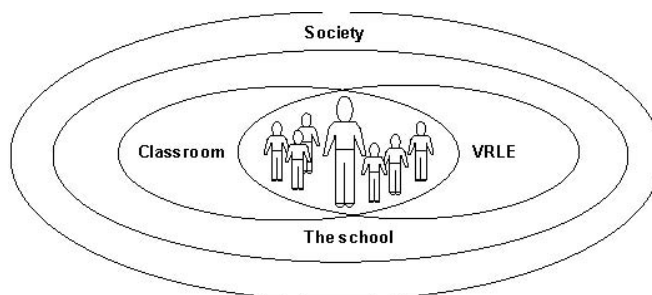


Figure 3. The IE activity, inside the VRLE classroom is connected to society through the Internet and offers multi-channel learning opportunities.

Collaboration around and through desktop computers in group settings. Desktop-based VRLEs commonly use basic computer equipment such as monitors, mouse and headset. They attempt to immerse the learners in an experience as close to actual as possible within the limitations of the equipment. The goal is for the learner to interact with both the VRLE and the actual environments at the same time in order to facilitate and improve on the collaboration that takes place in the classroom.



Figure 4: The teacher and students in the conventional and the VRLE classroom.

Computer Supported Collaborative Learning is not necessarily designed to replace face-to-face communication (Lehtonen, 2005). It can support and facilitate group processes in conventional face-to-face classroom based communication or be totally online for distance interaction and learning. CSCL is designed for multiple learners working at the same workstation or across networked machines. The purpose of CSCL is to support students in learning together effectively. CSCL can support communicating ideas and information, sharing information and documents, and providing feedback on problem-solving activities (Crook 1994).

Educators using VRLEs often aim for higher-order thinking skills, problem solving abilities, epistemic fluency, and collaborative development of knowledge within a field of practice. Often they include an emphasis on collaborative aspects of learning as well as individual ones; an identification of social interactions as an important element of knowledge construction, a focus on the learner(s) and their activities (Bricken, 1991; Bricken & Byrne, 1993).

VRLEs can also be considered as tools (Jonassen, 2000; Vygotsky, 1978) to support ideation (Thorsteinsson and Denton 2005). When such tools are used in social settings for socially important learning processes, providing objects for shared attention and activity, we could consider them as sociomental tools (Jonassen, 2000).

VRLEs can be more sophisticated than previous approaches of computer support in education. As an often-social learning context, there are an infinite number of variables. It is therefore more difficult to evaluate the effectiveness of VRLE activities (Bricken, 1990). Nevertheless, all actors involved in VRLE based CSCL processes, need to have evidence of whether, how, and when expected improvements in learning take place.

Human-computer and human-human relations.

Interaction and interactivity between students and computer environments has been the

foundation of constructionism developed by Seymour Papert and others (Papert 1993). Papert saw constructionism as a combination of two strands: first, "it asserts that learning is an active process, in which people actively construct knowledge from their experiences in the world. Constructionism deals with the idea that people construct new knowledge, when they are engaged in constructing personally-meaningful products" (Bruckman and Resnick 1995: 9).

VRLE technology can be defined by the interactions among the users within it, more than by the technology with which it is implemented" (Hamit 1993: 26). Multiple-user interaction is one of the major factors in creating VRLE. Interaction is also of central concern in the concept of learner autonomy which contains the idea that learning arises essentially from supported performance, which is central to the works of Vygotsky.

These principles could be realised quite effectively in the InnoEd VRLE this project deals with. The student's work has personal meaning as its origins come in the form of identified needs and problems from their home environments. When using the VRLE in the conventional school context the students experience both human-computer and human-human interaction. This could support them to create more meaningful solutions than in a formal institutionalised classroom.

The Icelandic InnoEd VRLE

Virtual Reality (VR) can be defined as "the idea of human presence in a computer-generated space" (Hamit 1993: 9), or more specifically, "a highly interactive, computer-based, multimedia environment in which the user becomes a participant with the computer in a 'virtually real' world." (Pantelidis, 1993: 23). Virtual Reality systems have been used for many different purposes. Probably the most common are games and occupational simulators. However, Virtual Reality has also been used for educational training and online meetings.

Because the software used in the IE project is a managed learning environment and includes the InnoEd Virtual Reality, it has been named a Virtual Reality Learning Environment (Thorsteinsson and Denton 2006). Hall (2001) defines the managed learning environment or e-learning environment as all-in-one solution software designed to facilitate online learning for an organisation. It includes the functions of a learning management system for those courses within the learning environment in addition to teaching and learning materials. A learning environment is characterised by an interface that allows students to register and partake in courses. The program will usually include self-instructional portions, along with an academic structure. An instructor often facilitates this model, where a group can proceed on a week-to-week basis with seminar assignments (Paulsen 2003).

The original idea behind the InnoEd VRLE was to find a new way of supporting ideation using virtual tools inside the managed learning environment (Thorsteinsson, Denton, Page and Yokoyama, 2005). The VRLE is accessed from the InnoEd site (<http://www.innoed.is>). It includes an e-mail system, discussion forum, and all features associated with content delivery and evaluations. Students can record needs found and solutions and share them with others as text and drawings. The virtual tools in the VRLE offer CSCL support to the students' ideation. The immersive VRLE 3D interface comprises numerous functionalities. Eight predefined avatars, which represent the user as a human figure in the 3D environment, are available, both as children and as adults. Five movements can be performed with these key board-controlled avatars: nodding or shaking the head for yes or no, gesturing, "come here", waving hello, and shaking

hands with the right hand. As for communication functionalities, the 3D environment offers chat, audio, PowerPoint slide projection screens, websites, file sharing screen, smart board, and video board. The 3D environment features different physical places where avatars can meet: main entrance, classrooms, group workroom, conference room, and corridors (Lehtonen, Page, and Thorsteinsson 2005), (see Figure 5).



Figure 5: A student using the Interface of 3D Virtual Reality Learning Environment Featuring Avatars from the student's perspective.

The student's autonomy in a collaborative model is fundamental within IE as the student brings his/her ideas into the school and works with them (Denton and Thorsteinsson 2003). This can promote a wider socio-economic view of inventive thinking and wealth creation. This makes Innovation Education different from most other school activities. Being in a VRLE might give the student more freedom to think and act independently and communicate in an environment without borders (Vezina et al 2004), (see figure 6). However, the students can communicate with the outer world through the Internet and access knowledge from it to bring their ideas to realisation, but their work is based on the IE ideation process.

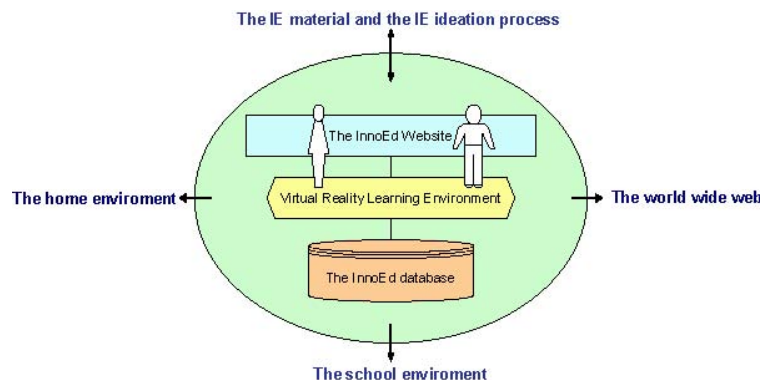


Figure 6: The Database keeps all the students' work they have made in VRLE.

Conclusion

Constructivist theory has been a useful basis for developing the pedagogy of using the IE VRLE. Earlier research implies that the IE pedagogical model can be used as a sociomental tool for bringing students closer into their zone of proximal development (Vygotsky 1978, Jonassen 2000). One of the characteristics of the IE pedagogical model is the relationship to the student's environment where needs and problems are identified at home. This part of the pedagogy gives IE a personal meaning for the

students (Gunnarsdottir 2001) and is a support to cognition in the IE classes. Using the VRLE in the classroom supports multimode communication and offers Computer Supportive Collaborative Learning opportunities to support ideation inside the on-going IE innovation process, in the conventional classroom. Throughout the VRLE the students can communicate with society outside the school in different ways that increase their possibilities further for a meaningful education.

VRLE researchers (Osberg 1994, Bricken and Byrne, 1993) state that students can explore and make mistakes safely in a VRLE as it is computer generated and physically safe. It can be used to establish a basis for different educational experiences that would be impossible in the physical world. However there is the potential for psychological danger when using any computer created realities, particularly when web based and in direct communication with others. At one level students may be subject to 'cyber bullying' and at another entry of outsiders into the system. The IE VRLE uses a secure access code system and the teacher continually monitors and can track activity in the reality.

There are health and safety issues related to the use of computers and displays in schools. Over-long use of computers can cause stiffness in the neck, and shoulders and eyestrain. In addition, the VRLE, as multi-channel learning technology, can cause an over-load of information, some of which may cause tropism; diverting attention away from the work.

How do we evaluate the effectiveness of the VRLE support on the development of the students' ideation skills and cognition and how can we understand how it affects the established pedagogical model focusing on ideation? The primary author has already undertaken action research based case studies to develop the application of the VRLE to support ideation in IE conventional classes (Thorsteinsson and Denton 2006). The next step is to observe the VRLE's impact on the already defined IE pedagogical model from conventional class contexts. This approach has to be based on earlier research and the pedagogical model already established and described for IE. According to the above, it would look closely at the teacher role and students' social interaction in the light of constructivism and VRLE Computer Supportive Cooperative Learning. Using the VRLE is intended to promote social interaction and collaboration to support ideation skill in the process of innovation. Gunnarsdottir (2001) showed the importance of the teacher's role. If the teacher dominates and directs student activity the students tended to stop using their experience and this may limit the potential for innovative work. The students' interaction with each other also appeared to be an important factor to stimulate the evolution of ideation skills and knowledge within the IE lessons (see figure 2).

Models of research and evaluation based on a scientific paradigm cannot be used to explore developments such as those described, as IE activity happens in a complex and dynamic sociological/educational context. Grounded Theory (Glaser and Strauss 1967), based on iterative paradigm and though observational analysis would be a good option for such research as the pedagogical value of using a VRLE to support the development of ideation skills has not been enquired before.

The literature indicates the importance of seeing the VRLE as a tool than can support constructivist learning based on CSCL processes. To see the pedagogical value of a collaborative VRLE for ideation, and how it affects the earlier pedagogical model, it is

important to look at the activity in the classroom when the students are using the VRLE and observe the following:

- How long it takes them to learn to use the interface, become immersed and comfortable with the environment.
- How much the students and the teacher use the VRLE in the classroom.
- The social interaction with and without the VRLE. How the teacher and the students communicate within and outside of the collaborative VRLE environment and the meaning of the collaboration when the ideation take place.
- The difference between the students' collaboration in a classroom with and without the VRLE and its role during the ideation.
- To talk to the teachers about how they have adapted pedagogical models to accommodate the VRLE.
- How the teachers role differs from conventional based classes and how it affect the students ideation skill when using the VRLE

To find out the educational efficacy of using the VRLE in the classroom requires development of appropriate and meaningful forms of assessing this new mode of learning support. This could be done by looking at the differences between a traditional classroom based pedagogical IE model (see figure 2) and the same model supported by the VRLE. The outcome might look as seen by figure 7.

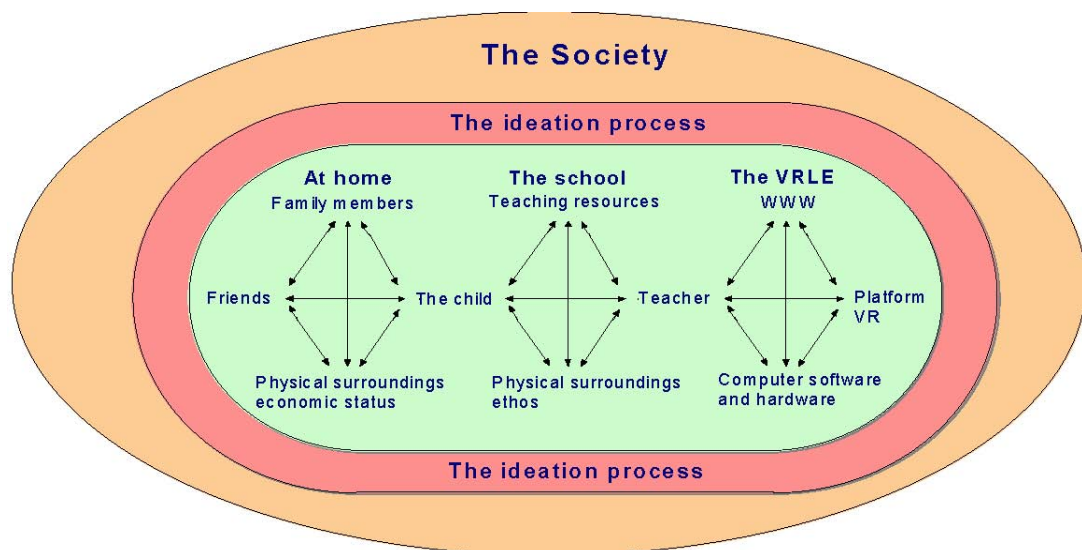


Fig 7: the VRLE as a contribution to the former pedagogical model.

The pedagogical understanding of using the VRLE for ideation has to be developed further, through research. The basis of the technology is already part of the daily lives of young people, but to date less advanced in general education. The indications from the literature show that we need to explore and understand the application of the VRLE to support ideation and its impact on IE pedagogy further. This has to be based on constructivist learning and computer supportive collaboration. It is intended that this will give a clearer picture of the pedagogical values of using VRLE for Innovation Education in Icelandic schools.

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Internet Safety issues in English schools

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Introduction

This paper arises from an Audit of Internet Safety Practices in English Schools, a research survey sponsored by the British Educational Communications and Technology Agency (Becta) and carried out in the summer term, 2002 (Becta, 2002).

The literature analysis prior to the survey revealed a number of perceptions regarding children's use of the Internet and recommendations for Internet Safety teaching but little direct research in schools. Similar results were found by Livingstone (2002) in her comprehensive review of the research literature. She reports that only one study of the fourteen she found on dangers of children's use of the Internet actually includes empirical research with children.

The literature review for this study identified a large number of organisations and related Web sites that were directly or indirectly linked to Internet Safety campaigns, guidance and resources, both for young people, their parents, carers and educators. Though this showed that concern about Internet Safety was high, few of the Web sites were based on or linked to research in this area. The FKBKO Web site at <http://www.fkbko.net> aims to remedy this by linking the Web site to the Cyberspace Research Unit of University of Central Lancashire as does the more recent Children Go Online project run by Livingstone at the London School of Economics <http://www.children-go-online.net/>. In addition, whenever a survey or research paper was released, the newspapers were swift to provide supporting articles, often focussing on the more negative findings of the research. For example, 'Children unaware of Internet dangers' (Batty, 2002) was one of the headlines reporting the release of the Cyberspace Research Unit's chat room project.

So, although a recent report examining young people's experiences reported that "Children are missing out on the real gains of the Internet due to parents' fears of dangers in cyberspace" (IPPR, 2001), parents remain fearful, and reportage of survey findings in the press tend to exacerbate this worry. In the Department for Education and Skills (DfES) report *Young people and ICT* on their survey of over 1700 children and young adults across England it was found that "Three-quarters of parents said they were concerned about Internet Safety issues. The percentage was similar across all child age groups and by social grade..." (DfES, 2002, p.36)

Thus a key finding of the literature analysis was that there is a conflict between perceived and actual Internet Safety factors and risks, and this occurs not only with parents but also teaching staff. For example, a 1997 survey (Research Machines, 1998), showed that 78% of respondents felt that filtering out undesirable information was the key Internet Safety issue in a survey of 300 secondary schools. Three years later little had changed, with Springford reporting in a comparative survey of European schools for the Bertelsmann Foundation that:

"Most British teachers, if asked to describe the major concern about safe and responsible use of the Internet in schools, would probably refer to the problem of

pornography on the worldwide web. This is understandable, partly because it is the topic most likely to be reported in the mass media. The other concern, again likely to be the result of media publicity, is the use of the Internet by paedophiles.

While these are two very important issues which must be taken seriously, it is equally important for managers and teachers in schools to understand that Internet Safety involves a much broader range of concerns. Teachers and managers will not necessarily be aware that the Internet can be used to transmit racist or politically extremist material or propaganda from religious cults. They may not appreciate the unregulated nature of the Internet and the availability of material which is likely to be illegal in their own country. The possibility of pupils having direct contact with undesirable adults may not be obvious to them. Those responsible for schools must ensure that teachers' knowledge is sufficient for them to recognise and respond appropriately to all these dangers." (Bertelsmann Foundation, 2000, p.6):

Though one of the largest perceived problems is accessing unsuitable material, O'Connell et al (2002, p.45) found that "Accidentally going on these sites [adult sites] often is very low but does seem to increase with age." Another key problem highlighted by O'Connell (2002) is children giving out personal details over the Internet. She found that in chat conversations, at the age of 9, children start giving away personal information such as first name (5%), last name (4%), e-mail address (3%), photograph (2%), phone number (1%) and home address (0.7%). By the time the children reach the age of 16, they seem to be divulging a higher percentage of information at a rapid rate. Furthermore, O'Connell's findings suggest that "1 in 10 children who use chat rooms have attended a face-to-face meeting" (O'Connell et al, 2002, p.104). Also, worryingly, 1 in 4 children have experienced online bullying via mobile phone text messages, e-mail or chat rooms (NCH, 2002).

Commentary in the literature itself highlighted that schools (both in England and internationally) were perceived to have a vital role in promoting and ensuring Internet Safety. For instance, a survey undertaken in Ireland revealed that 49% of parents thought that schools should provide online safety information (Amarach, 2001); a Canadian survey showed that 86% of parents thought it "very important that schools improve the online safety of children using school computers" (Media Awareness Network, 2001). In addition to parents, the Children's Charities' Coalition supported the notion that schools had a fundamental role to play in delivering Internet Safety measures - "Clearer guidance should be offered to schools on the safe use of Internet...e-mails...Chat rooms...school web sites...filtering and blocking software" (Children's Charities' Coalition for Internet Safety, 2001). O'Connell (2002) herself felt strongly that:

"The shortfall in the Internet Safety training in schools arguably results in children not being adequately equipped to safely deal with the challenging circumstances they may encounter in an on-line situation, i.e. communication with real people in a virtual context." (O'Connell et al, 2002, p.3).

and recommends that "Schools ought to be the main point of delivery" (2002, p.10) in providing a program of education for Internet Safety guidance, and that they should foster "a synergy between home and school so that young people's two main sources of advice work together to impart the same messages." (2002, p.10). This point is also

made by Livingstone (IPPR, 2001, p.17), who recommends “A co-ordinated response across school, community and home is essential for safe and fair use of the Internet by children”.

In summary, an analysis of the literature and its findings showed that a thorough survey of Internet Safety practices in schools was a vital stage in examining Internet Safety practices and informing future planning.

Objectives

- To identify which schools teach Internet Safety, in what ways, with which age groups and in what areas of the curriculum.
- To identify which schools have an acceptable use of the Internet policy and whether pupils and/or parents sign up to it.
- To identify which are the particular Internet Safety issues for schools and the overall importance schools assign to the topic.
- To identify where schools currently get advice from on Internet Safety and how they respond to that advice.
- To identify what breaches of Internet Safety have taken place within the school and what impact this has had upon their teaching of the subject.

Method

Just over a thousand schools from 27 Local Education Authorities (LEAs) across England were randomly selected for the investigation. Schools maintained by the state sector, privately funded independent schools and special schools for children with special educational needs were all included in the survey at both primary and secondary level. Respondents were given the option of completing a questionnaire or responding to the same questions as part of a telephone survey. ICT advisers and representatives of Internet Safety organisations were also invited to complete a linked questionnaire.

Responses were received from 577 schools (a response rate of 57%), 18 of the 27 LEA representatives approached (67%), and from representatives of three of the seven Internet Safety organisations contacted (43%). A further 38 questionnaires were received separately from the schools that had volunteered for the pilot of the Internet Proficiency scheme run by Becta.

