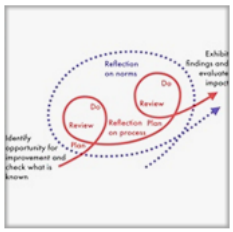
The Design of Learner-Centred, Technology-Enhanced Education



Richard Millwood

December 2013

Submitted in partial fulfilment of the requirements of the University of Bolton for the degree of Doctor of Philosophy on the basis of practice.

A hypertext version of this thesis can be found at http://phd.richardmillwood.net

Abstract

This dissertation articulates the contribution to knowledge made by my practice in the design of learner-centred technology-enhanced education. It describes my methodological approach with the research & development methods employed, my theoretical & conceptual framework and makes a claim for my original contribution based on a selected portfolio of practice.

In this practice, I have progressed from an individual, enthusiastic and creative teacher to a collaborative teacher-educator and leader of innovation in education, taking a full part in a developing research community concerned with the relationship between education and technology. My early work, over fifteen years, concentrated on improving the design of individual pieces of educational software to enhance the school curriculum. A developing interest in user-interface design led to an original analysis of learning based on cybernetic principles, which was then used to inform iterative design processes in a more holistic manner. This led me to confront wider issues in education which informed a systemic approach to large-scale action research, to design and innovate new systems of education for schooling, professional development and degree-awarding courses. In each case the key design approach is one of phases of prototyping, then small-scale roll-out followed by large scale implementation with plan / act / review cycles within each phase.

The experience gained through increasingly responsible work rôles, in which I was expected to guide others, has developed my understanding of criteria which can be used for evaluating designs as a springboard for improving them iteratively. These criteria are expressed through four analyses that I have developed which underpin decision-making in my design practice:

- an 'expressive constructivist' model of learning for the individual;
- an account of how technology can then support learning;
- a learner-centred holistic breakdown of questions faced by students;
- and an account of the perspectives of other stakeholders in education.

These arose from my growing, tacit understanding and have been framed by a theoretical and conceptual framework based on academic literature. Over time I began to articulate these ideas with colleagues, students, in conference presentations, reports, research papers and other publications including television programmes which form my portfolio. The application of these ideas has generated the originality, impact and importance claimed for my practice. This thesis combines these analyses with references to the literature and a selection of practice from my portfolio, which forms my original contribution to knowledge in the field.

Tables

Figures

Acknowledgements

In the final appendix, I make extensive acknowledgement, to as many as I could recall, who touched my life throughout my practice and the development of my thinking, but special mention is given here to those who helped me to finish this thesis.

Firstly to my lead supervisor Stephen Powell, who has shown me the way by his example and has treated me with the perfect level of encouragement, admonition and advice at every stage - I consider him my extra-brother. Dai Griffiths as supervisor has supported me enormously, especially in the final stages.

Thanks also to Margaret Nelson, Roberta Weber, Roger Carlsen, Brendan Tangney and Elizabeth Oldham who all offered me opportunity to talk about the thesis, listened and told me what for.

My mother, father, sister Liz and Joy Hooper have all enquired at regular and helpful intervals with love and respect and thus driven me on. And thanks to Jo, who has unwittingly inspired such a purple patch in the last months as the thesis was completed.

It is all their fault.

Candidates Declaration Form

Form R10

Candidate's Declaration Form

This form should be completed by the candidate and submitted to the University's Research Degrees Administrator with the final, permanently bound copies of the Thesis.

Name of Candidate: Richard Millwood

Title of Thesis: The Design of Learner-Centred, Technology-Enhanced Education

Degree: PhD by Retrospective Practice

Deposition of Thesis

1. I agree that the Thesis may be made available for reading and/or photocopying in the University of Bolton library[1], on the understanding that users will be made aware of the copyright restrictions. Copyright remains vested in the author of the thesis.

2. I agree[2] that the Thesis may be made available for use without charge on the Internet via the University of Bolton's institutional repository and that a digital copy[3] of the Thesis may also be added to the British Library's Electronic Thesis On-line System (ETHOS). In so agreeing,

- I understand that rights granted to the University of Bolton and the British Library through this agreement are non-exclusive and that I am free to publish the Thesis in its present version or future versions elsewhere;
- I agree that the administrators of the University of Bolton Institutional Repository may, without changing content, convert the Thesis to any medium or format for the purpose of future preservation and accessibility.

Declaration:

I declare that the attached permanently bound copies of my Thesis (and, if applicable, the accompanying digital copy) are identical with the version submitted for examination, except where amendments have been undertaken to meet the requirements of the examiners (see Research Degree Regulation 8.7).

Signature of Candidate: 

Date: 16th December 2013

[1] This is a requirement of Research Degree Regulation 12.7 (unless the Board of Studies for Research Degrees has agreed to an application for confidentiality under Regulation 12.8).
[2] This is desirable and strongly encouraged as standard practice but if you do not agree please delete the whole of section 2.
[3] Digital copies should be supplied in PDF format either on a CD-ROM or a pen-drive.

L:\AQAS\Contensis Documents\Research Staff and Students\Proforma R10 - Candidate's Declaration Form (Sep 11).docx

1 Introduction

The context to this thesis, including overall aims, information about the author, the nature & criteria for a PhD by Practice.

1.1 Aims

The overall aim of my PhD research have been to make an original contribution to knowledge through my practice, founded on an emerging theoretical and conceptual framework to guide decision making in the design of learner-centred, technology-enhanced education.

The individual, specific and diverse aims of my practice, connected with the 21 portfolio items selected for this thesis, are listed in the Claim section together with an assessment of my contribution to each item and their originality, impact and importance. Each is referenced in the text in the form [Cxx] and can be found with a full description in Appendix 1.

The 'Theoretical and Conceptual Framework' attempts to show the development of coherence related to these aims, and sets out four key analyses which are referenced in the form [Axx].

1.2 Structure of this thesis

The thesis has the sections shown in Figure 1 which are marshalled by the Claim to make the case for doctoral qualification.

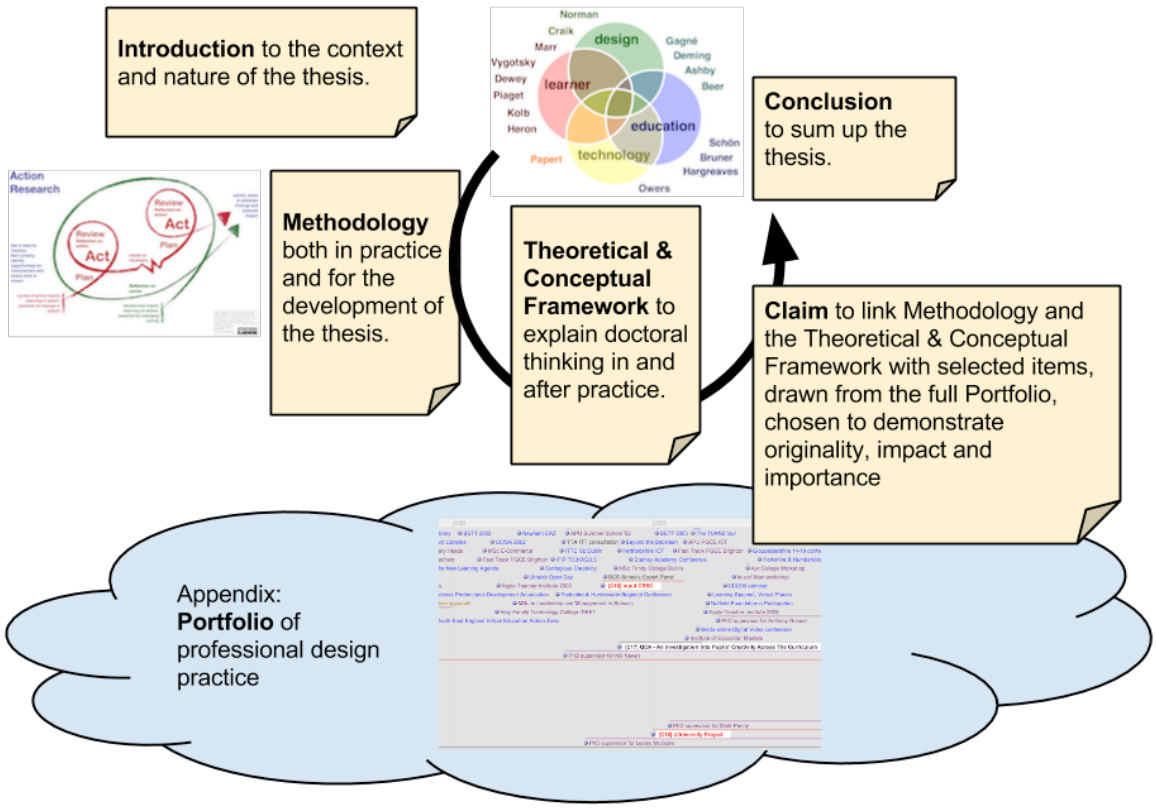


Figure 1: The structure of the thesis

1.3 About Richard Millwood

In writing this thesis, I came to realise that all the practice I had been engaged in had a common thread: an ambition to improve education through a better, theoretically-informed design practice for innovations using technology

I have been trying to do this since 1978 as a design practitioner in technology-enhanced learning. I have sought analytical and descriptive means to improve designs through effective design & development processes. I have focussed on learner-centred approaches and researched widely across multiple disciplines. My practice has also involved teaching at all levels, specifically at Masters level since 1984 and the supervision of PhD students since 1997.

I am currently a Director of Core Education UK Ltd, a non-profit organisation and I am Assistant Professor and Course Director for the MSc in Technology and Learning at Trinity College Dublin. Until very recently (July 2013) I was Reader in Distributed Learning in the Institute for Educational Cybernetics at the University of Bolton as well as a Research Fellow at Brunel University until September 2013.

I am responsible for the National Archive of Educational Computing and contributor to the Work Focussed Learning project.

I maintain a blog, a New Learning Landscape, and occasionally tweet as @richardmillwood.

I am a Fellow of the Royal Society for the Encouragement of Arts, Manufactures and Commerce (FRSA) and of the British Computer Society (FBCS) and have been an Apple Distinguished Educator since 2000. I have recently served as a secondary school governor, having previously chaired a primary school governing body for six years. I am active in the Labour Party, currently serving as Chair of the Brentwood and Ongar Constituency Labour Party and I am a founding member of Educating Brentwood, a local group dedicated to improving educational accountability.

1.4 PhD by practice

The Practice route to doctorate is designed for practitioners who have created major works and wish to present these for examination as original contributions in their field.

In my case, I am presenting my work as a designer of technology-enhanced, learner-centred education. I claim that some of this work has been state-of-the-art and has made substantial original contribution to the learning technology field.

I have straddled the groups of learning technologists and educational developers in my work, and these groups have only emerged in my lifetime, as reported in Alison Hudson's PhD Thesis *New Professionals and New Technologies in New Higher Education?* (Hudson 2009).

Hudson's study suggests that:

> …both groups occupy a highly politicised position, are affected by the shifting value of social, cultural and economic capital in the constantly changing higher education, are subject to struggle regarding 'position' and agency and are susceptible to the demands of new power regimes and technological solutions.
>
> (Hudson 2009, Abstract)

My work has encompassed early years, school and informal lifelong learning, although throughout most of my career I have been employed in higher education research & development contexts, frequently in short term contracts and struggling to establish a position.

This struggle with position has made the PhD by practice suitable for my situation, since the combination of disciplines necessary to carry out my work has shifted from instructional design, to multimedia creativity, to course design and ultimately the design of school and higher education itself. Thus I have never 'settled down' in any subject disciplinary sense, instead obtaining coherence from the focus on design, development, marketing, teaching and leadership in the creation of innovative 'products' at many levels. This combination of disciplines also leads me to draw broadly on theoretical and conceptual literature, and my literature review is spread throughout this thesis. Arguably I have experienced an 'expansive education', in response to Engstrom's problem "the elusive and uncontrollable nature of expansive processes where human beings transcend the contexts given to them" (Engstrom 1987), in my case stimulated by new technology developments. Thus I have defined multiple aims in the process of developing this thesis since it is in the nature of expansive education that a single research question could not represent my original contribution.

The consequence of these matters, together with the shorter account (in this case 20,000 words), the absence of a standalone literature review chapter and the range of eclectic practice itself, makes this approach challenging as compared to those made in more traditional and focussed PhD forms. Winter et al., in their paper *The 'Academic' Qualities of Practice: What are the criteria for a practice-based PhD?*, address this question head on, and suggest (minimally) that:

> …a PhD ought to:
> - be a report of work which others would want to read;
> - tell a compelling story articulately whilst pre-empting inevitable critiques;
> - carry the reader into complex realms, and inform and educate him/her;
> - be sufficiently speculative or original to command respectful peer attention.
>
> (Winter et al. 2000)

The regulations for the Bolton PhD by Retrospective Practice demand that the thesis should consist of “a rigorous critical appraisal, normally between 10,000 and 15,000 words” (University of Bolton, 2008, 8).

The regulations give 5 specific criteria, set out here in table 1 to guide the reader within this thesis to locate my response.

Table 1: Specific criteria for the PhD by Retrospective Practice at the University of Bolton and my response

Criterion	Response
1. details of specific dates and locations in relation to the conduct of the research on which the submission is based;	To be found in the first Appendix - Portfolio.
2. an analysis of the general and specific aims of the research programme, including an analysis of its component parts and a synthesis of the works as a coherent study;	To be found in the table of aims in the Introduction and in the Claim.
3. a discussion of the contribution made by the submitted works or evidenced by the items within the portfolio to the general advancement of the field of study and research area or professional or creative practice, which demonstrates a common theme;	To be found in the summary of the Claim and the discussion of each item of practice in the Claim, where reflections on learning, contribution, originality, impact and importance are made and in the four analyses made in the Theoretical & Conceptual Framework. The Conclusion includes a summary of the contribution.
4. a demonstration that the work or the practice constitutes an independent and original contribution to knowledge in the chosen field;	To be found in the discussion of each selected item of practice in the Claim, where reflections on learning, contribution, originality, impact and importance are made.
5. a review of the current literature, unless already incorporated within any of the other items submitted.	To be found throughout in the Methodology, Theoretical & Conceptual Framework and Claim.

2 Methodology

There are three aspects to this section - firstly an overview of my research approaches, secondly a discussion of the research methodologies I have developed in my practice, and thirdly a discussion of the methodology employed in developing this thesis.

2.1 Research approaches

This part discuss the overall approach for both practice and thesis which is founded in iterative cycles of development based on an action research paradigm. It also explains the values that have been at the heart of my practice.

2.2 Approach to Practice

The design of software, resources and systems I have developed has been undertaken in the context of a series of research projects. The inquiry paradigm of these projects started with creative curriculum development in the early part of my career and later became overlaid with a more explicitly collaborative action research approach (Lewin 1973, 205-6; Argyris and Schön 1978), within and on the education system itself. My mature visualisation of this approach is shown in the Figure 2, developed as a wall poster:

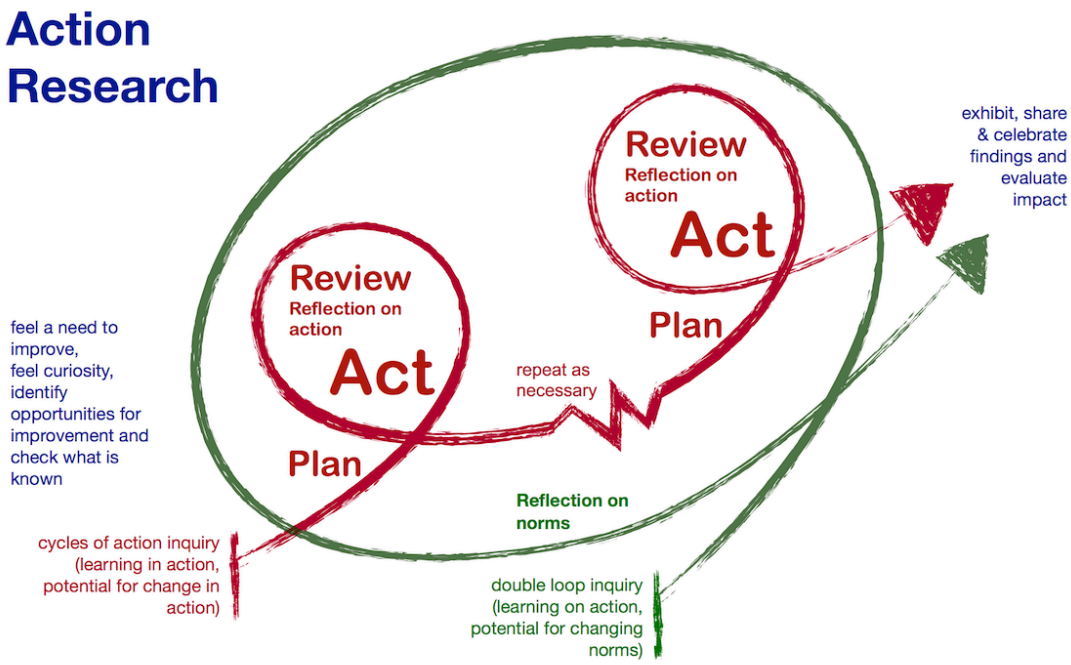


Figure 2: A model of action research

This paradigm is not without its problems, as Somekh and Zeichner put it:

> Action research, as a proposition, has discursive power because it embodies a collision of terms. In generating research knowledge and improving social action at the same time, action research challenges the normative values of two distinct ways of being – that of the scholar and the activist.
>
> (Somekh and Zeichner 2009, 5)

This notion of two ways of being has specific attraction for the designer & developer in me, who loves to make and do, not simply think and reflect. Thus it has been natural for me to engage in the iterative and cyclical phases of action research - planning, acting, reviewing and with growing awareness of its meaning. Planning has included collaboration with experts, practitioners and learners inspired to envision the potential for innovation with technology in education. Acting has ranged from coding programs, creating CD-ROMs, designing web-sites, configuring online communities, teaching, facilitation, marketing of courses and direction of large teams of colleagues. Reviewing has involved empirical data collection methods including observation, interview, focus group, survey and videography. This has been followed by analysis of the quantitative & qualitative data collected and subsequent interpretation to develop conclusions which inform the next cycle of inquiry. Double loop learning, the identification and critical questioning of governing variables, has been common throughout as I and collaborators bloodied ourselves confronting the inherent conservatism of educational practices, institutions and frameworks whilst making sense of technology innovations.

This action research approach and all these methods have been employed in my practice as part of the many research and development projects undertaken, and they are described and exemplified in the section 'Methodologies in Practice'.

2.3 Approach to Thesis

When setting out to develop this thesis, I decided on a reflective methodological approach and related methods to construct it, but, keeping true to my practice of design and what drives me, the design and development of a resource in the shape of a web site was a vital element. The steps taken to arrive at the substance and presentation of my thesis are discussed in the section 'Methodology for this thesis'.

This web-site can be found at http://phd.richardmillwood.net

2.4 Values

The research and development I have been engaged in has always been values-driven, in a nutshell 'to change the world for the better'. Over time these values have developed, but they clearly indicate a subjective viewpoint, and thus run the risk of introducing bias and overlooking issues. The approach has been to recognise these values, identify the risks and maintain the moral perspective.

The most important of these values are discussed below.

2.4.1 Collaboration

All the research and development I have engaged in recognises that collaboration is essential. The positive features for me are:

- a continuing dialogue of critical friendship;
- the benefit of diverse strengths and perspectives;
- and where possible, the democratic involvement of beneficiaries and stakeholders to improve ideas, evaluation and uptake.

The price on occasion has been an 'averaging' of creative ideas to achieve consensus, but on reflecting back over this work, this has rarely prevented innovation.

2.4.2 Social justice

The idea that research and development might address inequalities of opportunity in society through education has been central. This means that methodologies such as experimental design, which favour one group over another through a treatment group and a control group, have been avoided in the work I have undertaken, and more naturalistic and qualitative methods used to evaluate outcomes. In the design process it has meant paying attention to diversity, culture and gender issues and making positive efforts in the design of innovations to address these. This has occasionally needed to counter technology-led innovation, which so often simply addresses 'normal' users. In some cases, a compromise has been needed between exploring new designs and addressing accessibility, whilst maintaining a critical view of the issue.

2.4.3 Transparency and participation

My first software development work as a full-time researcher at Computers in the Curriculum in 1980 obliged me to work closely and to be led in pedagogical issues by teacher-groups and individual teachers leading on items of software. This demanded a transparency in planning and participation in design which I came to value. The returns were a growing awareness of practising teachers' knowledge and concerns combined with a practical means to deliver on the values of social justice. This in turn led to design and development criteria informed by my practice working with the teachers. In later projects, especially at Ultralab in the 90s this approach was extended to include school students as 'co-researchers', inviting them to understand the goals of our developments and to contribute at every level.

2.4.4 Delight

The idea that delight was essential to successful learning was a central tenet in Ultralab in the 90s, permitting us to develop software for learning with features intended to inspire delight in learners. But it wasn't until 2006 that I realised how much tacit knowledge had been developed. The opportunity to articulate this fully for Teachers' TV's School Matters series, *Happiest Days?* (Millwood 2007) and for a poster *An Analysis of Delight* (Millwood 2010) helped me to recognise the nuanced detail of this concept and how deeply it had become key to my design and

development. The influence of David Hargreaves (1975) in his book *Interpersonal Relations and Education* and John Heron in his *Feeling and Personhood: Psychology in Another Key* (1992) has been central to developing this concept of delight.

3 Methodology in My Practice

Over the span of my practice I have adopted a range of methodologies and employed many methods, as well as supervising students for Bachelors, Masters and Doctoral dissertations as they developed their methodological approaches and applied methods. This section focusses on those methodologies that I have applied directly in my design practice.

3.1 Approaches

3.1.1 Design & development

The key approach in my practice has been the design and development of educational software, multimedia resources, systems and ultimately courses. This design approach has been in a context where new technology offers new and unknown opportunities and despite disquiet about technology-led approaches, has inspired creativity and innovation in my practice. The key to this research approach has been a combination of developing design methodology and rigorous evaluation in real-world contexts. In this sense, I have been unconsciously engaged in a design science approach:

> A design science of education should be based on a linguistic framework which offers an intermediate level of systematisation, rising above anecdotes but remaining grounded in reality. Such a framework would allow us to capture the structure of educational situations, the challenges they engender, as well as the means of addressing them, in forms which should empower learners and teachers to control their practice as much as it allows researchers to inspect it scientifically.
>
> (Mor 2010, 14)

I would argue that the analytical perspectives I present in the 'Theoretical and Conceptual Framework' are my version of Mor's linguistic framework.

3.1.2 Participant action research

As my work developed, I became increasingly conscious that I was developing a participant action research approach (Denzin and Lincoln 2005, 33-34) to complement design & development. This was the result of a growing interest and opportunity to design courses, degree programmes and ultimately secondary (Notschool.net project) and higher education organisation ([C18] Ultraversity Project). In each case the concept of co-research with students became ever more explicit.

3.2 Specific Methods Used

3.2.1 Prototyping, iterative development and field testing

In developing new interactive educational software, an early discovery was that the traditional waterfall method (Bell and Thayer 1976), of identification of user needs followed by specification, implementation and testing, would not work. Participants (including myself) in the design process were discovering new needs, had little ability to specify unknown designs offering new practices and found themselves learning through the process of development in an 'expansive' sense

(Engstrom 1999). A further complication in practice was that the computers in use had a range of features and capabilities and the design team would often have diverse understandings of what could be achieved. So the method employed was of prototyping initial ideas to produce a working design, not fully debugged nor complete, to inform the next steps and inspire further invention.

Prototyping was only the beginning of course, and was followed by cycles of development and field testing, often in classrooms by the teacher participants in the design and development process, whose understanding was also growing. Alongside the successive improvement in the software itself, there was a parallel and important task to develop the teachers' and students' guidance material which underwent a similar process.

As Mor puts it:

> The design element in a design study may refer to the pedagogy, the activity, or the tools used. In some cases, the researchers will focus on iterative refinement of the educational design while keeping the tools fixed, whereas in others they may highlight the tools, applying a free-flowing approach to the activities. In yet others they will aspire to achieve a coherent and comprehensive design of the activity system as a whole.
>
> (Mor 2010, 27)

3.2.2 Analysis

Frequently in the development process, a failure in use would be identified in broad terms - a teacher or student would report that some aspect was unclear, difficult to use or simply baffling. At this point it was important to analyse the software, and the practice, to discover where improvement needed to be made. At first this was done informally and with tacit knowledge of what works, but later after making sense of knowledge from experts, this task was improved to make use of insights from the worlds of visual design and from human computer interface. The input from visual design theory offered clarity about the simplest ideas of placement and the overlapping of graphical elements on the screen, the treatment of white space, typography and combinations of colours. The input from human computer interface theory was primarily from Donald Norman regarding the task analysis of operating equipment, and resulted in our own interpretation to guide colleagues in our team expressed as *An Analysis of a Single Interaction* (Millwood and Riley 1988).

3.2.3 Survey

In later work, relating to the development of courses and educational practice, evaluation through direct questioning of participants became an additional method used. Particularly with the advent of online surveys with their immediate and low-cost summary analysis, this became an important method. Development in this methodology to take advantage of the particular strengths of interactive designs came in the design of Making Choices (Millwood 1993), a tool for modelling decisions by interactively dragging choices into order and the COGs passport a tool for transition between primary and secondary schooling. COGS helped learners evaluate their competencies by

dragging elements in a geometric design. This design thread has been developed most recently in the design of interactive learning needs analysis for health professionals and volunteers in the charity Macmillan Cancer Support.

3.2.4 Videography

In several projects, understanding the holistic context and seeing the detailed activity became important. In these cases, making video of the activity or of the discussion to evaluate it was employed, although this could prove challenging to access and analyse. In some cases, [C18] Ultraversity Project, the video was transcribed and the transcription added to the video as a text track which was searchable. Added value could be obtained by adding text tracks for chapters and for keyword analysis, permitting the video to be used as the vehicle for dissemination of research findings, not simply the data gathered.

3.2.5 Structured Interview and grounded theory approaches

In creating innovation in higher education, it became important to evaluate the experience of students and tutors in greater depth. In these cases we developed interview frameworks, conducted the interviews, recorded the audio transcribed and then employed an interpretive phenomenological analysis (Smith et al. 2009) to the data to discover in a grounded sense, the key themes of their response to our innovations (Millwood and Powell 2009).

4 Methodology for this Thesis

This section explains the methodology used in the completion of this thesis.

4.1 Philosophical Approach – Pragmatism

The philosophical approach of Pragmatism - that the function of thought is as an instrument or tool for prediction, action, and problem solving (Peirce 1935; James 1898) - has inspired my work and specifically been employed in the production of this thesis. It has guided me to gather my work practice, discover those aspects which have made the greatest contribution and attempt to link them to theoretical perspectives through the thesis web site.

4.2 Methodological Approach – Autoethnography

Although it is clear that the approach I have taken is of autoethnography, there are variants, and my approach has been closest to that defined by Ellis (2004) - “research, writing, story, and method that connect the autobiographical and personal to the cultural, social, and political”. Although I set out to describe and look critically at my experience, there is also the deliberate attempt to find theory in this thesis, and a move from my tacit theories to those articulated in the analyses ([A1], [A2], [A3] and [A4]) published with this thesis, where the intent is to provide reliable tools to other designers. I hope that this desire and the positive outcomes of much of the practice I have been engaged in will counter the criticisms levelled at auto-ethnographers as "unscientific, or only exploratory, or subjective" (Denzin and Lincoln 2005, 8).

The five factors described by Richardson (2000, 15-16) for evaluating such work are used here to justify my position, and for you the reader to judge my success as set out in table 2.

Table 2: Richardson's factors for evaluating autoethnographic work

Factor	Response for this thesis
Substantive Does the piece contribute to our understanding of social life?	Taken as a whole, the portfolio explains the career of an individual (me) in times of change in education as technology matured and became ubiquitous, changing the face of education. I have related my development to the more influential people that I worked with, but recognise a huge number of others that made my work and learning possible.
Aesthetic merit Does this piece succeed aesthetically? Is the text artistically shaped, satisfyingly complex, and not boring?	This thesis is also presented as a designed web-site, attempting to please aesthetically.
Reflexivity How did the author come to write this text? How has the author’s subjectivity been both a producer and a product of this text?	In reviewing all my professional practice to prepare for this thesis, I have systematically developed reflective written material for the most significant events. I have constructed identity and place in my life's work through this process and this has made me a product of this text.

Impactfulness Does this affect me emotionally and/or intellectually? Does it generate new questions or move me to action?	The demand to articulate more clearly my theoretical perspectives and find coherence in them has provided many questions. Impact has also been seen in the outcomes of my practice.
Expresses a reality Does this text embody a fleshed out sense of lived experience?	By including my employment, education and professional responsibilities I have tried to show a complete career. Although I could have included much more personal matters of family and relationship, the reflective section in my portfolio about people I have worked with will, I hope, illuminate how I have been humanly influenced.

4.3 Specific Method

4.3.1 Designing the thesis web site

From the outset, the processes of gathering, categorising, reflecting, selecting and presenting were identified as knowledge and information management tasks, which from the author's perspective demanded a content management system (CMS). The practice of designing such a system was aligned with the author's experience and ambition, offering not only a vehicle for development but also dissemination and participation. The structuring, semantic tagging, work-flow, language translation, accessibility, visual design and multimedia features of the Plone CMS were seen as appropriate for the task based on experience using this CMS for the websites of key relevant professional organisations in recent years - Ultralab, Core Education UK and the National Archive of Educational Computing.

4.3.2 Gathering the evidence

The first step was to enter the events in my practice using the event content type in Plone and collecting these in the Portfolio section. Each event consisted of a title, summary, description, start and end date for each of the elements of my practice. I chose to be broad in scope, creating an auto-biographical account which is more complete than required for this thesis, but allowed decisions on relevance, importance and contribution to made through a second pass. An important consequence of this process was the positive effect of building a rounded account of my life experience leading to a holistic picture. The outcome is a list of around 400 items of practice.

4.3.3 Categorising the evidence

Each entry was tagged as belonging to one of seven categories that emerged from considering the kinds of practice I had engaged in:

- **education** - events in my formal lifelong education;
- **employment** - posts held;
- **project** - research and development projects undertaken;
- **professional** - positions of professional activity, e.g. societies, examination, advice;
- **conference** - participation in conferences;
- **publication** - papers and other media published formally;
- **teaching** - activity where my rôle was to teach others.