The participating schools represented a wide cross-section representative of the different types of school across England.

Table I. School Type	Number
Community	332
Voluntary aided or controlled	125
Foundation	23
Special	27
Independent	58
No data provided	12

Table II. Age Phase of School	Number
Middle (approx 8y -13y)	15
Prep (approx 5y -12y)	8
Primary (5y - 11y)	319
Secondary (11y -16y or 18y)	192
Through (3y or 5y -18y)	40

Key Findings

- Teaching Internet Safety was reported in only 85 per cent of the schools, where it is most likely to take place solely within the subject area of ICT and be delivered via an Internet induction programme or the school's acceptable use policy than through a specific scheme of Internet Safety work. Primary schools are more likely than schools with other age groups to use discussion activities and Secondary schools are more likely to use their Internet Safety policy as a teaching vehicle. Using posters as reminders was popular with all age groups. Schools teaching the entire age range from less than 5 years to 18 years (which tend to be Special or Independent) were less likely to be teaching Internet Safety at all.
- 89 per cent of schools in the main study have an Internet Safety policy in some form or another in school, with about half of these expecting parents, pupils or both to sign to show their agreement to the statements in the policy.
- 95 per cent of the schools surveyed in the main study had Internet filtering arrangements in place though independent schools were slightly more likely than other schools not to have filtering in place.
- Filtering arrangements in state schools tend to be LEA dependent and were not well understood by the teachers. Customised filtering systems with differing levels

of access for staff and students were not reported by many schools though this may well be due to a lack of knowledge of the filtering system rather than their absence. There was a good deal of confusion in schools over the presence or absence of walled gardens and firewalls.

- Breaches of Internet Safety reported by schools were most likely to be pupils accidentally accessing inappropriate material. In fact, accessing inappropriate material is the teachers' single most important Internet Safety concern, with accidental access being more of a worry than deliberate access. Whilst LEA advisers and Internet Safety organisations worried about high levels of deliberate access teachers knew their pupils and the ones to watch out for.
- Schools tended to rely heavily on supervised Internet access, often ensuring that pupils only visited websites recommended by the teacher. This is understandable as teachers only have limited time (such as a 50 minute lesson in the ICT suite) for their pupils to find, read and retrieve information from the Web. However, it leads to concerns highlighted by Wishart (2004) that pupils may lack awareness of good Internet Safety practice when surfing the Internet outside school and that there is a lack of emphasis in school on developing Internet search and evaluation skills.
- Use of chat sites, even for school work, was banned in 95 per cent of schools. O'Connell et al (2002) and the Children's Charities' Coalition for Internet Safety (2001) who, like the Internet Safety organisations consulted in this study, argue that schools can better enable children's safety by providing them with the knowledge and skills to allow them to deal safely with chat room situations rather than by restricting their access.
- Teaching Internet Safety as part of Net literacy is the single most important concern for all the Internet Safety organisations and for nearly a fifth of Becta's Internet Proficiency Scheme pilot schools, yet worryingly does not appear as a concern for schools in the main study.
- Schools and LEAs Internet Safety concerns largely focused on pupils' use of web-based e-mail in school. They were also concerned over the time and network resources e-mail used. Internet Safety organisations, on the other hand, had moved on to worries over Internet access from mobile phones.
- Many schools reported they were concerned about parental awareness of Internet Safety issues. Most schools, all the LEAs and Internet Safety organisations recognise they have a responsibility to work together to inform parents about Internet Safety and need resources to support them in this.
- ICT co-ordinators would in general appreciate further guidance on Internet Safety, with most asking for resources they could use with other teachers, parents and pupils.

Conclusion

It is concluded that whilst the vast majority of schools in England are teaching Internet safety they were doing so in a restricted environment with safety conscious supervision

preventing exploration and in particular, the use of chat. This will cause problems when children are surfing the web and using chat and instant messaging at home which may well be an unsupervised and an unfiltered environment.

It is recommended that stakeholders such as government organisations and children's charities provide:

- Advice for LEAs on enabling chat in schools and support for schools aimed at teaching children about the use of chat rooms and instant messaging safely.
- An updating service to alert schools and LEAs to developments in technologies and new guidance on their use in school.
- Teaching materials for schools to use with pupils aimed at developing Net literacy and safe surfing practices that enable pupils to use the Internet responsibly and usefully both in and outside school.

In fact, since this study was carried out, an Internet Proficiency Scheme aimed at 7 to 11 year olds has been set up with UK Government support by Becta, the Department for Education and Skills (DfES) and the Qualifications and Curriculum Authority (QCA). The aim of the scheme is to provide teachers with easily accessible support materials to help their pupils develop a set of 'safe and discriminating behaviours' to adopt when using the Internet and help pupils demonstrate what they know.

Additionally it is recommended that methods of filtering or monitoring Internet access for children using mobile technologies to surf the web need to be investigated through negotiation with Internet Service Providers (ISPs). Their help will also need to be sought on monitoring peer to peer network use by children as recent concerns have arisen over unmoderated or unsupervised peer to peer network use. Children downloading this software are allowing strangers to share their files and once peer to peer networking is installed it may run undetected by Internet logging software.

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Where to go for more information

Internet Safety for Schools <http://safety.ngfl.gov.uk/schools/>

This UK Government site should be your first stop and provides advice on all aspects of Internet safety for schools and LEAs. It includes advice on Internet filtering, the use of chat rooms and e-mail in education, the use of pupil photographs on school web sites and lots of case studies of good practice.

Kidsmart <http://www.kidsmart.org.uk/>

Kidsmart is a practical Internet safety advice website for schools produced by the children's Internet charity Childnet. As well as providing resources for teachers and schools it acts as a portal to other Internet Safety sites such as the three below.

Advice on Using Chat in Schools <http://www.chatdanger.com/home/index.htm>

The UK based charity, Childnet International, offers important advice on its web site, use the link on the top left to read about using chat in schools.

Grid Club – more than just a safe Chat site <http://gridclub.com/>

GridClub is the official Department for Education and Skills (DfES) education website for 7 to 11 year-old children and hosts curriculum linked activities and games aimed at KS2 children. For an example of **Design Technology** activities see <http://gridclub.com/games/dt/designstudio/index.shtml>.

Internet Proficiency Scheme <http://safety.ngfl.gov.uk/schools/index.php3?S=3>

The Internet Proficiency Scheme has been developed by the DfES, Becta and the Qualifications and Curriculum Authority (QCA) to help teachers educate children about staying safe on the Internet. Detailed information and advice about all of these are included on this site, along with contact details for further sources of help.

Cyberspace Research unit at UCLAN <http://www.uclan.ac.uk/host/cru/index.htm>

Much of the research informing the Home Office approach to Internet Safety has been carried out by Rachel O'Connell at the University of Central Lancashire. Recent presentations given by her and her colleagues are at <http://www.uclan.ac.uk/host/cru/presentations.htm>.

Children Go Online: Emerging Opportunities and Dangers

This is Sonia Livingstone's project funded by the ESRC under its e-Society programme. It's aim is to balance an assessment of two areas of risk - (a) inequalities/the digital divide and (b) undesirable forms of content; with that of two areas of opportunity - (c) education, informal learning and literacy, and (d) new forms of communication and participation. The findings will contribute to the developing policy framework regulating children and young people's Internet use.

<http://www.children-go-online.net/>

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Engagement as the Key Feature of the Successful Use of the Internet for Information.

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Introduction

For some time now the use of the Internet has been promoted extensively to teachers by a number of different organisations and bodies. Not least of these in England is the Department for Education and Skills (DfES), through the medium of the National Curriculum. "Finding Things Out" is one of the strands of the National Curriculum programmes of study for Information and Communications Technology (ICT). The schemes of work for Key Stage Two (children aged 7 to 11) give suggestions for pursuing points from the Programme of Study, that involve using the internet to search large databases and to interpret information (Unit Ref 6D Year 6) (DfEE/QCA 2000). The use of the Internet is also promoted in the context of other subjects of the National Curriculum. In particular it is recommended when a topic can be researched and the findings used in a way which will lead to children achieving learning objectives concerned with knowledge and understanding in the subject area in question.

In the regulations which govern the ICT element of initial teacher education programmes in the United Kingdom (DfEE 1998, DfES 2002 ...4/98) another clear direction is given. "Trainees" must demonstrate that they "...know how to use ICT effectively, both in their subject and to support their wider professional role." (DfEE 2002b) The most recent guidelines for teacher training provided defines ICT as including "internet-aware computers" (Teacher Training Agency, 2003). Though the explicit mention of the use of the Internet is limited in the Qualifying to Teach Handbook (ibid.), the implication is that the Internet must be considered as an important resource, and used effectively for the attainment of subject based learning objectives.

Both teachers and learners always face difficulties when using information sources. It is often hard for an inexperienced Internet researcher to select relevant and appropriate items of information from the wealth with which they are presented. This problem is exacerbated significantly when access to vast amounts of information is so simple. The Internet gives speedy access to more information in one search than many children of the previous generation might have expected to come across in the course of their entire education. This can be seen as a great step forward, also if not dealt with effectively, as an enormous problem .

Copying large sections of text from paper sources has often been a problem in the past, and continues to feature in the non-fiction writing of many children in many classrooms (Lewis, Wray and Rospigliosi, 1995). Over many years teachers have encouraged children to "...write it in your own words.", but, without the appropriate help to enable this, the problem persists.

The user-friendly nature of the technology exacerbates the situation. Lifting sections of text wholesale from web sites, and relocating them in a piece of project work is a simple process. However, doing this does not imply the effective use, in terms of increasing knowledge and understanding, of information which has been relocated.

This particular danger has the potential to drive teachers away from Internet use.: One teacher reported ... "That is precisely why I won't use the Internet... there's too much (information) and they (the children) don't know what to do with it." (See, for example, Pritchard (1998, 2000) for short treatments.)

To make effective use of the Internet for learning, children need both technical level skills and other skills which could be classified as cognitive. It is possible to teach certain strategies which allow for more effective use of information the skills of research and information handling. This should be promoted in two ways: Firstly, internet sites should be designed with effective information use in mind. Secondly, the ways in which children are encouraged to use large information sources should reflect what is known about learning, most notably, the principles of constructivist learning, in particular that:

- new knowledge and understanding is built upon existing knowledge and understanding;
- active exploration of information and ideas is the most likely way for learning to develop effectively;
- dialogue, in one of its many guises, is fundamental to the learning process.

ICT in the context of Design and Technology has been described as being used in one of three modes, namely ICT as a source of information, ICT as a tool, and ICT as a component. (DATA, 1995, 1996a, 1996b)

Source of Knowledge:

The notion of ICT as a source of knowledge encompasses CD-ROM encyclopaedias, but more impressively, the Internet. It is this aspect of ICT supporting work in Design and Technology which will be expanded later.

Tool:

ICT can be used as a tool to support Design and Technology at any stage in the process of designing and making. The separate stages could be set out as: researching, analysing and presenting information; modelling; and manufacturing. Under the first heading ICT use can lead to more thorough planning, the development of organisational and information handling skills, the speeding up of the research process and the enhancement of language and graphical skills in the presentation of information. The idea of modelling can be divided into three. Firstly the group of programs which simulate specific situations - room layout, or nutritional values in particular combinations of food, for example. Secondly are the content free modelling programs such as spreadsheets which can be used to construct a more mathematical model of a situation, costs of raw materials and energy, for example. Lastly, the drawing and design programs which allow for such things as the design of patterns to be considered and tried out. All of these modelling programs add to the process of designing and making by allowing for pupils to ask, and in many cases answer, questions in the form of "What will happen if...?" Manufacturing includes, especially at Key Stages One and Two, the production of posters, adverts,

templates, nets for models and patterns for printing. All of these can be done with drawing, painting and design programs. The use of computer applications can lead to: the possibility of a more professional finish; accurate reproduction of shapes for patterns; and the removal of human error and inaccuracy being removed from the process.

Component:

This notion of a computer as an integral element of the finished product, rather than as a means to the end or as a tool for making the end more easily achievable, refers to the use of a computer to control, and sometimes computer sensing as a part of a control system. This notion fits in well with the idea that a great many artefacts in everyday life are designed to include, and rely upon, the use of computers of one sort or another.

In a small scale classroom based research project investigating the use of the Internet for information gathering, two groups of children were given an identical task, but one group offered and expected to use a set of three simple rules. Though not directly related to work in Design and Technology, the principles involved remain the same, and stay the same irrespective of the subject context. In any research situation the very thing that is not wanted is the wholesale cutting and pasting of large (or even small) extracts which have not contributed to the child's learning.

The Rules

The rules given to one of the groups were:

- i Keep any extract from the Internet short;
- ii Make a comment about any extract that you include;
- iii Say where the information came from.

The reasoning behind this guidance was as follows:

i *Keep any extract from the Internet short:*

By keeping the quote from a website short, the end product would be less likely to be made up of passages taken directly from the source. Being obliged to make a selection from a longer passage necessitates reading and the making of decisions about which part to select. Reading the information, instead of finding a "chunk" dealing with say, the Penny Farthing, and using the whole piece, means that the children will engage at some level with the text.

ii *Make a comment about any extract that you include:*

This rule can be followed in at least two different ways. The comment could be the child's reason for including the quote, for example: "*This sentence tells us that James Starley lived locally and started a bike factory close to our school. It was the first bike factory in the country.*" or "*I included this because it tells us about the first blow up tyres.*" An alternative style of comment could be concerned with something more personal: "*My dad says that his first bike was a Penny Farthing, but I don't believe that because he was born in 1968.*"

The purpose of this rule was similar to the purpose of the first. It was an attempt to encourage children to engage with the text. This rule also encourages the child to think more broadly about the extract and to give it a context.

iii *Say where the information came from:*

This rule was to encourage honesty about where ideas and information came from, and to encourage clarity about the difference between their work and the work of somebody else. It was hoped that applying this rule would lead to good habits, and help to avoid unintentional plagiarism.

The End Products

The children's comments made it clear that the Internet could be a highly motivating resource. When the children were told that they were going to be using the Internet there were cries of delight and excitement. During all of the lessons, the children were interested, involved and generally well motivated. Apart from the general atmosphere detected in the room, it was also clear from speaking with some of the children at a later date, that the work had been enjoyable:

Child A: It was a fun lesson. It was a good challenge.

Researcher: Did you enjoy the work?

Child B: I definitely enjoyed it. It wasn't easy, but it wasn't the hardest thing ...

Researcher: Did you enjoy the work that we did on the computer?

Child C: Yes I did, I thought it was fun, I enjoyed it. ... I enjoyed doing it ... So it was fun yes.

Researcher: Was it enjoyable?

Child D: Yes ...fun. It was fun, but complicated.

This confirms the findings of other research (Hammond and Mumtaz 2001, BECTa, 2001) which links the use of the internet and ICT in general to high levels of pupil motivation.

There was evidence that some of the children had 'personalised' their information and composed their own text, which suggests that they had some understanding of what they were writing about:

"Around 1790 a French craftsman named de Sivrac developed a "Celerifere" running machine, which had two in-line wheels connected by a beam. The rider straddled the beam and propelled the Celerifere by pushing his feet on the ground, scooter fashion. [Direct quote.]

I think that this bike is not very comfy and will break down very easily. The bikes were very uncomfortable the saddles were very hard not like modern day bikes like my mountain bike which has got suspension. [Personalised comment.]

And:

There weren't any human powered bikes before the 19th century they weren't considered sensible. We all know now that bikes are sensible and can go really fast. I've been to see speedway bikes, they go very fast and don't have brakes. [Personalised comment related to an idea taken from a website.]

However, the overall quality of the end products was disappointing. Even having fulfilled the requirements of the three rules there was no clear evidence of work of the

quality that might be expected. Some children took extracts directly from a website and gave the impression of not having read the words which they were using:

“Below are some photos of typical bicycle club uniforms.” [There were no pictures to be seen.]

“Announcing the launch of a totally new range within the Falcon Cycles structure”

“This link will return you to the Broadgate Cycles homepage.”

This copying is obviously not a new phenomenon but the technology makes it much more likely.

There was only limited recall of the facts when a selection of the children were questioned a few weeks after the work had been completed.

Researcher: What did you learn about the history of bikes in that work, can you remember?

Child E: Umm

Researcher: It's a long time ago, isn't it.

Child E: It was but err, I can't think. Oh I can remember the Penny Farthing.

Researcher: ... What's that like?

Child E: Umm it has a small wheel at the back and big wheel at the front.

Researcher: Good. ...Anything else you remember about bikes from the work and the information?

Child E: I think I can remember who made the thing but umm

Researcher: Do you remember his name? Was it a “he”?

Child E: I think it was a “he” but I can't remember.

Researcher: Did bikes make much difference to people's lives?

Child E: I don't know.

A good deal of time seemed to be spent on “distraction activities”, such as following links, writing elaborate titles and so on. It is clear that other teaching approaches are needed if we expect children to engage with information in a meaningful way, and to learn something from it.

This project highlights many of the problems that concern teachers in using the Internet. Even though the children were given websites to use, some still chose to ‘wander off’, accessing sites that had little to do with the activity. Hammond and Mumtaz (2001) point out the dilemmas faced by teachers in trying to address this problem - at one end of the spectrum is the scenario of over-controlled pupil activity in which pupils are given highly directed worksheets with the addresses of sites which teachers have chosen; at the other is unsupervised use in which pupils jump from site to site with little or no engagement. Hammond and Mumtaz (ibid) also acknowledge that a balance needs to be struck which can only be accomplished by careful scaffolding by the teacher.

Some of the children spent a proportion of their time focusing on technical problems such as navigating between windows and losing information during the cut and paste process. It can only be speculation when the extent to which these technical issues detracted from the main purpose of the lesson and how they might have led to differences in the end products. In cases like this children are concentrating on what has been called “the mechanical rather than cognitive”. (Hartmann undated) The “cognitive” being those aspects which involve engagement with the content of the information.

There was little evidence to suggest that the children had engaged with the content, facts, or ideas within the information in any meaningful way and this seems to be one of the reasons why the children seemed to have learnt so little. This is in line with the constructivist notion that it cannot be assumed that information will be learned by the simple transmission of facts from one place to another (Guile, 1998). For children to understand new information, they must become actively involved with it (Reid et al 1989). Reid and associates present a five stage model: engagement - exploration – transformation – presentation – reflection (ibid) which sets out a route to be followed with work of this nature. In this project there was a minimum of these first two stages very little transformation, some attention paid to presentation and no discernible reflection.

The children were beginning to acquire information and to explore it. It could be argued that they then went on to transform their information to present to their intended audience in the form of the information sheet. But many of the sheets were merely collections of a small sample of the information which the children had come across. The process they worked through could be likened to the initial stages of an investigation where every piece of information to do with the particular topic is collected, regardless of its worth or relevance to the purpose of the investigation.

Purpose, Structure and knowledge Transformation

What children perceive to be the purpose of the task is crucial here. It became clear when the children were interviewed that the purpose of the task was of little importance to them – they could hardly remember why they were doing the activity and did not talk at all about the intended audience for their information sheets. Most of them referred vaguely to “finding out about the history of bikes” and so it is understandable that they lacked a clear purpose that they could use in their explorations. It is not surprising that there was a temptation to cut and paste, gathering pieces of information in an indiscriminate fashion. This indicates the need for initial support and continuing scaffolding as the work progresses.

A framework to work within can be particularly helpful; the teacher has an important role in building and being part of this framework. In order for children to learn from any information they must move from the position where they are merely ‘collecting’ and ‘recording’ it to a position where they are actively involved with it, and it is the teacher’s role to provide tasks and activities which provide a setting in which this can happen.

The experience in this project is similar that reported by Selinger (2001) “Much Internet activity consists of unstructured searches, ill-defined tasks, and children’s work which consists of text and images cut and pasted into a report. Questioning children about their reports in these situations often reveals no evidence of understanding or learning.”

We have seen then, that what results from poor preparation when using the Internet is a lack of purpose leading to little discernible learning and, even with the guidance given to one group of children, the outcomes in terms of quality of the end product and the retention of information and ideas were poor. Purpose, or focus, seems to be a very important element of being successful when working with large information sources. We will see later that there are strategies which teachers can develop for children to use which can give a focus and a well defined purpose to this sort of work.

The conclusion which can be drawn from this short study is that if the Internet is to be exploited as a resource it is imperative that sufficient effective guidance is given and that good level of monitoring is in place.

For Internet use to have as much of an impact on children's learning as it has the potential for it seems that it is necessary to provide a good deal more initial support, including the practice of strategies (which will be outlined later) for dealing efficiently with the information which the Internet can so easily supply, and for encouraging engagement.

Bereiter and Scardamalia (1987) outline a model of the writing process which they term "knowledge transformation". Knowledge transformation can be seen as knowledge, possibly from a number of different sources, being reconstructed in order to answer certain questions and to help meet particular learning objectives. This model is characterised by the writer alone accomplishing what is normally accomplished through the medium of social dialogue. Knowledge is considered and "worked upon" by the individual – engagement takes place. This dialogue, which forms an important element of the thinking underpinning social constructivism, is seen as the medium through which learning takes place. A child working alone cannot take part in an actual dialogue, with the possibility of allowing engagement with the knowledge and ideas of the topic in question, but by undertaking a process of knowledge transformation, a similar process may come into play, and effective learning may be possible.

Encouraging Engagement

It can be surmised then that an important element of the role of the teacher is to encourage engagement, since without some measure of involvement with information and ideas – Bereiter and Scardamalia's knowledge transformation - there is reduced opportunity for effective learning to take place, especially the deep learning which is normally the aim of most teaching situations.

There are many effective ways in which teachers can encourage children to engage with factual information. A starting point for this would be to encourage children to consider what it is that they already know about, or understand about the topic in question. This notion is given prime importance in the "Extending Interactions with Text" (EXIT) model presented by Wray and Lewis (1997). The first stage of this ten stage model requires that children are encouraged to review their existing state of knowledge and sometimes, understanding, it is termed "Activating prior knowledge". It relates very closely to the constructivist notion that new knowledge and understanding is built upon a foundation of what exists already. By focusing attention on to what is already established the process of building is given a head start.

Another important principle is to encourage a focus on a specific aspect of what is probably a wide field of interest. Building on Ogle's initial work in this area (1989), Wray and Lewis (1997) set out the use of a KWL grid as a starting point for research work with non-fiction texts. KWL stands for: "What do I KNOW - What do I WANT to find out - What have I LEARNED" The grid encourages children to think more deliberately about what they already know, and what they would like to know about it and to be more aware of what they have learned. Again, this is a general approach, not restricted to use with information specifically from web based or other electronic sources. Another approach which could well be of value in work of this nature with children, is the writing

frame. This notion, also explained by, Wray and Lewis (1997) is a simple scaffolding device, now widely used in English primary schools, which gives a structure for children to use when writing in a format or style new to them.

The reading of website material could benefit from being similarly structured and supported, for example, through the reading system known as SQ3R¹ (Survey – Question – Read – Recite – Review), or the approach known as PREP² (Preview – REad to understand – Process to learn). Both these systems of approaching non-fiction text encourage the asking of questions, the making of notes and other activities which encourage cognitive activity.

1 Detail can be found at:
<http://virtual.parkland.cc.il.us/studyskill/Reading&StudySystem/ClassicSQ3R.htm>

2 Detail can be found at:
<http://virtual.parkland.cc.il.us/studyskill/Reading&StudySystem//PreP.introduction.htm>
and in many other places.

Directed Activities Related to Texts (DARTs) provide another setting within which engagement with the facts and ideas in non-fiction texts is encouraged. DARTs were first written about by Lunzer and Gardner (1979) and later by Davies and Greene (1984). The names covers a wide range of different types of activities all of which serve to focus the attention of the reader on the important elements of the text as a way of encouraging engagement and increasing the amount of cognitive activity which takes place.

DARTS are divided into two broad categories, namely, “Reconstruction Activities” and “Analysis Activities”. Reconstruction, or completion activities, are essentially problem-solving activities and make use of a modified version of the text in question. The text or diagram is reproduced by the teacher with parts missing: words, phrases or labels are deleted, or alternatively, the text is broken into segments which have to be re-ordered or re-arranged. The activities have game-like characteristics where the game involves hunting for clues in order to complete the text. To complete these activities it is necessary to read and often re-read the text and to think about the sense and meaning of the information, sometimes in some depth. *Analysis activities* do not need the text to be modified, it is used precisely as it is. These activities seem to be more educational in nature than the game-like reconstruction activities. Their aim is to find a particular meaning or to seek for particular “information targets” in the text. Searching for the targets involves children in locating information and categorising it .

Conclusions

Learning from information sources such as the Internet is not something which can always be guaranteed. That is to say that it is not possible for some readers or learners to take advantage of exposure to information as a straightforward learning opportunity. Simple exposure to information, or simple copying from one place to another does not imply learning. However, it is possible to do a lot to promote situations where effective learning is more likely to take place. Good habits can be encouraged from a very early stage in schools. Activities which encourage focus, and a consideration of what is already known, what is actually being sought, and what is going to happen to the information once it has been located help develop discerning users of information. Other more specific considerations, including context, interest, means of recording,

style of presentation, audience and means of communication, also have an important impact on the success or otherwise of learning situations of this type. In particular the role of talk in developing such understanding should be taken into account.

The project focusing on the History of Bikes did lead to some positive findings. Some children were able to keep the “rules” in mind and to make comments which indicated that they had considered the information and had gone beyond the information given. The project does, however, highlight the need for strategies to encourage engagement. Elements of the EXIT model could well serve this purpose, as could well structured DART activities. It should be borne in mind that different children are likely, for a variety of reasons, to benefit in different ways from the same activity, and that some children might well need an approach with different emphasis, or with more or less support. This notion of individual difference is no less important in this area of work than in any other. The teacher must always have in mind that whatever the children are asked to do, for whatever purpose, the activity should be geared towards encouraging optimum and meaningful engagement.

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Using ICT to enhance student understanding of classification

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Abstract

It is common for 13-year-old students in Victoria, Australia to learn how to classify animals and plants using the Linnaean system and dichotomous keys. This is usually done with text based research on the major groups of animals and plants and a few simple exercises with various objects to explain the underlying concept of classification. In this paper we describe our attempt to achieve similar goals using three computer software programs to build dichotomous keys and represent the data: Inspiration, MS PowerPoint, and MicroWorlds. Student work is included to illustrate what can be achieved by students of various abilities with these information and communication technologies.

Introduction

In this paper we would like to describe an attempt to enhance student understanding of the concept of classification using various computer programs. We start by describing the school setting and the class of students who have been involved. The teaching and learning environment is one characterised by constructivist philosophy and the manner in which this impacts on the task is then explored. The students' tasks are then explained in the context of a unit of study focussed on the scientific application of classification to the five kingdoms of living things. We conclude this paper by reflecting on the outcomes of the teaching and learning experience and what it has taught us, as teachers.

The Setting

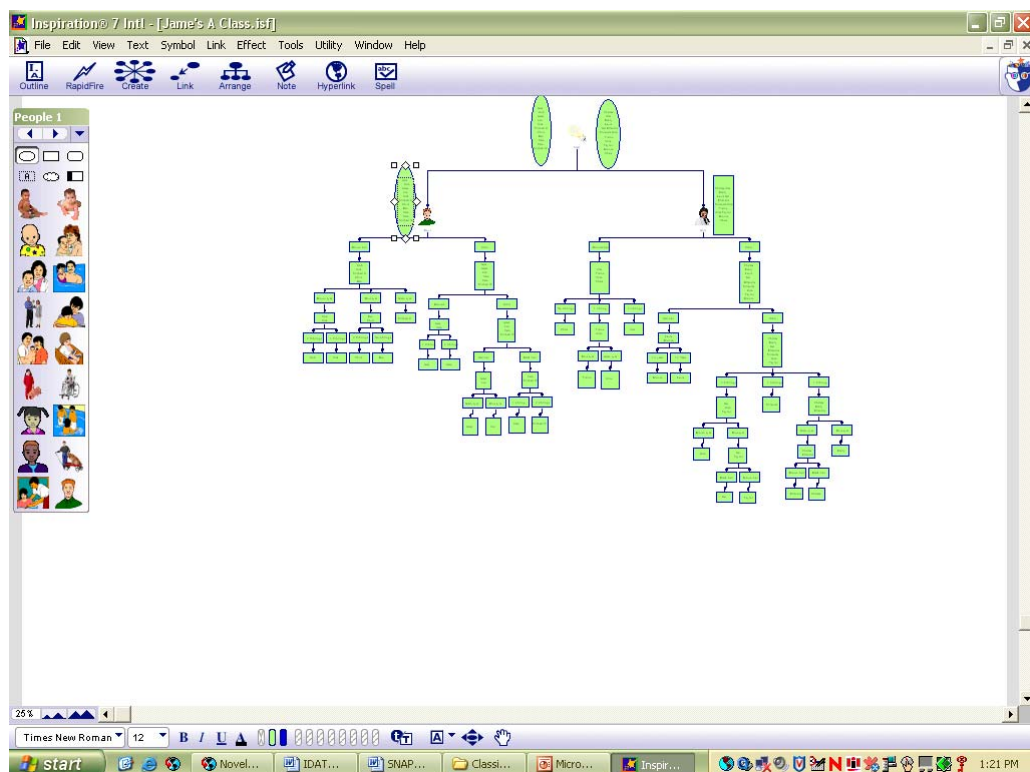
Woodleigh School is a small coeducational independent school approximately 50 kilometres south of Melbourne set on the rural/urban fringe. The population of the school is mainly Anglo-Celtic with some students of post World War II European immigrant descent (Greek, Italian, Dutch, and German) drawn mainly from the Mornington Peninsula. The School has an Early Education Centre for 3 and 4 year old students, a Junior School for 5 to 12 year old students (Preparatory Year to Year 6) and a Senior School for 12 to 18 year old students (Years 7 to 12).

This particular class are a mixed ability group of Year 7 students (12 to 13 years old) studying classification as part of their general science course. As can be expected from a mixed ability class (Simpson, 2001) the many intelligences of Howard Gardner are all represented and the students display a range of learning styles and learning abilities. That is, we are able to identify students with visual, auditory and kinaesthetic learning preferences, logical-mathematical, linguistic, spatial, musical, naturalistic, bodily-kinaesthetic, intra-personal and inter-personal intelligence preferences, students who have learning abilities and learning disabilities or difficulties as well as those who have prior experience of classifying objects and cognitive structures related to this concept and prior experience with information and communication technologies and confidence

in using them. We have twenty-five very individual children.

The students commenced their study of classification by completing a series of activities which were prepared for them. First they were required to sort wrapped sweets into various groupings, producing at least three different outcomes. The students' various groupings were collected on the white board and discussed. A discussion of objective characteristics and subjective characteristics ensued. Second, the students were given a range of natural and artificial objects. These included feathers, cones from plants, leaves, shells, rocks, buttons, and plastic animals. The students were again required to arrange the objects into at least three different groupings. The results were again collected on the whiteboard and discussed.

Having introduced the idea of sorting objects into groups, the next step was to introduce the concept of dichotomous keys. The students were required to collect information from each of the students in the class including things like height, eye colour, hair colour and siblings and use this information to complete a dichotomous key of the class (using pencil and paper, although some students chose to use Inspiration to represent their work).



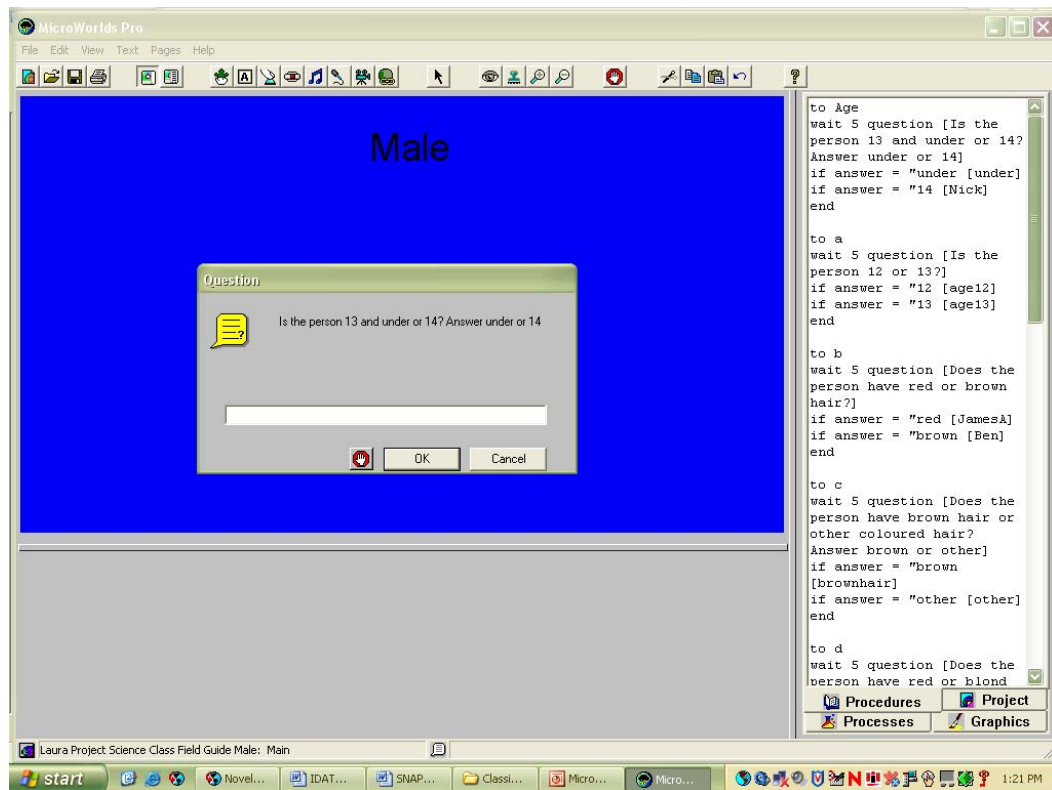
There is a link to the file that James created at

<http://www.woodleigh.vic.edu.au/idater/index.htm>. You will need a copy of Inspiration ¹ to view the actual file.

One very computer literate student decided to arrange this information with MicroWorlds.

1 Inspiration can be downloaded for a free evaluation from

<http://www.inspiration.com/home.cfm>



Hyperlink to Laura's work - <http://www.woodleigh.vic.edu.au/idater/LaurasMWCClass.htm>

The students were then required to use this information into a field guide of their class (the data collected while completing the key was used to build student descriptions and then represented as a field guide in MS publisher using digital photographs of each child taken by the teacher – Gary Simpson). The publisher document has not been linked to this paper in order to protect the privacy of the students in this class.

Following these activities the students were required to represent the Animal and Plant kingdoms in dichotomous keys using either Inspiration, PowerPoint or MicroWorlds. This task is the central point of this paper and presented in greater detail below. To complete the unit of study students were required to complete a short project on Carl Linnaeus to gain an historical perspective of the major scientific concept of classification and the technique of dichotomous keys. They were also required to explore the classification systems of the Karam of Papua New Guinea and the Yolgnu of Arnhem Land to gain a cultural perspective of these concepts.

Appendix 1 contains a description of the unit of work that the students received.

Constructivism

My teaching uses constructivism as a philosophical referent for my pedagogy. Therefore, I have included a short description of its core influence here. Ernest (1995) claims that constructivism originated with Jean Piaget, was anticipated by Giambattista Vico and is most fully explicated by Ernst von Glasersfeld (1995). Vico is credited, by

von Glasersfeld (1990), with recognising the basic tenet of constructivism. Vico wrote, "The human mind can know only what the human mind has made" (Vico, 1858). The mathematician and psychologist von Glasersfeld, working with the theories of Vico and Piaget was among the first to describe the way that human beings construct knowledge. To von Glasersfeld there are two basic characteristics of constructivism:

- a) Knowledge is not passively received but built up by the cognising subject.
- b) The function of cognition is adaptive and serves the organisation of the experiential world, not the discovery of ontological reality.
(von Glasersfeld, 1995, p. 18)

To apply von Glasersfeld's construction of Constructivism to the classroom it has been found, through reading, that Constructivists tend to agree on four characteristics:

- all conceptual knowledge is constructed,
- there exist cognitive structures that are activated in the process of construction,
- cognitive structures are under development but can be transformed through purposive activity or from environmental or social pressure, and
- acknowledgement of constructivism as a cognitive position leads to the adoption of a constructivist methodology by the teacher to inform the teachers pedagogical practice.

Critical constructivists, such as Peter Taylor (1998) add the concern of valuing. That is developing an ethic of care within the relationship between student and teacher and an ability to value knowledge claims which requires an acknowledgement that one knowledge claim may be more appropriate in a particular setting. Von Glasersfeld's construction of constructivism is founded in relativism, so this valuing tends to require a neo-relativist approach (Simpson, 2004) for critical constructivists.

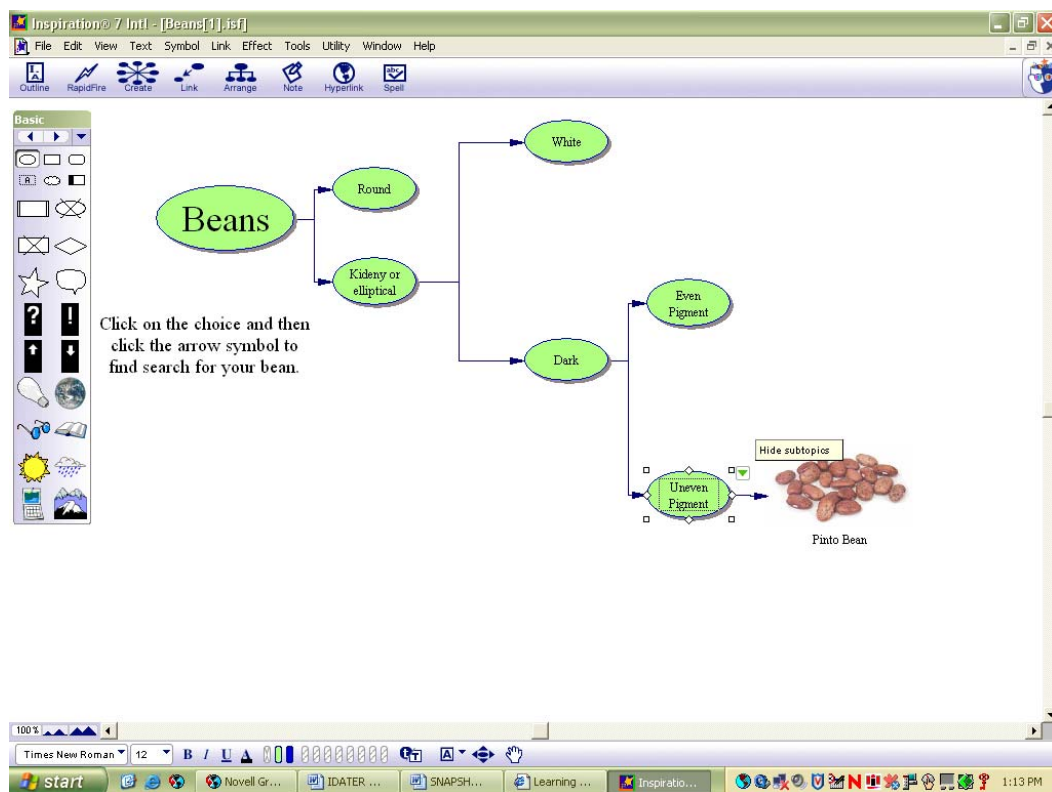
To me, this means that all students in my classrooms are capable of cognitive processes that will allow them to gain knowledge and understanding. That is, they have the ability to succeed. When I considered the implications for my own teaching of these general characteristics of constructivism, I coined six key pedagogical principles for guiding my practice:

- measurement of students' prior knowledge and understanding, especially to diagnose existing misconceptions - or non-viable constructions,
- intervention by the teacher to mediate the learning of students with purposive activity,
- establish social situations in which students can make sense of experiences in terms of what is already known,
- provide opportunities for students to represent their knowledge in a variety of ways that is matched by a variety of assessment techniques, including posing situations where students are caused to take action based on their knowledge and understanding,
- constantly monitor student activity to recognise signs of difficulty, disengagement and depth of understanding, and
- report student learning in a way that recognises the student as a unique individual.