4.3.4 Adding reflections and selecting key contributions

To create a manageable portfolio for assessment of this thesis, a selection of events was made that seemed to offer potential for the development of a doctoral thesis through a process of reflection. These events were edited to include a paragraph or more of reflection, identifying the key elements within them that influenced the development of my design practice and assessing the contribution made in what were frequently collaborative activities. As well as clarifying the nature of my contribution, I assessed the proportion of it in crude percentage terms.

From these items, a further selection was made to shorten the list to form the basis of a claim for examination. These items are tagged claim and show with a white background and bold text in the portfolio timeline as shown in Figure 3.

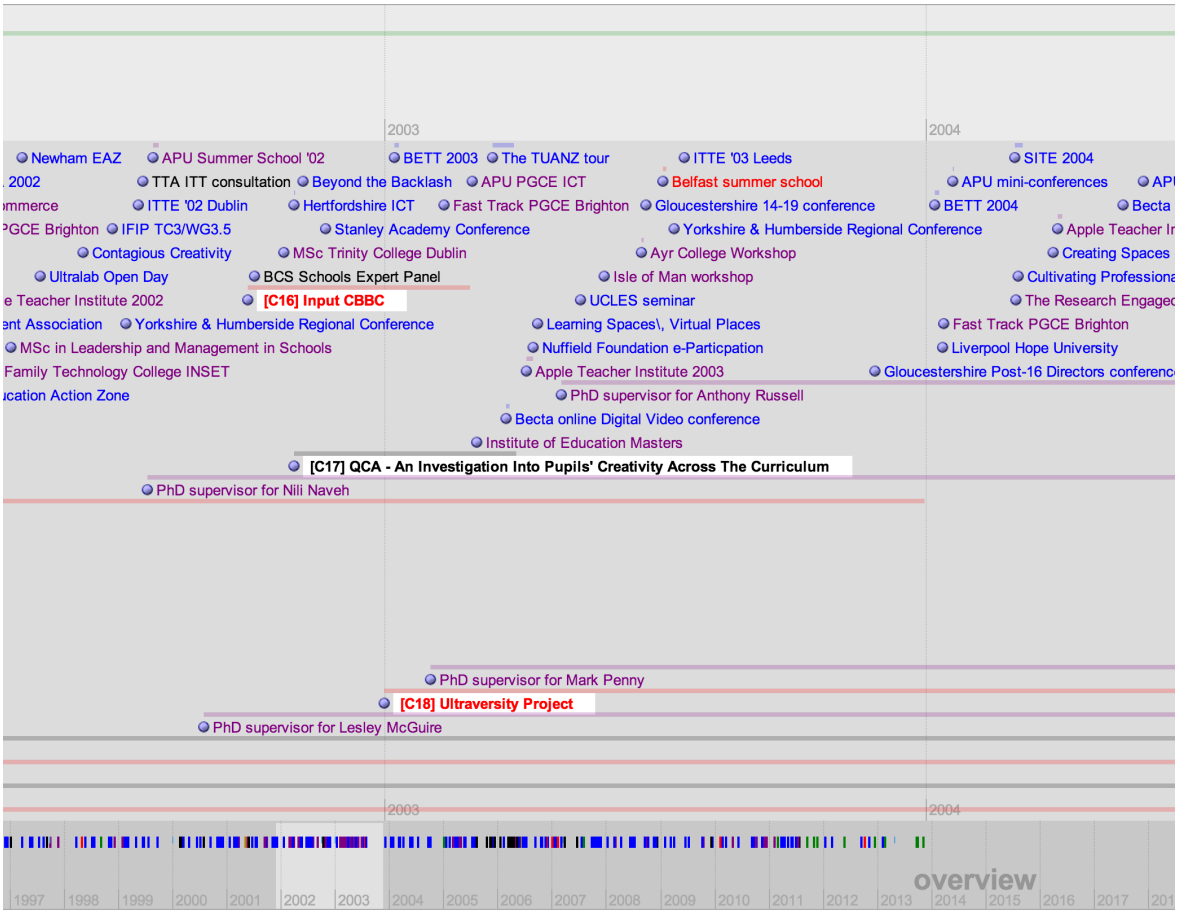


Figure 3: Claim items highlighted in white on a timeline of my professional practice

Each of these items has been shared with the original key collaborators, where possible, and they have formally agreed to my judgment of contribution. This process was followed as part of registration for this degree and is submitted to the Board of Studies for Research Degrees as one of the conditions of registration.

On reflection, I consider the estimate of my contribution in percentage terms to be too limited, and in future would propose the use of more qualitative terms ranked as:

- leader;
- one of a pair;
- member of small team;
- critical friend;
- member of large team.

4.3.5 Identifying originality, impact and importance

A final process of identifying the originality, impact and importance of the items of practice on which I based the claim was undertaken and referenced to evidence. In some cases the practice was very public and on the large scale and may be readily judged for these factors by other academics and practitioners in the field. The outcome of this process forms the basis of the Claim made in that section of this thesis.

5 Theoretical & Conceptual Framework

These are the central concepts which developed through my practice, the main theoretical views which have been influential and together have been used to make sense of it all and create my own theoretical foundation for action in my design practice. I argue that the application of these ideas has generated the originality, impact and importance claimed for my practice.

5.1 Overview

The four concepts of design, learner, technology and education intersect to provide an overarching conceptual framework for this PhD - my practice occurs in the intersection of all four. I have also made four theoretical analyses which connect to these concepts and act as an aid in decision making as a designer by helping me find where to focus attention to improve designs.

The authors that surround the four concepts, shown in Figure 4, are the most significant of those that have provided me with theoretical insight, foundation and explanation for the development of my own understanding.

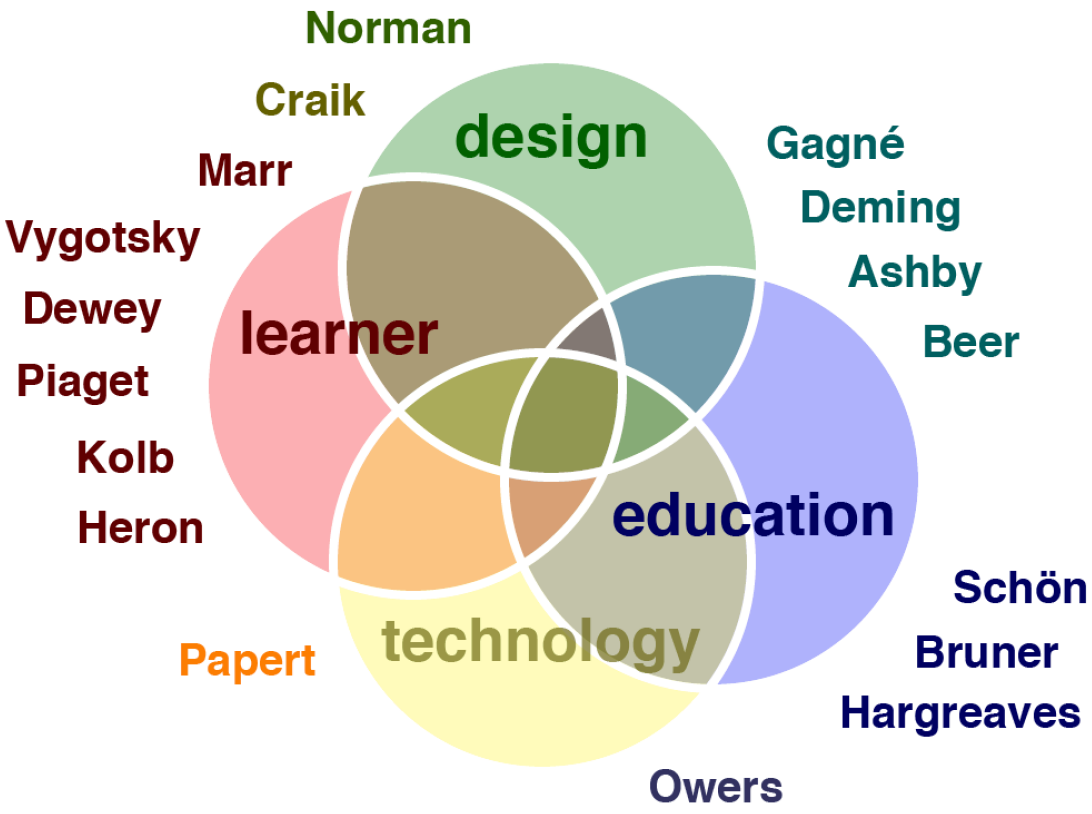


Figure 4: Conceptual framework for this thesis

My increasingly responsibility in rôles as a teacher, software developer, media designer, team leader and director together with a natural proclivity to be reflective practitioner, has broadened and deepened my understanding of the factors which lead to effective design methods and criteria for improving design quality in iterative design cycles.

Much of this understanding began as tacit in nature, but as I have had extensive opportunity to present work at conferences and workshops, I have made improving explanations of these factors and criteria to create my own theoretical framework in four key analyses, all of which are intended to inform my concept of design:

- **[A1] Expressive constructivism** - a creative and constructivist view of learning itself, founded on my concept of learner;
- **[A2] How can technology enhance learning** - some of the key contributions technology can make to learning, founded on my concepts of technology and learner;
- **[A3] The learner at the centre** - a learner-centred, holistic view of the decision points in education, founded on my concepts of learner and education;
- **[A4] Stakeholder perspectives in education** - the perspective of issues in education from some other key viewpoints - the teacher and the organisation, founded on my concept of education.

These analyses have been used to steer my design decisions made throughout 36 years of practice. As such they are a development of theories-in-use, and their articulation here espoused theory in Argyris and Schön's terms (1978).

5.2 Design

The concept of design employed in my practice extends from the imaginative formation of learning resources, environments and systems to their development and evaluation and culminates in the innovation of courses and organisations for education.

5.2.1 Definitions

Design as a verb entails the process of imaginative formation of an entity. In the context of education, the entity, which may be as simple as a text or as complex as an organisation, may provide a response to some or all the key questions to progress learning, from motivation to recognition ([A3] Millwood 2009 *The Learner at the Centre*). Design as a noun is concerned with the specification of such an entity. A more formal, nuanced and rich definition can be found in Ralph and Wand (2009), but is beyond the scope of the pragmatic view I have taken.

The verb design in my practice is an iterative process of development, accompanied by trialling, feedback and evaluation to determine the focus for further improvement. The mutability of designs may be promoted by their expression in computer formats, which offer ready correction and change. With the advent of computer programs, many designs can be expressed in the computer language or information system directly, although not all such languages make such designs accessible. This is the domain of Learning Design (Koper 2006), where one possible benefit is that the design may become enacted through the computer to guide a student on a learning trajectory, but this is not territory which I have explored in any detail in my practice, preferring designs to provide infrastructure and tools for human decision making in a freer sense. I regard learning as less likely to succeed when too tightly prescribed and in its nature, more of a creative activity which

benefits from openness in outcome rather than to be restricted to such sequences with too closely focussed learning outcomes.

In my practice the designed entities have all employed some element of computer technology to enhance learning. In my conception of 'design' as a noun, it is a mutable specification:

> a representation of teaching and learning practice documented in some notational format so that it can serve as a model or template adaptable by a teacher to suit his/her context
>
> (Agostinho 2006)

I would extend this definition so that a 'design' may be that of an information resource, tool, activity, environment or educational organisation. I have learned and employed a wide range skills including composition of words, graphic design, desktop publishing, video editing and computer programming. I have tackled the design and making of computer programs, web sites, films, furniture, office spaces, online spaces and rooms to support education.

5.2.2 Design Science

Defined by Buckminster Fuller (1963), Design Science brought systematisation to the design process, and became understood as the scientific study of design (Gregory 1966).

In the context of education, Mor explains it well:

> A design science of education should be based on a linguistic framework which offers an intermediate level of systematisation, rising above anecdotes but remaining grounded in reality. Such a framework would allow us to capture the structure of educational situations, the challenges they engender, as well as the means of addressing them, in forms which should empower learners and teachers to control their practice as much as it allows researchers to inspect it scientifically.
>
> (Mor 2010, 14)

I would extend Mor's view to say that a design science of education might also encourage creativity in the attempt to transform education for the better.

5.2.3 Complexity and iteration in design

Educational designs I have engaged with have been complex and iterative, and in a research context could be considered as design studies as described by Shavelson et al.:

> Design studies have been characterized, with varying emphasis depending on the study, as iterative, process focused, interventionist, collaborative, multileveled, utility oriented, and theory driven
>
> (Shavelson et al. 2003)

The iterative view of design (the verb) is not opposed to a design process base on architectural/ engineering specification, where well known and predictive calculations can be made to find the exact dimensions and materials to create a building or bridge. Instead, the iterative view

recognises the unpredictability of the design of education where people, their diversity, complexity and culture are part of the design space, not simply users of an end product. It is not enough to design a computer program which performs to specification, tests correctly and is viewed as satisfactory - in education such software is subject to the richness of human discourse, re-interpretation and creativity. In the process of iterative design, such issues can be explored and the design improved with the evidence gathered to make the most effective educational outcome in a dynamic context.

5.3 Learner

The concept of learner in my work has been particularly concerned with the developmental fulfilment of the learner at all stages in a lifelong venture, that is learning for intrinsic reasons, as well as preparation for work, culture and citizenship.

This section focusses on the learner perspective that informs my practice. The learner in my practice has been central to improving the design of materials and courses which aim to support the development of learners' knowledge.

5.3.1 Learner's Knowledge

Knowledge is a term that is naturally confused in definition, between the kind of knowledge which individuals have in their head in order to think, perform and make decisions, and that which is shared in speaking, writing and other media and used by society to coordinate meaning and action. I prefer to consider the first as primary, and analyse it below by dividing it into facts, skills, mental models, strategies and attitudes, all of which are of course intimately connected. The secondary, externalised or articulated knowledge, is not normally functional independent of human interpretation, but is essentially information, which in some cases can be formally expressed in code and is then capable of computer processing.

5.3.2 Facts

In my view 'facts' are the simplest form of knowledge that enable the learner to respond to simple questions of definition. In logical terms, they represent connections between two or more atomic concepts, for example 7 times 8 is 56 connects 7, 8 and 56. Such facts are interconnected with others, such as 56 divided by 8 is 7 and thus can become metal models. They are important in that they empower higher order knowledge, but becoming less vital as we are increasingly supported by technology in the form of calculators, online dictionaries and searchable information. Performance is shown by recall or recognition of sounds, acts, definitions or simple relationships.

5.3.3 Skills

Skills are the standard, well-established procedures to be carried out by the learner when applicable situations are recognised. Performance is demonstrated by carrying out the procedure in front of others or by recording steps in the process.

5.3.4 Mental Models

Mental models are complex and dynamic relationships which can be employed to explain and predict more complex issues and may be based on networks of facts and skills.

My design practice has developed with the fundamental assumption that mental models (Craik 1943; Johnson-Laird 1983) are the basis of an individual's knowledge. Facts and skills could be argued to be the simplest mental models, but I prefer to identify them separately and as building blocks.

My belief in the importance of mental models to educational design is based on Donald Norman's view:

> In interacting with the environment, with others and with the artefacts of technology, people form internal mental models of themselves and of the things with which they are interacting. These models provide predictive and explanatory power for understanding the interaction.
>
> (Norman 1983a, 7)

I contend that mental models enable explanation, prediction and thus decision-making and action in a much wider sphere than Norman's focus on the interaction with technology. Nevertheless, it is in the practice of developing better user-interfaces in educational software that my journey as a practitioner started. I found that by extending the concept of mental model to embrace a wide variety of modalities (sensory modes such as sound, vision, touch) and genre (expressive modes, such as narrative, diagram, play or poem), it could provide a basis for understanding learners' knowledge in all its guises.

I accept the constructivist view, that knowledge is created in the mind of the learner by their own mental activity in response to experience and information (Kolb 1984). In my view, at the heart of this is the establishment and improvement of mental models.

Mental models are not only faulty (as they continue to develop through refinement), but also unconscious in the sense that they may be unknown and even their nature unknowable to the person employing them. Nevertheless they may provide effective capability and thus form the basis of tacit knowledge (Polyani 1966).

5.3.5 Observing mental models

I do not believe that it is fruitful, especially for the design practitioner, to spend too long identifying mental models' structural properties nor attempting to use mental models as a basis for formal prediction or explanation. In my view, the biological representation and processing of mental models, in both the network and dynamics of the neural connections in the brain or the phenomenology of the mind, is simply too complex, diverse and subtle. To add further futility (or utility if this is seen instead as a teaching strategy), the act of discovering mental models, through dialogue with learners, can change the mental model itself. (Rogers et al.1992).

Further research in this area may be ultimately successful, but is a diversion in terms of my design practice. Clarity about the neural structure of the brain may indicate useful design issues, but often on a different level than that of thinking and learning. I suggest we can only objectively deduce the strengths and limitations of mental models by observing and analysing human behaviours, verbal utterances and written or graphic articulations - expressions. This inability to more directly observe mental models does not lead me to reject mentalism, the study of mental perception and thought processes, as Skinner might (Hill 1984, 63-87).

5.3.6 Introspection and self-report

Instead, in my design practice I have favoured a more subjective lens for examining mental models through introspection (Kind 2005), the self examination of thoughts and imagination which can support our understanding. This kind of self-report is, I believe, no more or less useful than any other evidence we gain from human behaviour, and clearly needs to be handled with care. Nevertheless, table 3 lists some examples of mental models and distinguishes between mental models (learner's knowledge) and externalised conceptual models (information).

Table 3: Examples of Mental models

Mental model	Description
Visualisation of a number line	In my own experience, I am aware that I imagine a timeline of numbers when comparing numerical values, which I suggest has grown organically as I have developed numerical understanding. The numbers 1 to 10 are arranged in a semi-circle with a slightly tighter bend after 5. Another sharp bend between 10 and 12 leads to a gentle spiral from there until 30 after which an even more gentle curve leads to 100. After 100 a final line, almost straight, leads to 1000 and beyond. Other numerical contexts such as temperature, time and calendar dates, offer other shapes to the line and with significance perceived at key points by bends - 32 degrees Fahrenheit, 100 degrees centigrade, 0 degrees Kelvin, breakfast, tea-time, midnight, December 31st/ January 1st, the centuries.... These mental models help me to estimate values and relate numerical symbols to real-world phenomena and decision making. If I attempt to draw this model on paper, as a conceptual model, it soon fails, since the mental perception often defies three-dimensional space, showing and revealing features dynamically as needed.

Arithmetical facts, e.g. 7 x 8 = 56, 56 ÷ 8 = 7 and 56 ÷ 7 = 8	These three number facts are combined as part of a bigger mental model for me - someone who was successful at memorising multiplication tables from an early age. An external representation would be in the form of a concept map relating the three numbers 7, 8 and 56 as nodes with directional arcs labelled with the relevant mathematical operations. The full model takes in all the factors up to 12 - in my day you learnt up to the 12 times table - and some other exceptional numbers beyond. A relationship with other number facts (70 x 80 = 5600) where other rules and patterns extend the basic multiplication table. I have no idea how this material is actually formulated in my mental model, it is recalled unconsciously, but I believe it is both parsimonious and effective for me because of its cross connections. The mental model helps me both predict and explain arithmetical results, estimate calculations and solve numerical problems. Externalised conceptual models which are often drawn include number squares, but the graphics do not make clear all the patterns and connections held in a complete mental model.
The effect of flattery	This complex mental model helps with other people's reaction to my behaviour. Through it I can predict how well received a comment about someone's performance, appearance or feelings might be, and thus choose my words carefully to achieve the effect I desire. It can go wrong and has often lead to doubt about my ability to make these judgements. It can be effective in forecasting behaviour or just as often, dissecting the reasons for upset. It is symptomatic of autism that this kind of modelling is poor. Externalised conceptual models for this can be found as narrative in literature, plays or films.
Catching and throwing a ball	The capacity to predict where a ball will be, and at what time, after being thrown by a distant person is good example of unconscious, and quite likely unknowable, mental model. It's converse and, I suggest, closely related mental model is that of throwing a ball to arrive at a particular place at a particular time. Externalised conceptual models for this capability are rare and these capabilities often remain tacit knowledge.
The Bohr model of the atom	Unlike the previous example, which was primarily about prediction, this is a mental model primarily for chemical explanation. It is a picture of orbiting electrons imagined as moons around an 'earth' which represents the atomic nucleus of protons and neutrons. It can be extended to imagine more complex orbital patterns and rules for the number of electrons at each level. Limited predictions can then be made to imagine new elements and chemical bonds between atoms. This articulation does not mean that this is exactly how the mental model is formed in the mind, but the gravitational and geometrical parallels to actual atomic forces provide a visual and visceral way to know about atomic particles, although incomplete and a fiction! An externalised conceptual model in the form of a diagram (or animated film) can be drawn - this can become a shared articulation helping to develop and align each individual's mental model.

How do I get to the station?	On many occasions, I have travelled from a railway station to a conference venue. My ability to return to the station is based on the mental model built on the journey, which in my case is considerably richer than a turn-by-turn account of street corners. The model is used to make decisions and affords flexibility, rather than simply followed by inverting the turns made on arrival. Its representation as an externalised conceptual model might be a map, but this only 0captures part of a more complex 3D visualisation and relationship with a body-centred decision making procedure.

These examples are important to me in my practice because they differentiate between the idea of mental model and that of externalised conceptual model. The latter is a shared articulation of knowledge, often in oral, written or diagrammatic form (including a map) which tries to capture the essence of mental models so as to communicate knowledge.

5.3.7 Problem solving strategies

This form of knowledge is the basis of analysis and creativity and may involve the application of complex mental models. I argue that the key capabilities are those of recognition, open-mindedness, backtracking and re-formulation. My own work in this area resulted in a published paper to identify the steps that the learner would need to undertake to formulate computer models (Millwood & Stevens 1990), based on the experience gained in formulating the Modus project to design modelling software:

- identifying a purpose;
- having concern for presentation and communication;
- constructing an interactive simulation;
- picturing the end-product;
- dentifying elements;
- characterising elements;
- identifying relationships and
- characterising relationships.

5.3.8 Attitudes

Learning attitudes are often the 'soft' and unrecognised aspects of knowledge in the learner, and not tested directly through summative assessment. I would argue that attitudes to be developed include determination, motivation, love of subject and a concern for quality & detail. Successful learners may also be patient, optimistic and persevering (Seligman 1998). A substantial development in my thinking in relation to attitude, inspired by collaboration with Stephen Heppell, was the concept of 'delight'. The challenge to script and present a Teacher's TV programme, *Happiest Days* (Millwood 2006), was the starting point for my own delight framework *An Analysis of Delight* (Millwood 2008) based on John Herons work (Heron 1992), which I articulated to explain and justify design choices in technology-enhanced education.

This view of the learner and the range of types of their knowledge helps me as a designer to identify how technology enhanced educational innovations can support learning and offer a critical framework within which improvement to designs can be made based on a static understanding of what is to be learned. But the dynamic processes of learning, as described by learning theorists in the next section - The challenge of Learning Theory, provide such a rich and challenging picture, that to be pragmatic in my design practice, beginning in 1986 with membership of the [C4] London Mental Models Group, I have drawn on such theories to develop a simplified analysis outlined in the section following - [A1] Expressive Constructivism.

5.4 The challenge of Learning Theory

For the designer, understanding the learner through learning theories can lead to a rich, diverse and contested quagmire, where the differences between concept, theory and paradigm are not well explained nor observed. This section sets out that complexity in order to understand the motivation to construct a simple model.

This concept diagram (Figure 5) and notes below are taken from the work I undertook to complete an overview of learning theory for the EU-funded HoTEL project in 2013 (Millwood 2013a), intended to help technology enhanced learning innovators untrained in educational theory to make better sense of theory in order to improve their designs and the impact of their innovations.

> Learning theory has been a contested scientific field for most of its history, with conflicting contributions from many scientific disciplines, practice and policy positions. With the continuing and disruptive influence of technology on information, knowledge and practice in all sectors of society it is no wonder that innovators, drawn to the interactive potential that computers bring to learning, are challenged by the theoretical basis for their innovations.
>
> Formal education is also a high stakes, culturally & institutionally conservative activity, which serves more than one societal purpose, including:
>
> - learner development and fulfilment;
> - child care;
> - preparation for citizenship, parenthood and retirement;
> - preparation for work;
> - selection for jobs.
>
> Even in the higher, informal and professional sectors of education, complexity of education is matched by complexity of learning outcomes which may include:
>
> - skills development;
> - knowledge acquisition;
> - improvement in strategic, analytic and creative capacities;
> - attainment of competence;
> - establishment of attitudes and values.
>
> Each of these societal purposes and these learning outcomes demand different approaches and understandings for the theorist and may develop at varying rates or found to be diverse in relation to context, location and culture.
>
> (Millwood 2013b)

In these circumstances, I as a designer have had to create a theoretical position which draws from the best, yet can provide a more straightforward basis for design decision-making - this position is explained in the next section [A1] Expressive Constructivism.

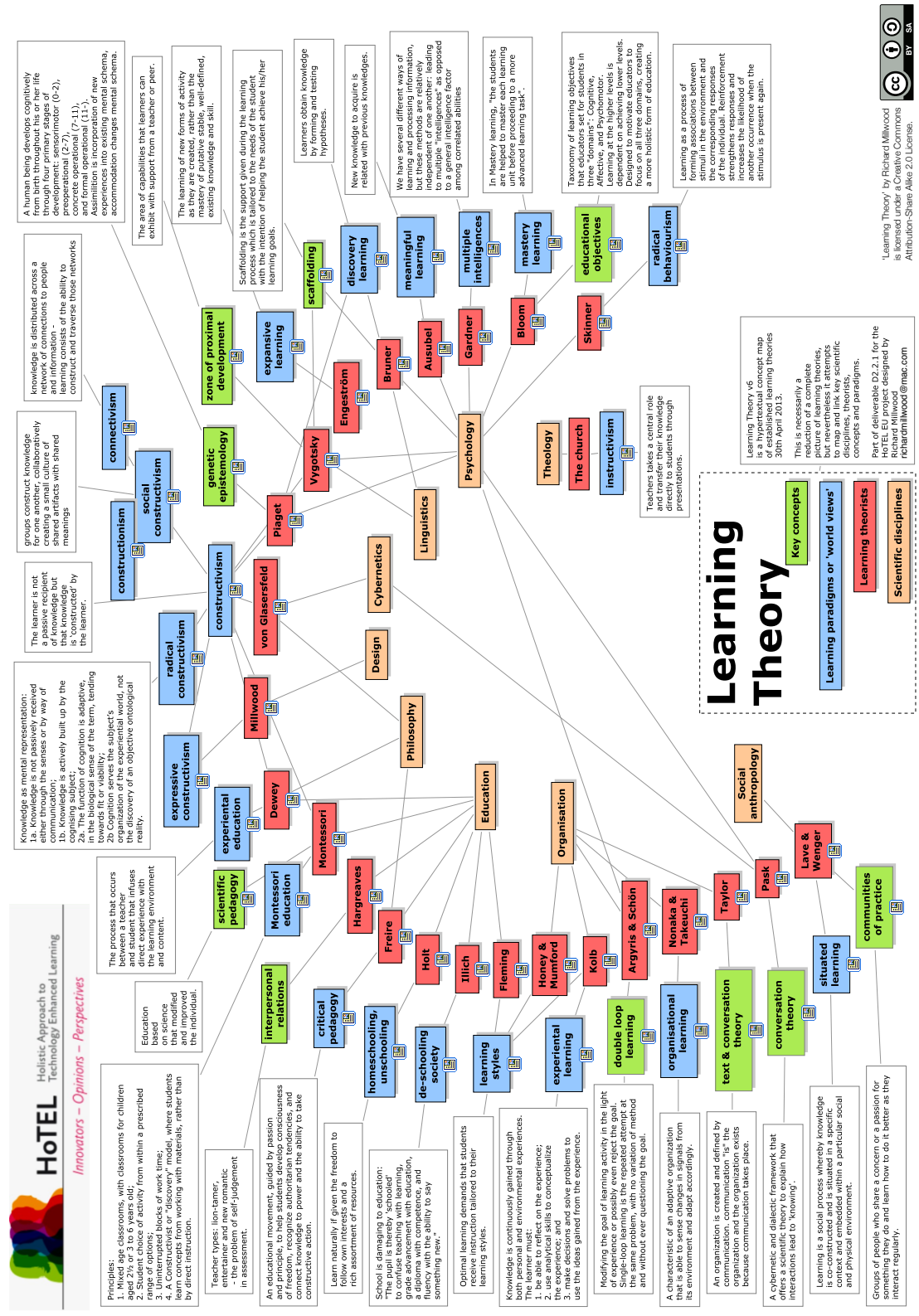


Figure 5: Learning Theory

5.5 [A1] Expressive Constructivism

This model was developed to explain how learning works dynamically in terms of the cognitive activities of expression (what you do to communicate an idea) and evaluation (deciding if the idea is 'right').

5.5.1 A basis for a pragmatic learning theory

The iterative process of production of expressions and their evaluation (described in detail below) is, I contend, a model of learning that helps the educational designer make effective decisions by examining their designs for technology support for both expression and evaluation. This way of looking at learning was first inspired by the analysis of a single interaction (Millwood and Riley 1988), after (Norman 1983b), extended by a reduction of the four stage cycle (Kolb 1984) and supported by the radical constructivist perspective (von Glaserfeld 1995).

Von Glaserfeld viewed:

> Knowledge as mental representation:
>
> 1a. Knowledge is not passively received either through the senses or by way of communication;
>
> 1b. Knowledge is actively built up by the cognising subject;
>
> 2a. The function of cognition is adaptive, in the biological sense of the term, tending towards fit or viability;
>
> 2b Cognition serves the subject's organization of the experiential world, not the discovery of an objective ontological reality.
>
> (von Glaserfeld 1995, p.51)

My expression / evaluation hypothesis holds that expressions are made continuously as an innate activity of the human condition - as if there were an internal 'fountain' of mental and physical expressiveness. Sometimes such expression is driven by internal motivation and at other times by external stimuli, and it can even be argued that it encompasses the imaginative, information-processing basis of perception, which far from being a passive act, can be seen to be a constructivist response to the raw data arriving at retina, eardrum, inner ear, skin, muscle, mouth and nose (Marr 1982, 329-332). Similarly the evaluation question 'is it right?' is frequently experienced as we wonder whether we have understood or articulated well and thus struggle for clearer and better expressions.