These principles guide this unit of study. The tasks at the centre of this paper are designed to provide opportunities for the students to represent their knowledge and understanding of classification, which they should have gained by completing the earlier activities which were used to measure the students' prior knowledge and understanding of the concepts and ensure that all students had the required information to be successful.

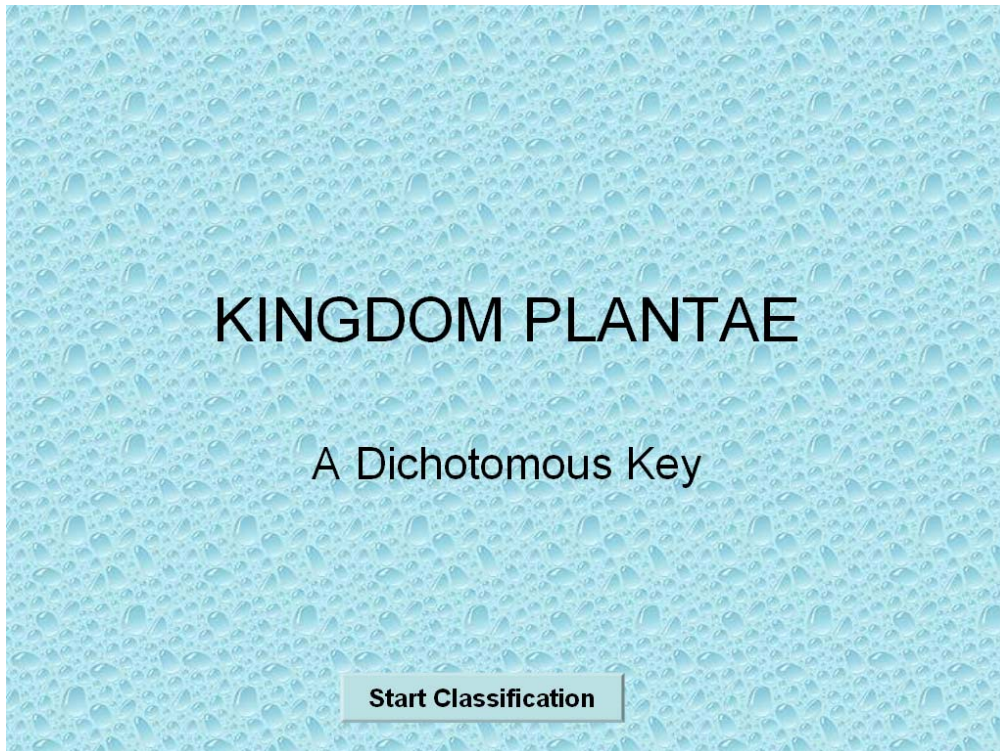
The Tasks

Having completed the preliminary activities which allowed me to both assess prior knowledge and ensure that the basic concepts required of the tasks had been experienced, the students were required to complete two dichotomous keys - one for the Plant Kingdom and one for the Animal Kingdom. As the students displayed a broad range of computer skill and experience a number of programs were offered to them. The simplest way to represent the information was in Inspiration. This program allowed students to arrange the data on the screen in front of them, as one would when concept mapping on paper, and insert all the relevant information about the various major groupings of animals and plants. Mark Chapple had created a key to beans using Inspiration which was available to the students via the school intranet as an example of how to complete a key using this program.



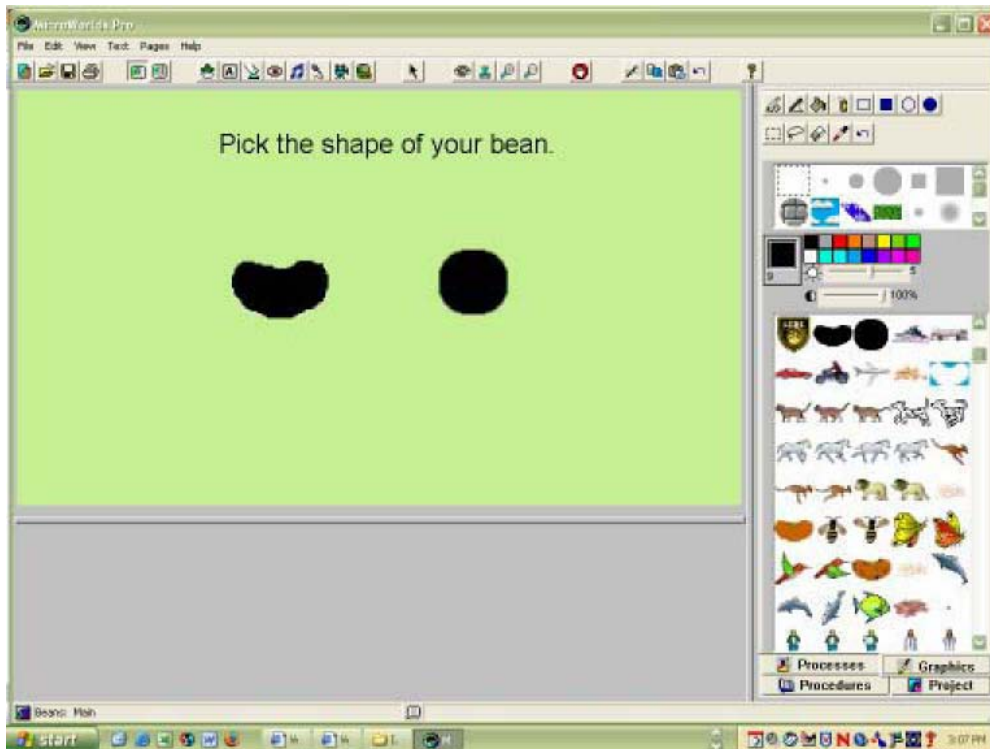
Page containing Mark's files - <http://www.woodleigh.vic.edu.au/idater/index.htm>

Students who were more comfortable with the computers were encouraged to use MS PowerPoint to make a more interactive key. Using the hyperlink capacity of this program students were able to pose a question, offer two solutions and link each solution to the next appropriate page of the slide show, eventually displaying the information required. Gary Simpson had created an example of a plant key using PowerPoint. It was deliberately incomplete and contained logic errors so that students would not directly copy it, but could improve on it.



Page containing Gary's file - <http://www.woodleigh.vic.edu.au/idater/index.htm>

The more able students were encouraged to use MicroWorlds. MicroWorlds is a collection of tools in the form of simple programming language which encourages students to explore concepts and show what they have learnt, how they have investigated a concept and sought for deeper understanding. Many teachers will be aware of the LOGO language of which MicroWorlds is a later evolutionary stage. Mark Chapple had created an example of how this program could be used to create a key for beans, which was made available on the school's intranet.



Page containing Mark's sample beans file -
<http://www.woodleigh.vic.edu.au/idater/beans.htm>

The information required to complete these two tasks was readily available in the students' text books (Lofts and Evergreen, 2000). Students needed to read, analyse and select the appropriate information to prepare questions for their keys and descriptions of the major groups of plants and animals.

Reflections

This was a highly successful teaching innovation. The students spent 8 x 80-minute sessions collecting the data for a class key and guide and preparing dichotomous keys for Animal and Plant Kingdoms. The students were highly motivated, spending their time productively discussing the biological concepts and sharing their knowledge of the various programs. We believe that by integrating ICT into the performance of these tasks that the student outcomes have been enhanced. The students have been required to carefully select information and images to construct a representation of their knowledge. While this is possible using paper and pencil techniques, we believe that by using ICT the students have been able to produce finished products of a higher standard more efficiently and are able to share these with a wider audience than their immediate peers. While not directly measured, essentially as it was an afterthought, we believe that the students have been able to retain their knowledge and understanding of these concepts, more so than our previous experience would suggest. The proof of the effectiveness of this activity has been in the student outcomes.

Nick is a student who has partial deafness and various diagnosed learning difficulties who usually struggles to complete the tasks set in this class. However, it must be said that he works hard to try to complete all activities. In this case he managed to finish a

key of Animals using Inspiration. It doesn't contain all the required information, but for a student who has struggled to complete tasks all year, this is by far his best effort and one of which he was very proud.

Page containing Nick's file - <http://www.woodleigh.vic.edu.au/idater/index.htm>

Tom is a very able student who generally finishes all tasks, but not always fully or to the best of his ability. In this case he managed to complete a paper based class key, a paper based class field guide (because he realised that the photographs would make the file too large for him to store in his network folder – a realisation he could have shared with the rest of us!) and then completed keys for both Kingdoms – Animals in Inspiration and Plants in PowerPoint. He was able to demonstrate a clear understanding of dichotomous keys and their use for grouping like objects.

Page containing Tom's files - <http://www.woodleigh.vic.edu.au/idater/index.htm>

Chelsea and Alex are friends who regularly work together. One is more able than the other when completing Science based work, while the other is more competent with computers (interestingly she is also more competent with mathematically based activities). They both completed the Animal and Plant keys, but worked together to share their various skills.

Page containing Chelsea and Alex's files - <http://www.woodleigh.vic.edu.au/idater/index.htm> . There are three files in all – two from Chelsea and one from Alex.

Laura and James are both highly motivated and highly competent Science students with excellent computer skills. Laura chose to extend herself by producing a class key in MicroWorlds as mentioned above. She then used the skills she had developed to prepare keys of Animals and Plants which displayed her growth of knowledge with both the software and the biological concepts.

Page containing Laura's class files - <http://www.woodleigh.vic.edu.au/idater/LaurasMWkey.htm>

James also chose to extend himself. He prepared a fabulous class key in Inspiration (above) and then worked with MS PowerPoint to produce a key of the Animal Kingdom which links 30 slides together to present a particularly intricate and detailed key of the major groups of animals.

Page containing Jame's files - <http://www.woodleigh.vic.edu.au/idater/index.htm>

We learnt that, as for all successful innovations with students, one is able to measure individual success. This is not always success against a predetermined outcome or goal or a class mean, but success for each individual in the sense of personal growth in skills and knowledge. Our students all started from different places and all ended up in different places, but they have successfully constructed dichotomous keys and grouped like objects. Their class test results suggest that the students have also successfully reconstructed their cognitive structures in relation to classifying living things and the use of dichotomous keys. They were asked to classify objects and develop keys for objects

which they mostly did very well. They were also asked questions about plants and animals and how they are classified and again mostly did very well. As one would expect the stronger and more confident the student the better their results, but all students were able to show growth in their knowledge and understanding of the classification of living things. They have also had rich experiences of information and communication technologies, using Inspiration, PowerPoint, and /or MicroWorlds, search engines to seek appropriate images for their keys and attaching files to e-mail to send their completed tasks to me for assessment. To add to this ICT rich environment the students have used the school intranet to view each others work. This experience has reinforced both their understanding of the biology and ICT.

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Mark Chapple is currently an onsite educational technology specialist working at the Woodleigh School. Mark also maintains an independent consultancy practice, working with teachers and schools as they strive to improve student outcomes using learning technologies. In previous positions within the IT industry, Mark worked closely with schools and teachers to assist them integrate technology within classrooms. Over the past ten years he has presented nationally at conferences and held workshops on issues such as planning for technology, developing collaborative learning environments and using technology within the classroom.

Gary Simpson is currently Coordinator of Independent Learning and Homestead Coordinator at the Woodleigh School, having worked extensively at incorporating ICT in the Science curriculum at his previous school. He is a NCISA Scholar completing his PhD on the application of constructivist epistemologies to the teaching and learning of middle school science, at the Key Learning Centre for Mathematics and Science Education at Curtin University, contributing Editor to *Science Education Review*, coordinating author of Heinemann Science Links Books 3 & 4 and a regular contributor to various publications.

APPENDIX 1 YEAR 7 CLASSIFICATION UNIT

Rationale

This unit of work requires the student to carry out tasks to investigate the manner in which objects can be grouped together to fulfil a social function. The investigation of other cultural groups and the historical development of the Linnean System will be complimented with practical investigations and applications of this theoretical knowledge. The conceptual setting is one of open ended but directed tasks. It is intended that an understanding of the theoretical setting of the classification of living things will occur through vicarious and tacit experiences. Students will be encouraged to hypothesise and draw their own conclusions.

Objectives

These objectives are based upon the Curriculum and Standards Framework for Science Curriculum foci for levels 1, 3, 4 and 5 for the sub-strand Biodiversity, change and continuity.

Knowledge - This unit aims for students to achieve the following:

- to be able to distinguish between living, non-living and dead things.
- to be able to classify living things in a variety of ways.
- to develop an appreciation of the historical development of Western taxonomical systems.
- to develop an appreciation of selected indigenous taxonomical systems.
- to be able to investigate the similarity and diversity of characteristics within and between groups of living things
- to be able to identify features of living things that determine their classification into major groups.

Skill - This unit aims for students to develop the following skills:

- to report on practical investigations in a structured, logical manner.
- to be able to make biological drawings.
- to be able to dissect plant specimens.
- to be able to use a light microscope.
- to present data in a variety of forms: as graphs, tables, charts; with words both written and spoken and through 2 and 3 dimensional representations.
- to conduct independent research using magazines, books, CD-ROM and the World Wide Web.
- to develop higher level abstract thinking to deal with scientific theories concerning the manner in which organisms are ordered.

TASK ONE - PRACTICAL EXPERIMENTS LOG BOOK DUE DATE: Monday 2 August 2004

You are to keep reports of all the experiments that you do during this unit. You must write an aim, a list of apparatus, a method, display your results and observations and include a discussion and conclusion. Students are to work in groups of 2 or 3. But each student must keep a logbook. The experiments that you will need to complete are:

1. Classifying Objects (Lollies)
2. Classifying Objects (Various) - The Sequel
3. Living, Non-living or Dead (p149)
4. Making a Class Key (p150)
5. Making a Class Field Guide (p151)

Practical Experiment No. 1 - Classifying Objects (Lollies)

1. Collect a box of objects.
2. Sort the objects into groups. Record the groups of objects and the reasons why you sorted them in that way on a piece of paper.
3. Repeat step 2 above at least twice more. You will have at least three different systems for grouping the objects recorded in your observations/results.
4. Choose the groups best sorting of the objects and present this on an A3 sheet of paper, explaining how you sorted the objects.
5. You may eat them when you finish.

Practical Experiment No. 2 - Classifying Objects (Various) - The Sequel

1. Collect a box of objects.
2. Sort the objects into groups. Record the groups of objects and the reasons why you sorted them in that way on a piece of paper.
3. Repeat step 2 above at least twice more.
4. Choose the groups best sorting of the objects and present this on an A3 sheet of paper, explaining how you sorted the objects.

CRITERIA FOR ASSESSMENT

1. Completion of five tasks. (10 marks)
2. All tasks completed correctly - that is correct method for presentation of the experiment, all results and observations included and conclusions make sense. (15 marks)
3. Work neatly and clearly presented. (5 marks)

TOTAL MARKS (30 MARKS)

TASK TWO – CLASSIFYING ANIMALS

DUE DATE: Wednesday 11 August 2004

Using the information presented on pages 152 – 161 of your text book you are to prepare a dichotomous key of the major animal groups – vertebrates (including the three groups of mammals) and invertebrates. All the information you require is in the text book. The key is to be produced using the computer and needs to operate in an interactive manner.

You need to make sure that your key uses the information about each of the groups of animals as the basis of the questions and includes:

- Birds
- Mammals
- Amphibians
- Reptiles
- Arthropods

- Molluscs
- Echinoderms
- Worms
- Cnidarians
- Porifera

You may use Inspiration to create your key, but this will not be interactive, it is possible to use a Web Page to achieve the interactive nature of this task, it is possible to use MS Excel and MS Access and MicroWorlds may offer a simple programming solution. We will work through the solutions to making an interactive key in class.

CRITERIA FOR ASSESSMENT

1. Completion of a working key. (10 marks)
2. Key contains all the information required. (15 marks)
3. Key presented in a neat, logical manner. (5 marks)

TOTAL MARKS (30 MARKS)

TASK THREE - CLASSIFYING PLANTS

DUE DATE: Wednesday 25 August 2004

Using the information presented on pages 164 & 165 of your text book you are to prepare a dichotomous key of the major plant groups. All the information you require is in the text book. The key is to be produced using the computer and needs to operate in an interactive manner.

You need to make sure that your key uses the information about each of the groups of plants as the basis of the questions and includes:

- Bryophytes
- Mosses
- Liverworts
- Tracheophytes
- Gymnosperms
- Angiosperms
- Pteridophytes

You may use Inspiration to create your key, but this will not be interactive, it is possible to use a Web Page to achieve the interactive nature of this task, it is possible to use MS Excel and MS Access and MicroWorlds may offer a simple programming solution. We will work through the solutions to creating an interactive key in class.

CRITERIA FOR ASSESSMENT

1. Completion of a working key. (10 marks)
2. Key contains all the information required. (15 marks)
3. Key presented in a neat, logical manner. (5 marks)

TOTAL MARKS (30 MARKS)

TASK FOUR - DICHOTOMOUS KEYS

DUE DATE: Thursday 12 August 2004

This task is to be completed by each student in their exercise books.

1. What is meant by the term classification? (pp 148 & 149 may assist)
2. There are eight things that all living things have in common. What are they? (p 149 may help).
3. When we classify things we make charts like family trees or dichotomous keys.
 - a) Make a chart of your family for about three or four generations.
 - b) What is a dichotomous key? How does it work? (see p150)
 - c) Try to turn your family tree into a dichotomous key. What difficulties did you have? How did you overcome those difficulties?
4. Carolus Linnaeus developed a system for classifying living things that is named after him: The Linnean System. (p148 will help – but you'll need more, Ask Jeeves turned up a treasure trove including <http://www.ucmp.berkeley.edu/history/linnaeus.html>, but the library is sure to have books with information on this famous scientists as well.)
 - a) Write a short history of Linnaeus.
 - b) Explain how his classification system worked.
5. There are five Kingdoms of Living Things. We have looked closely at animals and plants. What are the other three kingdoms? Describe the sorts of organisms that are in the other three kingdoms.

CRITERIA FOR ASSESSMENT

1. All questions attempted. (5 marks)
2. Family Tree Dichotomous Key - neat and complete (5 marks)
3. Carolus Linnaeus - neat and complete (5 marks)
4. Five Kingdoms – questions answered correctly (5 marks)
5. References (5 marks)

Total Marks (25 marks)

TASK FIVE - DIFFERENT CULTURES DIFFERENT CLASSIFICATIONS

DUE DATE: Thursday 26 August 2004

Students may work in small groups to collect and discuss the following information. But each student is to submit the work in their exercise books.

Common to most cultures is the need to explain the natural world. To find order and system in the natural world makes human beings more comfortable in their own lives. Classification of living things and non-living things is an attempt to impose a system that gives order to the natural world. It is usually done in such a way as to be sensible to the cultural group and therefore makes little sense to another cultural group.

Karam Culture - Papua New Guinea

The Karam people of Papua New Guinea live in the rainforests and have an extensive, richly detailed knowledge of the natural world and a well-developed classification system. As part of this system they have a group called *yakt*. The *yakt* include birds and bats, but not cassowaries. The cassowary holds a place of special significance within Karam culture and has a special relationship with humans. Because it walks on two legs it is seen as a stage between being human and what happens after death – so they are treated as sacred and their various body parts are used for special, powerful objects. The cassowary is also quite a dangerous animal, capable of killing a young person or frail adult. The websites below are included to help, there are others – but this topic is hard to search for.

1. Collect some information about what birds might live in the rainforests of Papua New Guinea. Describe their features. (<http://www.hbw.com/ibc/>, <http://www.gspeak.com.au/kirrama/newgui.html>)
2. Collect some information about what bats might live in the rainforests of Papua New Guinea. Describe their features. (<http://www.amonline.net.au/mammals/bats/index.htm>)
3. Collect some information about the Cassowary. Describe its features. What role might it have in Karam culture? (<http://www.zoo.org.au/education/factsheets/cassowary.PDF>, http://www.wettropics.gov.au/pa/pa_casso.html)
4. Why are birds and bats classified together by the Karam? Why is the cassowary not included?
5. Would you classify these animals in the same way? Why/Why not?

Yolngu Culture - Arnhem Land

The aboriginal people of north east Arnhem Land (the Yolngu) have a rich and detailed knowledge of the plants and animals of their environment. They classify plants and animals very differently to us - the *balanda* (essentially meaning non-Yolngu people). Many plants have a number of different names and can be found in their classification system in a number of places. One such plant is the Cycad. It has fronds like a palm-tree and fleshy fruit. It is found in coastal eucalypt forests around most of Australia. The Yolngu have a name for the fruit of the cycad and the bread that is made from that fruit. They have special ceremonies and dances about the use of the fruit and they know that the fruit must be prepared in a special way to remove the chemicals that the fruit contains that could harm them. The cycad has at least four different names for the Yolngu. Other plants and animals are the same. One name for the fruit, one name for the bark, one name for the leaves, one name for the root or one name for the eggs, one name for the flesh, one name for the bones and teeth. The names reflect the use of the part of the organism (a word we use to describe all living things). The website below is

included to help, there are others – but this topic is hard to search for.

Prepare a chart for a Yolngu classification system. It must include the cycad, a eucalypt, a yam, a goanna, a wallaby and a barramundi. You will need to do the following:

- a) Find out what parts of the different animals and plants are used by aboriginal people and for what purpose.
(<http://www.abc.net.au/message/radio/awaye/stories/s123780.htm>)
- b) Make up a name for each part of the organism – if you can find out the real name, you could use that.
- c) Present your classification system on an A3 sheet of paper, illustrating the chart with appropriate diagrams and pictures and including a key of what the names mean.
(You may chose to use Inspiration for this.)
- d) Write a short explanation of how your "Yolngu" classification system works.

It is not possible to use the real Yolngu system because it is far too complex and requires a detailed knowledge of Yolngu cultural and spiritual life. Many of the paintings, stories and ceremonial dances told to explain the system have never been explained to *balanda*.

CRITERIA FOR ASSESSMENT

1. All questions attempted. (5 marks)
2. All questions answered fully and completely (10 marks)
3. Yolgnu Classification Chart presented neatly with all the required information included. (10 marks)
4. References listed (5 marks)

Total Marks (30 marks) **Assessment**

For the students assessment is criteria referenced. The teacher should stress that there are a number of clearly defined requirements of the student for each activity. The students should receive copies of the criteria for assessment at the same time as they receive the task. Written tests and practical tests could also be used by the teacher to assess the degree to which the learning outcomes have been achieved.

Diagnostic Tests

To be used prior to the teaching of the unit and following the completion of the unit.

1. Concept Plan

Have each student brainstorm words under the heading "Living and Non-Living Things". After about 5 minutes ask the students to map all of their words on a piece of A3 blank paper. These maps should be retained by the teacher for comparison with the concept plans produced at the completion of the unit of work.

2. Test (Written, Audio or Graphical)

The same test will be applied prior to and following the completion of the unit of work. The teacher will hold the pre-test papers for comparison with the post-test papers to

evaluate how effective this curriculum package has been.

- a) Explain in your own words the difference between living and non-living things.
- b) All living things have six things that they share in common. What are they?
- c) Sort the following list of animals and plants into groups.
 Elephant, Whale, Dolphin, Seal, Tuna, Shark, Giraffe, Human, Gorilla,
 Chimpanzee, Koala, Echidna, Platypus, Kangaroo, Tiger Snake, Frilled Neck
 Lizard, Cow, Sheep, Anaconda, Oak Tree, Pine Tree, Tree Fern, Gum Tree,
 Bottlebrush, Protea, Grass Tree, Rose, Daisy, Petunia, Orchid, Couch Grass.
- d) Explain why you chose the groups you did in question three.

- e) Using the following collection of objects prepare two keys that sort the objects differently.
 Red Ball, Blue Triangle, Yellow Square, Green Cube, Blue Square, Red Cube,
 Yellow Triangle, Green Ball, Yellow Ball, Green Triangle, Blue Ball, Red Square,
 Green Square, Yellow Cube, Blue Cube, Red Triangle.
- f) Why is it possible to sort the objects differently?

The ten questions produced above test each of the knowledge and some of the skill objectives of the unit, they offer students to exhibit knowledge that they can recall (questions 1 & 2) and knowledge that they understand (questions 3 - 6). To cater for students with learning disabilities an audio tape of the questions with colour charts for questions 3 and 5 will be available. These students will be able to answer orally if they desire.

Learning Outcomes

For the teacher, the CSF requires evidence of the learning outcomes being achieved to be collected. Assessment is then based upon how well the students have achieved the Learning Outcomes. The table below should assist with this requirement.

LEARNING OUTCOME	EVIDENCE FOR ACHIEVEMENT
<i>Distinguish between living and non-living things</i>	* this knowledge is at the core of the whole unit and should be established by the pre-test and very earlier classroom activities.
<i>Classify living things in a variety of ways</i>	* tasks 1, 4 and 5 and the test require students to consider how living things can be classified.
<i>Investigate the similarity and diversity of characteristics within and between groups of living things</i>	* All five tasks require the students to display this learning outcome and it features on the test.

<p><i>Suggest why some species have become extinct.</i></p>	<p>* Tasks 2 and 3 require this learning outcome to be addressed and the test will discover if it has been achieved.</p>
<p><i>Identify current endangered species and examine strategies to conserve them.</i></p>	<p>* Tasks 2 and 3 require this learning outcome to be addressed and the test will discover if it has been achieved.</p>
<p><i>Identify features of living things that determine their classification into major groups.</i></p>	<p>* Tasks 4 and 5 require this learning outcome to be addressed and the test will discover if it has been achieved at a basic level.</p>

The development of a virtual learning environment site to support year one industrial design undergraduates: A case study

Howard Denton. Loughborough University

Introduction

This paper describes the development and initial evaluation of a site within a university virtual learning environment (VLE). This was designed to support more conventional teaching and learning on a first year undergraduate 'design practice' module. The first use of the VLE site in practice was evaluated from a triangulated set of qualitative data: staff observation, a student questionnaire and student reflections posted on a discussion board.

The paper firstly outlines the background driving the development of the Design Practice module site on the VLE. Secondly the planning and emerging structure of the site is described. Thirdly the strategy and data collection methods to evaluate student use of the site is described. Fourthly this is followed by a discussion based on data gained. Conclusions are then drawn.

Background

The author is the module leader for the first year design practice modules on an industrial design programme. The specific module under discussion has 130 undergraduates, taught in two groups of 65. The contact time has been reduced from one day per week to half a day following university policy to enable staff to have time to engage in research. Nevertheless, the weighting of the module within the programme and, therefore student effort required, stays the same. This translates into a requirement for a further 10 hours of student work beyond the contact time; an increase in non-contact time, pro-rata as the contact time has reduced. This represents a challenge in terms of supporting and directing first year students who, all too often, have minimal time management skills.

The University has developed an in-house virtual learning environment (VLE) called LEARN. Each module leader has control of an internal set of web pages termed a site, which can be used in whichever way they wish, from a basic collection of lecture/presentation notes, to more sophisticated learning environments. There is a discussion facility for each module. LEARN is not a managed learning environment (MLE) in that it is not directly linked to university management and academic record keeping ([JISC 2002](#)).

The author had explored the use of this VLE, in support of conventional face-to-face teaching and learning for two years previously. Material had been authored in MS Word and saved as web pages. This experience had its difficulties, but encouraged the start of a more developed learning environment for the module under consideration. Whilst, as a case study, the work is not directly replicable in other institutions, it is hoped that colleagues elsewhere will find points which will be useful in their own work.

The project started with the coming together of two factors: concern at student ability to manage substantial amounts of non-contact work-load, and the potential of the LEARN

site to support and extend student learning based on two years of experience by the author. Whilst a significant amount of staff time had been required setting up, monitoring and maintaining each site, student feedback indicated that there were positive benefits for teaching and learning. It should be noted that the use of a VLE in support of conventional teaching and learning is dependent on good student access to computers with web access. In this context the university has a number of computer suites available on 24 hour access. Added to this a significant number of students now bring their own computers to university and all student bedrooms on campus have links to the university system and www via the Super Janet 2 system.

Planning

The **aim** was to produce a module VLE site. The central **objectives** were to:

- Offer a framework for learning via a matrix of tasks within the six week timeframe plus additional, generic, materials to support students in their time and project management.
- Provide a resource base for materials which extend beyond those given in conventional teaching on the module, but also encourage students to look further for resources rather than being a 'one stop shop'.
- Encourage student self-reflection on their learning process

In addition the site would:

- Be 'accessible' to students in terms of style and compliant with guidelines for The Special Educational Needs and Disability Act (SENDA, 2001). This is important as, within the university it has been noted that industrial design students have a higher ratio of dyslexia. The relationship between good designers and dyslexia has been well established both in the experience of higher education design lecturers (Brigden 2001) and via the author's experience teaching in this context.
- Offer a peer-support network via the discussion facility. This could be used by students to ask questions of each other and offer tips and advice.
- Staff could monitor student discussion and offer tailored support.
- Support the conventional teaching and learning (3 hours per week contact time) in a nominal 10 hours per week of student non-contact work on the module assignments.

The module was centred on two six week projects; the design of an electronic product and the design of a mechanical product. This study focuses on the former. Essentially, each student was required to design a simple hand-held electronic product. They had to design and prove the electronics on a 'breadboard' and design an injection moulded plastic case incorporating appropriate ergonomics and internal and external detailing. The assessable components were a design folio including all 'lash-up' 3D modelling, an A3 presentation board of the final product, a 3D model in expanded polystyrene foam and a general assembly engineering drawing of the final product.

The VLE offered the opportunity to support students by providing a range of appropriate resources beyond those that could be sensibly given by more conventional means. Some of these resources could be based on the site, such as examples of former work, whereas some could be links to sites such as the British Plastics Federation.

An important feature was that whilst the project was to be completed individually, students were placed in cooperative groups of four and encouraged to support each

other in their work. Cowie and Rudduck (1988) offer a comprehensive summary of the advantages and techniques of using cooperative groups at a schools level. Hackman (1983) offers a seminal model of team based work in industry. The groups were selected by staff using a random formula from the class list (Denton 1997). Students were briefed on the purpose of this grouping and the value of experiencing new group formation as against allowing peer choice (Biott 1987). Each group was based at a table (Possible suggestion – based at a table/stationed at a table)which offered sufficient space for four to work and yet maintain good communications. Groups were encouraged to exchange email and mobile numbers to enhance off-timetable communication.

The VLE offered further opportunities for communications in the form of intra and inter group advice and support. In addition staff could take part in discussions on the VLE and react to arising issues. Materials giving advice on group and team working were placed on the site to supplement conventional teaching on the topic.

Another feature was the introduction of professional reflection based on the work of Schon (2003) and Moon (2001). Such reflection goes further than the ‘common sense’ meaning of the term and could be defined as a deeper form of thinking, used in complex or unstructured situations, when the aim is to learn. Moon (idib) considers it to be a *‘process of reorganising knowledge and emotional orientations in order to achieve further insights’* (p4).

Brockbank and McGill (2003) make a good case for the value of reflection in a higher education context. We can juxtapose this with the point that as staff/student contact is reduced reflective skills become more important for the learner. A ‘straw poll’ of the student cohort indicated that none had been introduced to the concept of reflection before. Moon (2001) describes a four stage process for effective reflection:

- the individual makes notes about what/how they have learned
- the individual reflects on that process
- individuals meet in their groups and then share their reflections
- the groups agree a summary of points.

Reflective thinking is a complex concept and one the author anticipated many students would find difficult to grasp, beyond the obvious ‘common sense’ meaning of the term. The concept was introduced through a conventional lecture but then supported, by the VLE in the manner described in the following section.

Structure

The VLE site was designed to complement conventional teaching and learning, not to replace it. The author’s personal experience is that direct contact with students is vital, allowing staff to direct but also enthuse and respond. The VLE did not impose any particular format or template on staff. This was a deliberate policy in that it was intended to allow the early users of the system to innovate and then to observe best practice. As such this author had a ‘blank page’ from which to work. MS Word had been used by the author to generate the LEARN sites previously, using the ‘save as web page’ facility. Whilst very simple to use this had limitations in terms of page layout and other features. After attending an in-service course on web page design DreamWeaver MX was adopted. This proved to be much more flexible than Word. However, the author found this package far more difficult to learn to use and that the use of various features

were easily forgotten unless it was being used frequently. An academic intending to use this package, unless an existing user of this software, should ensure they have an experienced user to offer support.

The design process for the site followed advice from a number of sources such as the [TQEF NCT Project Briefing No. 11 \(1999\)](#). The objectives given above were addressed by building a site structure. This was done, via a series of iterations, using 'post-it' notes on a wall to build 'site maps' at a series of levels. The site was laid out around five parallel strands:

- The electronic project
- The mechanical project
- Engineering drawing (used in both projects)
- Support pages
- Reflection

A set of [template](#) pages were developed and checked against SENDA (2001) requirements and a standard accessibility test (A-Prompt) run. The pages were given a soft yellow (code #FFFCC) background as this has been shown to assist dyslexics read (Dyslexia Research Trust). A non-serifed font was used and font sizes were kept a reasonable size.

An [index page](#) was set up and followed by a page explaining 'how to use this site'. The [main site map](#) followed the 5 strands. Each strand had its own index page and [site map](#). To assist student time and project management the two projects each had a [work plan](#) for the six weeks they ran. This plan gave the essential information of what would be covered in the timetabled sessions, the lectures and what students should cover during their off-timetabled work. The site also contained a set of pages and links to assist students in [time management](#).

One of the strands aimed to support students in the development of skills of [professional reflection](#). This followed the same structure as the two projects: an index page and introductory information followed by a work plan. In the work plan a reflection activity was described for each week. Following Moon's (2001) process, students were to firstly to make notes on and then reflect individually on their work and learning each week. They were then to call a group meeting in which the two strands of the project progress and their learning processes were to be discussed. Each group was then to post a summary of their reflection on the discussion board. This enabled other groups to see and comment on issues, whether they be practical/project orientated or the reflection work. The author, as module leader also read all the group postings and then composed a review of the summaries each week which was then posted on the board for all students to read. This process also enabled staff to gain another perspective on student learning; identifying issues and enabling focussed intervention if necessary.

Planning an evaluation of the site

It is important to plan for the evaluation of any student learning experience during the module design phase. This evaluation needs to be able to see the whole and yet to be able to differentiate specific aspects. One concern for the author was student feedback overload in an era where management systems for Quality Assurance in UK universities result in students filling in a substantial number of questionnaires at the end of each semester. It was decided, therefore, to make the evaluation system as

unobtrusive and flexible as possible, while ensuring it yielded information useful for module updating. The method chosen was aimed at a general evaluation of the module as a whole, the VLE site being only a part of the whole. It was intended to use the feedback from the first year of use to both develop the site and to improve the focus for evaluation.

A triangulated (Cohen et al 2003) set of data sources for feedback was planned for the first year of the module VLE site.

- Staff teaching the module were debriefed by the author each week on issues arising during the timetabled sessions.
- The author was also involved in teaching the module and used a process of professional reflection (Schon 2003. Moon 2001) to analyse the module and VLE in use.
- A general evaluation questionnaire was administered to the group: students were asked to list five aspects they enjoyed and found good about the module and five in which staff could improve it. This did not focus specifically on the LEARN site. A total of 95 returns were made from a total of 130 possible returns (73%).
- The site discussion group postings and reflection summaries were built as a log and available for further analysis.

The data generated by these specific methods was qualitative in nature. Analysis was by a simple direct comparison by the author. As it is impossible to present the raw data in its qualitative form within the restrictions of a paper the data is both presented and discussed in the section below.

It should be noted that data generated from the questionnaire was based on each individual listing five good points about the project as a whole and five where improvements could be made. This means that points raised are not bipolar, for example if 50 from the 95 responses stated that they felt a particular aspect was good this does not mean that 45 disagreed. To enable such conclusions to be drawn would require specific questions to be answered on a rated scale. The advantage of the approach adopted was that it raised issues that students felt were important rather than those staff wished to focus on.

Results and Discussion

Design and construction of the site

The site was designed and constructed by the author using DreamWeaver as the web authoring package. The basic structure of the site was relatively easy to put together based on prior experience of using MS Word as a web-authoring tool on other modules. The use of 'post-its' on a wall gave great flexibility to insert, delete and re-jig elements during the design stage.

A simple, but appropriate framework for the period of the project was drawn up and communicated in a manner which should be easily accessible to students. A sound resource base was drawn up enabling students to access the majority of materials they would need directly whilst encouraging further exploration via web sites. A reflection section provided further reading on the concept and specific guidance on techniques, a framework to work from, groups to work within and a means of communicating both

within and between these groups in the form of the discussion board.

These elements all appeared to be reasonably successful in use. Students were invited to report issues including accessibility via e mail. A few minor issues of linkages failing were raised but discussion during contact time indicated that the site was easily accessible and the framework transparent. These observations were supported by student feedback in the questionnaire and reflection summaries. The question remains as to the degree of support these elements offered. A framework can become over-prescriptive and encourage students to work only directly to it. Similarly over-provision of resources can mean a student is not encouraged to look beyond the VLE site. The feedback and reflection summaries indicate that these elements worked reasonably well, but it would require more focussed data collection such as the use of bipolar questions in the evaluation of the next year's operation of the module and VLE in order to be more precise.

The objective to encourage student self-reflection on their learning process has been reasonably successful, as confirmed through observation and the student reflection summaries. However, both these sources of data indicate that most students valued the process and some produced insightful reflection, others struggled, typically frequently asking for examples of good practice. This is much as expected by the author. The concept is complex and the activity required does demand time and support. Time, in turn, is a precious commodity which some students did not see as well spent on reflection. This issue is discussed in more detail below.

Accessibility was a key objective in the design of the site. Of the year group a total of 10 are registered as dyslexic, but with a significant number of others who, while not registered, claim dyslexic symptoms. The author followed 'good practice' (TQEF briefing 11) and used the A-Prompt software (see below for reference) to confirm the site met the '3 stars' standard for accessibility. All students were required to use the site and there were no accessibility problems reported by users.

The site also met the other two objectives in that it provided a discussion facility and that this could be monitored by staff and used for tailoring support to suit. Students could, of course, also communicate directly with each other via email, telephone or face-to-face if they did not wish to place their communications on an accessible discussion board. A number of requests and advice were placed on the discussion board by students independently.

As a framework for learning and time / project management.

Reaction to the project in general was positive, with 18 of the 95 responses specifically reporting that they considered it 'well planned', one stating '*it inspires people to push themselves*'. Only 38 students specifically referred to the VLE as a positive or to the support it offered. This does not mean that 57 did not, only that students saw their 'top five' aspects differently when asked to evaluate the project as a whole rather than just the VLE. Specific scaled questions on attitudes to the VLE would have enabled more precise data to be gained.

A significant number of students reported that the project was good at integrating learning from other modules (68 of the 95 responses). Whilst this related to the project as a whole a significant part was played by the VLE in showing links to other modules and the specific skills and knowledge taught in them, for example electronics, graphics,

ergonomics and materials. 36 responses referred positively to the way in which the project took theoretical electronics from the technology module and put it in an applied context.

44 students reported that the project helped develop their time management skills. Two features of the VLE site were central to this: the weekly synopsis of what should be achieved and the VLE site pages on time management skills. It is interesting to contrast this with general observations from the reflection summaries that many students found the work load for the year (across all modules) hard. For example staff report frequent student requests for all deadlines to be in sequence. This, again, emerged in the reflection summaries. This indicates that while students are recognising time management as a significant issue for them and that they recognise the value of the project VLE site in supporting them, some were still struggling to manage their overall work load or appreciate the fact that parallel deadlines are a fact of professional life they must learn to manage. It is interesting to contrast the 11 responses that stated they appreciated the degree of freedom the project offered. It might be hypothesised that these students were ones who were managing time effectively and appreciated the flexibility of the module workload. This gave them the flexibility to work when they preferred.