5.5.2 Validity and reliability for the practitioner

As a designer, this model has supported my practice by focussing my attention on how to make expression more creative and evaluation more powerful, and has been refined through regular exposure in conference settings. It relies on the literature cited above and my own experiences and observations in practice for its validity and reliability. Nevertheless I have found the analysis to

work, and have observed and filmed the expression/evaluation loop in practice, as evidenced in these films, transcribed below, of children working at the computer together:

Figure 6: An example of expression and evaluation in conversation

In this example (Figure 6), Sasha is expressing his thinking about the way the game works explicitly using natural language to his brothers. After several turns through the loop re-expressing on the basis of his own evaluation listening to his own words (although seeking the others' evaluation), eventually his brother evaluates his words.

> Patrick - I'll die if I go down there!
>
> Sasha - Like getting damaged. Getting all the way damaged do you mean? Getting damaged.
>
> Sasha - Do you know when you die? You die when you get all damaged, is what it means, when it all gets red or the green turns into red.
>
> Sasha - The red is damage and the green isn't damage. Do you understand?
>
> Sasha - When you get all damaged then you die, is that right Patrick?
>
> Patrick - Yes, yes that's right.

Figure 7: An example of meta-level learning in conversation

In this second example (Figure 7), Sasha explains how he came to know about the game by repeatedly playing a section. This simple meta-level learning shows that he knows something more than the game, that he is aware of his own processes of learning.

> Sasha - That's right, when you get down there you can just go from there and then straight down to there without a single damage.
>
> Sasha - And do you know how I know that?
>
> Sasha - Because I tried it several times - that's how I know.
>
> Patrick - That's very good, thanks Sasha!

Figure 8: An example of expression, constrained by programming, and evaluation by computer performance

In this third example (Figure 8), Sasha uses the computer (a small robot) to evaluate his expression of the algorithm for making a zig-zag path like 'steps'. He is constrained to simple statements - move forward, turn left 90˚, turn right and start. He enters the algorithm into the robot and then sits back to watch its execution. If there is a mistake in his expression, it will be indicated by unexpected behaviour by the robot, thus offering a clue to the correctness of his algorithm and mental model. The opportunity to repeat this experience, and make sense of his ideas without interpersonal judgement can provide a useful learning opportunity and also a platform for further engagement with peers or adults.

In tables 4, figure 9 and table 5, the following types of expressions and evaluations are proposed: internal, natural and formal, each overlapping and extending the other.

Table 4: Types of Expression

Internal expression	Natural expression	Formal expression
Thinking a thought in response to listening, watching or reading. This kind of expression is conscious thought, frequently, but not exclusively, in the form of internal linguistic statements and arguments. Other forms include the imagination of bodily acts, the visualisation of scenes statically and dynamically or the feeling of moods.	*Speaking, playing, performing or doing.* These expressions are made outwardly and form part of a communicative act to others (or possibly to oneself, if thinking or acting 'aloud'). There is an extra demand on expression to be coherent, meaningful and effective - some preparation in thought is demanded and in this sense, natural expressions overlay internal expressions.	*Writing, drawing, proving, planning or computing.* Formal expressions use visual symbols, formalisms, syntaxes and grammars whether in written language, diagrammatic convention, logical argumentation or in programming vocabulary. There is a further demand placed on the individual making such expressions, that of complying with the formalism. As before, formal expressions overlay the internal and natural expressions and at times may be hard to distinguish.

Figure 9: The expression / evaluation loop

As expressions are made, they are evaluated in order to decide of they were 'right' and this is elaborated in table 5 overleaf.

Table 5: Types of evaluation

Internal evaluation	Natural evaluation	Formal evaluation
Does it make sense to me? This evaluation is carried out in the mind, considering the expression's quality through processes of recalling memories, analysis and enacting mental models. A major part of this kind of evaluation can be the imagined response of others to the expression or the application of logic of formal systems thus overlapping or substituting for the natural and formal evaluations.	*Do other people understand me?* In addition to one's own thoughts ann expression may have a response from another, a group or an audience. In the best cases new challenges may be encountered or suggestions for improvement offered. Moral support for continuing the cycle is also possible in natural evaluation.	*Does the computer do what I expected?* If the expression has been articulated using formal systems, an evaluation can be carried out if the expression is 'executable' - enacted by computer in the most extreme case or performed by other people in the less formal case of recipe, musical composition or play script.

Whichever kind of evaluations are employed, new expressions are generated - often with improvements in areas identified by evaluation - and the cycle continued until satisfaction or distraction intervenes. It is my belief that this cycle leads to the improvement of mental models, whether they are of the simplest of factual relationships or the richest of human behavioural situations.

The expression / evaluation model, which I have termed 'expressive constructivism' has been the explicit basis for decision making and a source of directions for improvement in my design practice to consider how technology can enhance learning since 1986.

5.5.3 Technology

Technology as an augmentation of human performance has been central to my design practice - for creativity, communication and content. I have been a strong advocate of Owers' ideas (2001) regarding the evolutionary symbiosis of technology and humankind, which provides a context for justifying educational design with technology.

Technology in education is often positioned as its servant, a tool to help achieve pedagogic ends already determined without technology. Although there is merit to be driven by educational needs when employing any resource, this position can be questioned in the light of technology's relationship with humankind more generally. As Stan Owers pointed out in his PhD study:

> The literature research confirmed that technology is as old as humankind. The foundations of technology resides in our imaginative capabilities as toolmakers. Humankind has always used tools, and recently technologies, as extensions of itself. Tools and technological evolution have been constant companions to the evolution of humankind.
>
> (Owers 2001, abstract)

Owers' point of view, that technology extends humankind and has been a constant companion in evolution, suggest that we look for extension to education through technology, not simple service to education. Educational software has the capacity to support new pedagogies, and this has been recognised since the 1970's as evident in the analysis offered by McDonald et al (1977)., as tabulated by me in table 6 (Millwood 1987), to identify the computer's potential contribution through three paradigms: instructional, revelatory and conjectural.

Table 6: Educational Paradigms for Computer Assisted Learning

	INSTRUCTIONAL	**REVELATORY**	**CONJECTURAL**
Key concept:	Mastery of content.	Articulation and manipulation of ideas and hypothesis-testing.	Discovery, intuition, getting a 'feel' for ideas in the field etc.
Curriculum emphasis:	Subject matter as the object of learning.	Understanding, 'active' knowledge.	The student as the subject of education.
Educational means:	Rationalisation of instruction, especially in terms of sequencing presentation and feedback reinforcement.	Manipulation of student inputs, finding metaphors and model building.	Provision of opportunities for discovery and vicarious experience.
Role of computer:	Presentation of content, task prescription, student motivation through fast feedback.	Manipulable space/ field/'scratch pad'/language, for creating or articulating models, programs, plans or conceptual structures.	Simulation or information handling.
Assumptions:	Conventional body of subject matter with articulated structure; articulated hierarchy of tasks, behaviouristic learning theory.	Problem-oriented theory of knowledge, general cognitive theory.	(hidden) model of significant concepts and knowledge structure; theory of learning by discovery.
Idealisation / Caricature:	At best, the computer is seen as a patient tutor; at worst it is seen as a page turner.	At best, the computer is seen as a tool or educational medium (in the sense of milieu, not communications medium); at worst, as an expensive toy.	At best, the computer is seen as creating a rich learning environment; at worst, it makes a 'black box' of the significant learnings.

McDonald et al. also propose a fourth paradigm, the emancipatory paradigm, in which the key concept is the reduction of inauthentic labour, but this does not occur in isolation to the three paradigms initially defined, since each reduces such labour to some extent.

This analysis was hugely influential in the 1980s, often cited by students exploring the possibilities of technology, but as time passed and new capabilities of the technology available were developed, I found the need to clarify the potential contribution made by technology in learning as set out in the next section.

5.6 [A2] How can technology enhance learning

Figure 10, published as a poster in June 2012 (Millwood 2012), as an analysis was the culmination of years of developing understanding. It proposes features of the use of computers mapped on to the expressive constructivism model of learning, thus detailing ways in which technology can enhance learning.

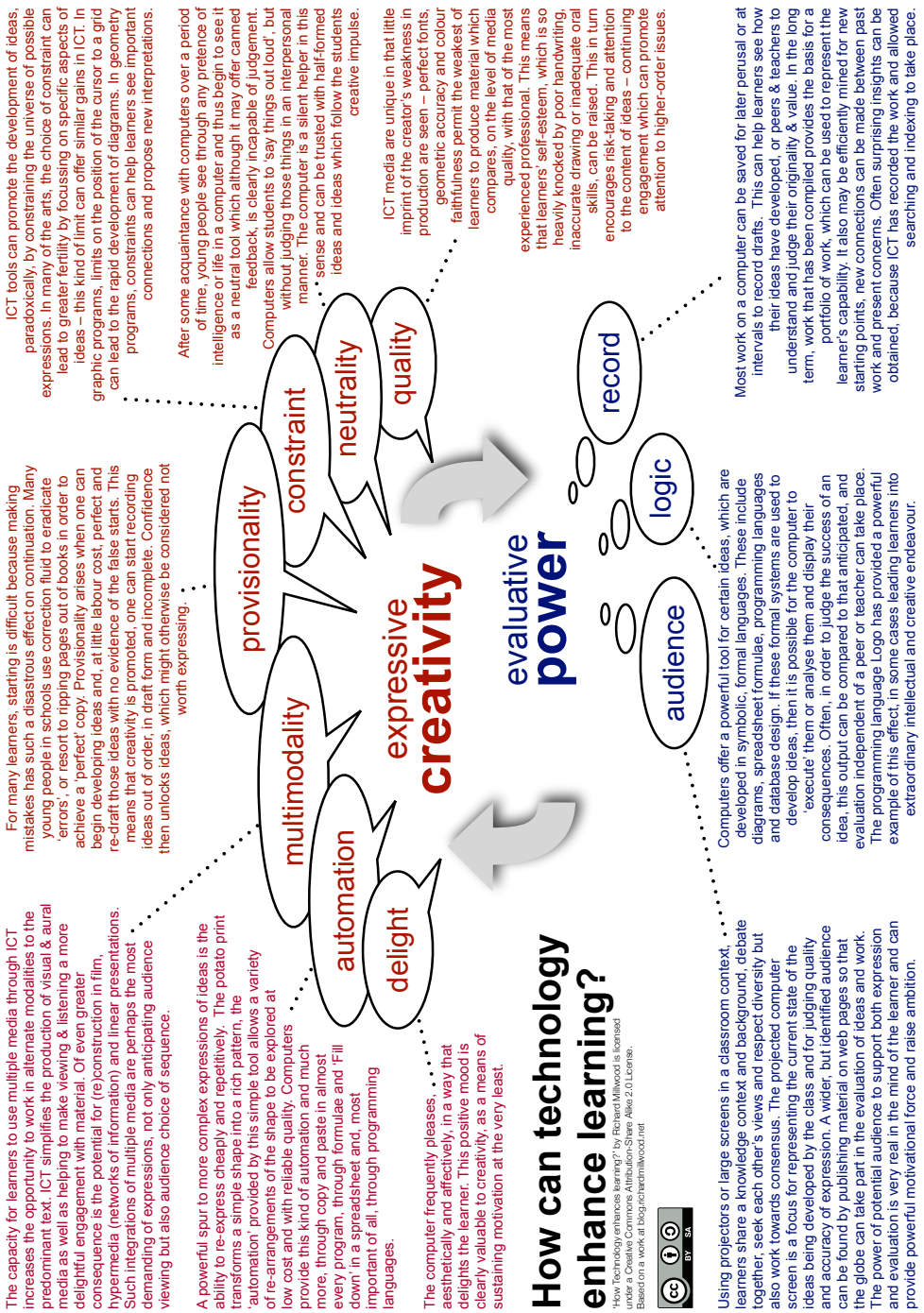


Figure 10: How can technology enhance learning?

The expressive constructivist model of learning directs my attention towards the learner as an active, creative individual who is best served by tools for expression on the one hand and by tools for evaluation on the other.

This forms the basis of this analysis of key features of technology (the terms in the speech bubbles) that might enhance expression and evaluation. In turn this clarifies the basis for choosing aspects of technology to incorporate into designs, and to see what might be missing. The analysis also acts as a framework for decision making when comparing technologies for their likely effectiveness in learning situations.

5.6.1 Education

The concept of education is here concerned with the aims, objectives & values, the organisations, processes & culture of the instruments & institutions society has formulated to address the needs of society to educate lifelong learners. The ideas of Hargreaves concerning the interpersonal, Deming regarding the pursuit of quality and the cybernetics systems theory from Beer and Ashby have been influential.

5.6.2 Teacher and Learner

In the early years of my design practice, I focussed on learning in the microcosm of the individual learner. Even within this context, my attention was on the use of the computer rather than the wider process of education signified by the classroom. When first registering for PhD in 1986, I was invited to produce a qualifying essay Millwood (1987) which I based on teacher types identified by Hargreaves (1975).

These are set out with a selection of quotes from Hargreaves, highlighted in pale yellow, in Table 7 overleaf.

Table 7: Hargreaves' teacher types

	Liontamer	Entertainer	New Romantic
Motivation	Learner unwilling, must be pushed	Learner unwilling, needs stimulation	Naturally motivated, facilitation required
Curriculum	Subject disciplines, a matter for the teacher	Subject boundaries should not stand in the way of interesting material and activity	Self determined, supported by teacher
Teaching style	chalk and talk, expert, demanding attention	audio-visual aids, computers and structured packages	trust
Pupil's role	sit and listen, work in isolation	alternate sources, group work, differentiation	self-reliance, awareness that you want to learn, discovery of what to learn, how to learn and how to question
Evaluation	teacher evaluates	pupil may evaluate	problematic with regard to approval, self-evaluation with 'approval-free' support from teacher
Summary	formality, conflict and the belief that learning is hard	happiness, informality and planning to keep pupil's busy	transfer of status, power and authority to the pupil

Thus History is taught with a local bias, mathematics with examples from cricket scores and gas bills, which hopefully will be as potentially useful as they are enthralling.

Ultimately the choice must be his. We cannot make all his choices for him and then wonder why he does not want to learn.

The creation of the appropriate classroom atmosphere, namely one that is non-threatening and acceptant springs directly from the kind of relationship (s)he establishes with the pupils.

A teaching machine can give pure feedback because the machine does not form a personal relationship with the pupil. (Even in this case approval cannot be entirely absent, since the pupil may approve or disapprove himself when the machine tells him that he is making the right or wrong response.)

Acceptance arises when one makes an active effort not to approve or disapprove but instead shows 'unconditional positive regard', trust and a non-threatening attitude to others.

It is perhaps the most disturbing of all the New Romantic contentions that it is the death of teaching which marks the birth of real learning.

This diversity of aims, objectives and values devised by Hargreaves was new for me, not only as a perspective on education but in how the design of technology enhancements might take account of the context of use and indeed support the aims of such de-schoolers as Illich (1970) and Holt (1976). In my essay (Millwood 1987) I made a connection between the paradigms for computer assisted learning and Hargreave's teacher types that helped me understand why teachers might propose designs in different ways according to the predominant teacher type in their practice.

5.6.3 Educational quality and improvement

In producing the CD-ROM for the 'Business of Quality' ([C6] The Renaissance Project), an interactive multimedia account of Deming's theories for improvement in manufacturing and business (Deming 1982), I learnt about the notion of quality and how it can be monitored. What came as a revelation was the idea that customers should be delighted, not simply satisfied in order to succeed in competition with other companies. I found these ideas transformative in my own thinking about educational institutions and their improvement, and connected to the social sciences notion of an action research approach with the plan–do–check–adjust cycle. It gave foundation to my later work to design education organisations to be profoundly learner centred ([C11] TeacherNet UK; [C18] Ultraversity Project).

5.6.4 Educational community and variety

The development of online ducational organisations presented many new challenges to the designer, and tacitly these were solved by encouraging online learning community to develop where peers expected to learn from each other as well as from content, experts or tutors. This thinking became clearer when contrasting the [C18] Ultraversity Project and the [C20] Inter-Disciplinary Inquiry-Based Learning (IDIBL) project. The first was considered highly successful and the second struggled to make headway. By applying the concept of 'variety' in the context of Cybernetics (Beer 1985; Ashby 1956), it was clear that the successful design benefitted from the absorption of variety in student states by inviting them to build relationships of mutual respect and support with each other. This meant that the facilitation team, tasked with leading the community, were able to manage the variety that remained without being swamped with diverse questions and problems (Millwood and Powell 2011).

5.6.5 Educational design

In my practice, applying the ideas of design to education was initially tacit in nature, but later influenced by the explicit principles developed by theorists such as Gagné (1985). These are based on an analysis of instructional events (and corresponding cognitive processes):

- gaining attention (reception);
- informing learners of the objective (expectancy);
- stimulating recall of prior learning (retrieval);
- presenting the stimulus (selective perception);
- providing learning guidance (semantic encoding);

- eliciting performance (responding);
- providing feedback (reinforcement);
- assessing performance (retrieval);
- enhancing retention and transfer (generalisation).

But these events are focussed on what the teacher should do, with the assumption of a Hargreaves 'lion tamer' or 'entertainer' style. It also focusses on the lesson, rather than the complete scope of educational experience for the learner. This led me to analyse education from the perspective of the learner, which is the subject of the next section.

5.7 [A3] The Learner at the Centre

The model depicted in Figure 11 is a learner-centred analysis of questions that might be asked in order to make decisions at all stages of a cycle of learning within an educational context.

Focussing on the learner's perspective meant imagining a complete set of essential questions that they need answers to in order to progress in education. Normally these questions are not asked, the answers are simply supplied by the educational organisation. But by taking this perspective, gaps in the designs I developed for educational organisations could be identified and closed in the development process. For example, a design may make provision for formative assessment (7 Assessment, in the analysis) but forget that it may be also important to have some means to gain an award (8 Recognition) through summative assessment.

Figure 11: The Learner at the Centre

I wrote about this analysis in a paper in 2009:

> Few real learners will articulate such concerns in the form of questions, partly because we usually do not ask them to participate in such issues, but by posing these questions as ‘constants’ we may test future proposals more effectively than starting from the status quo of a current or historical solution. In this diagram, the learner is imagined to be concerned with eight questions, relating to eight areas that an innovator should consider if they wish to make an impact on learning with an invention in technology or practice.
>
> But the issues at the bottom of the diagram – responsibilities and rights – are at the heart of the modern dynamic that education and technology present. Learners’ entitlement to access knowledge was at the heart of the development of the National Curriculum, but we must add to that the entitlement to opportunities for access, creativity and communication and the responsibilities that a free and open education brings.
>
> (Millwood 2009)

The lists of issues related to each question will form part of a future research & development to elaborate this analysis more fully, but the question ‘Who can help me and I them?’ (4 Community) led me to consider the other stakeholders in education, analysed in the next section [A4] Stakeholder perspectives in education.

5.8 [A4] Stakeholder perspectives in education

These analyses, presented in figures 12 and 13 overlead, attempt to take the perspective of organisation and teacher with respect to education. They complement the learner at the centre perspective, and are intended to inform the action researcher in decision making and awareness of potential barriers.

5.8.1 Teacher and Organisation

The analysis [A3] Learner at the Centre cannot complete the designer's toolkit, because of the inter-dependency even the most auto-didactic of learners must have with the teacher (tutor or facilitator) and with the organisation that provides the formal educational elements, particularly the recognition through accredited qualification that can be used by the learner to compete for job or authority in society.

The questions in these analyses are posed to help the developer to consider how a technology-enhanced, learner-centred educational design can meet the needs of teachers and institutional managers when faced with new design issues. Such issues are found as the increasing societal use of technology challenges established authority and increases complexity of inter-relationship between experts and practitioners, as characterised in educational paradigms such as Connectivism (Siemens 2005).

For example, in developing the design for a work focussed learning enterprise, [C18] Ultraversity Project, [C20] Inter-Disciplinary Inquiry-Based Learning (IDIBL), I recognised that little attention was paid to the nature of teacher and organisation in the first project, Ultraversity, since this was already favourably established and a team ready to deliver. When trying to achieve a similar enterprise in the University of Bolton, I realised that the questions in the analysis from the teacher's perspective and from the organisation's perspective needed answers that matched the design's aims, and were not readily found. In this sense these analyses make explicit my linguistic framework for design (Mor 2010), which had tacitly operated in the development of Ultraversity.

These two analyses are more speculative and neither complete nor polished, since they are my most recent efforts in relation to the last decade of practice and have had fewer opportunities for testing and refinement in a practical context.

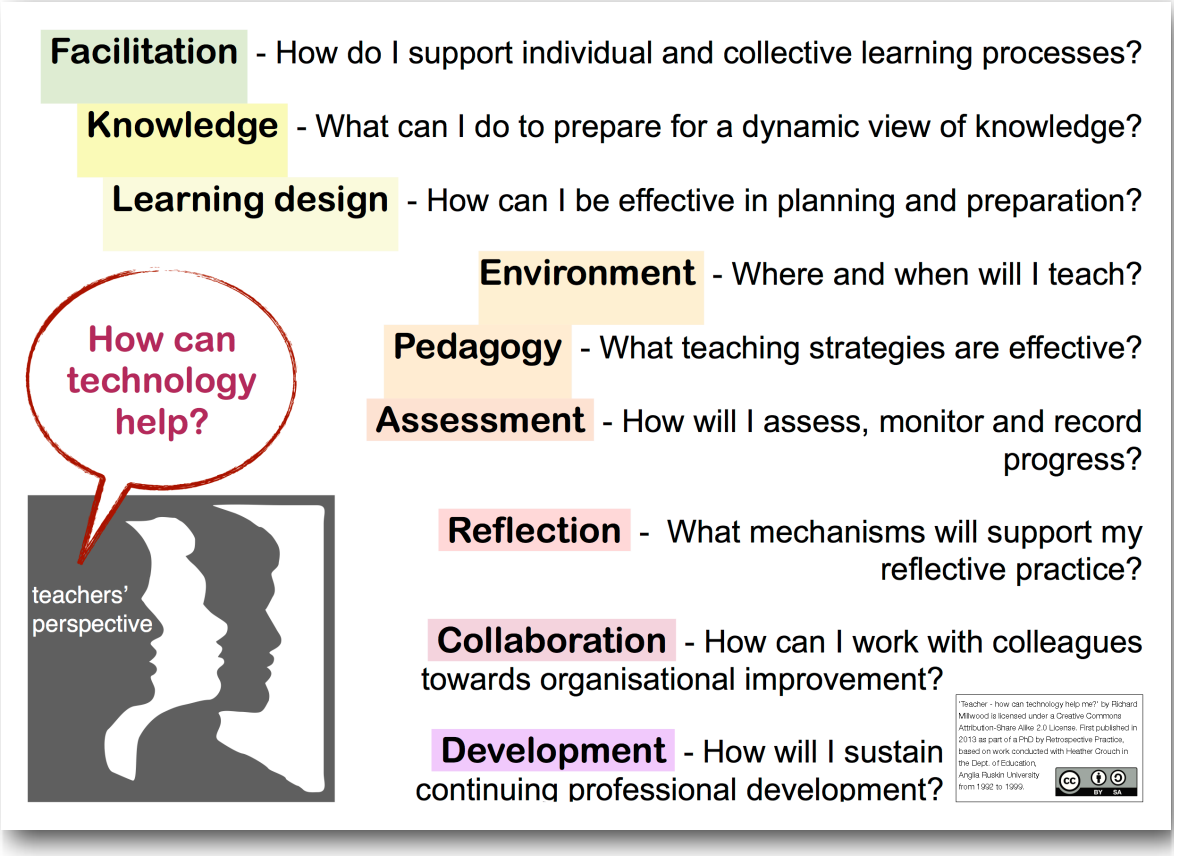


Figure 12: The teacher's perspective - How can technology help?

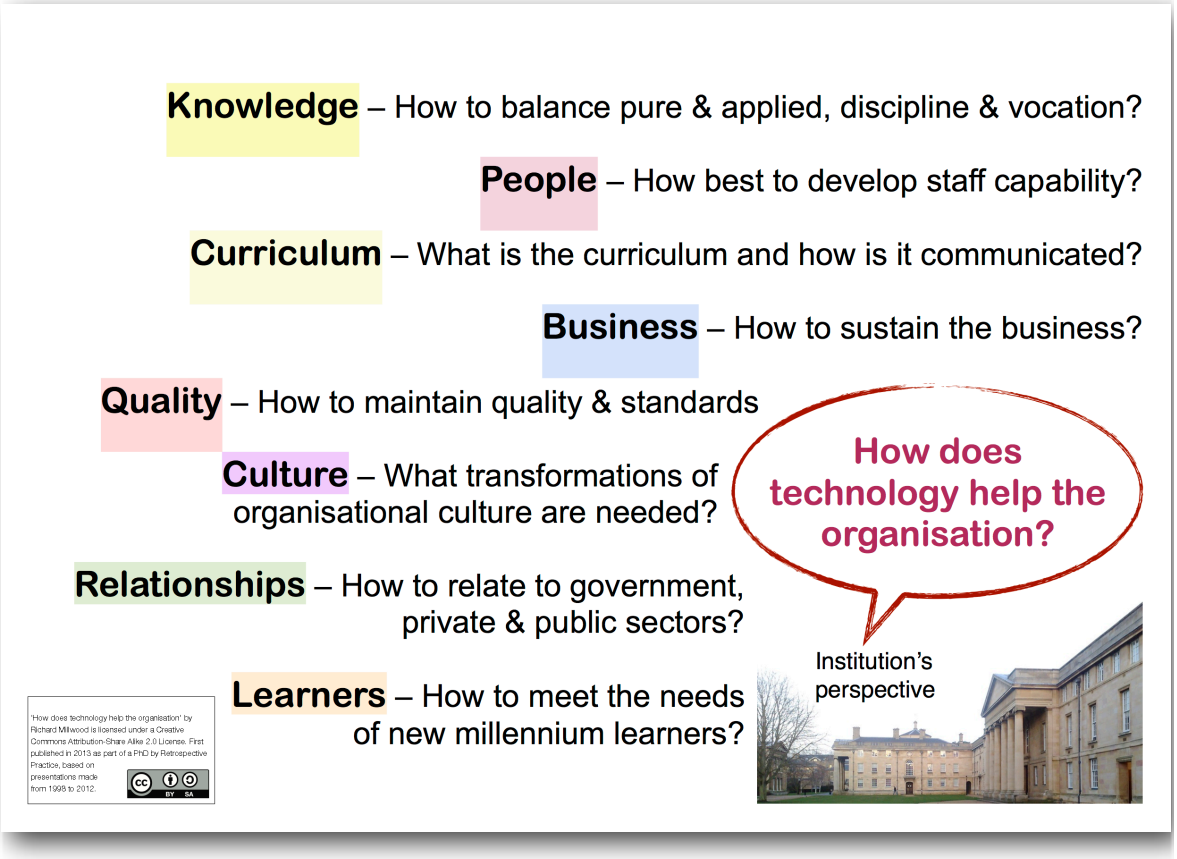


Figure 13: The organisational perspective - How does technology help the organisation?

5.9 Validity and Reliability

This section has addressed a theoretical and conceptual framework that has developed through practice and as such is naturally eclectic and diverse in influences, none of which were selected in advance to find the focus in a PhD study.

Nevertheless, the framework has been exposed to considerable 'stress testing' in numerous projects, many on the large scale and the national stage. There is much more to be developed in detail and to find more reliable empirical evidence to make the framework more rigorous, but ultimately there is enough cohesion and precision to make the designer's pragmatic task possible and indeed successful. In this way I would argue that it has strength in validity, whereas reliability with other designers and contexts is yet to be fully established.

6 Claim

My claim for PhD by Practice connects the threads which have emerged in my career by reflecting on the development of my knowledge and my practice structured into four decades. I link projects, artefacts, peer-reviewed publications and employment with my theoretical & conceptual framework. The 21 items cited are a selection from all of my output, and are to be taken together as a whole to represent my claim. Finally, I discuss the next steps to develop my research and practice further.

6.1 Introduction - from tacit to explicit knowledge

I have been designing, developing and researching educational materials, contexts and practices based on computer technologies since 1978, and as a practitioner in this field, sought to design these more effectively. In that time I have focused on learner-centred analyses and researched widely across multiple disciplines to improve education. This section describes this practice, setting the individual portfolio items, labelled as [C1] to [C21], in the context of my story and linking them to my theoretical development of the four analyses [A1] to [A4].

6.1.1 Teaching

I have progressed from an individual enthusiastic and creative teacher [C1] taking part in developing practice [C2] to a researcher/teacher-educator [C3] and leader of innovation in education [C7], taking a full part in a developing research community.

My early work concentrated on improving the design of individual pieces of software for addressing challenging learning in the school curriculum [C3, C5].

6.1.2 Curiosity about learning

An interest in user-interface design and mental models [C4] led to an approach to analysing individual learning based on cybernetic principles [A1] and an account of how technology enhances such learning [A2]. My work on new multimodal learning based on multimedia technology [C6], together with an appreciation of cultural and linguistic factors [C10], led to a simplified and more holistic model of the learning process itself [A1] to inform my design practice.

6.1.3 Creativity in learning

In this period my increasing awareness of the wider context of education informed a holistic and systemic approach to large-scale action research addressing the development of new systems of education [C7, C9, C11, C12, C14, C18, C20]. Alongside this work, I focussed in on creativity and reflection in learning through a sequence of projects aimed at enhancing creativity and reflection at a range of levels in education [C13, C15, C16, C17, C19].

6.1.4 Leadership

My increasingly responsible rôles as a teacher, software developer, media designer, team leader and director led to a broad and deep knowledge of the factors which lead to effective design methods and criteria for improving design quality in iterative design cycles. My identification of

these factors and criteria is structured on a creative and constructivist model of learning [A1], a learner-centred holistic model of the decision points in education [A3] and a perspective analysis of other stakeholders in education [A4]. I recently created a critical overview of this knowledge of learning theory for non-academic innovators in a report for an EU project [C21], and I have been working for twenty years to develop an historical research archive of developments in educational computing [C8].

This account of the progression in development of my knowledge is followed in the next sections by an account of each decade's practice.

6.2 Seventies

The early seventies saw my transition from university undergraduate to school teacher at the same time as low cost computers became available. This fertile time offered early experiences, influences and practice that laid the foundation for a career as a designer.