The reflective summaries illuminated another aspect of time management; decision making within the design process. Student summaries and staff observation showed that while they saw the framework showing where they should be within their design process many students reported that they struggled with keeping up with the timeline. This was partly due to a failure to take appropriate decisions at the right time and move the design work forward. These students preferred to spend more time on a broad range of basic conceptual ideas, leaving insufficient time to advance the chosen concept to a stage of advanced detailing. To some extent this is a factor relating to the style of design they had been taught in schools. It was very apparent that students came to the university with very little appreciation of the importance of understanding how to design the insides of products despite the fact that product analysis is a part of Design and Technology syllabi in UK schools.

As a resource base

The questionnaire was not very helpful in identifying attitudes specifically to the VLE as a resource base. The responses referred to above indicate a positive response to it as a structure for learning, but few mention the resources within the VLE as a specific one of their 'top five' positives. This does not, of course, mean that they did not use them, only that they saw their five priorities elsewhere. This issue requires more focussed evaluation which will have to be done in this year's project.

A further issue relating to resources is whether the VLE encouraged students to research beyond the resources it contained or provided so much that they used it as a 'one-stop-shop'. Staff observation and on-going verbal feedback from students appears to indicate that the resources within the VLE were used and appreciated, but more focussed research will be needed to establish how it is used and its strengths and limitations.

Student self-reflection on their learning process

The questionnaire generated 44 positive references to the value of the group reflection meetings. These were fairly general and could encompass factors including the self-

supporting group as well as the specific act of reflection. On the negative side there were two observations that group meetings were sometimes difficult to organise and two that *'reflection didn't seem very useful'*. Three asked for more examples of reflection in practice. The number of negative comments relating to the reflection element of the module, therefore, were minimal.

Staff observation and analysis of the reflection logs posted on the discussion group, however, show that the great majority of students had difficulty in achieving any depth of self-analysis in their reflection. The self-supporting group aspect appears to have been well accepted and the group meetings were the most frequently mentioned positive aspect on the questionnaire. Analysis of the reflection summaries showed that the majority managed the first step of the four step process as described by Moon (2001); the description of their learning activity. Their analysis of their learning process tended, however, to be far weaker. This is hardly surprising as such analysis is a high level skill and one that it was evident nobody in the year group had been introduced to before.

The most frequent observations from the reflection summaries were:

1. Some students found what they saw as ambiguity in a design process difficult to handle. There were frequent requests for clarification and examples of 'what staff wanted'. This showed two distinct areas: a clear message that students felt there was a specific 'answer' or design approach that staff wanted and would reward; secondly that students wanted to banish ambiguity in their design work from the earliest stages. The group as a whole were unaware of the potential positive value of ambiguity in the early phases of design work (Gaver et al. 2003). This was supported by staff observation of student design work which showed a strong tendency to over-detail initial concept work. This both slowed down concept exploration and tended to mean students would associate concept forms with detailing placed on them at that stage, making concept selection confused.
2. Several students recognised that they preferred to 'take their time and produce a good drawing' even though the work was at an initial concept. This was often related to a perceived need for all images to be carefully rendered even at a concept phase. These factors relate to the teaching on the module which was trying to move students on from an approach adopted in many UK schools which emphasises the design folio as a 'product' in its own right. Students were being encouraged to adopt a more professional approach to design where design drawings and models are used efficiently to move-on a design idea. The fact that a number of students recognised that they preferred the schools approach was, at least, a useful step in professional reflection.

Conclusions

The first year of an undergraduate industrial design programme is a difficult one for students. They are coming to terms with a major culture shock in terms of living away from home (100% in this cohort). In addition the approach to design at the university is a significant step away from the approaches they had been taught in schools and towards that required for professional practice.

This change in culture and the new focus in design, linked to falling contact time with

staff, was a central drive for the author in designing and setting up the VLE site under discussion. The author's experience of planning, writing and maintaining the VLE site shows such work to be a very significant task. A lot of time, however, was spent gaining a very basic working knowledge of DreamWeaver. The load would have been lighter had the site been constructed using Word and the 'save as web page' option. DreamWeaver, however, did give far more control over pages. The author is indebted to the colleague who supported him on DreamWeaver issue but would not recommend any colleague taking on anything but the most basic site construction without prior experience or such local support.

The evaluation strategy used had significant limitations, though it was relatively unobtrusive. In the next use of this VLE/module it is intended to adopt a more focused evaluation strategy. Staff observation and records of the reflection meetings will be used again. As the module structure itself appears to be gaining positive feedback from students the focus can switch specifically to the VLE site itself. The proposal is to use Nominal Group Technique (NGT, O'Neil & Jackson 1983). Initially a volunteer group will be used to brainstorm the general question 'how useful was the VLE site?'. The results of the brainstorm will be used to generate a set of statements which can then be entered into an on-line questionnaire for all 130 students on the module to rate using a 6 point scale from 'fully agree' to 'totally disagree'. This will enable a far stronger and more focussed set of data to be obtained on the way students use the VLE.

The central objectives of the site appear to have been largely met. The framework for learning and time management was clearly well received. It remains to be seen, however, how well the principles within the framework can be used by students in a broader context; can they develop their own frameworks without staff support? As a resource base the site appears to have been well used, though perhaps students tended to take it for granted. Subsequent evaluation needs to check on whether the site prompted students to look beyond the site for research. The development of reflective skills was clearly very new to this cohort of students. In the context of working in small self-supportive groups, though on individual projects, this aspect of the module was highly regarded. Students were, however, finding it difficult to develop the depth of self-analysis that staff require of undergraduates. This aspect of the site requires careful thought before use with the next cohort. Finally all students had to use the site and there were no issues of inaccessibility raised informally or formally.

Clearly such sites are not a way of saving staff time. The first indications, however, are that there is a great deal of potential for supporting student design activity and their growth as designers.

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ICT – a modern solution to the science teaching equation?

Jenny Turner: Portland School, U.K.

Science teaching – Bunsen burners, test tubes, lab coats, and chemicals – I associated all of these with science and teaching but not computers. I was starting a teacher-training course for secondary science after having graduated with a chemistry degree some thirteen years earlier. My mind was full of questions and doubt – Would I remember any science? Would I be able to control a class of teenagers? Would I be able to control my nerves? The last thing on my mind was using the Internet to teach science.

Three months earlier, during the initial interview for a place on the Post Graduate Certificate of Education (PGCE) course, I had been asked the question ‘How would you use ICT in the science classroom?’ A bit of quick thinking and jargon, dragged from somewhere deep in the depths of my memory, saved the day, surprising myself and managing to fool the interviewer into thinking I knew what I was talking about. I resolved there and then to learn as much about computers and the Internet as I could during the summer months before starting the course. Of course, best laid plans and all that.....!

I began the PGCE course in October 2003 and it seemed as if every lecture that I attended seemed to incorporate some aspect of ICT and I began to think that maybe I should have done some of that summer revision after all!

Starting my first placement was an experience I had been looking forward to. The science labs in my teaching practice school had been recently refurbished and looked lovely. The science staff enjoyed showing me round and proudly displayed their new interactive whiteboards, laptops and large computer suite linked to the network. During the observation days at my new school I realised that each of my classes had been timetabled for one lesson per week in the newly refurbished computer suite. This added up to a lot of computer lessons! My knowledge of computers was limited to computer games that my sons played endlessly. I was a complete novice without even a basic working knowledge of computers. How did I switch the computers on? And what did all the symbols on the screen stand for? My questions began to give way to a sense of rising panic, which inevitably meant many, many long evenings in front of a computer screen trying to work out what everything was and how to use the machine. A lot of frustration and ‘trial and error’ was involved in these evening sessions and many documents were lost and programmes had to be re-installed as I battled to understand the complexities of this technology, but I slowly began to learn through my mistakes – the first lesson being the value of ‘backing up’ any material or documents that I may later need!

During this experimental stage of learning, I discovered an invaluable resource – The World Wide Web. It’s a huge place with enormous amounts of information available to all. The question was how to access this to best effect. Again, I became my own teacher and spent hours ‘browsing’ the web, familiarising myself with the different search engines and web browsers and I quickly learnt some basic rules for searching for information.

Be specific – type in exact words rather than a vague topic heading e.g. type in ‘metals’ and the first few results are irrelevant if as a chemist you are looking for

a description of different metal elements. 'Metal sculpture', '*metal testing*' and '*heavy metal music*' all have their place but just not in my science lessons. So typing in '*metal elements*' proved much more fruitful leading me to the website www.chemsoc.org which provided all the information required and more!

For a U.K. based teacher, select a UK search rather than a whole world search – this again reduces the amount of irrelevant information presented. E.g. typing in '*metal elements*' as a whole world search led me to a metal jewellery website. However, with a UK search it led me, once again, to the www.chemsoc.org website.

Check the spelling and do not include any punctuation. Typing in 'metlas' reveals nothing of any use (dependent upon the search engine, as some would return – did you mean 'metals'?).

And finally, the first page of results usually is the most relevant to the search! (Believe me, after trawling through several pages of worthless information I usually went back to the first result!)

I began to see the Internet as a tool for teaching science more effectively and not just as an 'extra' when lessons had been timetabled in the computer suite! My worry now was that, like my own children, having had computers accessible to them from a young age, these students would already be experts and more competent and familiar with using computers than I would be. It would either be embarrassing or could be a great opportunity to learn something from the pupils. I didn't know which scared me most!

My first attempt at using the Internet as a research tool with a whole class went remarkably well. A year 10 class of students were learning about the Periodic Table and its elements. We had decided to 'build' a 3-D periodic table and display it along the back wall of the classroom. The aim was for each student to research one element and find out 6 facts about that element and make a cube displaying one fact on each side of the cube. I gave them the element to research and two websites that would provide them with the information required www.chemicalelements.com and www.webelements.com and they then completed the seemingly simple task with enthusiasm.

As I became more confident in using the Internet myself and became more confident in my classroom management I decided to allow the pupils more freedom to experiment and become familiar with the process of using more than one website to gather information for themselves. A class of year 8 pupils studying the topic of 'food and digestion' used the project as a means of assessing their learning. The pupils were presented with a booklet in 4 sections containing questions to answer and tables that needed to be completed. By using the various websites provided for them in the document such as www.bbc.co.uk/food and www.learn.co.uk and www.kelloggs.co.uk they were able to research the information on different food groups and the nutrients that they contain and so answer the questions. The final part of the project was to use a publishing package such as Power Point or Publisher or Word to produce an individual balanced menu for one day using some of the information previously gathered.

One of the final projects that the students completed during my school placement allowed for even greater freedom. It was partly an exercise in using search engines and partly an exercise in the students gathering and collating information for themselves with the possibility of presenting that information to the class the following lesson The

students were set the challenge to find out about antagonistic muscles. I gave a brief explanation on how to use a search engine effectively and provided them with a couple of the most commonly used ones such as www.google.co.uk and www.yahoo.co.uk. Once the task had been explained clearly and everyone knew what was expected from him or her, I was able to monitor progress, offering advice when necessary. It quickly emerged that the biggest problem was how to best consolidate and comprehensively condense the sites that resulted from the searches in order for the students to make sense of them all and not be overwhelmed with all the information that was available. It reinforced the fact that the first page of results is usually the best. Using the Google search engine and typing in 'antagonistic muscles' yielded many sites the following 3 of particular note: www.longleypublications.co.uk and www.helicon.co.uk and the ever useful www.bbc.co.uk/schools/gcsebitesize .

Many pupils also accessed the images section of the Google search engine and were able to download pictures to go with their notes.

I found many positive reasons for using the Internet in teaching within the classroom. Pupils who were involved in using the Internet were motivated to complete the tasks, they turned up early to each lesson, were in a hurry to start the lesson and behaviour was not a problem because all students were on task.

However, I found that certain factors had to be considered when the teaching took place in a computer room:

- The way that the ICT suite is set up varies considerably from one school to another. Generally the classroom dynamics change considerably and the noise level occasionally increases slightly; this requires extra vigilance and patience from me as the teacher.
- I occasionally found myself in a position where the pupils knew more than I did about the hardware and the logistics of the system being used. However, I began to use this as an opportunity to increase my knowledge and the self-esteem of pupils increased as they realised that they could teach me.
- Tasks had to be relevant and pupils well prepared for their tasks before being given assignments which meant a lot of forethought and preparation by me, the teacher.
- Pupils still needed a lot of teacher input and intervention throughout the lesson reminding them of the purpose of the lesson, offering advice where necessary and to draw the lesson to a close to discuss the achievements at the end of the time.

As well as setting research projects I was able to download many pictures, images and illustrations from the Internet and combine these into individual lessons to reinforce a particular point or to illustrate certain aspects that I could not have done justice to. To this end the following book became my Bible - The Usborne Internet-linked Science Encyclopaedia. It covered a whole range of topics from chemistry, physics and biology through to earth science and genetic engineering and contained descriptions and links to web sites that provided illustrations and diagrams making the subject matter fun as well as informative. Many of the images contained in the book could be downloaded for free from the Usborne site and became the basis for many games and card sorts that I created and carried out in the classroom.

I downloaded pictures of the 4 different types of adult teeth from the encyclopaedia by

typing in www.usbornequicklinks.com and followed the instructions to get to the correct page online. After downloading and saving these images to my computer I was able to manipulate them. I enlarged them, added the appropriate name of each tooth, along with a description of the function of the tooth. I was then able to print this out on to card, cut them into smaller, individual cards and put one of each into an envelope. I wrote the instructions for the game on the front of the envelope and the pupils could then rearrange and match up the name, picture and function of the teeth – a good starter game revisiting work previously learnt in earlier lessons. This entailed a lot of work the first time but the resources can be used and re-used again and again and using the pictures from the site rather than hand drawing them meant that the game had a professional look.

I was also able to download many images from other websites that I found during my 'browsing' sessions, including many suitable for Key Stage 3 pupils (in the U.K. these are between the ages of 11 and 14). Ones that I found extremely useful included www.kidshealth.org and www.chem4kids.com and www.enchantedlearning.com .

The availability and ease of access to the Internet enables both pupils and teachers to access an enormous range of resources and information never previously possible and traditional approaches to teaching, where teachers often taught pupils in a didactic fashion have to be challenged and reviewed in the light of what technology can now offer. Many pupils now have the opportunity to achieve, where once they failed, through the use of ICT, however, this does not mean it should be used in every circumstance. ICT should only be used where its use can be justified as a method of achieving the learning outcome for any particular lesson and where it enhances the learning. I began Initial Teacher Training in September with little experience at using ICT either in or out of the classroom. Now, at the end of the course I feel competent and able to use ICT whenever the opportunity presents itself. I enjoy using ICT and am eager to take advantage of any opportunity that presents itself to expand both my knowledge and experience during my years of teaching. I have, in learning how to teach others, found a renewed enthusiasm for learning.

Jenny Turner graduated with a B Sc in chemistry in 1991 from Hull University. She initially worked as a teaching assistant with children who had special behavioural and educational needs before re-training at Loughborough University in 2003/2004 as a secondary science teacher. She is now in her first year of teaching science.

Recreating ecosystems in micro worlds

Gary Simpsonⁱ and Mark Chappleⁱⁱ
Woodleigh School, Victoria, Australia.

Introduction

In this paper we explore the incorporation of information and communication technologies into a Year 8 Science unit concerning Ecology. Our students explore concepts concerning the structure and function of ecosystems including abiotic and biotic characteristics and the interaction between these characteristics. In this unit the students have been required to use MS Excel, Inspiration and Micro Worlds to organise their data and represent the knowledge and understanding they have gained about these concepts. The unit description can be found at http://www.woodleigh.vic.edu.au//IDATER/MW/Ecology_Unit.pdf (the page references in the unit description refer to the students' text, Science Quest 2 {Lofts and Evergreen, 2000}).

Setting

The Woodleigh Schoolⁱⁱⁱ senior campus is set in bush land with a creek and wetland ecosystem and Manna Gum and Tea-tree woodland ecosystem. The students in this class (25 students) have 4 x 80 minute sessions of Science each week. Prior to commencing the field work we had spent a session in class exploring the main concepts of this unit: biotic factors, abiotic factors, relationships within biotic factors and between abiotic and biotic factors, and energy flow through the ecosystem. We were then able to spend four full sessions in our field location. The first session we simply explored the parameters of the field site and learnt how to complete quadrats along transects using the Braun-Blanquet method to record species diversity, abundance and distribution. We then spent the next three periods collecting the data from the field.

Having collected the data we used various computer programs to organise, analyse and represent the data. The first step was to use MS Excel to record the data collected about each species by quadrat linked to a map locating each quadrat. The students had little difficulty using MS Excel as they had used it in mathematics, however, they did need the style of spreadsheet explained as they had not used MS Excel in this way before.

Species Name	James 1	James 2	Dan 1	Dan 2	Dan 3	Dan 4	Dan 5	Catie 1	Catie 2
Acacia longifolia Sallow Wattle						2	1		
Acacia meamsi Late Black Wattle									
Acacia melanoxylon Blackwood									
Acacia paradoxa Hedge Wattle									
Agapanthus							1		
Allocasuarina littoralis She oak									
Banksia marginata Silver Banksia	#	#							
Blackberries									1
Bursaria spinosa Native Box									
Callistemon salignus Willow Bottlebrush	#	#							
Cape Weed				1		1			
Casuarina stricta Coast She Oak									
Correa alba White Correa							1		
Dead trees							2		
Dianella tasmaniensis Flax lily	#	#							
Eristemon sp. Wax flower									
Eucalyptus ovata Swamp Gum								#	
Eucalyptus pauciflora Snow Gum	#	#							
Eucalyptus sp.									
Eucalyptus viminalis Manna Gum	#		2			4	4	3	1
Gahnia radula Sword sedge							1		
Leptospermum laevigatum Coast Tea Tree							1		
Leptospermum phylloides Burgan									
Lomandra longifolia Spiny Headed Mat-rush		2	#	1					
Melaleuca ericifolia Swamp Paperbark		3	#				1	#	
Amyema pendula Drooping mistletoe									
Pinus radiata Pine tree									
Pittosporum undulatum Sweet Pittosporum							1		
Poa contortalis Tussock Grass									
Prostanthera sp. Mint bush									
Pteridium esculentum Bracken	#			3					

Figure 1. Excel spreadsheet developed from students collected data

Then the students were asked to list the biotic and abiotic data and highlight the links between them in a concept map using the program Inspiration. The students had little concern using this program as we had used it regularly to organise concepts in previous units, however, they were used to a situation in which the concept plan was used to organise what is known, rather than what was still needed to be known. They were asked to highlight what information they did have and what questions they still needed to have answered. The students were then instructed to seek answers from their peers. A number of examples can be found on the website <http://www.woodleigh.vic.edu.au/IDATER/MW/index.html>.

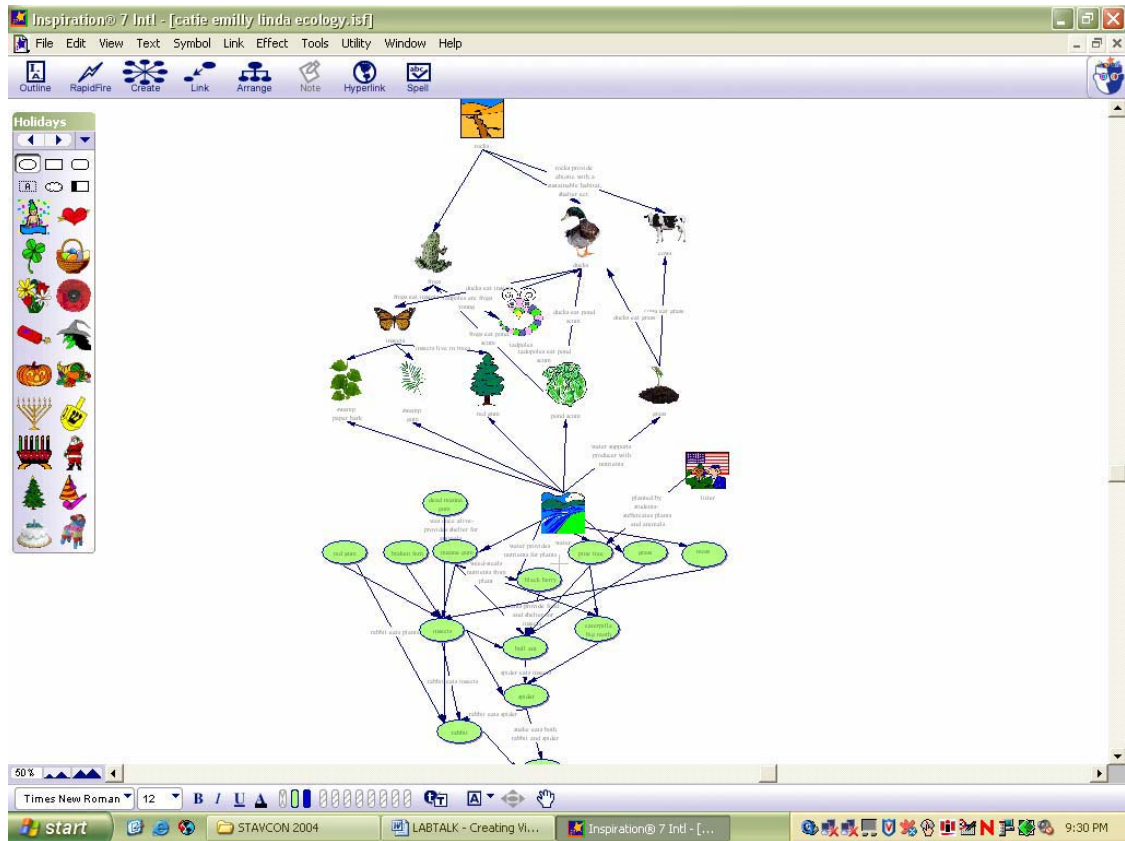


Figure 2. Catie, Emily, and Linda’s Concept Plan

Following this we explored the concepts of food chains, food webs and relationships between plants and animals in a single class.

Representing Student Learning

The students now had the information they needed to reconstruct the Woodleigh environment and represent what they had learnt using Micro Worlds. None of the students had previous experience of this program and Gary had little more than they, having used it the previous term with his Year 7s (Chapple and Simpson, 2004) and in preparing this unit. We had a clear vision of what we wanted the students to achieve using Micro Worlds. That was a visual representation of the environment which displayed the knowledge and understanding they had gained. However, Gary did not know how to do it – just that it could be done. The students, likewise, understood what we were asking, but they could not imagine what it may look like, or how to do it either. Fortunately we had the support of Mark who, as a Science teacher, understood what we wanted to recreate and, as an IT consultant familiar with Micro Worlds, knew how to achieve it.

We gave the students 3 x 80 minute sessions to complete the task and Gary openly confessed to his students his personal challenges with this task. We also showed them some examples of things that can be done with Micro Worlds – some simple examples produced by Mark and some simpler examples that Gary had produced:

<http://www.woodleigh.vic.edu.au/IDATER/MW/index.html> . The students were encouraged to explore the software and try different things out. We were able to use a computer room for our first class, but then had use of the school notebooks for the other two classes; these come as 8 notebooks in a trolley with a whole lot of management issues with which to deal (see Chapple and Simpson, 2004).

The students became engaged with the visual aspects of Micro Worlds and many quickly came to grips with the programming required of the more complex features.

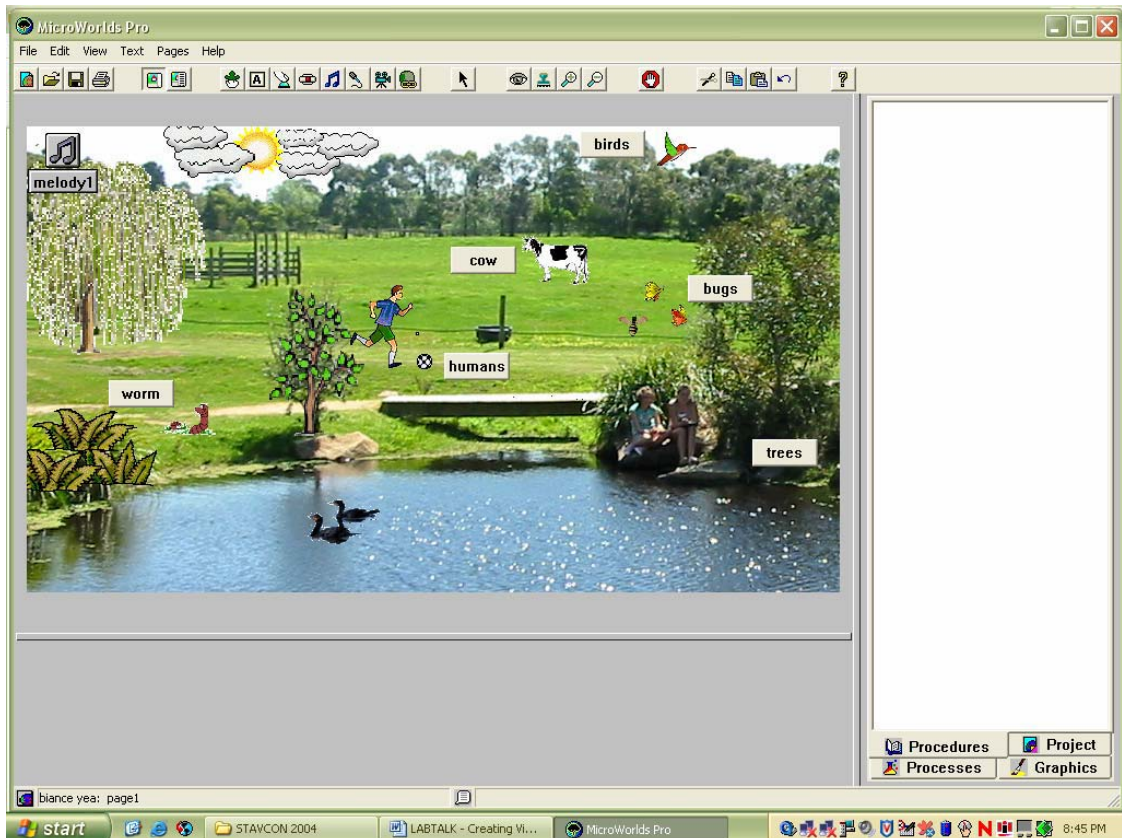


Figure 3. Bianca's Virtual Ecosystem

Some student examples may be found at this link:
<http://www.woodleigh.vic.edu.au/IDATER/MW/index.html>

Reflection

We gained a great deal from this exercise. It was edifying to see students engaged with the software as they struggled to master it and then use it to represent their knowledge and understanding of ecological concepts. Many of the students were able to quickly master the skills required and pushed Gary beyond his comfort zone with Micro Worlds and Adobe Photoshop (the students used digital photos of the environment within their projects to illustrate points and these needed to be cropped and resized). The students appreciated the presence of Mark, who was able to answer their questions and show them better ways to do things.

It became obvious that the students needed a very clear understanding of what they were trying to create. Fortunately, some of the computer savvy students quickly came to grips with Micro Worlds and we were able to share their early attempts via the data projector. These students were also very willing to act as mentors. However, before using something like this again we will endeavour to produce the same work that we want of my students, so that we can show them how and what we have done – essentially to act as an example. (Lesson learnt for Gary – improve his computer skills, asap.)

The students responded wonderfully to this activity and many were able to clearly identify the important parameters of ecological study that we had wished them to gain and represent it in a digital environment. That they were able to do this in a rich visual environment and a rich digital environment was an added bonus – for them and us. They were clearly engaged by the field work activity and gained skill and knowledge by using MS Excel to organise the data and Inspiration to analyse that data. They were also clearly engaged by Micro Worlds and enjoyed using it to create and animate virtual environments. The students acted autonomously for much of the time supporting each other and referring to the teachers for advice on how to do (computer) questions and what does (concept) mean questions.

Other students were able to explain the concepts but were challenged by the need to represent this in Micro Worlds. They still gained experience in a new software program and gained confidence with using computers and in their own ability as they worked hard to achieve some sort of visually rich product.

We believe that this was a highly successful incorporation of information and communication technologies in a meaningful manner. Stoll et al. (2003. p62) listed ten features of successful teaching and learning that enhanced student engagement.

Enhancing student motivation

- *Use cooperative learning rather than competitive learning*
- *Stimulate cognitive conflict*
- *Encourage moderate risk taking*
- *Praise good work*
- *Make academic tasks interesting*
- *Provide feedback that is connected to learning and effort*
- *Identify many intelligences and showing that they are not fixed but incremental*
- *Encourage self-images as learners*
- *Increase student self-efficacy*
- *Encourage volition*

We believe that this classroom innovation has achieved the majority of these criteria. The students were praised for their excellent work and their excellent efforts, the task was rich and interesting (and demanding) and the students worked in a cooperative atmosphere helping each other to take intellectual risks. Students were encouraged to take many risks in a highly supported and supportive environment in which they were able to work as active learners and perceive themselves as such.

References

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i

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ii

Mark Chapple is currently an onsite educational technology specialist working at the Woodleigh School. Mark also maintains an independent consultancy practice, working with teachers and schools as they strive to improve student outcomes using learning technologies. In previous positions within the IT industry, Mark worked closely with schools and teachers to assist them integrate technology within classrooms. Over the past ten years he has presented nationally at conferences and held workshops on issues such as planning for technology, developing collaborative learning environments and using technology within the classroom.

iii Woodleigh School is a coeducational independent school with a junior campus (3 year-old kindergarten to Year 6) and a separate senior campus (Year 7 to Year 12) situated on the Mornington Peninsula, 50 kilometres south of Melbourne, Australia.

A new dimension to Science teaching in the 21st Century

Lorraine Ellison

Co-ordinator Of Science at Woodbrook Vale High School, Loughborough

I can get quite excited when I think about the potential of adding stimulating material to lessons on a spontaneous basis – or even the pre-planned use of magnificent resources available at the touch of a few buttons.

Remembering my early years of teaching – the Banda – wow – you spent an age drawing out a wonderful diagram and it would only print about 30 copies. Then I remember getting a colour TV and video. The first one seemed to break down nearly every time I looked at it, and there wasn't exactly a good range of programmes to record. The Overhead Projector- I think I was probably the first person to make use of one at my school, and the kids loved it because it was different. I could draw a diagram and then keep it forever – or at least until the syllabus changed and the work became archaic.

But now there is an explosion of information at our fingertips, so many spurs to the imagination to help make good lessons into really wonderful learning experiences.

How can it be used? When teaching about gases, and hydrogen in particular, how about listening to a radio programme made at the time that the Hindenburg Airship was just arriving in America from Germany – the actual original recording (7mins 19 seconds) as it was seen to arrive looking fine, then blew up. www.otr.com

A search site like Google is a godsend when it comes to research. There are times in a school year when I find it necessary to do things a bit differently, and then I introduce the History of Science. Originally it was centred around Sir Isaac Newton. We have a few books in the library, but not enough for a whole class. Putting photocopies of pictures into a presentation doesn't look great these days, so we go to www.google.com/images and type in Isaac Newton to get a whole collection of pictures and cartoons. We then look for some basic information, when he lived, what science he was famous for, and do a Power Point Presentation. To help teach the pupils what was expected I did my own version, got carried away as I was teaching myself how to use

Power Point at the time, and ended up setting the work to 17th century music and showing it in Assembly. [Issac Newton.ppt](#) Again, it was the novelty which inspired the pupils, there was a standing ovation – rather unexpected! My own version is now available to use year after year as a starter. We've since developed the theme to a whole range of scientists and have introduced new skills to improve their Power Point Presentations. The History of Science PPP [History of Science Project](#) was developed, again using the Internet, but is now on the school network, so that pupils can refer to it when developing their own material.

Looking on the Standards Site a few weeks ago I found that the A.S.E. have put useful resources on-line. I shall be using a couple of them this coming school year – spreadsheets on the costs of insulation, linking science with citizenship, and again, some good work on renewable resources again giving a link between Science and Citizenship www.standards.dfes.gov.uk/keystage3/respub/sc_ict

When teaching Astronomy there are two great programmes on Planet 10 found at www.scienceyear.com/wired/index.html The first is travelling through the Solar System, viewing it from different places, the second is about making wise choices about where a planet should be if it is to be people friendly.

When teaching Geology, there is a free on-line resource from the Oxford University . It's an Interactive Rock Cycle www.oum.ox.ac.uk/children/rocks/cychome/htm or the interactive bits at two levels at www.oum.ox.ac.uk/children/rocks/rocgames/rocgame1/htm

When teaching Photosynthesis, there is a useful website "The Tomato Zone" with simple activity revising aspects of photosynthesis. At www.thetomatozone.co.uk Go to secondary Grow Your Own workshop. The same website has a rather nice, simple activity showing growth of plants in distilled water, complete mineral solution, solution minus nitrogen and solution minus magnesium. Go to secondary Hydroponics workshop.

We network a variety of programmes for the pupils:- Summary sheets set out as Cloze tests, with clues for the missing words; Words and Meanings programmes; reinforcement programmes such as a homemade programme to help learn the names of apparatus [Apparatus Interactive.ppt](#), or to do labelling exercises such as the structure of the leaf [Leaf Structure.ppt](#) They can produce their own poster on "Adaptation" by working through a presentation and following instructions. [Adaptation.ppt](#) We use a programme of Food Chains, Food Webs and Pyramids of Number as a teaching tool, (home-made with pictures from the Internet – the foxes and rabbits in my garden seem to run away when I get my camera out) The pupils can then use the same resource for revision by looking on the school network. [Food chainswebs and Pyramids](#)

When we teach Investigation skills the work can be presented using Power Point, used initially as a teacher-led lesson, then, using the network, pupils can refer to them when working through an Investigation. To teach some skills we use [Variables.ppt](#) , then we introduce a neutralisation investigation using [Sc1 Chemistry Investigation](#)

Some schools are really organised, and put their work on the Internet. A good source of Power Point Presentations is Great Barr School in Birmingham. www.greatbarr.bham.sch.uk If the presentations aren't quite perfect for your own pupils, it is easy enough to modify them, but what a useful resource!

At the end of the course there is the dreaded revision for exams. We all have to do it at some time or other, but there are revision aids on-line: www.bbc.co.uk/education/ks3bitesize www.bbc.co.uk/education/gcsebitesize , www.learn.co.uk to name a few. Yes, the pupils should use them at home, but a lesson spent actively directing them to a few sites for some focussed revision can clearly demonstrate their usefulness – then perhaps they will log on at home.

What schools do need to maximise on the tremendous potential is an Internet link in every school laboratory linked to an up to date computer and Interactive White Board, as well as a suite of computers for regular Science use. The future of Science teaching should be phenomenal!

Teaching Science Online

Michael Walsh, St. Benedict School, UK.

Introduction

In this paper I describe an online approach to teaching a General National Vocational Qualification (GNVQ) science course using digital materials produced by 3E's Multimedia delivered via the Digitalbrain platform. When I first came across this approach to teaching science I realised that it was likely to make big changes to the way in which I teach.

All other 100 schools involved in piloting the 3E's Multimedia materials were given several days of training spread over four terms. Despite this, the first year in which the materials were used was a steep learning curve for me and for my pupils.

Each Digitalbrain user, both staff and pupils, is given their own web space. Once the user has logged onto the Digitalbrain website they are presented with their home page (figure 1). This contains a calendar for appointments and a series of links to various tools, and can be easily customised by the user. The other tools available include the user's web space and Digitalbrain email; it is these that have proved to be most useful in delivering the GNVQ science course at my school.



Figure 1

The Course

Without the Internet, the online GNVQ Science course materials could be used as a good interactive textbook, complete with Macromedia Flash animations to assist descriptions of scientific phenomena. In conjunction with a projector, the whole class can be led through a complex explanation that would be difficult to do with a text book or worksheet. However, with access to a broadband Internet connection, together with pupil access to computer rooms for at least two out of their five science lessons per week, I have radically changed the way I deliver the curriculum.

The first thing I disposed of was the exercise book. The pupils keep rough notes during experiments in the lab and write up their work into computer files. A lot of the preliminary work for experiments is done using the science content from 3E's Multimedia, e.g. figure 2, which shows the top level choice for Unit 1 of the course. When the pupil has chosen either chemistry, biology or physics they are then presented with a further set of choices until they home in on the specific procedure they intend to carry out. From this page the pupils can choose the experiment they are going to do and think about the best way to carry out the procedure.

What you need to learn

- Standard Scientific Procedures
- Applying Practical Skills in Chemistry
 - Practical Skills CHEMISTRY
- Applying Practical Skills in Physics
 - Practical Skills PHYSICS
- Applying Practical Skills in Biology
 - Practical Skills BIOLOGY
- Assessment Evidence

UNIT 1 IS MANDATORY, ASSESSED BY PORTFOLIO. You need to produce a portfolio in which you have recorded at... [more]

list edit my notes make a note add link

Figure 2

Figure 3 shows the pupils what to do when testing a chemical sample for hydrogen carbonate ions. The photographs from the sequence can be copied by clicking on the Word icon next to the text. The Acrobat icon is for fast downloads on a slow system (figure 4a to c).

ACTIVITY 1.1a Chemical Tests for Anions

3



HYDROGEN CARBONATE IONS

If the gas produced turns **limewater "milky"**, carbonate, CO_3^{2-} , or hydrogen carbonate ions, HCO_3^- , are present in the sample.

SELECT ANION

Links:

- Portfolio Evidence - Word Format (.doc)
- Portfolio Evidence - Acrobat Format (.pdf)

list edit my notes make a note add link

email: user-support | webmaster | partnerships | © 2002 digitalbrain | company information | terms and conditions
digitalbrain revision version 4.0 browser with java/flash enabled. some areas are enhanced with Macromedia Flash

Figure 3



Figure 4a Figure 4b Figure 4c

Access to these electronic resources saves a lot of time copying unnecessary information into exercise books. Pupils can quickly download an experimental

procedure and put it into a style that suits themselves. In converting the information into a form with which they are comfortable they retain the important elements of what they need to do in the lab.

Following the experiment the pupils write up their work which will go towards the portfolio of evidence they must collect for the unit they are studying. To assist them, a frame with hints and headings has been provided. To access the frame the pupils click on the “portfolio evidence – word format (.doc)”, as shown at the bottom of figure 3. In this particular case the frame appears as shown in figure 5.

Unit
1 Applying Practical Skills

Chemistry – Carrying out chemical tests to identify substances

Portfolio Evidence – (Enter your name)

Activity 1.1a & 1.1b: Chemical analyses

1. Introduction: Type of chemical analysis to be carried out
2. Safety points
3. Materials and methods
4. Results
5. Evaluation
6. Discussion of vocational implications

Figure 5

Not all the pupils choose to use this frame. I have written my own frames that give more guidance to those who need it; my version of the results and evaluation section for the activity shown in figure 5 is shown in figure 6.

Results for Ions Tests			
Ion	Type	Test	Result
Chloride (Cl ⁻)	Anion	Add silver Nitrate Solution	
Sulphate (SO ₄ ²⁻)	Anion	Add acidified Barium Chloride solution	
Carbonate (CO ₃ ²⁻)	Anion	Add dilute acid and test gas with lime water	
Copper (Cu ²⁺)	Cation	Add Sodium Hydroxide solution	
Iron	Cation	Add Sodium Hydroxide solution	

Evaluation

- Do qualitative tests tell you how much of a substance is present?
- If the test substance is a mixture will you get clear results?
- Will the tests work if the substance is insoluble?
- Is there an amount of substance needed to get a positive test?
- Can your test substances be contaminated?

A scientist was asked to identify four samples of unknown substances. The results of the analysis are in the table. Use the results of your experiment to identify each sample (both the metal cation and the anion it is bonded with).