Table 8: Selected items from the 1970s

Portfolio reference	Aim	Contribution	Originality, Impact and Importance
[C1] Teacher of Mathematics and Computer Studies at Scott Lidgett School	To design improvements to mathematics education practice.	I led the teaching and development of Computer Studies in the school working with colleagues in the local authority, developing Mode 3 syllabus and examination. I independently developed the Snooker learning software for mathematics and for computer studies and was solely responsible for creating a curriculum analysis for the whole school. My part: 100%.	The software developed, Snooker, was in its time completely original as a design for learning and foreshadowed many interactive graphic simulations to come. It was published later and was widely used in schools in the 1980s (SMILE 1984).
[C2] Microcomputers in Computer Education (MICE)	To develop new ways to teach computer studies using animated visualisations.	The design and development of educational software and the critique of others' designs. My part: 20% (with the members of the group).	Although there was a growing interest in teaching programming concepts through animations in higher education, it was new to be focussing such innovation on secondary school. Our work made impact on the practice of colleagues in the Inner London Education Authority and at the time was considered a vital part of the development of teaching computer studies there. Its work was reported regularly in the newsletter distributed to computer studies teachers in London by the advisory service.

My work began in 1976, aged 20 as an untrained teacher of Mathematics in a secondary school in London. Even at this stage, I was exposed to the design of (mathematics) education through the Secondary Mathematics Individual Learning Experiment (SMILE 1984).

In this period I developed a computer program called ‘Snooker’ [C1] which simulated a snooker table, inviting learners to estimate angles to improve their knowledge of bearings, which was subsequently published as part of the SMILE Mathematics scheme, after peer review by teachers engaged in that curriculum development.

In my second post as a Mathematics and Computer Studies teacher (1977-1980), I developed an interest in the teaching of both Computing and Mathematics using the computer. As well as taking part in the design of the Computer Studies Mode 3 CSE exam syllabus, I attended continuing professional development courses in the design of educational materials for the computer and joined a development group of computer studies teachers, Microcomputers in Computer Education [C2], to develop computer software as educational resources for learners.

6.3 Eighties

I took up my first professional research post in 1980 to design and develop educational software. This period saw a progression in my practice from a focus on technology to a concern for design & pedagogy and my first attempt to engage with doctoral study.

Table 9: Selected items from the 1980s

Portfolio reference	Aim	Contribution	Originality, Impact and Importance
[C3] Researcher in the Computers in the Curriculum Project at Chelsea College London	To establish design leadership for teams of programmers developing computer assisted learning for secondary age students.	I designed and developed many educational programs, guidance documents, course materials and developed analytical models for evaluation of user-interfaces. I exercised nationwide team leadership and national leadership in educational software interoperability. My part: 100%.	The Computers in the Curriculum project, first established in 1973, was one of only a very few world-leading curriculum development projects in its time to create brand new computer assisted learning materials based on a 'revelatory' approach using simulations (Millwood 1987,8). There were very few predecessors in the schools sector. It was funded for the first half of the eighties by the UK government funded Micro-electronics Education Programme, absorbing a large proportion of its budget. The materials were widely published internationally through Longman, BBC and others. The work covered a wide range of subjects in the secondary curriculum (Watson 1987).
[C4] London Mental Models Group	To discover new perspectives on the mental models of learners with regard to their use of technology as a tool for developing such models.	I participated and contributed ideas to seminars considering models of learning with technology. My part: 5% (project led by the late Joan Bliss).	The work to integrate an educational approach to technology, learning, artificial intelligence and mental models was unique, recognised by an Economics and Social Research Council grant for the 'Tools for exploratory learning' project (Bliss & Ogborn 1989) and peer-reviewed publications. It had impact on the design of new modelling software and importance in raising the level of debate at an early stage in the maturation of technology in education amongst the educational research community in London.

[C5] Procedure Library	To improve standards of interoperability in the design of educational computer programmes.	I designed the set of procedures and functions, wrote the BBC BASIC and Pascal code and technical guide and co-authored the design guide which included the creation of the diagram and analytical explanations. My part: 50% (with David Riley).	The design, code and analysis were new, based on lessons learnt over seven years of using a BASIC subroutine library and the best of graphics routine library literature (Newman and Sproull 1989). The impact and importance was on the development and design of educational software by the Computers in the Curriculum team.
[C6] The Renaissance Project	To design the most effective uses of multimedia in higher education.	Working within a small team I helped design, collate, program and took sole responsibility for technical production of some of the earliest CD-ROMs developed for education. My part: 20% (with Stephen Heppell and others).	Our exploration of the educational design to discover the potential of new interactive multimedia on CD-ROM led to some of the first such products created for higher education in Europe. At the time I had to travel to a factory in Germany, since there were few facilities in the UK for manufacture and very few places we could prototype the CD-ROM materials. They were subsequently distributed worldwide with international publishing agreements. Each CD-ROM pioneered interactive and participative learning design in the years before internet. (Neesham 1990)

In 1980 I sought a position as a university researcher to develop educational resources. I was appointed as the first developer for the Computers in the Curriculum Project [C3] at Chelsea College, University of London. Over the decade I became a project leader in software development, an author of design guidelines [C5] for the team and a teacher educator involved in teacher training. I was responsible for the design and development of many educational packages based on computer simulations, working with teams including practising teachers to offer advice on the pedagogical and practical design issues. In researching human computer interface issues, I was strongly influenced by Donald Norman’s models of user-centred design (Norman, 1983). These proved practical as applied theories in my everyday work and formed the basis for my first ideas for a simplified model of the learning process, later developed as 'expressive constructivism' [A1]. In this decade I joined the ESRC funded London Mental Models Group [C4] led by the late Professor Joan Bliss and Professor Jon Ogborn and planned to conduct a PhD supervised by Professor Paul Black to focus on modelling using computers. I took part as a lecturer in the development of a diploma course to retrain teachers for Computer Studies and finally as a half-time lecturer in Mathematics Education [C3]. I co-directed the Modus project to develop computer modelling software for learners to create their own simulations, resulting in the

development of Expert Builder and Model Builder software. I acted as Research Fellow on interoperability in educational software for the national Microelectronics Education Support Unit, creating several reports and peer-reviewed publications and was a member of the Software Advisory Group for the BBC Domesday Project. As pointing devices, audio, picture, video and the CD-ROM, became available, I led the technical production and contributed to the educational design of interactive multimedia for higher education in mathematics, environmental science, theatre studies and business studies for higher education [C6]. In this decade I began to be invited to academic conferences as a speaker and to take part in international seminar and workshop activity as co-tutor.

6.4 Nineties

In 1990 I stepped back from an academic research focus and returned to creative practice, developing interactive multimedia materials to distribute on CD-ROM, albeit as a senior lecturer in the education faculty of Anglia Higher Education College. The decade saw the rise of Ultralab, of which I was an informal deputy head, growing from half a dozen to over fifty staff. My practice saw a move from software development to medium-scale action research in pilot projects relating to online communities. I also helped develop an online Masters degree and begin supervising doctoral students.

Table 10: Selected items from the 1990s

Portfolio reference	Aim	Contribution	Originality, Impact and Importance
[C7] Senior Lecturer in Ultralab at Anglia Polytechnic University	To develop a collaborative team approach to the design & development of new technology in learning.	I was a designer, developer and technical producer of many projects, a lecturer in ICT in Education and a designer and developer of a Masters level course. My part: 25% (with Stephen Heppell and others).	The Ultralab team was distinctive in its structure, ethos and practice, developed on values and principles of inclusion and participation. It's ethos was to directly change the world of education with its action-research innovations and thought leadership. Its work influenced national policy in the UK and throughout the world.
[C8] National Archive of Educational Computing	To design & develop a historical archive and narrative for developments in technology enhanced learning.	Since leaving Ultralab I have taken sole responsibility for this work, establishing working methodology, designing a participative web site and convening and attending events to disseminate knowledge. My part: 90% (Initially with Stephen Heppell and Greta Mladenova).	The archive is unique in the UK in its focus on educational computing. Its impact has been on international education conferences and events where it has exhibited and in its support for other projects such as the BBC's Domesday Reloaded. I believe its importance will be found in the future to satisfy a desire to interpret the historical development of technology enhanced learning and to mine the ideas which have been developed and forgotten, but are ripe for re-invention.

[C9] Learning in the New Millennium	To research the new uses for creative & communicative digital tools in secondary classrooms.	My part was very small in the action of the project, but I acted as a mentor (with Stephen Heppell) to the project and as research supervisor to Carole Chapman who led the project. As such I helped develop the conceptual thinking which then provided a basis for much other research. My part: 10% (with Stephen Heppell and Carole Chapman).	The project was groundbreaking in its online connection between professional scientists and school students to discuss science problems, in its early use of mobile technology and in its development of the concept of online community. The impact of the project was felt in its larger scale successor projects such as Notschool.Net, Schools Online, Think.com, TeacherNetUK, Talking Heads and Ultraversity. Its importance was the establishment of design, practice and conceptual knowledge for Ultralab and beyond.
[C10] Translating software: what it means and what it costs for small cultures and large cultures	To clarify the importance of designing in opportunity for users to localise educational software to suit their own cultural and linguistic environment and thus enhance regional and international uptake.	I helped design the software methodology for translation and the implementation of it in the 'Work Rooms' software as well as co-authoring the paper. My part: 20% (with Dai Griffiths, Stephen Heppell, Sam Deane and Greta Mladenova).	The practice and paper was novel in education at that time and the conceptual thinking was only just making impact in the software operating systems world. Its importance is seen in the way modern software is now developed and content management systems such as Plone have been developed to manage translation as a matter of course.
[C11] TeacherNet UK	To develop the design proposition for online communities of practice to support the continuing professional development of teachers.	In TeacherNet UK, I co-designed and developed the organisation itself, designed, developed and maintained the the initial website, made many conference presentations and acted as one of six directors of the company. I exercised national and European thought leadership to establish notions of informal professional development online. My part: 25% (with Marilyn Leask, Norbert Pachler, Darren Leafe, Kryss Durling and Keith Byrom).	TeacherNetUK was inspired by the Australian OZ TeacherNet, but proposed original think around continuing professional development for teachers and self-profiling of teachers in order to match content to their interests. Although it did not become a mass-movement, it enjoyed a considerable membership for a time and was in demand by UK government and industry for consultancy, culminating in the government creating its own TeacherNet service with the help of members of the team.

[C12] The Online Learning Network	To research the practice of human facilitation and software design to support online communities.	I was mentor to project leader, contributor to the online community design and provided technical support for the service. 10% (with Stephen Heppell, Leonie Ramondt and others).	This project was Ultralab's first to create a community of practice for adults. It informed the design of the emerging UK University for Industry and also many successor projects at Ultralab. (Ramondt and Heppell 1998).
[C13] Étui	To research & develop a toy for use by early learners to encourage learning about learning.	I acted as co-developer of the project's ideas about meta-level learning, mentor to the project leader and other personnel, researcher in classrooms and disseminator of the progress and outcomes. My part: 20% (with Andy Simpson, Dai Griffiths, Stephen Heppell and Kris Popat).	The project was unique for its design of a mysterious toy which did not represent existing creatures in order stimulate wonder, inquiry and imagination. As part of the i3 research network, it was shared widely to the European research community and generated much debate about early years learning with technology.

In 1990 I joined Professor Stephen Heppell to form a new research centre, ultimately called Ultralab [C7]. Over seventeen years I offered practical, analytical and evaluative guidance to this large and geographically distributed team, offering research leadership and developing collective knowledge, procedures, values and attitudes for the development of delightful learning approaches.

Early in this decade Stephen Heppell and I began collecting materials to form a [C8] National Archive of Educational Computing and we were funded by the National Council for Educational Technology to employ Greta Mladenova to organise the materials.

I continued development of new interactive multimedia CD-ROM materials, taking responsibility for production of published learning resources for Teacher Education [C6]. The possibility to distribute globally and the development of new materials using Apple's HyperCard led to a realisation that we could allow for adaptation to local culture and languages by the teacher and this became the subject of a published paper [C10].

The predominant research approach of Ultralab became applied and action research, creating small and large-scale actions involving education in formal and informal contexts. I helped formulate the conceptual framework, manage development and analyse findings in many projects including the a longitudinal study of online community as a learning tool, Learning in the New Millenium [C9], the University for Industry pilot project, the Online Learning Network [C12], the teachers' informal continuing professional development online community TeacherNet UK [C11] and the creation of a new toy for pre-school meta-level learning, Étui [C13].

This decade saw a heavy load of conference and workshop presentation, which gave me the opportunity to refine analyses of learning and education and develop them further based on the feedback from audiences and colleagues ([A1], [A2], [A3], [A4]).

6.5 Noughties

In 2000, Ultralab undertook the Talking Heads project with over one thousand head teachers joining an online community of practice, thus marking a move towards large-scale action research. Later in this decade I took on the leadership of Ultralab, participating and overseeing the development of Ultraversity - an innovative online work-focussed degree programme - and later moved to the University of Bolton to help create a university framework based on Ultraversity's success.

Table 11: Selected items from the 2000s

Portfolio reference	Aim	Contribution	Originality, Impact and Importance
[C14] Talking Heads / Virtual Heads	To design learning resources to support headteachers in embarking on an online community of practice for their continuing professional development.	I helped set up the project initially, developing the database of participants and continued to act as a mentor to the personnel involved. I also designed and developed the interactive multimedia and carried out the technical production of the CD-ROM, applying my knowledge of multiple text tracks and interactivity in Quicktime. My part: 5% (with Stephen Heppell, Leonie Ramondt, Carole Chapman, Stephen Powell and others).	These projects devised new online facilitation for the busiest of professionals as they led schools. It opened new channels of communication for heads who otherwise were rarely in contact with each other and who were distributed throughout the UK. The learning conversations that resulted lead directly to school improvement and the project laid the foundations for the National College's practice for years to come.
[C15] Summer School	To develop informal learning for digital creativity through student video production.	My role was to prepare the ground for understanding what could be achieved with new digital creativity tools and help articulate this in collaboration with colleagues in Ultralab, and when the Summer School project took off, to observe its results and feed them in to subsequent work. My part: 10% (with Stephen Heppell, Matthew Eaves and others).	This approach had been a hallmark of Ultralab's approach to new digital media since the early nineties, but was refined to include unique and key features of student-led creativity and mutual celebration, including the production of a DVD with all the outputs. This DVD was widely circulated to make impact on the children's creativity community. I am particularly proud of having led the Summer School with youth groups in Belfast. This was held in the week leading up to the 12th July parades which were catalysts for trouble. Our colleagues in Belfast pointed out that we had successfully retained the interest and celebrated the talent amongst teenagers collaborating from both sides who would otherwise be engaged in building bonfires.

[C16] Input CBBC	To design the support web site to explore the potential for students' creativity with video to be broadcast.	I took the role of co-leader at Ultralab developing the key values, participant action research approach and philosophy, working with the CBBC Future TV section at the BBC. I took on the visual and information design challenge of presenting templates and guidance in a child friendly web-site whilst maintaining a connection to the CBBC's visual style. My part: 25% (with Matthew Eaves and others).	The project was quite new for a national broadcaster to take a serious view of children's digital creativity. Its impact was on the BBC itself in determining its future policies and confirming the research outcomes from earlier Ultralab projects.
[C17] QCA - An Investigation Into Pupils' Creativity Across The Curriculum	To clarify criteria that explain how technology enhances creativity in learning.	From my report, the 'Features of ICT' section was adopted by the committee for the final Creativity Framework Taxonomy. 20%.	This was a synthesis of my original thinking and other sources including my experience as a designer in discussion with many others. This was newly articulated in print by me for this consultation and adopted by this national advisory body for advice on future curriculum thinking nationally.
[C18] Ultraversity Project	To design and develop a new work focussed online university experience to suit 'those for whom traditional university did not fit'.	Initially, as part of a small team, I developed the documents for validation and designed strategy and materials for recruitment in 2003. I then had oversight of the direction of the Ultraversity Project in my role as Head of Ultralab from 2005 to 2007. I frequently took a practical developmental role, creating and designing resources, infrastructure, marketing, research and team collaboration as well as a refining a theoretical stance to champion the values and philosophy of the project. 20% (with Stephen Heppell, Stephen Powell and many others).	This project combined unique elements into a completely new undergraduate opportunity. Its impact was felt deeply on the student's lives and on the researchers who made it possible. It influenced a wider academic community that drew inspiration from its success, and continues to be the subject of much interest today as well as a current course at Anglia Ruskin University. Its importance was recognised by newspapers, government ministers at the time and by organisations such as the Centre for Recording Achievement, who invited me to keynote at their conference to celebrate 10 years of the patchwork text.
[C19] SCHOOL MATTERS – Happiest Days?	To research and develop the script and present a television programme discussing well-being in school education.	I provided a design practitioner's perspective to the programme maker's research, and articulated the ideas by editing the script and acting as presenter for the programme. My part: 25%.	This television program was a new synthesis of ideas about well-being in schools - it was published on Teachers' TV and viewed and reviewed by many teachers. Its importance is in the way it links well-being with effectiveness in learning.

[C20] Inter-Disciplinary Inquiry-Based Learning (IDIBL)	To design and develop a whole university framework for work focussed learning.	My role was of co-developer, working closely to establish aims & values, design the curriculum, seek validation, organise, teach & mark work, operate quality mechanisms. I also designed the web site and fliers for marketing, sought meetings with stakeholders to market the course directly, worked with staff to disseminate ideas within the university, undertook research to establish evidence and co-wrote academic papers and made presentations at conferences. My part: 25% (with Stephen Powell and others).	The project was based on the experience of Ultraversity, but broke new ground by taking a whole university framework approach. It led to wholehearted adoption by some colleagues, whilst others appropriated parts of it for other courses. Its importance was in recognising the conditions under which work-focussed learning could prosper.
[C21] Report on good practice of innovative applications of learning theories in TEL	To clarify the accepted learning theories and explain their connection to theorists, disciplines and paradigms.	I exercised analytical and visual design skills in the construction of the conceptual diagram and contributed the statements about the complex, contested and dynamic nature of learning theory. I also tidied up and commented on the stakeholder analysis for innovation designers. My part: 80%.	This work is a new synthesis of key theorists and their ideas. It has been widely reported as part of the Hotel EU project and achieved considerable dissemination and impact as evidenced by the public feedback and continuing debate on my blog. It is intended to address an EU identified problem of educational technology innovators who are actively developing without a full understanding of the scope of learning theory and its problems in relation to technology (Millwood 2013a).

The new millenium saw a change in Ultralab, and my practice, from medium to large scale, national and international projects beginning with the headteachers' online community Talking Heads [C14], the development of learner's creativity through multimedia technology for Ultralab's Summer School [C15] and the Children's BBC Input CBBC pilot [C16], and many more.

In the middle of this decade I took over as head of Ultralab for two years before joining the University of Bolton in 2007 to further develop Ultralab's ground-breaking Ultraversity project [C18] as the Inter-Disciplinary Inquiry-Based Learning project [C20].

In this period I was invited as consultant to many organisations, but most significantly, to the Qualification and Curriculum Authority's panel to identify the role of technology in creativity and learning [C17]. This work was founded on an early form of my learning model of expressive constructivism [A1] and helped me to clarify the role of technology in learning [A2]. I was also invited to take part in two Teachers' TV programmes the first relating to innovation in assessment and the second to 'delight' in learning related to well-being in school education [C19].

I founded my own consultancy company, Core Education UK, and continued to find national and international organisations willing to employ me for my analytical perspectives and design capability.

This most recent period permitted substantial reflection, analysis and articulation of ideas through peer-reviewed publications and enabled the development of this PhD by Practice.

6.6 Next?

This section identifies next steps in my practice and future directions for research and development.

My new post at the time of writing, November 2013, is as Course Director at Trinity College Dublin for their Masters in Technology and Learning. The course provides me with the best opportunity to make use of my background and, in designing and preparing learning experiences for the students, to improve my theoretical analyses in three ways: flesh out the detail; enhance coherence; and provide interpretation with respect to design decisions that educational developers must make.

At the same time, I hope to seek PhD supervision rôles that encourage development of these analyses including correction and extension. This may include seeking empirical evidence to strengthen what I claim is a valid designer's tool-set to have greater scientific reliability.

The other major direction forward is to develop the potential of the National Archive of Educational Computing to become a trusted and rich research resource. This includes continuing to design new software, but based on some of the ideas developed and forgotten over the last four decades which are stored in the archive. The comparison of a modern design with its updated pedagogical thinking against the original material will in itself clarify trends in education, but also provide a basis for critiquing both past and present. This strategy has the added value of providing relevancy, currency and forward direction to the archive which is easy to dismiss as simply backward looking.

In order to achieve this objective, I will need to make new alliances with disciplines I have so far not touched upon and learn about historical interpretation, artefact curation & preservation, cataloguing and knowledge engineering - a challenge I relish!

7 Conclusion

Through discussion and analysis of the 21 selected items from my portfolio, connected to a methodology and theoretical & conceptual framework, I have made a claim for the award of PhD. The key to this is the practice itself, which I argue has been internationally significant in originality, impact and importance.

Starting with the development of a single piece of educational software, Snooker, created at the time the genre was established, I have grown in ambition ultimately to design educational institutions based on significant projects such as Ultraversity, which at its first graduation in 2006 awarded a BA to around 150 students with almost half with first-class honours.

My work has been guided by the four theoretical analyses I have presented and used in practice to steer design decisions. I have begun to develop these further as an original contribution to knowledge that will become the basis of research & development to refine their validity and support their reliability.

The portfolio selection made could have been larger but a pragmatic decision to limit the choice for both handling and for coherence has been made.

My contribution has mostly been in collaboration with others, but in total I argue there is enough evidence of my individual input, often in the form of critical advice and mentoring to colleagues as well as personal creative innovation.

Finally, I have developed this thesis extensively by using a web site and content management system to source, develop, organise, design and present my argument and hope that the model I have explored, described in the section Methodology for this thesis will act as useful basis for others to follow in my footsteps.

8 Bibliography

Agostinho, S, 2006. *The use of a visual learning design representation to document and communicate teaching ideas* In: Proceedings of the 23rd Annual Ascilite Conference: Who's Learning? Whose Technology?, Sydney.

Argyris, C and Schön, D, 1978. *Organisational learning: a theory of action perspective* Addison-Wesley, Reading, Mass. (ISBN: 0201001748).

Ashby, WR, 1956. *An Introduction to Cybernetics* Chapman and Hall, London.

Atkins, K and Hopkin, N, 2012. *How We Learn What We Learn* Rosendale School, London, 2 ed.

Beer, S, 1985. *Diagnosing The System for Organisations* John Wiley, London.

Bell, TE and Thayer, TA, 1976. *Software requirements: Are they really a problem?* Proceedings of the 2nd international conference on Software engineering:62-68.

Bliss, J and Ogborn, J, 1989. *Tools for exploratory learning: A research programme* Journal of Computer Assisted Learning, 5(1):37-50.

Bruner, JS, 1966. *Toward a Theory of Instruction* Harvard University Press, Cambridge, Massachusetts.

Craik, KJW, 1943. *The Nature of Explanation* Cambridge University Press. (ISBN: 0521094453).

Deming, WE, 1982. *Out of the Crisis* MIT Press, Massachusetts.

Denzin, NK and Lincoln, YS, 2005. *The SAGE Handbook of Qualitative Research* Sage Publications, Inc, third ed. (ISBN: 978-0-7619-2757-0).

Ellis, C, 2004. *The Ethnographic I: A methodological novel about autoethnography* Altamira Press, Walnut Creek, California.

Engeström, Y, 1999. *Learning by Expanding: An Activity - Theoretical Approach to Developmental Research* Web published, http://lchc.ucsd.edu/MCA/Paper/Engestrom/expanding/.

Fothergill, R, 1981. *The Microelectronics Education Programme Strategy* Web published, http://www.naec.org.uk/organisations/the-microelectronics-education-programme/the-microelectronics-education-programme-strategy.

Fuller, R, McHale, J, and Inventory, SIUaCWR, 1965. *World Design Science Decade, 1965-1975: Five Two-year Phases of a World Retooling Design Proposed to the International Union of Architects for Adoption by World Architectural Schools* World Resources Inventory. World Design Science Decade, 1965-1975: Five Two-year Phases of a World Retooling Design

Proposed to the International Union of Architects for Adoption by World Architectural Schools.

Gagné, RM, 1985. *The Conditions of Learning* Holt, Rinehart & Winston, New York, 4 ed.

Gregory, S, 1966. *The Design Method* Butterworths.

Griffiths, D, Heppell, S, Millwood, R, and Mladenova, G, 1994. *Translating software: What it means and what it costs for small cultures and large cultures* Computers & Education, 22(1–2):9 - 17.

Hargreaves, DH, 1975. *Interpersonal Relations and Education* Routledge & Kegan Paul, London.

Heron, J, 1992. *Feeling and Personhood: Psychology in Another Key* Sage Publications, London.

Hill, WF, 1985. *Learning: A Survey of Psychological Interpretations* Harper & Row, Cambridge Massachusetts.

Holt, J, 1976. *Instead of Education* Penguin Books Ltd, New York.

Hudson, A, 2009. *New Professionals and New Technologies in New Higher Education?* Thesis, Nationella Forskarskolan i Pedagogiskt Arbete, Umeå University, Umeå University, Department of Interactive Media and Learning (IML), SE-901 87 Umeå, Sweden. (ISBN: 978-91-7264-824-1).

Illich, I, 1970. *Deschooling Society* Penguin Books Ltd, New York.

James, W, 1898. *Philosophical Conceptions and Practical Results* In: University of California Chronicle, ed. by -. University of California, vol. 1, chap. 1, pp. 287-310.

Johnson-Laird, PN, 1983. Mental Models: Toward a Cognitive Science of Language, Inference and Consciousness Harvard University Press. (ISBN: 978-0-674-56882-2).

Kind, A, 2005. *Introspection* Webpublished, http://www.iep.utm.edu/introspe/.

Kolb, DA, 1984. *Experiental Learning* Prentice-Hall, New Jersey.

Koper, R, 2006. *Current Research in Learning Design* Educational Technology & Society, 9(1): 13-22.

Lewin, K, 1948. *Action Research and Minority Problems* In: Resolving Social Conflicts, ed. by Gertrud Lewin. Souvenir Press (Educational & Academic) Ltd, London, chap. 13, pp. 201-216.

Marr, D, 1982. *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information* Freeman, New York.

McDonald, B, Atkins, Jenkins, and Kemmis, 1977. *Computer assisted learning: its educational potential* In: National Development Programme in Computer Assisted Learning, Final Report of the Director, Richard Hooper, ed. by Richard Hooper. Council for Educational Technology of the United Kingdom, London, chap. 3, pp. 33-62.

Millwood, R, 2013b. *Learning Theory* Webpublished, http://cmapspublic3.ihmc.us/rid=1LNV3H2J9-HWSVMQ-13LH/Learning%20Theory.cmap.

Millwood, R, 2013a. *Report on good practice of innovative applications of learning theories in TEL* v1European Union, Deliverable.

Millwood, R, 2012. *How does technology enhance learning* Webpublished, http://blog.richardmillwood.net/2012/06/30/how-does-technology-enhance-learning/.

Millwood, R, 2009b. *A short history off-line* Webpublished, http://webarchive.nationalarchives.gov.uk/20101102103654/emergingtechnologies.becta.org.uk/index.php?section=etr&rid=14826.

Millwood, R, 2009a. *The learner at the centre* Webpublished, http://blog.richardmillwood.net/2009/01/16/teachmeet-09-the-learner-at-the-centre/.

Millwood, R, 2008. *An analysis of delight* Webpublished, http://blog.richardmillwood.net/2008/05/15/an-analysis-of-delight/.

Millwood, R, 2008. *Can we improve the future with lessons from our past?* In: JISC Regional Support Centre South West Summer Conference, pp. 32, Brentwood, Richard Millwood.

Millwood, R, 2007. *Happiest days?* Miscellaneous publication, television programme.

Millwood, R, 2006c. *What jobs do student researchers in Ultraversity do?* Booklet, Booklet.

Millwood, R, 2006b. *Innovation in assessment* Booklet, Booklet.

Millwood, R, 2006a. *What action did student researchers take?* Booklet, Booklet.

Millwood, R, 1997. *Interfaces – No. 35* Miscellaneous publication, British Computer Society HCI Group.

Millwood, R, 1987. *Strategies for Computer Assisted Learning* Masters Thesis, King's College London.

Millwood, R and Powell, S, 2011. *A cybernetic analysis of a university-wide curriculum innovation* Campus-Wide Information Systems, 28(4):258-274.

Millwood, R and Riley, D, 1988. *An analysis of a single interaction* Webpublished, http://blog.richardmillwood.net/2011/02/23/analysis-of-a-single-interaction/.

Millwood, R and Smith, T, 1994. *Caught in the Web: Traditions, Cultures & Spidermen* In: Proceedings of the Multimedia over Networks conference, ed. by Josep Blat, University of the Balearic Islands, Palma Mallorca, University of the Balearic Islands.

Millwood, R and Stevens, M, 1990. *What is the modelling curriculum?* Computers & Education, 15(1-3):249-254.

Mor, Y, 2010. *A Design Approach to Research in Technology Enhanced Mathematics Education* PhD Thesis, Institute of Education, University of London, London.

Neesham, C, 1990. *Apple is funding a project to show how multimedia technology can aid education* Webpublished, http://www.rops.org/cen/writing/cen_guardian_10.htm.

Newman, W and Sproull, R, 1989. *Principles of Interactive Computer Graphics* McGraw-Hill. McGraw-Hill computer science series.

Norman, D, 1983b. *Four Stages of User Activities* In: Interact '84 Conference Papers, vol. 1, pp. 81-85, IFIP.

Norman, D, 1983a. *Some Observations on Mental Models* In: Mental Models, ed. by Dedre Gentner & Albert L Stevens. Lawrence Erlbaum Associates, Inc., New Jersey, chap. 1, pp. 7-14. Cognitive Science.

Owers, S, 2001. *The Place and Perception of Technology in the Curriculum: Historical Developments up to 1997* PhD Thesis, Anglia Ruskin University.

Papert, S, 1980. *Mindstorms: Children, Computers, and Powerful Ideas* Harvester, Sussex.

Peirce, CS and Hartshorne, C, 1935. *How to Make Our Ideas Clear* In: Collected Papers of Charles Sanders Peirce, Volumes V and VI, Pragmatism and Pragmaticism and Scientific Metaphysics, ed. by Not sure. Harvard University Press, chap. V-VI, pp. 248-256.