Test	Sample A	Sample B	Sample C	Sample D
Add silver Nitrate solution	No	No	No	White ppt
Add acidified Barium Chloride solution	No	White ppt	White ppt	No
Add dil acid and bubble gas through lime water	Milky ppt	No	No	No
Add Sodium Hydroxide	No	Blue ppt	Brown ppt	No
Flame Colour	Red	Green	No	Yellow

Sample A =
Sample B =
Sample C =
Sample D =

Figure 6

To see this frame pupils access my web space on the Digitalbrain site. This is where access to the Internet comes into its own.

Electronic Homework and the Internet

The pupils do not just visit my web space to access the frames for portfolio work. There are also documents there to aid understanding, links to other sources of information and an area where they can post their completed work (figure 7).



Figure 7

The web space is made up of a series of online folders; the power of these lies in the way in which access to them can be controlled by the host user. For example the Admin and Lessons folders in figure 7 are accessible only by me, while Y10 pupils and Y11 pupils can access their respective folders only.

Inside the pupil folders are sub-folders that contain frames and other documents to help pupils understand the course content and to help them produce evidence for their portfolios. If pupils use a digital camera to record a novel set up or outcome from a procedure, I will post the images here for them to access. Sometimes the pupils ask if I will upload a piece of work or explanation of a scientific principle that we have done in the lab so that they can make use of it. For example, Unit 5 of the course requires them to test sports shoes. Digital images of these shoes are posted in the Unit 5 folder before they begin to take the shoes apart (figure 8).



Figure 8



Figure 8a Figure 8b

The Pupil Work folder contains individual folders for each pupil in the group. Access to a pupil's folder is restricted to that pupil and to me. When a piece of work is complete, the pupil has the option of showing me on screen if we are in a lesson, or they may upload it to their folder and then send me an email to tell me that they have done this. As long as the email is dated before the deadline for that piece of work, the pupil will avoid detention.

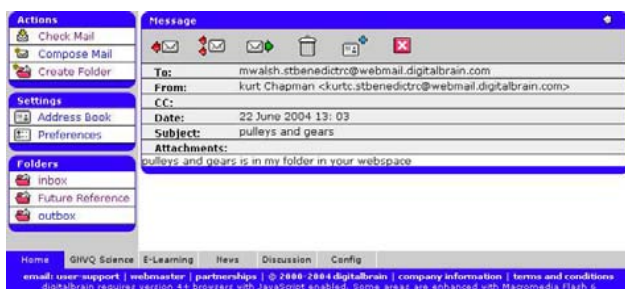
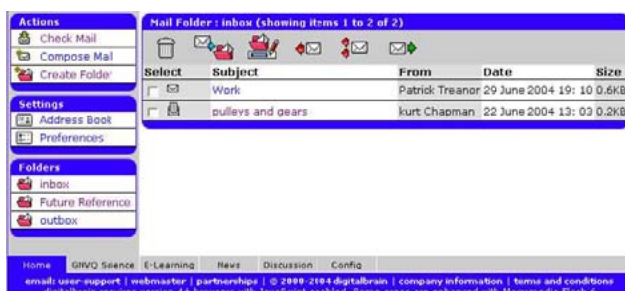


Figure 9

The power of this system allows pupils to keep up with work even if they cannot be in school for any reason. One pupil completed his work on a plane to Australia and posted it while on holiday; pupils think it is outrageous that they cannot escape the long arm of the coursework deadline!

When they have finished their work, pupils use the exam board criteria to mark their own work. Once again I have a folder to help them (figure 10).

Welcome, mw Walsh.stbenedictrc. This is your digitalbrain:

[new](#) [edit](#) [view](#) [cut](#) [copy](#) [paste](#) [delete](#) [upload](#) [download](#) [inform](#) [url](#) [access](#) [browse](#) [tag](#)

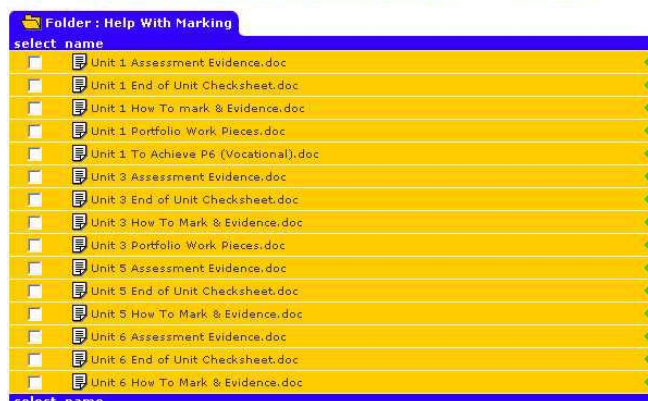


Figure 10

Towards the end of year 11 (age 15 / 16) pupils have completed their coursework and spend time improving it so they can improve their grades. During this time I am constantly bombarded with emails asking if a piece of work is good enough to fulfil a particular merit or distinction criterion. I have even had one pupil, working in an ICT room some distance from the lab, who sent me an e-mail to ask if I would pop down and give him some help.

Most of the help files for marking were produced to reduce the amount of emails and to enable the pupils to progress with their work outside the school environment.

Conclusion

Teaching this course has had a dramatic impact on the pupils and on me. Lessons are much more pupil orientated, and I move around the room answering questions about a variety of different aspects of science. The pupils who find learning difficult have more time to come to terms with the basic knowledge, while the more able explore new depths of knowledge, sometimes finding out things I knew little about. I don't think I have ever worked so hard during lesson time, as there is always another question about a different piece of work. However, when I do get the odd chance to look about the room I see pupils fully engaged on their studies and thinking about what they are doing.

One observation that has been made about more traditional approaches to teaching science is that the pupils produce a mini version of a text book in their exercise books and can be quite passive during the lesson; there is no way that my pupils are engaged in this kind of activity. The consequence of this is that more quality time is spent practising experimental skills or carrying out scientific investigations. This dramatically improves their understanding of science and their ability to carry out safe experimental procedures that produce reliable data. Another advantage that I have seen is that it is very easy to run mixed ability groups, with pupils accessing work at a level they can cope with. In addition to this, I have also been aware of a lot of peer learning as they ask each other for help almost as much as they ask me.

I am sorry to see the end of GNVQ in 2006 but I know that 3E's Multimedia are working on taking Internet Science into the new specifications at 14 – 16 using an extension to this GNVQ course called "Click Science". I intend to be as fully involved in this new initiative as I can, as I am certain that this is the way we should be teaching Science.

Michael Walsh is Science Curriculum Director, Head of Physics and Science Mentor for Initial Teacher training at St Benedict Catholic Secondary School and Performing Arts College, U.K. Mike has been involved in an EU initiative to increase the amount of creative learning in Science. In all the schools in which he has taught he has had responsibility for introducing new technologies in the classroom; in the last ten years this has mainly centred on computers and the Internet.

Acknowledgements:

1 Digitalbrain PLC

<http://www.digitalbrain.com/digitalbrain/corporate/education/index.htm>

2 3E's Enterprises (Trading) Ltd

<http://www.3es.com> and <http://www.3esmultimedia.com>

For a full list of acknowledgements regarding the course, please visit

<http://www.3esmultimedia.com/science>

The use of search engines in the teaching of ¹ 'Classification' in Key Stage 3 Science

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As a science teacher who also teaches Year 7 information and communication technology (ICT), I have developed a variety of techniques to integrate science into my ICT teaching and vice versa. Our Year 7 classes are of mixed ability and enthusiastic to complete any work that involves practical activities or ICT. The area of 'Classification' is taught in our Eureka (Chapman et al. 2000) scheme of work within the topic of 'Living things' in Year 7, and contains only a small amount of practical work. Therefore, the use of ICT for pupils to understand the process of classifying invertebrates as well as their identification is both motivating and challenging.

In the topic of 'Living things', the initial lesson looks at the classification of animals into 'vertebrates' or 'invertebrates' and then specialises on the vertebrate groups, of which pupils have a good deal of previous knowledge from Key Stage 2. The second lesson then moves onto the application of their knowledge of classification and classification of the invertebrate groups. This is the lesson that I combine with the use of ICT. My science learning objectives are:

- For pupils to understand that invertebrates can be classified into different groups;
- For pupils to know the invertebrate groups;
- For pupils to be able to describe the characteristics of organisms in each group;
- For pupils to be able to use their knowledge to classify an organism into one of the invertebrate groups.

Literacy objectives can also be included in this lesson, which are:

- For pupils to synthesize information from a variety of sources.

The Key Stage 3 National Curriculum² for ICT states that pupils should be taught 'how to obtain information well matched to purpose by selecting appropriate sources, using and refining search methods and questioning the plausibility and value of the information found'. It is this area of the curriculum that my Classification lesson is based on and ICT aims of the lesson are:

- For pupils to refine search methods to find appropriate information for the task;
- For pupils to select information appropriate to the task.

After a starter activity recapping the principles of classification and the

vertebrate grouping, the main activity is introduced. This is for pupils to produce an A4 fact sheet of information on a given invertebrate group. (This may be completed on Microsoft Word or Publisher depending on the pupil's competency with these applications). Their fact sheets are to include:

- The name of the invertebrate group;
- A picture;
- A description of the features of the invertebrate;
- What the invertebrate eats;
- The habitat of the invertebrate.

These points can be adjusted to differentiate for more/less able pupils; for example all pupils should have the first four points on their fact sheets, some pupils could include the names of different species within the group and a few pupils could look at the way in which the invertebrate is adapted to its environment. Pupils are also told that they will have to explain to the rest of the class what they have found out towards the end of the lesson, so they should bear in mind that the audience for their fact sheets are their peers.

The first ICT teaching point might be to discuss with pupils how to obtain useful information from the Internet. The school homepage is linked to the Google search engine [<http://www.google.co.uk>], so this is one that I recommend that the pupils use. If pupils have recently covered a 'Searching the Internet' lesson within their ICT lessons, or regularly use Internet searches in other subject areas, then little whole-class teaching is necessary at this point. However, if pupils are unfamiliar with the process of refining a search, a more thorough discussion may be required. I find that, even if pupils are competent Internet searchers, it is worth reminding them of some of the strategies for refining searches before they start.

There are various methods for refining searches to find useful information. For the activity in question, refining the search is clearly important due to the amount and variety of information available on invertebrates. For example, pupils studying the group of 'molluscs' might type the word into Google and, during August 2004, would have received 187 000 hits. These hits range from sites on research into molluscs to where they can be visited. A search may be refined by adding more words using the plus (+) sign or omitting words with a minus (-) sign to gain the required type of information. For example, pupils might type in 'molluscs +facts' or 'molluscs +schools' to take the hits down to around 10 700, the top 5 sites which are more appropriate for the task. Also by typing 'molluscs -research', sites on research into the area are eliminated, again reducing the number of hits. The two methods can then be combined by entering 'molluscs +facts -research', limiting the results further.

Searches can be confined to groups of words by placing words in speech marks, for example "key stage 3". By combining this with the first method, "key stage 3" + "molluscs" may be entered. I found that the best search result was gained by typing in "mollusc facts" which reduced the number of hits right down to six. The first site, [<http://www.mcsuk.org/marineworld/molluscs.htm>] was

exactly the sort of site that the pupils could use to extract the required information. Pupils should be taught to experiment with a range of search methods until they get the required results. They might also need reminding that some search engines are case sensitive, so if 'MOLLUSCS' was typed into such a search engine, only sites with the word in capital letters would be found.

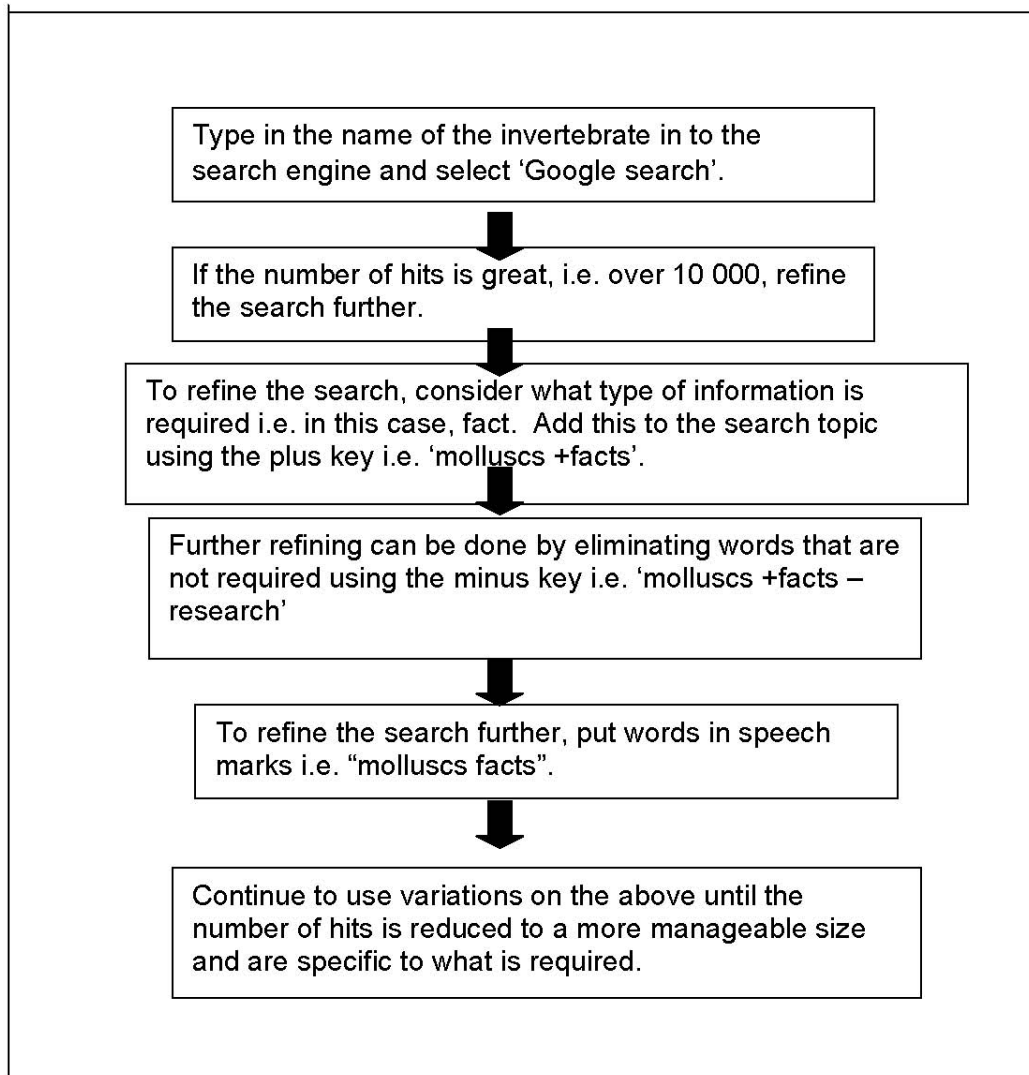


Figure 1.1: Flow chart to show how to carry out and refine a search using the search engine 'Google'.

Pupils should be aware that the hierarchical system Google uses to list the hits from a search is not perfect. The site that the search results list as number one, is not necessarily the best site for the information required. It is also worth discussing with pupils how they know whether a site is useful for the purpose of the task or not. This might be done by a brief comparison of two sites on the same topic to bring out issues such as language used, whether sites are accredited, how recently updated they were etc. Accredited sites may be those written by universities, museums, encyclopaedias etc. and are more likely to contain accurate information. For example the site mentioned above was

written by the Marine Conservation society, therefore, the information it contains is known to have come from a good source. Other sites, for example, can be found by the same search method that are written by companies advertising products for sale for aquaria. The information on these sorts of sites may be less accurate as they may have been manipulated for advertisement purposes. Pupils should be aware that anyone can put a site onto the Internet, therefore the information that they are viewing may not be reliable.

Prior to the lesson, it is important to check that sites are available and also to do a quick teacher evaluation of the sites that searches are likely to bring up. The factors that I consider when looking for suitable sites are:

- Overall content – it is obvious by the text and pictures whether the content of the page is of the correct subject matter. For example if 'arachnids' is typed in and the page displayed is an advertisement for the film 'Arachnophobia', it is unlikely that this site will contain the desired information.
- Text to picture ratio – too many pictures is unlikely to yield enough relevant information and too much text is off-putting for pupils and heavy-going;
- Suitability of language – scanning the text often gives an idea of the language but if in doubt, counting the number of words over 7 letters in a sentence usually helps. If there are more than 3 words over 7 letters in a few of the sentences, this usually means that the text is too complex.
- Text font – this needs to be pupil friendly. If it is very small and close together, pupils may find it difficult to read.
- Text layout – large amounts of text on a page is off-putting. Ideally text should be split using subtitles and if different colours are used, this is even better. Coloured text can also help dyslexic pupils who struggle with reading black and white text on a computer screen.

Most of the websites found should have suitable pictures on that pupils can use, however if this is not the case, pictures can be gained by using the 'images' section in Google. This is accessed by the link that says 'images' on the Google website and works by searching the Web for sites that contain pictures of the word or words entered into the search engine. A thumbnail image of the results is shown on the screen which can then be selected to give larger versions of the image. Again, the same methods can be used for refining the search to gain appropriate pictures for pupils to use. As with text suitability, pupils might need reminding of the type of picture that is most appropriate for their fact sheets; discussions can centre around 'fitness for purpose' of diagram, cartoons or photographs for the task in hand. It is also important to check before the lesson what the pupils' experience is with editing tools. This may be something that you need to go over as a whole class or with just a few individuals, although the 'cut, copy and paste' actions are taught at the beginning of the Year 7 ICT curriculum in our school, therefore most pupils should be confident with their use.

Once time has been given for pupils to carry out their own searches, any groups that have been unable to find suitable sites may be given direction by predetermined sites. If the school has access to the Children's online Britannica, this is a useful site to direct the pupils to. Other excellent sites include [<http://www.enchantedlearning.com/>] and the BBC site, [www.bbc.co.uk]. Directing pupils to these sites means that they can carry out their own searches within the site to find information on their chosen invertebrate. Searching the BBC website for the topic of 'molluscs' should lead pupils to the site: [<http://www.bbc.co.uk/nature/blueplanet/factfiles.shtml>] which is another excellent source of information for pupils to carry out the set task as individual fact files for all invertebrate creatures can be found. Also, searching the Enchanted Learning website in the same way produces the following site: [<http://www.enchantedlearning.com/painting/Mollusks.shtml>] which also has relevant information that pupils can use for their fact sheets.

Once pupils have completed their fact sheets, they can be printed and selected pupils can briefly describe the information that they have found out about their invertebrate. Once all of the invertebrate groups have been described, posters can be displayed somewhere where all pupils can see them and they can be given their final challenge of the lesson. Pupils can be given the name and description of these invertebrates and they have to use the information that is presented to work out which group each of the invertebrates belongs to. This activity can be done as a whole class or in groups depending on the time available. Also the number of invertebrate descriptions given might allow differentiation for groups or could vary depending on time. Either way, this is an excellent way to consolidate the information retrieved.

Teaching the lesson of invertebrate classification in this way is not only motivating for the pupils but it provides useful material for a display that can also act as constant stimuli during the topic, reminding them of the work carried out. Pupils are able to look in more depth at the features of an individual invertebrate, whilst still having a good overview of the characteristics of others. They are also able to apply their knowledge of classification to an actual situation, improving understanding of the subject.

Glossary of terms

Key Stages

In England, the compulsory years of schooling are divided into 4 Key Stages:

Key Stage 1 (Years 1 and 2): Ages 5+ to 7

Key Stage 2 (Years 3, 4, 5 and 6): Ages 7+ to 11

Key Stage 3 (Years 7, 8 and 9): Ages 11+ to 14

Key Stage 4 (Years 10 and 11): Ages 14+ to 16

National Curriculum

In England, there is a statutory National Curriculum for all pupils in state maintained schools. The National Curriculum determines the content of what will be taught and sets attainment targets for learning. It also determines how performance will be assessed and reported.

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