Polyani, M, 1966. *The Tacit Dimension* University of Chicago Press, Chicago.

Powell, S, Tindal, I, and Millwood, R, 2008. *Personalized Learning and the Ultraversity Experience* Interactive Learning Environments, 16(1):63-81.

Ralph, P and Wand, Y, 2009. *A Proposal for a Formal Definition of the Design Concept* In: Design Requirements Engineering: A Ten-Year Perspective, ed. by Kalle Lyytinen, Pericles Loucopoulos, John Mylopoulos & Bill Robinson, Berlin, Springer. Lecture Notes in Business Information Processing (ISBN: 978-3-540-92966-6).

Ramondt, L and Heppell, S, 1988. *Online Learning — Implications For The University For Industry; A Preliminary Case Study Report* Journal of Education through Partnership, 2(2):7-28.

Richardson, L, 2000. *Evaluating ethnography* Qualitative Inquiry, 6(2):253-255.

Rogers, Y, Rutherford, A, and Bibby, P, 1992. *Models In the Mind - Theory, Perspective, and Application* Academic Press, London.

Seligman, M, 1998. *Learned Optimism* Free Press, New York. (ISBN: 0671019112).

Shavelson, R, Phillips, DC, Towne, L, and Feuer, MJ, 2003. *On the Science of Education Design Studies*Educational Researcher, 32(1):25-28.

Siemens, G, 2005. *Connectivism: A Learning Theory for the Digital Age* Webpublished, http://www.itdl.org/Journal/Jan_05/article01.htm.

SMILE, 1984. *MICROSMILE* SMILE Centre, Middle Row School, Kensal Road, London W10 5DB, 2 ed. (ISBN: 0708500099).

Smith, JA, Flowers, P, and Larkin, M, 2009. *Interpretative Phenomenological Analysis: Theory, Method and Research* Sage Publications Ltd, London. (ISBN: 1412908345).

Somekh, B and Zeichner, K, 2009. *Action research for educational reform: remodelling action research theories and practices in local contexts* Educational Action Research, 17(1):5-21.

Trowler, P, 2008. *Cultures and Change in Higher Education: Theories and Practices* Palgrave Macmillan, Basingstoke.

University of Bolton, BoSRD, 2008. *Regulations and Procedures Governing the Award of the Degrees of: Doctor of Philosophy by Published Work and Doctor of Philosophy by Practice*, Miscellaneous publication, University Regulation.

von Glaserfeld, E, 1995. *Radical Constructivism: A Way of Knowing and Learning* Falmer, London.

Vygotsky, L, 1986. *Thought and Language* The MIT Press, Cambridge, Massachusetts.

Watson, D, 1987. *Developing CAL: Computers in the Curriculum* Harper & Row, London. (ISBN: 9780063183827).

Watters, A, 2012. *Why Should Techies Care About Education Theory?* Webpublished, http://www.hackeducation.com/2012/08/02/education-theorists/.

Wenger, E, 1999. *Communities of Practice: Learning, Meaning, and Identity* Cambridge University Press.

Wertsch, JV, 1985. *Vygotsky and the Social Formation of Mind* Harvard University Press, Cambridge, Massachusetts.

Winter, R, Griffiths, M, and Green, K, 2000. *The 'Academic' Qualities of Practice - What are the criteria for a practice-based PhD?* Studies in Higher Education, 25(1):25-37.

Appendix 1 - Portfolio of 21 selected items

Item	Page	Description
[C1] Teacher of Mathematics and Computer Studies at Scott Lidgett School	82	Taught Mathematics to mixed ability groups from 11-16 and sixth form A-level groups. Took responsibility in 1978 for Computer Studies and created whole school curriculum analysis in 1979.
[C2] Microcomputers in Computer Education (MICE)	84	A group of computer studies teachers led by Brian Weaver, Advisor for Computer Education in the Inner London Education Authority, who collaborated to create interactive for learning concepts in computing
[C3] Researcher in the Computers in the Curriculum Project at Chelsea College London	85	I was employed by Bob Lewis, Director in 1980, at first to translate paper tape software simulations to cassette and floppy disk. I continued under Margaret Cox's direction, developing over ten years as a team adviser, lecturer, educational researcher and author.
[C4] London Mental Models Group	88	This multidisciplinary research group was led by the late Joan Bliss of King's College London and involved staff in science, mathematics and history education, but also in language, cognitive psychology, educational computing, expert systems and artificial intelligence.
[C5] Procedure Library	89	This was a library of procedures in Pascal and BBC Basic written on a range of computers to provide an interoperable set of functions for educational software. It was the successor to the Subroutine Library. The package was complemented by a technical guide and a design guide.
[C6] The Renaissance Project	91	This project sponsored by Apple created early interactive multimedia materials on CD-ROM aimed at the Higher Education sector spanning my employment at Kings College London and the then Anglia Higher Education College.
[C7] Senior Lecturer in Ultralab at Anglia Polytechnic University	93	I was employed by Stephen Heppell to build Ultralab as a developer, technical expert and mentor in the design of interactive multimedia software. I also had a role as lecturer in ICT in Education.
[C8] National Archive of Educational Computing	94	This 20 year project has created a research and public archive of artefacts, papers, software and media recording the UK history of technology enhanced learning.
[C9] Learning in the New Millennium	97	This longitudinal project in three phases explored the possibilities offered by new technologies to communicate, be creative and learn together between schools and together with adults industry. Underpinning this work was an online learning environment created in the FirstClass software.
[C10] Translating software: what it means and what it costs for small cultures and large cultures	106	This paper discussing the case for making software translateable was written with Dai Griffiths, Stephen Heppell and Greta Mladenova and was selected for publication in the journal Computers & Education after presentation at the CAL '93 conference
[C11] TeacherNet UK	107	A project to develop an online community and service for all teachers to engage in professional exchange and development, inspired by OZ-TeacherNet established in 1995 in Australia.

[C12] The Online Learning Network	108	An Institute for Public Policy Research (IPPR) funded project in advance of the University for Industry (Ufl). Education professionals from the school, museum, HE, broadcast and private sectors generated dialogue on a selection of issues, and participated in 'online experiences' to demystify and learn how use ICT effectively. Phase two of the project supported a number of the participants to establish their own online learning communities appropriate to their context.
[C13] Étui	109	This EU-funded project developed an educational toy to support children's learning as part of the Experimental Schools section of the i3 network (Intelligent Information Interfaces). The device stimulated meta-level learning awareness, problem solving, creativity and collaboration through the activities it was designed to enable.
[C14] Talking Heads / Virtual Heads	111	These two large-scale action research projects delivered by Ultralab were directed at the development of school leadership, establishing an online community of practice for headteachers (Talking Heads) and subsequently an online learning community for aspiring headteachers to support the National Professional Qualification for Headship (NPQH).
[C15] Summer School	113	A six year collaboration started with the South East of England Virtual Education Action Zone and the Victoria & Albert Museum to establish and promote the capabilities in young people for digital creativity using technology.
[C16] Input CBBC	114	A collaboration between Children's BBC Television and Ultralab to explore the future of kids TV. Computers and digital video cameras were placed in schools, community and learning centres across the North of England to find out what television could be like if children were to make it themselves.
[C17] QCA - An Investigation Into Pupils' Creativity Across The Curriculum	117	I contributed to this UK Qualifications and Curriculum Authority consultation as a member of a panel contracted to synthesise clearer ideas about ICT and creativity towards the end of a wider effort to consider creativity across the curriculum from 2000-2003
[C18] Ultraversity Project	125	Ultraversity was the degree course for those who university did not fit. The design allowed students to focus on their own work, negotiate learning, submit work created as part of their job in the form of assessment 'patches' using the genre and media which suited them, stitch a patchwork of such pieces to make a final submission, celebrate their dissertation through an exhibition and all supported by an online community of inquiry.
[C19] SCHOOL MATTERS – Happiest Days?	139	I presented this Teachers' TV programme and co-authored the script. I was recruited to this work after a long telephone conversation with the researcher about the concept of 'delight' which Ultralab had been promoting throughout its work in the previous decade.
[C20] Inter-Disciplinary Inquiry-Based Learning (IDIBL)	142	Development of a framework model for undergraduate and postgraduate work-focussed learning based on the Ultraversity work, but intended to support curriculum innovation throughout the University of Bolton.
[C21] Report on good practice of innovative applications of learning theories in TEL	145	A report on learning theories and how the design of innovations in technology enhanced learning may be reviewed through a multi-levelled stakeholder analysis.

[C1] Teacher of Mathematics and Computer Studies at Scott Lidgett School

Sep 01, 1977 to Jul 31, 1980

Taught Mathematics to mixed ability groups from 11-16 and sixth form A-level groups. Took responsibility in 1978 for Computer Studies and created whole school curriculum analysis in 1979.

> **Aim**: To design improvements to mathematics education practice.

I took this post in order to pursue my new found interest in teaching in a comprehensive and mixed ability setting.

The Mathematics department, led by Keith Philip adopted the Heinemann Modular Mathematics scheme - a limited flexibility mixed ability resource-based learning curriculum. Oleg Liber, a colleague in the school, led a vigorous debate around switching to the Secondary Mathematics Individualised Learning Experiment (SMILE), but the consensus in the department was to remain with the existing scheme. Oleg Liber left after my first year to pursue his passion at Stockwell Manor school.

In my second year, I took additional responsibility for teaching Computer Studies and helped develop a Mode 3 CSE syllabus and examination with teachers from local schools. I also joined professional development courses run by the Inner London Educational Computing Centre (ILECC), based at the City of London Polytechnic.

> **Reflection**: Developing examinations led to an interest in the design of objective tests - multiple choice questions - and I began to see the value of building reliable banks of such questions for testing factual knowledge.

In this period I taught programming with BASIC (Beginners All-purpose Symbolic Interaction Code) and CESIL (a simplified assembly language). The BASIC work was achieved by marking the code for each character on 80-column cards. The cards were sent to ILECC and returned by motorcycle courier a week later. This introduced me to the idea of a learning loop, in this case a week long before another cycle could begin! Some work was also done using the teletype connected by acoustic coupler modem to the City of London Polytechnic minicomputer.

In my third year I took a much greater interest in programming when the school was encouraged to purchase a Research Machines 380z microcomputer. This found its way home with me each weekend whenever possible. Using it, I constructed a simulation of a snooker ball which used dynamic graphics to show the path it would take once given a bearing and cue strength - the aim was to pocket the ball.

> **Reflection**: Observing children using my snooker program for fun, showed me how engaging simulations could be and how they could drive mathematical inquiry. Pupils would search the cupboard

> for a protractor to hold up against the screen, and, as they continued to try and pocket the ball, a non-judgmental learning-loop occurred, later cemented by reading David Hargreaves ideas (Hargreaves, 1975) where their attempts drove an understanding of bearings. My analysis [A1] Expressive constructivism is rooted in this experience which also informed [A2] How can technology enhance learning.

As the year progressed I became involved with the Microcomputers in Computer Education (MICE) group which tried to develop new software which used the new dynamic graphics capability of microcomputers to explain and explore computing concepts. I was now fully involved in my spare time designing educational software and begun looking for a job which could fulfil this new-found passion. I signed up for a course run at the Polytechnic of the South Bank by Dr Morfydd Edwards - her lectures and workshops brought the current research into the field, particularly that of the National Development Programme for Computer Assisted Learning (NDPCAL) (Hooper 1978; Millwood 1987 8) into an effective relationship with practical design, development approaches and skills.

Also in this year I undertook to create a summary analysis of the curriculum offered by the school in terms of the resources allocated to each subject area.

> **Reflection**: The task of creating a whole school curriculum analysis brought me into direct contact with the school's management and permitted me to gain insight into a holistic view of a school's organisation.
>
> **Contribution**: I led the teaching and development of Computer Studies in the school working with colleagues in the local authority, developing Mode 3 syllabus and examination. I independently developed the Snooker learning software for mathematics and for computer studies and was solely responsible for creating a curriculum analysis for the whole school. My part: 100%
>
> **Originality, impact and importance**: The software developed, Snooker, was in its time completely original as a design for learning and foreshadowed many interactive graphic simulations to come. It was published later and was widely used in schools in the 1980s (SMILE 1984).

Filed under: claim employment

[C2] Microcomputers in Computer Education (MICE)

Sep 01, 1979 to Jul 31, 1985

A group of computer studies teachers led by Brian Weaver, Advisor for Computer Education in the Inner London Education Authority, who collaborated to create interactive for learning concepts in computing

> **Aim**: To develop new ways to teach computer studies using animated visualisations.

Each of us developed a program to help with teaching computing.

My proposal was based on the teaching of the computer language CESIL, which was intended to be a simplified assembly language. An assembly language consisted of a set of short terms made up of alphabetic letters. Each term formed a cryptic mnemonic name for each operation instead of the computer's numeric or binary codes, thus making it easier to understand programs. Nevertheless this was low-level programming, matched to the central processing unit architecture rather than the high-level problem-related languages such as BASIC, COBOL, Fortran and Pascal.

> **Reflection**: My own program was intended to visually simulate the layout and operations of the central processing unit of a computer and would respond to CESIL programs. My intention was to bring these to life in a 'revelatory' mode (Millwood 1987) and relate them visually to the computer hardware.
>
> **Contribution**: The design and development of educational software and the critique of others' designs. My part: 20% (with the members of the group)
>
> **Originality, impact and importance**: Although there was a growing interest in teaching programming concepts through animations in higher education, it was new to be focussing such innovation on secondary school. Our work made impact on the practice of colleagues in the Inner London Education Authority and at the time was considered a vital part of the development of teaching computer studies there. Its work was reported regularly in the newsletter distributed to computer studies teachers in London by the advisory service.

Filed under: claim professional

[C3] Researcher in the Computers in the Curriculum Project at Chelsea College London

Sep 01, 1980 to Aug 31, 1990

I was employed by Bob Lewis, Director in 1980, at first to translate paper tape software simulations to cassette and floppy disk. I continued under Margaret Cox's direction, developing over ten years as a team adviser, lecturer, educational researcher and author.

> **Aim**: To establish design leadership for teams of programmers developing computer assisted learning for secondary age students.

I was the first employee at the Computers in the Curriculum project to be hired as a programmer, their earlier programs having been developed by teachers, lecturers and helpers.

I took this post after applying for two others in the field for which I was shortlisted, firstly for the ITMA Research Fellow, and secondly to have been research assistant at the Polytechnic of the South Bank working with Morfydd Edwards. I didn't get the first and declined the second in favour of the job in the Computers in the Curriculum Project, which offered greater scope and prestige as well as a longer contract!

> **Reflection**: The design challenge of taking a finished piece of software and make it work in a quite different interactive graphical environment was a real foundation for understanding the interoperability issues and design questions for educational software.

My first challenge was to acclimatise to the more laid-back HE sector as a researcher after working as a teacher in school. My work was to take programs developed for minicomputers to output onto teletype which were distributed on paper tape, and make them suitable for use on microcomputers with 'glass-teletype' screens. As graphics capabilities became more widely available, we began to develop more interesting and visually clear outputs, often graphs, but increasingly diagrams and visualisations.

> **Reflection**: The design of simulations that invited students to make decisions and evaluate consequences was based on innovative and learner-centred pedagogy.

In 1981, the establishment of the Microelectronics Education Programme (MEP) (Fothergill 1981) by the government led to a large investment in the development of software by our project. This meant the expansion of our software team and our whole enterprise.

I was attached to several groups of teachers to develop simulations, notably the Economics 14-16 group (based in Stoke-on-Trent) and the History 13-16 group (based in Leeds). My activity was to develop software that responded to the teachers' ideas and specifications and that was suitable for the range of microcomputers becoming available to schools. I became responsible for the

'Subroutine Library' designed to offer an interoperable framework for development amongst a team of a dozen programmers.

> **Reflection**: Teaching programming to adults in the context of their development as computer studies teachers caused me to consider the pedagogy of computing afresh with considerably more articulate and educationally aware students. Together with discussions with colleagues I developed a lifelong interest in the role of computing as a subject for learners. My widening role as a higher education lecturer at Masters level gave a broader view of the educational computing scene beyond the merely technical and towards a social, cultural and systemic understanding. As a lecturer in Mathematics Education, I was regularly visiting schools and engage in debate with practitioners so that I could keep my feet on the ground.

In the middle of this decade I was invited to teach programming as part of a new Diploma course to re-train a range of subject specialist teachers to take responsibility for Computer Studies. In turn this led to greater involvement in the Post Graduate Certificate of Education (PGCE) programmes, and finally I took on the rôle of Mathematics Education lecturer for part of my time and also designed and delivered a Masters module on the Social Context of Educational Computing.

> **Reflection**: The role of MESU fellow made me take a nationwide perspective across private and public developments in educational computing.

Meanwhile my development work evolved into a Micro-electronics Education Support Unit (MESU) fellowship in Software Tools, for which I was expected to investigate and evaluate tools for authoring educational software. As part of this work I pioneered the use of the Compulink Information Exchange (CIX) online community to connect educational software developers around the country and to continue professional discussion beyond our face-to-face meetings.

> **Reflection**: Team leadership for development of interactive multimedia gave me real responsibility for design and development guidelines for others in our large nationwide team, giving me a first taste of leadership in educational computing.

Towards the end of this period, I became involved in developing using HyperCard and with colleagues wrote books to guide others on how to design in this environment. We also began to create interactive multimedia and CD-ROM software.

> **Contribution**: I designed and developed many educational programs, guidance documents, course materials and developed analytical models for evaluation of user-interfaces. I exercised nationwide team leadership and national leadership in educational software interoperability. My part: 100%

> **Originality, impact and importance**: The Computers in the Curriculum project, first established in 1973, was one of only a very few world-leading curriculum development projects in its time to create brand new computer assisted learning materials based on a 'revelatory' approach using simulations (Millwood, 1987, p8). There were very few predecessors in the schools sector. It was funded for the first half of the eighties by the UK government funded Micro-electronics Education Programme, absorbing a large proportion of its budget. The materials were widely published internationally through

> Longman, BBC and others. The work covered a wide range of subjects in the secondary curriculum. (Watson 1987)

Filed under: claim employment

[C4] London Mental Models Group

Sep 01, 1986 to Aug 31, 1990

This multidisciplinary research group was led by the late Joan Bliss of King's College London and involved staff in science, mathematics and history education, but also in language, cognitive psychology, educational computing, expert systems and artificial intelligence.

> **Aim**: To discover new perspectives on the mental models of learners with regard to their use of technology as a tool for developing such models.

The group's members were from King's College London, the Institute of Education, Imperial College London and Kingston Polytechnic and met monthly.

The common ground was Education, with specific focus on modelling cognition to inform more generally issues of learning and teaching in an information technology setting.

> **Reflection**: The group provided me with a regular and powerful discourse to engage with in relation to the role of computers in learning and in particular analysing the nature of modelling and simulation software and its potential for learning.
>
> **Contribution**: I participated and contributed ideas to seminars considering models of learning with technology. My part: 5% (Project led by the late Professor Joan Bliss)
>
> **Originality, impact and importance**: The work to integrate an educational approach to technology, learning, artificial intelligence and mental models was unique, recognised by an Economics and Social Research Council grant for the 'Tools for exploratory learning' project (Bliss and Ogborn 1989) and peer-reviewed publications. It had impact on the design of new modelling software and importance in raising the level of debate at an early stage in the maturation of technology in education amongst the educational research community in London.

Filed under: claim professional

[C5] Procedure Library

Jan 01, 1987

This was a library of procedures in Pascal and BBC Basic written on a range of computers to provide an interoperable set of functions for educational software. It was the successor to the Subroutine Library. The package was complemented by a technical guide and a design guide.

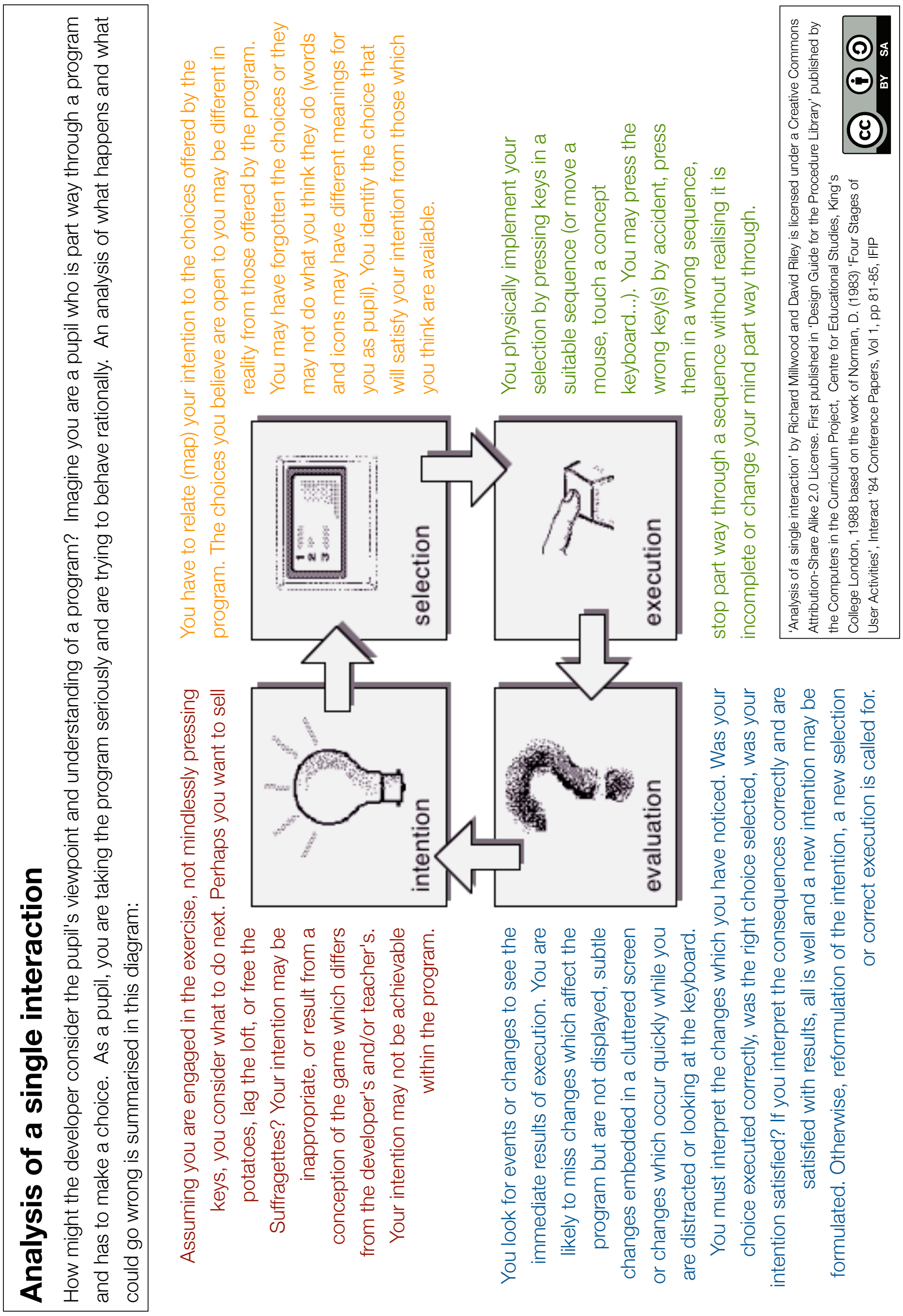
> **Aim**: To improve standards of interoperability in the design of educational computer programmes.
>
> **Reflection**: This work followed earlier attempts in the Computers in the Curriculum project to standardise software development and user interface in order to provide users with confidence, but this was not agreed by all. Others were keen to innovate and felt that standards would inhibit innovation. The needs of users won out in the end as the industry more widely created graphical user interfaces with consistent controls and software developers reaped the benefits, particularly pioneered in the Apple Macintosh operating system. I learnt that a learner-centred approach helped design decisions in this contested area of development.

In the late eighties, BASIC as a programming language was beginning to show its age. It had originally been chosen for its ubiquity on small computers that schools and colleges could afford, but towards the end of the decade, computing power had increased to the point were a much wider range of powerful programming languages were readily available.

This situation inspired the development of the Procedure Library, focussing on BBC BASIC's extended capabilities and the language Pascal on other systems. It was intended to continue the principle of interoperable development established in the earlier Subroutine Library. As well as the program code for the Procedure Library, two guides were written in October 1988 *The Procedure Library Technical Guide* and *The Procedure Library Design Guide*.

I worked on the latter with David Riley to produce the diagram *Analysis of a Single Interaction* (Millwood and Riley 1988) after reading Donald Norman's work breaking down the steps of interaction with a user interface, which we expanded on to analyse the user's perspective when engaging with educational software.

I re-published this thinking more recently as this poster, *An analysis of a single interaction*.



Contribution: I designed the set of procedures and functions, wrote the BBC BASIC and Pascal code and technical guide and co-authored the design guide which included the creation of the diagram and analytical explanations. My part: 50% (with David Riley)

Originality, impact and importance: The design, code and analysis were new, based on lessons learnt over seven years of using a BASIC subroutine library and the best of graphics routine library literature (Newman and Sproull 1989). The impact and importance was on the development and design of educational software by the Computers in the Curriculum team.

Filed under: claim publication

[C6] The Renaissance Project

Jan 01, 1988 to Jan 01, 1993

This project sponsored by Apple created early interactive multimedia materials on CD-ROM aimed at the Higher Education sector spanning my employment at Kings College London and the then Anglia Higher Education College.

> **Aim**: To design the most effective uses of multimedia in higher education.Reflection: The task of integrating the whole package of interactive design, pedagogy, educational software, supporting materials, contents and indexing, graphic design and desk-top publishing, CD-ROM mastering and finally manufacture taught me about the end-to-end process in designing educational materials.

I began working with David Riddle to assemble and produce a CD-ROM containing the tools for creating multimedia which were available in 1989. Later I supported a team led by David Riley to create a CD-ROM called 'Planet Earth: a Gaia Library" which provided materials for learning about James Lovelock's theories.

> **Reflection**: I learnt through visiting the CD production plant how much cheaper and error-free the production process for CDs in comparison to audio-tapes. The implications of this cost equation and the direct access to large volumes of data made the CD-ROM the obvious choice for delivering educational materials opening new horizons in multimedia, interactivity and large data-sets and thus became my focus for the next five years before the internet arrived.

When I took the post of Senior Lecturer with Stephen Heppell in September 1990, I continued on the same project taking a leading role in the design and production of the CD-ROM packages and working on the Insights for Teachers and Parents CD-ROM in particular developing software and the overall design of the CD-ROM and its packaging. I advised and supported the other teams in the project from Coventry Polytechnic, the University of Cambridge and Keele University who provided substantial opportunity for developing thinking through the dialogue around our mutual design and production.

I prepared master CD-ROM 'disk images' and took them on magneto-optical cartridges to the headquarters and factory of Sonopress in Guterslöh in Germany. Part of the Bertelsmann publishing conglomerate, Sonopress were a leading manufacturer of Compact Disc content.

Many other products, papers and presentations were created under the publishing umbrella of this project.

> **Contribution**: Working within a small team I helped design, collate, program and took sole responsibility for technical production of some of the earliest CD-ROMs developed for education. My part: 20% (with Stephen Heppell and others)

> **Originality, impact and importance**: Our exploration of the educational design to discover the potential of new interactive multimedia on CD-ROM led to some of the first such products created for

higher education in Europe. At the time I had to travel to a factory in Germany, since there were few facilities in the UK for manufacture and very few places we could prototype the CD-ROM materials. They were subsequently distributed worldwide with international publishing agreements. Each CD-ROM pioneered interactive and participative learning design in the years before internet. (Neesham, 1990)

Filed under: claim project

[C7] Senior Lecturer in Ultralab at Anglia Polytechnic University

Sep 01, 1990 to Aug 31, 1998

I was employed by Stephen Heppell to build Ultralab as a developer, technical expert and mentor in the design of interactive multimedia software. I also had a role as lecturer in ICT in Education.

> **Aim**: To develop a collaborative team approach to the design & development of new technology in learning.

I was employed primarily to carry out project duties to develop multimedia CD-ROM materials in the first instance, and over the next eight years the work developed into designing and developing software for primary children, for language learners and increasingly, young people developing multimedia for themselves.

> **Reflection**: The real value of this job for my development was an increasing level of responsibility and a powerful combination of design, development, team leadership and teaching at a high level.

In addition to my software development and project duties, I was employed in the School of Education to teach Primary and Secondary B.Ed. student teachers about computers in education and some part-time Diploma work which grew into a set of Masters modules developed and delivered with Stephen Heppell in the evenings.

As our project scope and team expanded, I found myself more and more in a mentoring / leadership role with both internal colleagues and with external collaborators, and the internet and online community became central to our work.

> **Contribution**: I was a designer, developer and technical producer of many projects, a lecturer in ICT in Education and a designer and developer of a Masters level course. My part: 25% (with Stephen Heppell and others)

> **Originality, impact and importance**: The Ultralab team was distinctive in its structure, ethos and practice, developed on values and principles of inclusion and participation. It's ethos was to directly change the world of education with its action-research innovations and thought leadership. Its work influenced national policy in the UK and throughout the world.

Filed under: claim employment

[C8] National Archive of Educational Computing

Sep 01, 1992 to Jul 31, 2013

This 20 year project has created a research and public archive of artefacts, papers, software and media recording the UK history of technology enhanced learning.

> **Aim**: To design & develop a historical archive and narrative for developments in technology enhanced learning.

This project began at a time when the last remnants of the first national programme for schools, the Microelectronics Education Programme (MEP) were closing. Stephen Heppell and I rescued a number of key collections from regional and national centres and others donated materials.

Ultralab hosted the archive until 2006, when I took ownership and hosted the work within Core Education UK. Various supporters and organisations have added funds for the archive, which continues to act as a focus for proposals to enhance, disseminate and make relevant the wealth of materials it contains.

This is the summary text about the archive:

> The development of educational computing in the UK began in the early 1970s. This has resulted in a wealth of knowledge, experience and artefacts. It is timely now to look at these materials and to represent them as an accessible and substantially complete collection of one nation's pioneering and world-renowned innovation.
>
> **Aims**
>
> The proposal is to:
>
> - disseminate the archive so that past successes (and failures) can better inform the future potential for learning with ICT;
> - enhance the archive by using the internet, emulation, video digitisation and virtual reality techniques to provide access to artefacts which have become difficult to view, operate and maintain;
> - expand the archive so that it represents the range of innovations and practice in educational computing with personal stories, interpretations and analyses.
>
> Valiant Turtle
>
> **Audience**
>
> Many will have an interest in this archive. Specifically:
>
> - Public - parents interested in home & school learning with ICT, those interested in its history;
> - Learners - children researching projects about technology and learning;
> - Teachers, lecturers and trainers - in initial and in-service professional development;
> - Researchers - engaged in policy, educational technology and pedagogical research worldwide;

- Educational managers - decision-makers considering purchase and implementation of ICT learning resources;
- Policy makers - regional and national decision makers when considering effective ICT strategies.
- Industry - eager to benefit from effective ideas and wishing to see their contribution over time.

Online visitors and face-to-face viewers of the archive will be encouraged to add their comments and stories.

Methods

The project will create specific interpretations and representations for each of the audiences and will enhance access to the archive in five ways:

- using multimedia, emulation and virtual reality techniques to provide interesting and stimulating representations of historical artefacts;
- recording in digital formats the experience of many of the participants in educational computing innovation in the form of oral and video histories;
- digitising existing video materials and software from the collection and indexing them for viewers to see how educational computing was pioneered;
- categorising and recording its collection in a publicly-available database on the internet;
- providing a publicly accessible location where the archive and all supporting resources can be used.

Objectives in 2013

- preserve the existing collection;
- employ staff / identify volunteers / recruit doctoral students to catalogue the existing collection;
- source additional artefacts to grow the collection;
- create an organisation with charitable status to permit a long-term, self-sustaining mechanism for funding;
- plan a representative, substantial national archive of UK educational computing which is open to the public;
- establish a world-wide-web site which publishes the searchable database of the archive collection and a selection of representations of software and hardware artefacts, personal records and official documents.

More details can be found on the National Archive of Educational Computing web site - http://www.naec.org.uk.

Reflection: I have learnt about the history of educational computing, the methods of curation and cataloguing materials, the processes of dissemination and sharing of artefacts and the nature of voluntary research activity. I have benefited from relationships with the museum, library and gallery sector and developed thinking about the semantic web and questions of interpretation within the scope of historical analysis.

Contribution: Since leaving Ultralab I have taken sole responsibility for this work, establishing working methodology, designing a participative web site and convening and attending events to disseminate knowledge. My part 90% (Initially with Stephen Heppell and Greta Mladenova)

Originality, impact and importance: The archive is unique in the UK in its focus on educational computing. Its impact has been on international education conferences and events where it has exhibited and in its support for other projects such as the BBC's Domesday Reloaded. I believe its importance will be found in the future to satisfy a desire to interpret the historical development of technology enhanced learning and to mine the ideas which have been developed and forgotten, but are ripe for re-invention.

Filed under: claim project

[C9] Learning in the New Millennium

Sep 01, 1993 to Jul 31, 1999

This longitudinal project in three phases explored the possibilities offered by new technologies to communicate, be creative and learn together between schools and together with adults industry. Underpinning this work was an online learning environment created in the FirstClass software.

> Aim: To research the new uses for creative & communicative digital tools in secondary classrooms.Reflections: I was lucky to be on the edge of this project, occasionally invited to school visits and project meetings, frequently involved in reflective thinking and planning. I learnt that young people could be trusted with expensive equipment and powerful functionality and that their creativity and attainment could be enhanced by technology tools, enabling considerable achievement. It also taught me that children's safety and confidence were precious and needed positive and careful action to assure.

This project was sponsored by the Nortel company, maker of communications equipment, and initially connected five schools and engineers in Nortel to create an online learning community. Its influence on Ultralab projects was far-reaching, influencing and inspiring the thinking of the Schools Online Project, the Etui project and the NotSchool project and many others. The close contact with schools and pupils, the confidence of the sponsors and the early provision of equipment permitted an agile action research to develop, establishing possibilities and identifying challenges.

A description of the project written by Carole Chapman, the project leader and Greta Mladenova describes in more detail its development and findings:

> **Learning in the New Millennium: A longitudinal project in three phases**
>
> Carole Chapman, Greta Mladenova
>
> ULTRALAB, Chelmsford, UK
>
> June 2001
>
> **Abstract**
>
> This paper sets the background to the Learning in the New Millennium (LiNM) Project which was undertaken at Ultralab, a learning technology research centre at Anglia Polytechnic University. This longitudinal research project ran from 1993 to 2000. The project informed the debate in the UK in the arena of learning beyond traditional confines. LiNM started from a constructivist conception of learning and aimed to empower project participants to utilise technology and to develop processes that enhanced participation and collaboration.
>
> The paper covers briefly all three phases of the project and then describes the findings of the final phase which was concerned with a range of mobile IP devices. Recommendations based on the findings are made.

Introduction

At Ultralab we develop our projects within a framework which accepts that learning should be ambitious (and preferably delightful). Anecdotally we know some of our best learning occurs when we can explore and extend our understanding with interested others, where we can scaffold (Vygotsky1 , 1976) learning. Ultralab projects recognise that our most memorable learning often takes place outside the formal school curriculum: we often forget lessons but remember the experience shared when friends or parents talk around a dinner table, the television programme we found by mistake, or by a teacher dropping a set lesson to speak with real passion about a topic or idea. Such an experience, topic, idea, eccentricity can establish new relationships and encourage formal and informal debate. New technologies, which enhance our abilities to communicate, for example asynchronous conferencing, allow this extension of learning by enabling the following through of a story or learning experience beyond the traditional physical and temporal confines of professional educational institutions or time limits imposed by the curriculum. New technologies can be harnessed to deliver content (Information Delivery Technology) or can be used to support the building of deeper understanding through two-way communication, participation and engagement (Information Communication Technology). Constructivist theory (Bruner2 , 1986; Fosnot3 , 1996), which emphasises the latter, has informed the pedagogical foundation for the design of Ultralab projects. Constructivist theory specifically aims to empower participants via collective learning to actively construct their knowledge rather than passively receive information.

Background to Learning in the New Millennium

The Learning in the New Millennium (LiNM) project took place against an educational background in the UK of growing 'panic' surrounding educational achievement and failing schools, which resulted in the implementation of the National Curriculum and OFSTED, rhetoric concerning standards and the implementation of almost continuous rigorous testing. The model of education that developed is best described as an input / output model.

The LiNM project, throughout its three phases, has emphasised collective learning as a social process, involving the active construction of new knowledge and understanding, consideration, participation in and discussion of existing knowledge. Collective learning is most effective because it involves the active construction of knowledge, combined with peer learning, which results in the development of different methods of problem solving and interaction. This results in motivated and considered feedback (Kaye4 , 1995). Stafford in 1990 examined 96 learning studies and concluded that interactivity was associated with learning achievement and retention of knowledge over time (Najjar5 , 1995). Educational theory (Bruner, 1986; Vygotski, 1978) has long established that people learn material faster and have a better attitude toward learning material when they learn in an interactive learning environment. At Ultralab we would make a clear distinction between interaction, evoking choice and response and participation, evoking contribution and ownership. Our research projects emphasis participative environments.

Learners in a collaborative learning environment control their own learning and the asynchronous nature of the flexible learning environment of LiNM enabled this control to take place. Pupils learnt from others and collaborated to construct knowledge. Thus the project in its second phase did not simply involve working on project studies or set tasks, but true collaborative learning, where the pace of work and knowledge acquisition was in the control of the learner. Thus the second phase of LiNM involved pupils sharing and distributing their multimedia work. A cycle of comment and iteration was built into the process, which was transparent. It is worth emphasising here that communication is not collaboration, just as interaction is not participation. Effective learning requires both participation and collaboration (Vygotski, 1978). As with all Ultralab project participation and collaboration were 'built into' LiNM. The simple addition of multimedia materials and self paced learning is not enough to deliver other than the most basic task orientated training. The best elements of the LiNM project used new technology in a non linear, participative and collaborative way.

LiNM Project Phases

The LiNM project was sponsored by Nortel Networks. The project started in 1993, aiming to raise the profile of science and technology with school pupils in the UK. As a longitudinal project LiNM has been able to examine the considerable developments in technology which have taken place since 1993. The ethnographic, organic nature of LiNM enabled the project to adapt to meet changes in both education and technology. Teachers were always given equipment for their own use before it was taken into classrooms and were encouraged to become researchers, keeping logs of use and diaries as well as reflecting in the conferencing environment. Pupil participants communicated via conferencing and developed an open and honest approach, feeding back their success and failures as well as their observations and reflections. These logs, diaries and reflections, combined with Ultralab research observations, formed the basis of the research.

The project pupils came from a number of state schools across South East England, and were chosen specifically to cross barriers of ethnicity, age and/or ability. During the course of LiNM some 1,850 pupils aged 8 to 16 years were involved in the project.

LiNM fell into three natural phases.

Phase one of the project (1993 - 1997) connected pupils, aged 8 to 18, to scientists and engineers at Nortel, and to teachers and academics. The schools participating in the LiNM project were among the first in the UK to have a connection which allowed them to contribute to the www. The project added "experts" as additional areas of expertise became required . Project participants never met physically for the two year period of phase one and only communicated via the text based conferencing environment. In phase one of the LiNM project, connection to the computer conferencing environment took place almost entirely at school, home Internet connections being rare. The findings of phase one are published and can be found on the website6 .

Following phase one of LiNM, Ultralab recognised that the asynchronous conferencing process, where people could reply to someone's message after thinking about it and preparing their reply at leisure, had significant advantages in that it offered excellent opportunities for reflection. Elsewhere in Ultralab sociometric analysis of face to face meetings were helping us to understand the gains in parity of

esteem and parity of contribution of asynchronous distributed online environments. Natural scaffolding (Vygotsky, 1976) was developed through the continual focus on collaboration, and participants were encouraged to use the computer and software environment as mind tools (Brown, Collins, & Duguid7, 1989, Jonassen8 , 1994; Prickett, Higgins, & Boone9 , 1994). Our research saw reflection and collaboration develop among the bulk of project participants.

With phase two (1997 - 1999) the research focus moved from communication and communities to the contribution symmetrical, multiple media and broader band communication might add. Ultralab had a long track record of pioneering work with multimedia stretching back into the 1980's. LiNM Project participants were encouraged to expand communication from text to multiple media, to share and distribute their work on multiple media projects across physical boundaries and age limitation, to build their own interactive webspaces, for which they were responsible (for example they directly updated and controlled), and to explore their own new media literacy. The findings of phase two are published and can be found on the website10 .

Phase three of the project (1999 - 2001) aimed to add diversity to the technology and look at the implications of mobile IP (Internet Protocol) with a clearly distinguished personal identity for each user. In 1999 pocket mobile wireless devices were introduced into the school environments. One of the aspects investigated in this phase was the impact of the new technology on classroom practice and behaviour. This rest of this paper draws together some of the specific findings of this research

Phase three: context of the third phase

Since phase one of LiNM there has been an extension of use of the internet for learning purposes. This is demonstrated by the development of web sites by those institutions who consider they have a learning remit (Bitesize from BBC , HomeWork High from Channel 4, Learn from the Guardian, SchoolNet2000 from Tesco). Children's use of the Internet in Europe was recently researched by NOP and the findings showed that use in England was only surpassed by Scandinavian countries11 .

Since 1994 there have been twelve major UK government programmes with an investment of over £250 m to support the use of ICT in education. In schools these government initiatives, for example NGfL (National Grid for Learning), have ensured that all schools will have internet connections by 2002 and NOF (New Opportunities Fund) training for all teachers will ensure that teachers are familiar with the Internet and understand its potential value.

Children are spending the majority of their spare leisure time inside their or their peer groups homes. NOP research found that this was mainly due to parents concerns over 'stranger danger' and road safety (NOP, 2000). NOP research also found that most computers are based in bedrooms. This is in contrast to Ultralab safety guidelines to site computers in social spaces. Given the context outlined above it is unsurprising that under 16s are using the Internet in ever increasing numbers.

In our research we have observed a pattern of online activity amongst the project participants where increasingly pupils have extended the activities undertaken in the project into their leisure time. We questioned, and asked for feedback from, teachers and pupils in LiNM schools where their exposure to, and understanding of, technology futures, through LiNM phase three has informed the debate.

Phase three: findings

Our observations showed that increasingly, where given the opportunity by technology, pupils go to great lengths to keep in touch with their peer group. We observed pupil groups SMS messaging to friends and logging in to access online communities at anytime, anywhere. Here individual identity was crucial so that children knew who was sending to them as well as who they were sending to: they felt the need to identify the audience. Pupils found messages from 'unknown' numbers' or emails from strange addresses disturbing.

The majority of pupils who used WAP technology (over 70%) preferred to SMS even when the activity was almost synchronous (defined by 6 communications sent in a 4 minute period) . We asked why this was the case and most pupils cited reflection as the reason;

“I can think before I answer”

“I like to know what I am going to say”

“It gives me more time”

Rarely were pupils observed using hand held devices to simply read personal mail or messages without making some response, even if it was only an acknowledgement. Almost all pupils who used the community software regularly (over 70% of our group logged into the community software at least twice a week) checked the discussions within the active communities they were members of. Currently this is only possible in a limited way with mobile phone technology, as multiple messaging is limited in the SMS world. This means that support for learning or social cohorts is non existent. This situation is changing with the development of 3rd generation mobile phone technology, which offers enhanced functionality. Already (June 2001) mail lists are available through mobile phones and the games industry is attempting interactive gaming using SMS. Advances in technology will enable participative functionality (see Ultralab m-Learning project) and our research shows that this will be increasing demanded by a young, sophisticated audiences.

Within the school environment duration of time contacting with others was limited and thus any spare minute was liable to be grabbed. This was true in LiNM schools where access was open and an integrated approach to new technology encouraged. Using conventional computers the most popular login times - and the longest - were just after school or lunchtime, pupils often using the whole lunch break. This was because pupils had to go to a specific place to log onto a computer. This takes time because it may involve finding a member of staff and queuing. Once a computer is obtained pupils wish to keep control of it. Personal devices which use wireless connections, were observed to be used in breaks to 'keep up to date'. We noted the tendency to use every single opportunity to communicate when pupils have access to the technology. They stopped at the cloakroom area and opened the mobile device simply to login for a few minutes to check email and/or conference messages. We observed that almost without exception they originated messages as well as read them. For them the Internet was a participative environment.

Our research showed that on systems where there was a resumés or a type of 'about me' available, children accessed this information many times. They were interested in any information concerning

others in their communities or others communicating with them. They wanted to know who was in their community, what their interests were. They reread resumés of active users on a regular basis to look for additions and/or changes. They were keen to write information about themselves for others to see and changed their comments to update their information. One of the first five messages in over 50% of pupils communicated with was, “have you read about me”.

Although pupils do respond to messages in an online community in large numbers the communication, when children are the main members of a community, is characterised by short and direct responses. An average discussion involving mainly children consists of a number of quick fired one liners and/or questions interspersed with longer comments. This pattern was observed before SMS but is reinforced in SMS messaging 'conversations' which we observed taking place.

We asked LiNM pupils what they most liked doing in the online communities in which they belonged. Children's answers were as follows

"chatting", “asking” "looking things up", "making web pages", "movies"

We also asked our teachers involved in phase three what they had observed their pupils enjoy doing most when participating in the LiNM project. The teachers answers included

"..giving feedback and seeing their ideas take shape",

"sharing joint project and communicating", "taking part".

In both cases the majority (72%) mentioned some aspect involving communicating and creating , or as the children commented, "doing things!" This is not surprising: memorable learning takes place when we are 'doing', especially with others.

Within the classroom in the primary sector the attitude to wireless mobile devices was very open and positive. Pupils were encouraged to move around the school, collect equipment, use the equipment in a self directed way and return equipment to a central point, thus pupils were given control of the technology and their own learning. Teachers noted that this had a direct impact on the pupils attitudes, with younger children becoming investigative and the older more difficult pupils more stimulated and interested in learning. One teacher commented that in the case of a very difficult pupil excluded from lessons the ability to control and pace learning using a wireless computer and open ended tasks had reawakened the childs interest in the world around him.

The ability to use the wireless technology outside the confines of the school building was seen by the teachers as one of its greatest assets. The ability to include extracurricular staff, “even the dinner ladies were roped in...” proved invaluable in involving the whole school in learning. Caretakers also became involved in helping the pupils to achieve their objectives of collecting images, video and audio from around the school.

Also worthy of note was an increase in creativity. Freed from the boundaries of desk and wires pupils were able to use software tools in an inventive way. We observed for example the increased use of digital manipulation of downloaded images. Video and audio became a standard feature of work. It was common to see a group of children in the field searching for images of plants to check their rarity or

crowded around the pond looking at movies of insects and, for example comparing their movements to those observed in real life. Pupils were rarely observed as one individual using a machine but in groups working together, collaboratively.

Secondary school lessons tended to be fixed, located in a central subject area. For these classes mobile IP was equally valuable, as many lessons were constrained to separate teaching areas and pupils/classes did not have the flexibility which allowed them to move to central computer suites when needed. Thus with pupils in control of the technology they became classroom researchers for both peers and teachers, able to add an additional dimension to lessons. We observed pupils not only by extending the information available to the classes but also posing questions in online conferences and receiving answers during the lesson, finding and observing online simulations or models on relevant subjects and synchronously and asynchronously questioning pupils working in the same areas in other schools and exchanging files with these pupils. All this is possible in a computer suite but of interest is the way in which these activities became a feature of almost every lesson and the way in which pupils no longer simply interacted with teachers, answering questions but truly participated in lessons.

A key feature therefore of pupils behaviour in a world of mobile IP is that pupils will access where and whenever they can, from a multiplicity of computers and from a number of devices. Increasingly, when allowed, they slip time boundaries to blur the lines between their school and leisure and wish to use their learning from their leisure time to enhance their school learning.

It would be as wrong to presume a consistency of software/ hardware in the classroom as it would be to presume such in the wider population. LiNM phase three has demonstrated the diversity of equipment available for pupils to use and the willingness of children to accept and use such technology. LiNM pupils used whatever equipment we presented them with, and will use whatever is available: ubiquitous desktop machines, portables but also anything else that they have access to, even temporarily, however limiting the interface. When we gave pupils data phone technology, they happily used these mobile wireless devices to access the Internet, despite the impoverished environment and unreliability of gateways.

Recommendations

We would be foolish to expect more consistency of technology in the future, indeed diversity is widening considerably. The findings outlined above, combined with the movement towards an integration of devices (third generation mobile phones which will allow recording of video, receipt of information, synchronous video conferencing, televisions which allow for interactivity and asynchronous conferencing etc.) point to a move from the traditional desktop computer towards a "thin client" device. Like the devices we introduced to schools these will have no local applications at all and minimal local storage. This effectively rules out local storage of files other than as a very short term expedient. This raises a number of interesting issues for schools surrounding managed service provision and standardisation around specific hardware and/ or software platforms.

Phase three has demonstrated that schools with flexible and adaptable approaches to new technology, as opposed to being locked into managed services, can successfully adopt new technologies, integrate them into the school environment and benefit from an increase in creativity that such innovation brings.

LiNM pupils had limited problems with software choice; they used whatever browser and/or device was available and whatever operating system, as long as the door remained open for their participation.

Our observations confirm that children log on where (and when) there is opportunity: from school, home, public access points, friends, anywhere. The pattern of use identified in the findings above clearly evidences the importance of individual identity over group identity and of mixed age, distributed, asynchronous communities.

1 VYGOTSKI, (1967) "Mind in Society", Harvard University Press

2 BRUNER, J. (196). Actual minds, possible worlds. Cambridge: Harvard University Press.

3 FOSNOT, C. T. (EDS.). (1996). Constructivism: Theory, perspectives, and practice. New York: Teachers College Press

4 KAYE (1995), "Computer Supported Collaborative Learning" in "Information Technology & Society" Edited by Heap et al., The Open University

5 NAJJAR, (1995) "Multimedia Information and Learning", Journal of Educational Multimedia and Hypermedia, Vol 5, No 2 1996

6 Findings Phase one http://research.ultralab.anglia.ac.uk/One/linm.html

7 BROWN, J. S., COLLINS, A., & DUGUID, P. (1989/95). Situated Cognition and the Culture of Learning. available at http://www.ilt.columbia.edu/ilt/papers/JohnBrown.html, last updated 29-Nov-95

8 JONASSEN, D. (1994). Technology As Cognitive Tools: Learners As Designers. ITFORUM listserv discussion paper published 2nd May 1994: available at http://itech1.coe.uga.edu/itforum/paper1/disc1.html

9 PRICKETT, E. M., HIGGINS, K., & BOONE, R. (1994). Technology for learning ... not learning about technology. Teaching exceptional children, summer, 56-60.February 1998

10 Findings Phase two http://research.ultralab.anglia.ac.uk/findings.html

11 NOP research (June 2000)“Children and the Internet” March 2000

Under 16's using the Internet by country:
Denmark: 90%
Sweden: 84%
France: 40%
England: 55%
Italy: 45%

Contribution: My part was very small in the action of the project, but I acted as a mentor (with Stephen Heppell) to the project and as research supervisor to Carole Chapman, who led the project. As such I helped develop the conceptual thinking which then provided a basis for much other research. 10% (with Stephen Heppell and Carole Chapman)

Originality, impact and importance: The project was groundbreaking in its connection between professional scientists and school students to discuss science problems, in its early use of mobile technology and in its foundation on the concept of online community. The impact of the project was felt in its larger scale successor projects such as Notschool.Net, Schools Online, Think.com, TeachernetUK, Talking Heads and Ultraversity. Its importance was the establishment of design, practice and conceptual knowledge for Ultralab and beyond.

Filed under: claim project

[C10] Translating software: what it means and what it costs for small cultures and large cultures

Jan 01, 1994

This paper discussing the case for making software translateable was written with Dai Griffiths, Stephen Heppell and Greta Mladenova and was selected for publication in the journal Computers & Education after presentation at the CAL '93 conference

> **Aim**: To clarify the importance of designing in opportunity for self-localisation to educational software to allow regional and international appropriation.

Abstract

In this paper the authors report as a case study their experience of adapting a set of software for other languages and cultures, drawing attention to the potential pitfalls and sharing what was learnt. This experience was based on a project to translate the 'Work Rooms' software for young learners into Bulgarian and Catalan. It is also hoped to broaden the debate on CAL, stimulating consideration of multicultural and international issues.

While the questions raised by this particular adaptation of software are relevant to all those working with CAL, they have particular importance for software authors, publishers, and teachers of linguistic minorities.

> **Reflection**: The discussion and research arising from the developments we made to create programs in the 'Work Rooms' suite as user-translateable software, had a far-reaching influence on my awareness of the importance of seeing the world from the position of the learner within the culture they inhabit and the language they use, not simply what their interests or processes in learning might be. It made clear how profound the concept of learner-centredness needed to be.

> **Contribution**: I helped design the software methodology for translation and the implementation of it in the 'Work Rooms' software as well as co-authoring the paper.My part: 20% (with Dai Griffiths, Stephen Heppell, Sam Deane and Greta Mladenova)

> **Originality, impact and importance**: The practice and paper was novel in education at that time and the conceptual thinking was only just making impact in the software operating systems world. Its importance is seen in the way modern software is now developed and content management systems such as Plone have been developed to manage translation as a matter of course.

Download the full paper as a PDF file -

http://phd.richardmillwood.net/en/bibliography/griffiths-1994

Filed under: claim publication

[C11] TeacherNet UK

Oct 23, 1996 to Dec 31, 2000

A project to develop an online community and service for all teachers to engage in professional exchange and development, inspired by OZ-TeacherNet established in 1995 in Australia.

> **Aim**: To develop the design proposition for online communities of practice to support the continuing professional development of teachers.

TeacherNet (UK) was established in 1996, following consultation with and support from DfEE, British Council, NCET (then BECTA), TTA, OFSTED, private sector, Scottish Office, professional associations teachers and teacher educators.

TeacherNet (UK) established philosophy, principles and practice underpinnning a national web site centred on teachers interests and professional development. It explored many avenues for developing, financing, managing and sustaining a service whilst maintaining independence from government and the private sector in order to ensure effective change with teachers by winning their confidence. As a result it formed a not-for-profit company named TeacherNet to form a charity, run seminars and conferences, work with innovative practitioners to publish in books and journals, advise DfEE and the General Teaching Council and others. It also explored the possibility with companies such as BESA, ICT companies and publishers and others to develop teacher-centred e-commerce solutions using profiling. TeacherNet (UK) had a paid membership composed of a relatively small number of teachers.

> **Reflection**: TeacherNet UK allowed me to consolidate and apply my design ideas about a comprehensive, national & professional online community. This included the establishment of professional online values, the notion of a passport for professional identity and a profiling mechanism to enable teachers to claim their competencies and develop a portfolio of evidence. It was a participant action research as I took the role of designer, developer and company director.
>
> **Contribution**: In TeacherNet UK, I co-designed and developed the organisation itself, designed, developed and maintained the initial website, made many conference presentations and acted as one of six directors of the company. I exercised national and European thought leadership to establish notions of informal professional development online. My part: 25% (with Marilyn Leask, Norbert Pachler, Darren Leafe, Kryss Durling and Keith Byrom)
>
> **Originality, impact and importance**: TeacherNetUK was inspired by the Australian OZTeacherNet, but proposed original think around continuing professional development for teachers and self-profiling of teachers in order to match content to their interests. Although it did not become a mass-movement, it enjoyed a considerable membership for a time and was in demand by UK government and industry for consultancy, culminating in the government creating its own TeacherNet service with the help of members of the team.

Filed under: claim project

[C12] The Online Learning Network

Sep 22, 1997 to Jul 31, 1998

An Institute for Public Policy Research (IPPR) funded project in advance of the University for Industry (UfI). Education professionals from the school, museum, HE, broadcast and private sectors generated dialogue on a selection of issues, and participated in 'online experiences' to demystify and learn how use ICT effectively. Phase two of the project supported a number of the participants to establish their own online learning communities appropriate to their context.

> **Aim**: To research the effectiveness of human facilitation and software design to support online communities.

The idea of a University for Industry (UfI) was a Labour Party manifesto commitment prior to the general election in May 1997, and a central plank of Government policy for promoting a skills revolution.

The Institute for Public Policy Research (IPPR) had been working on the idea of the UfI for the previous two years. In December 1996 it published 'University for Industry: creating a national learning network' which set out the challenges facing a UfI. The report argued that the UfI should be a 'national learning network', bringing opportunities for learning to people where and when it is most convenient: in the workplace, in the home and in local community-based centres rather than in existing institutions. On-line technologies were clearly central to this concept.

This project was designed to explore these ideas was led by Ultralab, using the First Class computer conferencing software to connect a community of learning professionals.

> **Reflection**: Working with Leonie Ramondt, I began to understand more clearly the challenges of establishing and maintaining an online community of practice for learning professionals.

Further details setting out the projects aims can be found on the initial website -

http://www.naec.org.uk/online-learning-network/index.htm

> **Contribution**: I was mentor to project leader, contributor to the online community design and provided technical support for the service. My part: 10% (with Stephen Heppell, Leonie Ramondt and others)

> **Originality, impact and importance**: This project was Ultralab's first to create a community of practice for adults. It informed the design of the emerging UK University for Industry and also many successor projects at Ultralab. (Ramondt & Heppell, 1998)

Filed under: claim project

[C13] Étui

Sep 01, 1998 to Jul 28, 2000

This EU-funded project developed an educational toy to support children's learning as part of the Experimental Schools section of the i3 network (Intelligent Information Interfaces). The device stimulated meta-level learning awareness, problem solving, creativity and collaboration through the activities it was designed to enable.

> **Aim**: To research & develop a toy for use by early learners to encourage learning about learning.Reflection: In the éTui project, I proposed the ideas of meta-level learning that the toy would foster based on more general ideas of identity, reflective activity and exploratory learning.

This project summary is taken from the original bid:

> **Project Summary**
>
> **Objectives**
>
> The éTui will be a prototype electronic device for young learners. The learning activities which the device should stimulate are: problem solving, collaboration, creativity and meta level learning awareness. The design objectives of the device to support these are: programming through direct manipulation and iconic program representation; real-time synchronisation between one éTui and another; multi-sensory capacity (perhaps including motion, sound and vision) and response based artificial learning.
>
> **Results**
>
> The project will result in the following:
>
> - A prototype electronic learning toy - the éTui.
> - Information from the design stages and field trials.
> - A set of specifications linked to learning outcomes.
> - Software resources designed for the project including operational, visual, programming and interactive elements.
> - A specification for further development based on an evaluation of the project.
>
> **Approach**
>
> The project will include: four testing stages, software development, hardware development and dissemination. The testing stages will have two distinct research populations: the four main field research sites and an online community of research reference sites. The four stages of testing will be for the conceptual visual designs, the conceptual physical designs, the conceptual software design and the final prototype. Ultralab will coordinate the project, create the research infrastructure and undertake work in conceptual software design and conceptual hardware design, the last two in conjunction with Apple. Conceptual visual and physical designs will be managed by Pompeu Fabra.
>
> **Outcomes and Impact**

We expect the éTui to engender a new philosophy for creating toys for young learners, one which will make the process of fully exploring such a device intuitive and flexible. The information gathered from the field testing stages should create further debate in this area and also inform design goals for further prototypes. This information linked with the specifications and the software resource should make a firm foundation for further work in iteratively testing and designing the éTui.

Dissemination

Information about the project and project results will be communicated through a variety of channels. These channels will include the world wide web, popular television or printed media and publication. There will be a site dedicated to the project on the world wide web which will describe results and show the current stage of the project. Specific outcomes may be prepared for television broadcast and/or publication.

Reflection: The guided experiments I carried out in the primary classroom helped me understand the profound effect of participant research and the depth of thinking that an exploration of the unknown can promote.

Contribution: I acted as co-developer of the project's ideas about meta-level learning, mentor to the project leader and other personnel, researcher in classrooms and disseminator of the progress and outcomes. My part: 20% (with Andy Simpson, Dai Griffiths, Stephen Heppell and Kris Popat)

Originality, impact and importance: The project was unique for its design of a mysterious toy which did not represent existing creatures in order stimulate wonder, inquiry and imagination. As part of the i3 research network, it was shared widely to the European research community and generated much debate about early years learning with technology.

Filed under: claim project

[C14] Talking Heads / Virtual Heads

Jan 01, 2000 to Dec 31, 2003

These two large-scale action research projects delivered by Ultralab were directed at the development of school leadership, establishing an online community of practice for headteachers (Talking Heads) and subsequently an online learning community for aspiring headteachers to support the National Professional Qualification for Headship (NPQH).

> **Aim**: To design learning resources to support headteachers in embarking on online community for their continuing professional development.

Talking Heads provided a solution to the National College for School Leadership to network headteachers. It provided a place for practitioners to share knowledge and support and a platform for continuing professional development. The software used was an adaptation of Think.com, the web-based online community software developed and designed by Ultralab in collaboration with Oracle.

To support the headteachers, an introductory pack including an interactive CD-ROM was developed with multimedia materials including speeches from then Prime Minister Tony Blair, NCSL director Heather Du Quesnay and project staff. It was set up within a very short timescale, initially addressing the 1,200 new headteachers taking up posts in 2000 and subsequently extending to all.

Led by Leonie Ramondt, Carole Chapman and Stephen Powell, the Talking Heads project drew on experienced Ultranauts from the Tesco Schoolnet and Mpowernet projects and laid the foundation for the Ultraversity project in 2003.

In 2001, Virtual Heads was launched as an online learning community for school staff studying for the NPQH. The introductory CD-ROM was developed further to incorporate new material addressing their needs.

> **Reflection**: This project was the first managed directly within Ultralab that involved so many participants nationwide, and in my position as effective deputy head of Ultralab I was aware of a real step up in responsibility and impact. Matters of ethics, organisation and communication became paramount in this large-scale action research.
>
> **Contribution**: I helped set up the project initially, developing the database of participants and continued to act as a mentor to the personnel involved. I also designed and developed the interactive multimedia and carried out the technical production of the CD-ROM, applying my knowledge of multiple text tracks and interactivity in Quicktime. My part: 5% (with Stephen Heppell, Leonie Ramondt, Carole Chapman, Stephen Powell and others)
>
> **Originality, impact and importance**: These projects devised new online facilitation for the busiest of professionals as they led schools. It opened new channels of communication for heads who otherwise

were rarely in contact with each other and who were distributed throughout the UK. The learning conversations that resulted lead directly to school improvement and the project laid the foundations for the National College's practice for years to come.

Filed under: claim project

[C15] Summer School

Jul 01, 2000 to Jul 31, 2006

A six year collaboration started with the South East of England Virtual Education Action Zone and the Victoria & Albert Museum to establish and promote the capabilities in young people for digital creativity using technology.

> **Aim**: To develop informal learning for digital creativity through student video production.Reflection: The project and its many preparatory events provided me with the opportunity to discover the potential for alternate genre and media for young people to communicate ideas. Later workshops showed that this also suited adults. This provided a basis for adoption of the patchwork media model in work-focussed learning.

This digital creativity project invited students to make short films on the basis of a themed challenge. Each year, young people in small groups from schools in the south east of England took part in their summer holidays. A one-day kick off meeting in Ultralab set the scene and familiarised them with the equipment and video-editing tools process. A second day was used to polish and present in friendly circumstances before taking over the theatre in the V&A in London to exhibit all the work to a wider audience, often including television executives. Finally Ultralab prepared a DVD which was distributed widely to disseminate the work.

This project could not have taken place without many years of experimentation with digital tools and many one-off workshops with the schools we invited to join us in Ultralab, and later, the extension of the project to international (Thailand, Scotland and Northern Ireland) and other age groups.

All of this experience set the scene for the Input CBBC project, in which the Children's BBC channel investigated the conditions under which children's work might be sought for broadcast.

> **Contribution**: My role was to prepare the ground for understanding what could be achieved with new digital creativity tools and help articulate this in collaboration with colleagues in Ultralab, and when the Summer School project took off, to observe its results and feed them in to subsequent work. My part: 10% (with Stephen Heppell, Matthew Eaves and others)
>
> **Originality, impact and importance**: his approach had been a hallmark of Ultralab's approach to new digital media since the early nineties, but was refined to include unique and key features of student-led creativity and mutual celebration, including the production of a DVD with all the outputs. This DVD was widely circulated to make impact on the children's creativity community. I am particularly proud of having led the Summer School with youth groups in Belfast. This was held in the week leading up to the 12th July parades which were catalysts for trouble. Our colleagues in Belfast pointed out that we had successfully retained the interest and celebrated the talent amongst teenagers collaborating from both sides who would otherwise be engaged in building bonfires.

Filed under: claim project

[C16] Input CBBC

Oct 01, 2002 to Feb 28, 2003

A collaboration between Children's BBC Television and Ultralab to explore the future of kids TV. Computers and digital video cameras were placed in schools, community and learning centres across the North of England to find out what television could be like if children were to make it themselves.

> **Aim**: To design the support web site to explore the potential for students' creativity with video to be broadcast.Reflection: Although Ultralab had shown that young people were capable of this kind of creativity, we were challenged by working with other adults and young children from a range of backgrounds and the BBC's sense of propriety, health and safety and risk analysis.

From the final report of the project:

> **SUMMARY**
>
> Input CBBC was a research pilot project which ran from October 2002 to February 2003, developed by CBBC, in collaboration with Ultralab, a research centre of Anglia Polytechnic University. It encouraged a group of children who'd never made a film before to produce their own output. It attempted to give children control at every stage of the process - from idea through editing to screen. It aimed to investigate the best ways to encourage such output, thinking ahead to a future where these methods could potentially be used on projects with bigger scale. Further pilots could also test the viability of children constructing whole magazines for themselves on broadband, with some content produced by them, other content being professional items.
>
> It was known from the start that Input CBBC would be a tall order - the aim was to test its ideas harshly - to see if any child, with no special ability or ambition, could succeed at filmmaking with little guidance.
>
> Forty children in Sheffield and twenty four in Hull, aged ten to fourteen, took part, working in groups of around four. The pilot was conducted "at arm's length", through established institutions, such as schools, community groups and City Learning Centres, with each group of children supervised by an approved responsible adult. The adult's role was to organise film-making sessions, keep children safe, provide limited technological help if the children got stuck - but not to interfere in the creative process.
>
> The children were introduced to digital cameras and to the editing package called iMovie by CBBC and Ultralab, then encouraged to learn through play and experimentation. They were made aware of important aspects about making a film, such as safety, copyright and editorial considerations. Amongst other methods of support available, Ultralab developed a prototype website, which also acted as a base for information and contact.
>
> **Final Conclusions**
>
> So, to conclude

- this was an experiment - and it was tested really harshly - but still came up with results. It has proved that when children get their hands on equipment they are clearly producing media that is of value to them, for the first time.
- the children and adults were co-researchers, keeping logbooks, doing interviews, being filmed. The research and their films are proving fascinating.
- Input CBBC encouraged some more voices and empowered a group of children to make films
- the other stated aims, of investigating and learning from how best to encourage this material, were met.
- the project established ways of handling health and safety issues and rights management for user-generated CBBC projects at arms length

Input CBBC helped some children see television with new eyes:

- First child: “We know how hard it is to make the films and stuff.”
- Second child: “You just watch TV and like you don’t like see all the work that has been put into it.”
- First child (of a different group): “I take a bit of sympathy with people who have the worst parts.”
- Second child: “Yeh like soaps that have to make four half hour ones every week and it took us three months to do one minute, but they probably have millions of people.”

Input CBBC has proved children can be creators of content - and these are not children with special abilities or a burning ambition to make films - and they come from many different communities.

But it is not easy for children to produce films, because of the factors described earlier in this report

The jury is still out about the true extent that children may in the future be able to contribute en masse to programmes, much as they send letters and pictures in now.

CBBC, as the country’s foremost broadcaster to and for children, remains the best place to give children a voice on television. It is a stated aim that “your input is our output” and this project has fed that aim.

Finally, it is not just broadcasters who have learnt from this experience. Input CBBC has proved that filmmaking is a journey of growing self-discovery, self-expression, self-discovery and confidence building for the children concerned:

- “Working as a team gets you a lot further than working by yourself.”
- “I’ve learnt how to work as a group. I’ve never done that before. I’ve always wanted to be on my own which is my fault. I’ve learnt to be as a group, to be a good team-member.”
- “I’ve learnt not to get frustrated when I want to use the computer and someone else is using it.”
- “I can be hard to work with sometimes, very stubborn.”
- “I’ve learnt not to get in a moody as such but to join in with the fun.”
- “I kinda liked doing everything but I don’t think I would have been able to do it on my own - we needed each other.”

Contribution: I took the role of co-leader at Ultralab developing the key values, participant action research approach and philosophy, working with the CBBC Future TV section at the BBC. I took on the visual and information design challenge of presenting help, templates and guidance in a child friendly web-site whilst maintaining a connection to the CBBC's visual style. My part: 25% (with Matthew Eaves and others)

Originality, impact and importance: The project was quite new for a national broadcaster to take a serious view of children's digital creativity. Its impact was on the BBC itself in determining its future policies and confirming the research outcomes from earlier Ultralab projects.

Filed under: claim project

[C17] QCA - An Investigation Into Pupils' Creativity Across The Curriculum

Nov 01, 2002 to Mar 31, 2003

I contributed to this UK Qualifications and Curriculum Authority consultation as a member of a panel contracted to synthesise clearer ideas about ICT and creativity towards the end of a wider effort to consider creativity across the curriculum from 2000-2003

> **Aim**: To clarify criteria that explain why technology enhances creativity in learning.Reflection: The summary table at the end of this article was developed by the QCA project to characterise creativity and the rôle of ICT. The development of all of these ideas, in the company of several colleagues who I highly rated for their thinking, gave me confidence in the usefulness of my analysis of the potential contribution of ICT, as my work provided a major part of the 'Features of ICT' column in the table.

This is the original brief for the work:

> **Brief**
>
> An Investigation Into Pupils' Creativity Across The Curriculum 2000 – 2003
>
> Contractor: Richard Millwood (Ultralab) - Budget Code: Fee: £2000 - Deadline: 24 January 2003
>
> **Context**
>
> In March 2003 QCA will be providing advice to Creativity Advisory Group (CAG), and then ultimately Ministers, on the potential of ICT for promoting creativity across the National Curriculum. We want your work to inform that advice.
>
> **Purpose**
>
> To clarify how and why pupils' creativity is promoted through their use of ICT to develop ideas and judge value and originality.
>
> **Requirements**
>
> Write a paper which:
>
> - Explains how and why this use of ICT promotes creativity, making reference to:
> - the effect of the relevant features of ICT;
> - the effect on pupils' creative thinking and behaviour;
> - the types of ICT applications used;
> - evidence of the effects of this use of ICT in practice.
> - Highlights the potential for this use of ICT to promote pupils' creativity.
> - Makes recommendations and raises key issues.
> - Critical Success factors
> - The paper:

- is written in plain English.
- covers the requirements above.
- can be used to inform advice to the CAG and Ministers on how and why ICT promotes creativity.
- is received by the deadline date.

Deadline

Send back the completed paper back to QCA by Monday the 24th of January.

Project Management

Seb Ross, QCA Subject Manager, will oversee the work of the contractor. Please also send the paper via e-mail to rosss@qca.org.uk.

Copyright

QCA owns all relevant data and material produced under this project. A note confirming that the contractor understands these terms and agrees to comply with them will be included in the contract.

My contribution:

An Investigation Into Pupils' Creativity Across The Curriculum 2000 – 2003

Contractor: Richard Millwood (Ultralab)

DRAFT 2 February 14th 2003

Introduction

It is commonly held that the basis for an innovative and financially healthy nation is the creativity of its adult population in the workplace.

"Our success depends upon mobilising even more effectively the imagination, creativity, skills and talents of all our people. And it depends on using that knowledge and understanding to build economic strength and social harmony,"

Charles Clarke, UK Secretary of State for Education

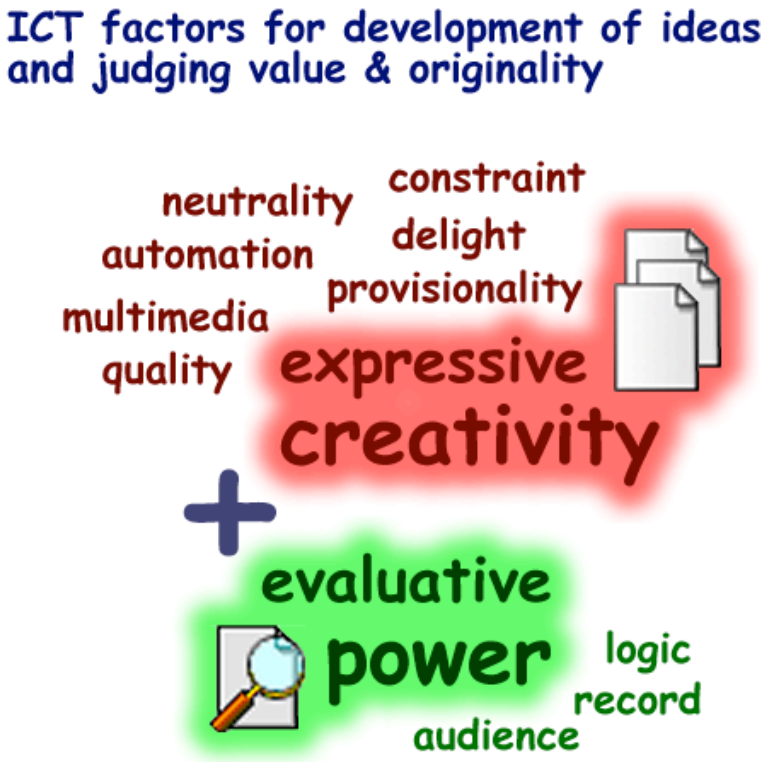
in the government's white paper 'The Future of Higher Education' January 2003

I argue that creativity is more important than that, and that it underpins all learning in the development of ideas and concepts and furthermore fulfilment in people's lives. As a natural part of everyday activity learners are creative in thought (as they listen, read or watch), natural expression (as they speak, play, perform or make) and more formal recorded expressions (as they write, diagram, prove or program a computer). Information & Communications Technology (ICT) can promote such expressive creativity in a number of ways to be described in this paper.

But expressive creativity has to be matched with evaluative power in order to develop ideas and to judge them for value and originality. ICT also has role to play in enhancing evaluative power. Normally

expressive creativity and evaluative power will happen in a cycle of improvement which ICT can enhance and maintain.

To summarise these concepts, the following diagram shows the factors in ICT which might enhance creativity both in expression and evaluation, and which are expanded and developed in this document:



Creativity in the wider context of classroom, school, community, nation or globe demands increasingly higher levels of originality as measured against these wider contexts and the contributions of increasing numbers.

Creativity at each of these levels of society, from individual to global is natural and instinctive, but is inhibited or enhanced by a number of interacting factors, some of which relate to competition and originality (winning or being unique), others to interpersonal and emotional relationships (valuation of oneself in relation to others) and yet more to skills and competence (ability to articulate creativity). Some of these factors are influenced by ICT, some are reduced in their effect as inhibitors and others enhanced by new opportunities.

It's important to note that ICT cannot act in this way without the complicity of teachers – they are also creative, but need that to be recognised. ICT is often introduced as a support mechanism for the delivery of knowledge, but in this analysis it has to be the tool for developing pupil's knowledge. Similarly teachers should be encouraged to see this perspective, of a tool culture rather than information culture. Thus teachers will not inhibit such use and indeed can join in the debate about the tool of ICT and how it is best used.

How ICT enhances expressive creativity

Neutrality

In a typical learning environment, students often have a stereotypical interpersonal relationship with those around them including peers and teachers. [Hargreaves 1975] This relationship often includes a judgemental factor, which both the student and the peer or teacher feel and which drives a particular negative behaviour: that of avoiding risks with intellectual ideas. This judgemental factor acts to prevent free expression, either because the student fears approbation or because they wish to please others, particularly the teacher, by seeking their answer already known to them but unknown to the student. This in turn inhibits development of new ideas – good teachers (and friends) know how to turn this judgemental factor off explicitly when appropriate.

With ICT equipment, as with other tools and vehicles, there is an imaginary interpersonal relationship (consider the way in which ships are often called 'she' and imagined to have a life of their own). After some acquaintance with computers over a period of time, young people see through any pretence of intelligence or life in a computer and thus begin to see it as a neutral tool which although it may offer canned feedback, is clearly incapable of judgement. Computers allow students to 'say things out loud', but without judging those things in an interpersonal manner. The computer is a silent helper in this sense and can be trusted with half-formed ideas and ideas which follow the students creative impulse.

Automation

A powerful spur to more complex expressions of ideas is the ability to re-express cheaply and repetitively. The potato print transforms a simple shape into a rich pattern, the 'automation' provided by this simple tool allows a variety of re-arrangements of the shape to be explored at low cost and with reliable quality.

Computers provide this kind of automation and much more, through copy and paste in almost every program, through formulae and 'Fill down' in a spreadsheet and, most important of all, through programming languages.

Arguably, programming has lead to the current information age, since all technologies related to ICT rely on computer programs to automate functions to a level where qualitative changes in education, the workplace and society as a whole have taken place and are still developing. This explosion in creativity ought to be more widely available to all learners in educational contexts, but suffers from a disregard for tools which is an endemic problem in our society [Owers 2001].

Multimedia

The capacity for learners to use multiple media through ICT increases the opportunity to work in alternate modalities to the predominant reading and writing. ICT simplifies the production of visual and aural media as well as making viewing and listening a more delightful engagement with material. Of even greater consequence is the potential for reconstruction in film, hypermedia (the establishment of networks of knowledge) and linear presentations. These are integrations of multiple media and are perhaps the most demanding of communications, not only anticipating audience viewing but also audience choice of sequence.

Quality

ICT media are unique in that little imprint of the creator's weakness in production are seen – perfect fonts, geometric accuracy and colour faithfulness permit the weakest of learners to produce material which compares, on the level of media quality, with that of the most experienced professional. This means that learners' self-esteem, which is so heavily knocked by poor handwriting, inaccurate drawing or inadequate oral skills, can be raised. This in turn encourages risk-taking and attention to the content of ideas – continuing engagement which can lead to judgements about higher-order issues on a level playing field.

Constraint

ICT tools can promote the development of ideas, paradoxically, by constraining the universe of possible expressions. In many of the arts, the choice of constraint can lead to greater fertility by focussing on specific aspects of ideas – this kind of limit can offer similar gains in ICT. In graphic programs, limits on the position of the cursor to a grid can lead to the rapid development of diagrams. In geometry programs in Maths, constraints can help learners see important connections and propose new interpretations of figures.

Delight

The computer frequently pleases, aesthetically and affectively, in a way that delights the learner. This positive mood is clearly valuable to creativity, as a means of sustaining motivation at the very least.

Provisionality

In order to embark on any piece of work of substance, a start has to be made – for many learners, making this start is difficult because making mistakes has such a disastrous effect on continuation. Many young people in schools use correction fluid to eradicate 'errors' as they perceive them, or resort to ripping pages out of books in order to achieve a 'perfect' copy. Provisionality is that certain knowledge that with a computer, one can begin developing ideas and, at little labour cost, perfect and re-draft those ideas with no evidence of the process. This means that for creativity, one can start recording ideas out of order, in draft form and incomplete. For many, this knowledge unlocks their ideas, which would otherwise not be worth expressing.

How ICT enhances evaluative power

Logic

Computers offer a powerful tool for certain ideas, which are developed in symbolic, formal languages. These include spreadsheet formulae, programming languages and database design. If these formal systems are used to develop ideas, then it is possible for the computer to 'execute' them and display their consequences. Often, in order to judge the success of an idea, this output can be compared to that anticipated and evaluation independent of a peer or teacher can take place. The programming language Logo has provided a powerful example of this effect, in some cases leading learners into extraordinary intellectual and creative endeavour. [Papert 1980]

Record

Most work on a computer can be saved for later perusal or saved at intervals to record drafts. In the development of ideas this can help learners see how their ideas have developed, or peers and teachers to understand and judge their value and originality. In the long term, work that has been saved in this way and compiled provides a portfolio of work. This portfolio can be used to represent the learner's capability, but also may be mined for new starting points by that learner in a much more accessible and labour saving way than with a traditional portfolio. New connections can be made between past work and present concerns – often surprising insights can be obtained, because ICT has recorded the work and allowed searching and indexing to take place.

Audience

ICT offers a number of ways to allow communication of ideas to take place, both deliberately and serendipitously. By using presentation tools, learners can show and defend their ideas to audiences in the whole classroom, potentially with access to to the whole body of their work (see Record above).

This kind of ICT use, using projectors or large screens in a classroom context, enhances another kind of creativity which may be teacher-led. This is described as 'interthinking' [Mercer 2002], where learners sharing a knowledge context and background, debate together, seeking each other's views and respecting diversity but also working towards consensus. The projected computer screen is a focus for representing the current state of the ideas being developed by the class. Some software has been specifically designed to benefit from this shared working knowledge [Millwood & Mladenova 1994], but all software can be used in this mode. It has many of the advantages described above for the individual, but now for the group e.g. quality, multimedia and provisionality. Each of these promote creativity to a far greater degree than a more traditional whiteboard.

By joining online communities through the Internet, a wider, but identified audience can be found for ideas and dialogue with others following the same interest can be informative in order to judge work. Publishing material on web pages permits the globe to take part in the evaluation of ideas and work. This is clearly potential audience not real audience, not all viewers will see or comment on such work. Nevertheless the power of potential audience to support both expression and evaluation is very real in the mind of the learner and can provide powerful motivational force and raise ambition.

Conclusion

The analysis of the development of ideas as a cycle of expressive creativity and evaluative power helps us identify key factors which ICT offers to promote such development, but also the judgement of both value and originality.

References

- Hargreaves, D.H., (1975), Interpersonal Relations and Education, Routledge & Kegan Paul.
- Owers, S.C. (2001), The Place And Perception Of Technology In The Curriculum, PhD thesis available at http://www.ultralab.net/tools/
- Papert, S. (1981) Mindstorms, Harvester Press.

- Mercer, N. (2002)
- Millwood R., Mladenova G., Modelling with ordinal data to support debate of subjective issues, proceedings of East-West conference Computer Technologies in Education part 2 p166, Crimea, Ukraine, 1994

QCA's Creativity Framework Taxonomy

Definition of Creativity	**Pupils Creative thinking and Behaviour**	**Use of ICT**	**Features of ICT**	**ICT Applications**
• Using imagination • A fashioning Process • Pursuing purpose • Being Original • Judging Value	• Questioning and Challenging • Making connections and Seeing relationships • Envisaging what might be • Playing with Ideas • Representing Ideas • Evaluating the effects of Ideas	• Making Connections • Creating and Making meaning • Publishing • Developing Ideas • Collaborating • Communicating • Creating a learning environment • Assessing	• Provisonality • Interactivity • Capacity • Range • Speed • Accuracy • Quality • Automation • Multi-modality • Neutrality • Social Credibility	• Information resources • Publishing and presenting software • Creative Software Tools • Simulations and Modelling • Programming and Control applications • Datalogging • Databases, Spreadsheets, graph plotters and graphical calculators • Programs that support learning in a specific context.
NACCCE: All our futures: Creativity, Culture and Education, 1999.	Taken from Creativity Pack information sheet 3 (September 2002)	Developed from: Draft Literature Review in Creativity, New Technologies and Learning – A report for Nesta FutureLab (A.M. Loveless October 2002)	Developed from ICT features defined by DFEE 1998 and R Millwood (Ultralab) presentation (October 2002)	Taken from: Key Stage 3 National Strategy – Framework for teaching ICTcapability: Years 7, 8, 9 (DFES 2002)

Contribution: From my report, the 'Features of ICT' section was adopted by the committee for the final Creativity Framework Taxonomy. My part: 20%

Originality, impact and importance: This was a synthesis of my original thinking and other sources including my experience as a designer in discussion with many others. This was newly articulated in print by me for this consultation and adopted by this national advisory body for advice on future curriculum thinking nationally.

Filed under: claim professional

[C18] Ultraversity Project

Jan 01, 2003 to Dec 31, 2006

Ultraversity was the degree course for those who university did not fit. The design allowed students to focus on their own work, negotiate learning, submit work created as part of their job in the form of assessment 'patches' using the genre and media which suited them, stitch a patchwork of such pieces to make a final submission, celebrate their dissertation through an exhibition and all supported by an online community of inquiry.

> **Aim**: To design and develop a new work-focussed online university experience to suit 'those for whom traditional university did not fit'.

Ultraversity was a new fully online work- focussed degree employing multiple innovations, with a curriculum and pedagogy created by a small team and further developed and delivered by a 20 strong team for which I had oversight as line-manager to the director. 144 students graduated in 2006, almost half with first-class honours degrees.

As well as developing a new experience for students, the project developed managerial, operational and team-teaching methods with a geographically distributed group of lecturers using its own online community of practice.

It was the subject of many conference presentations and publications and led to the invitation to create the Inter-Disciplinary Inquiry-Based Learning project at the University of Bolton in 2007.

But a real feel for its impact and unique features may be gained by listening to the students themselves - this video was filmed by Andrew Wood and Robin Cusick at the first major graduation event in November 2006. Together with Greta Mladenova, I transcribed and added text tracks for a transcript and for chapters for navigation.

The complete transcript of the movie is below:

> **Eve Thirkle & Sharon Sweeney**
>
> - Hi Eve, I'm Sharon, at last we get to meet.
> - Yes I've seen your name many times, but, not met.
> - I can't believe we're here, it's been, well getting to this stage, a total of three and a half years
> - Yes, it has been, hasn't it.
> - That first year doing our first assignment, I never thought I'd be here.
> - The first Christmas was dreadful, because I was up to all hours thinking 'oooh' why have I chosen to do this?
> - But it's been fantastic.
> - Well the opportunities I think it's now actually given me I've not realised until now,
> - how much it has actually changed things,
> - how when I look at my old job and things, and different things, then everything is so different.

- You're ICT aren't you?
- I do ICT and I'm now doing High Level TA
- and doing other, I seem to be being pulled to doing other support things this time
- it's opened quite a few doors, that I would never have had opened without it
- and doing other distance learning, this has been so much more supportive in comparison
- The community has been fantastic, hasn't it.
- I wouldn't have survived without people like yourself
- Oh, thank you!
- and staff here, especially in the first year I found it really tough on different things and stuff
- but people like yourself kept us going and stuff and it became a team
- and although we never met, I think we're actually stronger as a team.
- We know each other, but we've never met and it's weird.
- And you could mention about fun things, and we did have some fun online with different things and stuff
- The celebration on the last night was quite funny as well
- That was good wasn't it
- We had like a party online.
- Well for me it hasn't done so much in job, though, obviously because I'm a parent
- But it's made a difference in the way I look at what I do as a parent
- and it's always there in the back of my mind, sort of, "ah I'm doing that"
- and then I start to think "ah yes", and it's putting that reflection into practice is amazing
- and makes quite a difference.
- You get a sense of achievement, and when I looked at my first work, and how it was put together
- and look in comparison at the end
- I know
- You realise that you can still learn more, you can take on more roles
- I think the way it works gradually, you weren't given more than you could handle at the start
- although it seemed like it sometimes
- and then to the work that you produce in year three, it's amazing growth
- When we went through today and got the gowns and I was getting the gown on
- this gentleman Les who put the gown on me, as he was putting it on I was flooding with tears
- I knew not to wear make up, because it just meant so much
- the idea was, you know, I would love to have had a degree in earlier life, and never got the chance
- Same here
- and then to do this has just been amazing
- and to see the other people and now we're all going round looking at names and different stuff
- but I'm finding that its actually making contact, because I've met up with a few other people through other things in education now
- Yeah, Well I came straight up the stairs here from reception, saw Glenda and went 'haaa'!
- Because it's so great to sort of see the faces, see them in person, it's great
- I think sometimes as well, we some of us did put our pictures up, but then we get to here, em
- You forget, yeah

- I was thinking about my group, that we actually worked in a small group, and I knew their names off by heart
- and I've got here today, and I can't think of them, its awful
- so I'm sort of looking, but I know the names will trigger
- Yeah, yeah once you see them
- It's just unbelievable to be here.
- And we've got that walk across to get our certificates
- I know, I've got, I've had to get new glasses since doing this
- because I've actually found my eyesight's sort of being going with age a bit
- but I'm not wearing my varifocals today because I'll be tripping up the stairs and different stuff
- the actual meeting people and stuff has given me the confidence to now go and do more
- and why can't I? and why, you know, it has to be a really good reason why I can't do something now
- I found school and things are asking me for things about autism and things, because obviously that's what I've gone into
- and the head the other week asked me something about that she didn't actually know
- and I could inform her on it, which was brilliant
- And when I did my exhibition it was quite interesting when I had some of the like parents coming in
- and some who were graduates and stuff
- and they'd done a small part about reflection in their degree, and the research a small part
- they said "You've done your whole degree through that, how did you manage it?"
- I said well, we did!
- It's a fantastic tool to actually have
- For me, it has had an effect on the school through my research, through the project I did
- We have changed some of the things we're doing now
- and you think, "I did that!"
- I'm going to actually see if I can follow it through a bit more
- I don't know what I'm going to do next
- but look just to see how that has affected the learning
- Next step masters?
- Well I think no at first and my husband said no
- My husband said no as well
- I wondered how I fitted in the time, but everyone says I would find that time again
- I think I would, because the rewards I have personally got out of it, it's worth it for me, if nothing else.
- It would repay our family if I went on and did work on autism as well, so...
- OK, thank you very much.

- I have been a teaching assistant for about 12 years
- Yes, the same as me.
- 12 years is a long time to be a teaching assistant.
- When you see that you do a lot better job than some supply teachers that the school bring in
- So, that is what I started off with.
- Having said that, now that I've done the degree, I do not want to go into teaching.
- Too much hard work, too much paperwork
- Yes.
- But, I'd say it's had an impact on my workplace.
- What school do you go to?
- I was a senior teaching assistant in an autistic school for autistic children when I finished my degree.
- and as a result of it, I was given an unqualified teachers' post
- so I was employed to teach, even though I wasn't a qualified teacher.
- And plan activities: take the pupils out and do things.
- But now, since I've qualified, I've been accepted onto the graduate teacher programme
- and I'm training as a primary school teacher
- I work in a primary. With Key Stage 1, 2?
- I'm with Key Stage 2 at the moment but after Christmas, I'll be with Key Stage 1.
- Prefer Key Stage 1? Teaching primary? Or Key Stage 2?
- I like them both actually. Because they are slightly different, aren't they.
- But I think I like the older ones more.
- Well I did, as part of the degree we did the exhibition, the final exhibition
- senior management team saw me as an organiser, somebody who can work ICT
- so what they've decided to put me into is Learning Resource Centre at the Primary School.
- so I'm now looking after the Library and the learning resources for the school, which is quite a big impact.
- I'm sure if I'd just done teaching assistant, I will still be a teaching assistant.
- But it's done. Gone that far.
- Through the degree then you've been able to show them that you're more than just a teaching assistant,
- You've got more skills, than just
- and you can go around and say "Now I am a graduate." Got the piece of paper that says I am a graduate,
- which was what was stopping me from being a, becoming a teacher in the first place.
- The thing is, with becoming a teacher now, it's becoming more challenging
- because you now you need literacy, numeracy and science at GCSE level,
- which I'm OK with literacy and numeracy, science is not my subject
- so, maybe
- maybe in the future
- in the future, maybe. I might go to take GCSE in Biology or something and then do it

- we could do it before now
- yes but now they have changed...
- but the Age Discrimination Act came from 1st October, so everybody has to have a GCSE in Science now.

Sally Houghton & Helen Smith

- OK. Several of my research projects were obviously based at work,
- but my last one was about introducing new strategies to reduce barriers to enable in life style interventions groups
- and as a result of that, there's lots of changes that were made to the sessions
- and I learnt a huge amount about running focus groups
- and I think it was good because it involved genuine consultation with the patients and they felt they'd been listened to as well
- and the actual changes every single suggestion that they made and intervention was based on what they'd had to say about it.
- So then they were able to see, so I think it just restores a bit of faith really in that proper patient-public involvement
- yeah, it was really good, though that it was work-based, wasn't it and you could do
- because I managed to tie mine into a big project I was doing at work anyway,
- so the fact that I could tie it in, meant it was easier for me to do and I could justify doing some of it in work time as well.
- But I did a piece about NVQs and quality assurance and trying to tie in the impact that training has on service.
- so I mean, it kind, there are some long term effects, I think
- around the fact that everybody became a lot more aware about evaluating training
- rather than just saying whether it was good or bad or indifferent.
- and about actually what the difference is to patients, which I know is something that you tried to tie in as well, wasn't it?
- But the NVQ funding has run out, so that's kind of been a bit of a negative side to it but that's outside of control anyway, so you know...
- but it was a really good thing to be involved in and my confidence at work is much more increased
- because I am dealing with lots of different people now, whereas before it was always training people.
- What about you?
- As a result of the exhibition that we did in the final year, the team of people I part coordinate with
- to give life style intervention advice increased, 'cause people, we needed new members but
- that opportunity to exhibit to them gave them an insight more into what the programme's about
- so in the end they volunteered to be be involved which is nice because I think they realised that they were doing something worthwhile
- It's really hard to get other people involved otherwise, isn't it?
- definitely, definitely...

- and I think like you say about evaluation it is actually giving me more confidence in evaluating other people's work
- in courses that I have been to, I have been confident to be critical really, so hopefully
- give them some useful suggestions.
- yeah... I mean, a bit of a spin-off for me was because I'd done so much around like reflection and learning styles,
- is that I now run all of the team development sessions for our teams,
- so that was something quite unexpected but I am really enjoying that and that's what I want to do next.
- I want to do something around organisational development
- But actually, I recently applied for a job in a college and I played on that the study that we've done into learning styles
- and I think that is probably one of the reasons I ended up getting the job,
- and they did say, you know: "What's the most memorable thing you've achieved in the last 12 months?"
- and it was really nice to say: "Well, I've got a degree."
- Not many people able to say that, so
- No, no... I mean that's significant when you talk to people
- and you say "Oh yeah I did it in three years - and I worked".

Sarah Brown & someone

- So, how did you find the degree?
- For work it's been really, really useful, especially the third year. The organisation is going through merger
- and so I concentrated my final action research on a communication tool for staff
- and that's proved really, really popular. We decided to do something that was web based
- so that if you are at work or if you are at home you can actually access information about the merger
- and especially now we've got all the jobs coming out, I've been able to sit at home,
- look at jobs and apply for jobs. So that's been really good.
- I think thats been the best bit for me about the degree as well, is that I have been able to use all my work that I was doing at work
- and actually sort of go deeper into it than perhaps I would have been able to have done on a general day-to-day basis.
- So, and it's helped, you know all the staff I was doing it around the knowledge and skills framework
- and I produced a leaflet which they've now found very useful now that they're having to use it,
- so that's been good. And I think other people have realised about the degree
- and I had lots of congratulations and that, so it's been good.
- Yeah, and I think as well, it's the fact that with the sort of action research every time I think of something now,
- I was watching Robots, the video, and it was going about find a need, fill a need
- and that's how I think now: what's the problem and how can we actually get over it

- and I am doing some work with the Department of Health at the moment,
- and whereas before I would have just gone: right, OK, let's do it,
- I'm going: hang on a minute, is this the right thing to do? what do we need to do? how do we need to accomplish it?
- is this the right way of doing it? and asking a lot more questions, which I don't think before I may have actually done
- I might have just gone: vro-oom, let's get in there.
- Do you think the degree has got you into that work with the Department of Health?
- Would you have felt that confident to have done it before?
- Probably... I would have worked with them, but I don't think I would have been so, I say, critical
- positively critical about about what's been asked of us. I think beforehand, I would have just accepted things,
- whereas now I question absolutely everything, which I don't know, it sometimes gets me into a bit of trouble.
- but I think, you know that's what it's about, isn't it? So, yeah, on that count it's been really good.
- Is it helping you with the merger, 'cause I know with us we are going through major changes
- everyone's applying for jobs and that, to suddenly show that you've got a degree is making quite a difference
- Yes, it has. Yeah, definitely. Because once I, even at my band you need a degree, so that's fantastic
- The sort of the downside is: anything higher, I need a Masters
- That's what I have noticed the other day: it said, you know, you had to have a degree, desirable is a Masters or studying towards it.
- Exactly, yeah. So really to be at the band I am, I need a BA which I've now got, which is really, really good.
- And it's made me think about what I want to do in the future a lot more, because my job isn't about teaching
- but there's lots of things I can do with teaching people how to do things.
- And I sort of did, for the second year, I did a training guide and I am doing a lot more training just even internally,
- and that's the sort of way I think I want to go.
- Do you think you will carry on your education now?
- Well, I've thought about teaching for two seconds, until I realised it will be little children
- But yeah no, I'm seriously thinking about that now, so will see what happens.
- And what about you?
- It's helped, yes.

Pauline Eustace-Day & someone

- How are you feeling, Pauline?
- Well, I am more excited than I thought I was going be actually. I was quite calm this morning.
- And now I am here, it's lovely, it's absolutely lovely. I feel, we have really done it today coming here, yeah.
- Do you know, the people look so different.

- I know, I know. I have been looking at everybody's name tags and trying to put the faces to the names.
- And it has been quite strange, really. But everyone's so friendly, even though we've never met in person,
- it's really lovely
- Will we do it again?
- No, I don't think I ever want to do it again. It was very stressful, but now it's all over with I'm just so proud of myself, yeah.
- What about you?
- I do, I'm excited, I like the hat after all, I think I'll take it home with me.
- Yeah.
- And the community, it's just so strange thinking we finally all got together and everyone actually, everyone is
- Everyone's real.
- Everyone's real and most people are our age. I was expecting, I don't know what I was expecting.
- A lot people to be younger perhaps, but they're all our age which I think is great.
- So the old birds can do it.
- Yeah. Well, I don't know really what else to say, except that I'm so excited.
- I'm so excited today. It is lovely.
- Well I'll take lots of photos.
- Yeah. That's it. Sorry.

Phillip McCann & Colin Shaw

- So what did you study online?
- What did I study online?
- Why?
- Why... I actually studied online simply because one, I have essential skills problems and also dyslexia
- and found Ultraversity was a very good way to study using technology
- and therefore could use my weakness as a strength to study
- Yeah, I found that. I've done it because I just felt that I could go in whenever I wanted to
- I can put the time in when I wanted to and I wasn't in that set routine
- when you have to go to a college or university for those set lectures, so that is why I studied online.
- And that is actually a very good benefit, because like yourself, I mean, as I said I had the essential skills issue
- but again I was able to come in, cope and do the work at times that suited me and family
- because I was there to care for one of the family members and I find that studying online at times was a godsend.
- And I think for the workplace there is a benefit because they don't have to release you during work time,
- because do you find you've got any time at work?

- I actually got no time off of work at all, so any work I've done was done at home or in my own time
- and obviously that was an advantage to use Ultraversity to do so.
- Yeah, I found that as well, very beneficial.

Barbara James & Shirley Murison

- OK
- Yeah, I think the last year did help us go on when we were online
- I definitely think that the interaction between all the members in our learning set was beneficial
- it was useful to bounce different ideas off people,
- it was useful to have some feedback from other students about the work we were doing,
- and I don't think, I think without that interaction we would have found it very difficult to continue
- through to the end and to succeed as we have.
- I think the online community, it helped you, you didn't feel so isolated
- because when people, other researchers had problems they posted it
- and you could, you could connect to their problems.
- I agree with you and I think there were many people online who were very supportive
- and were always there to give advice and to give critical feedback when it was needed
- I think I would have found it very difficult, especially the last year
- if I hadn't had people in my learning set questioning what I'd written
- and giving me the opportunity to answer their sort of criticisms with my own thoughts and feelings
- and in that way I think my overall performance improved because of it.
- Yes, I also think as well where sometimes I used to think that you had a small little silly problem
- somebody would post the same problem and I'd think, ahh, you could relate, really relate to it.
- and definitely the criticism that you had, the constructive criticism helped you in especially in the last year
- Yes, I agree.
- with your reflection
- It was very difficult to take sometimes
- you know, it was, you would feel quite sort of hurt sometimes by it, but you overcame it and you moved on
- and you were definitely improved because of it.
- What surprised me was the friendliness that developed on the online community
- and though you've never met a lot of the people
- you felt that with the postings, that you did really get to know them.
- Yes, they became your friends
- And for us in the management community we actually met several times over the period of the three years.
- and I made life-long friends through being on the online community and I think that's wonderful, you know.
- One of the benefits I also found was when you're insular in your own school, you also read the problems that are in other schools
- and you could, you could identify with them and it made you realise well you're not alone.

- No but in many schools, all school communities are quite similar
- and that the degree and actually talking to people about the degree you realise that
- you were sort of a valued member of the community in which you work.
- Enough, is that enough?

Jill Felton

- You have a different journey, so would you like to tell us about it?
- Yes, well I was an LSA in my local primary school where my children went for about 10 years
- and they always encouraged me to be, to go into teaching because I used to teach groups as an LSA,
- I wasn't actually a classroom based LSA
- then I found out from my staffroom for this degree
- and in the third year of my degree, I managed to get a place on the Registered Teacher Programme
- and with the wisdom of my school, at the same time they actually gave me a class to teach at the same time,
- so I was teaching a Year 5 class doing the third year of this degree
- and as I say, I started a Registered Teacher Programme, so I was doing sort of three things at the same time,
- which was quite hard but I managed to get through the year, and I am also a mum of four children as well.
- It was very hard, but the support of the people on my learning set was fantastic
- They were all saying "Are you mad? Can you fit anything else into your life?"
- But after the degree finished, they then fast-tracked me on to the GTP which is the Graduate Teacher Programme,
- and I am due to qualify as a teacher after Christmas.
- So I literally finished my degree in July and I will be qualified as a class teacher,
- although I have been teaching as an unqualified teacher for virtually two years now.
- So it is a really special achievement today, then?
- Yes, I was really pleased actually to get a first as well, I was amazed.
- I mean, it did take a lot of hard work, and tears sometimes and the support of my family was fantastic.
- But, yeah I am really pleased to have made the journey and got there in the end, so yeah, it is fantastic.
- Thank you.

Denise Binks

- Hello, I am Denise Binks. Hello, I am Denise Binks. I've... I really don't know what to say, we really have to start thinking what to say really.
- To begin, when did you first found out about this degree?
- Shall I start off by when I was a child?
- Because when I was a child, I really wanted to do a degree
- but I had to leave school and start work, that was the culture of my family

- and so I then went into working for a travel agent, I was a travel agent for quite some time
- and I did my exams for travel agencies. But then I had a career break to have the children
- and at that point when I wanted to go back to work, I had no qualifications to show exactly what I could do.
- So it was then that I found a leaflet on my desk about the Ultraversity
- and it seemed the obvious answer for me, because it meant that I could still continue to work but at the same time do the degree.
- So I took the first steps into doing the degree.
- I found it very good, because it was using my skills in workplace and therefore it was workplace orientated
- and we could structure the degree around what we were doing in the work. So it didn't feel as though I was doing two things
- and I also found the online community was very good because it meant that we could find we were all there together
- there are other people like myself who had children, who were out at work and they pushed me on,
- so when I said "I can't do this because I've got the children",
- I found that I was doing it because other people were in the same boat as I was.
- Can you tell us about your role?
- I started off as ICT technician, LSA, and at first I was simply looking after the computers
- my rôle has changed through doing the course I'm now an ICT teacher
- and I'm looking forward to trying to qualify as a fully qualified teacher.
- Thank you
- OK then, sorry.
- start telling me about the major gain doing the degree for you, OK?

Dean Ibbotson

- The degree helped me to gain my teacher status at my employment, George Dixon.
- I'd been going as a teaching assistant helping in mainly ICT and science.
- As I progressed through the degree, how can I put it, I gained some certain skills that I was using at work
- it helped me to gain confidence, and it just boosted me in my work, really.
- So I was put forward to possibly teach as an instructor
- I started teaching just one or two lessons on my own and now, this year, I was put forward to doing a full time teaching
- teaching, full time teaching science and ICT. So this is basically it.
- Any other questions? 23
- So when you left school, what kind of qualifications did you have?
- I left school with 11 GCSEs. I went to a college and studied PE and Geography at A-level.
- So I finished ending up with two A-levels coming from college and I was working on building sites initially!
- And then a friend of mine got me a job at the school where I work right now.

- After a year I have been at the school, I got on to the Ultraversity course and then it's just taken off from there to be fair.

Maureen Slack

- Tell me about your contribution then to the community.
- I personally got a lot out of it. I mean, I like speaking to people in an online community
- and I liked being able to help people. I chatted a lot online to people and emailed people
- and I felt that I was able to support other people who were perhaps less confident in online communities
- and I think, that they appreciated that. I got a lot of positive feedback from that.
- We all learnt from each other, and by opening up discussions in FirstClass, we got to know one another on a personal level
- which we then took a stage further by meeting up at various locations and that built up a really good relationship with other students.
- So, I felt that helped our learning experience because we trusted each other
- because we had met on the online community and then in person,
- we could share our work and our experiences perhaps at a deeper level.
- You also got humour into it.
- Oh yes, yeah, we had lots of laughs, I mean, we shared sort of funny emails and we talked about what we did at work
- and the silly things that the staff did at school to annoy us. We brought our own personal experiences in to it
- and all of that helped us to develop this sort of deeper relationship which I felt, personally helped my learning experience
- but I think also helped other people who were perhaps less confident.
- I mean, I could see over the three years how people's confidence grew, because we were such a friendly bunch of people
- and we got on so well together and we trusted each other.

someone & someone

- What do feel that you, that's been your major gain working with Ultraversity? What do you think you gained?
- Initially, the gain was being able to do a course while I've got two children and managing
- and also being able to work as well
- How did you manage the fitting in the course as well as working?
- Well I think that it makes you really good at time management because you have to juggle, haven't you?
- You've got to juggle your children and your workplace,
- but the great thing is, is learning from experience and taking that experience into …
- From everybody else's views, when you go online and you gain experience from everybody else's views
- … and work experience as well. You know, going in to work and sharing your experience with colleagues as well.

- Did you find that, that helped you?
- To be able to compare my experiences with their's and researcher's online
- it really helped me to re-learn what I already know, if you like, to confirm what I already know
- and then cascade that information back down to other work colleagues as well, to help them in their role
- I just could never envisage myself here, with a degree, because I always thought that I wasn't an academic
- because the books didn't mean much to me, but actually reading and then putting everything into work experience
- it came alive to me. Is that what happened to you?
- It did to me. And I think the main, that one of the things that really helped me when I was working with Ultraversity
- was the learning journal, logging everything down and every experience
- I still do that, do you? Do you still do that? Yes, I do.
- It's very hard to get out of that habit and I think it is a good learning curve
- to have that and to be able to refer back, whether it's written or whether it's tapes or whatever. You got it there and that helps.
- And it's great evidence as well, isn't it for everything you do: in the workplace, home learning, its great.

Michelle Townsend

- My name's Michelle Townsend and I've just recently achieved my degree in Learning Technology and Research through Ultraversity
- It was a difficult journey really, but manageable due, thanks to the support really of my family and also my work colleagues.
- I work in Grimsby, North East Lincolnshire at a children's' centre
- which is a Sure Start initiative run by the government.
- I was very well supported by the head of the centre throughout my degree, she actually paid for the training completely
- and was very supportive in any research that I needed to carry out during the degree.
- As a result of achieving this degree, I am now acting family services manager at the children's centre.
- A brief history of what of my life at the children's centre is:
- I went there in the year 2000 as a nursery nurse, working in kind of outreach work.
- I then became the training coordinator three years later,
- where I worked with parents and families to try and help them achieve their potential basically,
- helping them achieve literacy, numeracy skills, also helping them get back into the workplace.
- So it was a real rewarding but difficult task, as I work in one of the most deprived areas in the country.
- but you know, I am just really grateful that this route was available to me because
- it was a long-term aim of mine to achieve a degree,
- but there was no way I could afford to give up my job and go and study for three years full time.

- So when the flyer fell on the staffroom table, it was really you know the answer for me, it was the right route.
- And that is me, really.

Reflection: Through this project I consolidated my knowledge and developed new ideas for course design, modular frameworks, online community of practice, action inquiry as a pedagogic model and assessment through patchwork media and exhibition. I also helped developed concepts of business model & operational thinking, and as such it was the closest to the design of a new higher education institution that I had engaged in. I consider it to be the most significant project of all my experience, in that it successfully empowered many hundreds of students in meaningful and effective ways, delivering on the promise of technology enhanced learning.

Contribution: Initially, as part of a small team, I developed the documents for validation and designed strategy and materials for recruitment in 2003. I then had oversight of the direction of the Ultraversity Project in my role as Head of Ultralab from 2005 to 2007. I frequently took a practical developmental role, creating and designing resources, infrastructure, marketing, research and team collaboration as well as a refining a theoretical stance to champion the values and philosophy of the project. My part: 20% (with Stephen Heppell, Stephen Powell and many others)

Originality, impact and importance: This project combined unique elements into a completely new undergraduate opportunity. Its impact was felt deeply on the student's lives and on the researchers who made it possible. It influenced a wider academic community that drew inspiration from its success, and continues to be the subject of much interest today as well as a current course at Anglia Ruskin University. Its importance was recognised by newspapers, government ministers at the time and by organisations such as the Centre for Recording Achievement, who invited me to keynote at their conference to celebrate 10 years of the patchwork text.

Filed under: claim project

[C19] SCHOOL MATTERS – Happiest Days?

Mar 13, 2007

I presented this Teachers' TV programme and co-authored the script. I was recruited to this work after a long telephone conversation with the researcher about the concept of 'delight' which Ultralab had been promoting throughout its work in the previous decade.

> **Aim**: To research and develop the script and present a television programme discussing well-being in school education.

Link to video - http://www.tes.co.uk/teaching-resource/Teachers-TV-Happiest-Days-6049143/

Script:

> Parents often ask their children “What did you do at school today? Nothing?” How much does it matter for pupils and staff to enjoy school? In a recent report, Lord Layard claims that 1 in 3 families are affected by depression and that this costs the economy billions of pounds. The failure of well-being in the population at large is critical. Can the foundations of happiness be laid in schools?
>
> This programme looks at a range of strategies for developing well-being: We visit a primary school in Norfolk which has turned around behaviour and performance by adopting nurture principles … In Essex we see how self-assessment tools are helping pupils to analyse their capabilities and share responsibility for improvement … We look at new initiatives in the States that deal directly with issues of personal fulfilment … And we go to Liverpool where confidence and self-esteem humour are being developed through performance and humour.
>
> Our first example is of leadership throughout the school organising explicit opportunities for convivial social experiences and creative teamwork. These opportunities need just as much planning, know-how and commitment as any subject in the National Curriculum. It is the creation of a space for children to take responsibility and find their fulfilment which marks out this ‘nurture school’ approach.
>
> 5 years ago, St. Andrew’s Primary in North Pickenham was a problem school. Although located in a small village in rural Norfolk, St. Andrew’s pupils exhibited all the symptoms of urban deprivation. They were disruptive, and had low esteem and low expectations.
>
> Newly appointed Headteacher Jeni Barnacle realised she had to address the problems at a fundamental level.
>
> Jeni’s approach was based on the principles of Nurture Groups, which were originally designed as an intervention strategy. A basic nurture tenet is that education can only take place in the context of positive, human relationships. Jeni decided to take the bold step of applying nurture principles across her whole school.
>
> Nurture is essentially about creating an atmosphere of mutual respect and positive values. One of the most visible examples of that occurs at 1030 everyday, when lessons stop and all the classes sit down to a late breakfast.

Much of the teaching at St. Andrew's is centred on themes, rather than individual subjects, with lots of emphasis on a hands-on approach. Teachers and children are given the freedom to develop to the extent of their imaginations.

And parents have noticed the beneficial affects of the nurture scheme as well.

So a 'nurture school' approach helps children understand each other. But what about making sense of themselves? In our next example, secondary age pupils are identifying their strengths and weaknesses, and with that self-knowledge taking control of finding a balanced whole. In this way they share responsibility for their learning, and may develop capability to maintain a balanced attitude for the rest of their lives.

At King Harold School, in Waltham Abbey on the outskirts of London, Year-10 students are undergoing a process known as 'brain mapping'.

The questionnaire and subsequent analysis is based on principles developed at a university in South Africa for applications in the business community. Its use in schools however is a novel development.

Brain mapping attempts to associate a student's thought processes with different functional areas of the brain. The ultimate purpose of the analysis is to find out which particular areas dominate. The idea being that self-knowledge is an important route to personal fulfilment.

As this practice develops, school teachers will begin to note the pupils' self-analysis and use it to plan the curriculum. At Strath Haven School in the United States, the curriculum is being developed to affirm young peoples' lives and help them celebrate positive experiences. This recognises that being young does not prevent you from enjoying life and that learning is also about the self.

At Strath Haven, experimental positive psychology courses have been on the agenda for the last three years.

Today, teacher Kevin Haney is running a refresher session with students he first taught 3 years ago, when they were in 9th Grade. He is developing optimism skills – encouraging students to respond to adversity in a positive way. He starts by exploring the theme of gratitude.

Kevin's English class is just one example of how positive psychology can be introduced into the curriculum. Psychologist Jane Gillham explains what it is all about.

Next year Jane and her team will be bringing positive psychology to some schools on Tyneside, as part of a pioneering, resiliency programme.

This responsibility – to take charge – has been taken to the limit in Liverpool, where everyone has the chance to stand up in front of the class and perform.

At Alsop High School in Liverpool something rather remarkable is about to take place. A select audience of parents, teachers and friends has been invited to an evening of stand-up comedy. The show is compered by professional comedian Steph Davies.

But the evening is really about 8 pupils that Steph has been mentoring for the last term.

Alan and his fellow comedians are undergoing an experience which Deputy Headteacher Paul Dickinson believes will have a profound, lasting effect.

The project is supported by Creative Partnerships and the Liverpool Comedy Trust, with the aim of building confidence among pupils.

Liverpool lays claim to being the home of English comedy, so it is no surprise that a Liverpudlian school should be the centre of this education experiment.

… which is why, 8 weeks ago, comedy tutor Steph Davies was invited to become a temporary member of staff.

Over the course of her workshops, Steph's aim was to bring out the best in everyone.

And that confidence is there for everyone in the audience to see.

For the comics and their families the evening is a huge success and Alison is delighted.

It is not just pupils who have come under Steph's influence. She is working with selected members of staff to help them develop comedy techniques for use in their lessons. But there is a serious side to the project.

My view is that a knowing happiness is key to intellectual fulfilment. But happiness is also an entitlement – it relieves the anxiety around taking risks with big ideas, which is at the root of creative learning. In this way, in the examples we have seen of schools deliberately planning for well-being, happiness can be seen as central to effective learning. This should become a responsibility for all schools and executed with all the rigour offered to planning subject knowledge. Happy with that? I am!

Reflection: Responding to the challenge posed by the programme's researcher - 'What do you mean by delight?' - led me to clarify the foundations of my thinking about affect in education which had tacitly influenced the design practice I was carrying out. It later led to the development of my 'Analysis of Delight' poster, based on John Heron's work and my own ideas. (Heron, 1992)

Contribution: I provided a design practitioner's perspective to the programme maker's research, and articulated the ideas by editing the script and acting as presenter for the programme. My part: 25%

Originality, impact and importance: This television program was a new synthesis of ideas about well-being in schools - it was published on Teachers' TV and viewed and reviewed by many teachers. Its importance is in the way it links well-being with effectiveness in learning.

Filed under: claim publication

[C20] Inter-Disciplinary Inquiry-Based Learning (IDIBL)

Aug 01, 2007 to Jul 31, 2013

Development of a framework model for undergraduate and postgraduate work-focussed learning based on the Ultraversity work, but intended to support curriculum innovation throughout the University of Bolton.

> **Aim**: To design and develop a whole university framework for work focussed learning.

The rationale offered for validation of the framework in 2008:

> The inter-disciplinary inquiry-based learning framework (IDIBL) provides a pedagogic, organisational and assessment structure which can be used as a basis for course approval through modification of appropriate sections in this document by departments who identify an opportunity for an inquiry-based, work-focussed programme.
>
> This should provide an agile procedure for introducing new courses, which intend using the innovative approaches developed for IDIBL. It remains for each course validation to identify a rationale for professional engagement, viability and delivery.
>
> The framework is designed to offer a combination of pedagogical approaches, which together provide a different route for academic study and appeal to people who are committed to their. The course will widen participation by satisfying learners' whose need is for flexibility with time, place and pedagogy. More specifically this could be because:
>
> - They need to continue in full-time paid employment whilst they study;
> - They wish to make their study directly relevant to their work;
> - Family commitments prevent their on-campus attendance;
> - Geographical location or poor transport links makes campus attendance difficult;
> - They seek to develop further their communicative creativity and technological understanding as a complete professional;
> - Traditional examinations and academic essay writing are either intimidating or uninviting;
> - They seek the company, support and intellectual challenge of fellow students rather than studying alone;
> - They seek the advantage offered by technology to enjoy the possibility of work on joint ventures and studying collaboratively.
>
> The modules contained within the framework focus on process, and generic concepts and outcomes rather than subject content. Through a process of negotiation between the individual learner and the course staff, a personalised inquiry will be developed to include learning activities and assessment products that meet the module requirements and informed by the learners' professional practice. All learners in a cohort will be carrying out their inquiries and develop assessment products to the same set of milestones. Thus they are expected to provide support and challenge to each other and travel a

common path in spite of the personalisation of their study. The design encourages different perspectives from diverse professional and academic disciplines to be exchanged.

Learners will align and defend their attainment against module learning outcomes and with reference to competencies or national standards relevant to their work context. Learners are expected to look critically at their work setting as a source of knowledge and experience from their own experience, colleagues' experience and reference documents. This approach puts responsibility on the learner to maximise their effectiveness and efficiency through reflection on their work practice scaffolded by module requirements that are intentionally directed to enhance the quality and outcomes of work.

The framework is designed to enable progression by learners from a Foundation Certificate of CPD at level 3 through to level 7 Masters course. Common throughout the framework is an inquiry-led, work-based approach to learning that meets students' progression and continuity needs throughout.

There is a growing realisation that practitioner knowledge can inform academic knowledge. This proposal recognises and supports a realignment of knowledge acquisition and sharing and a re-alignment of roles for staff in higher education and the practitioner in society.

As a backdrop, the 2006 Leitch report examines the UK's long-term skills needs and identifies increasing employer investment in higher level qualifications to meet the target of more than 40% of adults skilled to graduate level up from 29% in 2005. The approach outlined in this document is one route that should be attractive to employers and employees alike in that it offers a cost effective approach for students as they can gain their qualification at a full-time rate of study. It is attractive to employers as the focus of student study is directly related to improving their work performance.

The development and outcomes of this work are more fully reported on the Work Focussed Learning web site - http://wflearning.org/

Reflection: Developing the IDIBL project meant taking a successful project, Ultraversity, and attempting to make it a whole university development – a huge challenge. Explaining the various aspects of this challenge meant exploring new theoretical perspectives and articulating the rationale for the model we designed for peer-review. This included learning about cybernetic theory, patchwork media, organisational analysis, change processes and disruptive innovation and analysing the findings of the project in this light. The approach was of participant action research and methods of survey, interview and interpretive phenomenological analysis were applied to the evaluation phases of the cyclical inquiry.

Contribution: My role was of co-developer, working closely to establish aims & values, design the curriculum, seek validation, organise, teach & mark work, operate quality mechanisms. I also designed the web site and fliers for marketing, sought meetings with stakeholders to market the course directly, worked with staff to disseminate ideas within the university, undertook research to establish evidence and co-wrote academic papers and made presentations at conferences. My part: 25% (with Stephen Powell and others)

Originality, impact and importance: The project was based on the experience of Ultraversity, but broke new ground by taking a whole university framework approach. It led to wholehearted adoption by

some colleagues, whilst others appropriated parts of it for other courses. Its importance was in recognising the conditions under which work-focussed learning could prosper.

Filed under: claim project

[C21] Report on good practice of innovative applications of learning theories in TEL

Apr 30, 2013

A report on learning theories and how the design of innovations in technology enhanced learning may be reviewed through a multi-levelled stakeholder analysis.

> **Aim**: To clarify the accepted learning theories and explain their connection to theorists, disciplines and paradigms.

The HoTEL Support Action aims to contribute to more effective, holistic and faster innovation cycles in European Technology Enhanced Learning (TEL), focusing on the design, testing and validation of a new innovation working method.

This document sets out the learning theories which influence innovators, identifies the new learning practices supported by TEL in higher education, professional learning and informal learning, and offers a multiple stakeholder analysis for TEL innovations in learning & education.

Educational innovators should benefit from this document as a guide to effective analysis, decision-making and implementation.

> **Reflection**: Creating this document was a challenge for me in making sense of the diverse theoretical and conceptual positions and disciplinary backgrounds of learning theorists and to propose the application my own stakeholder analysis to innovations in technology enhanced learning - but it helped to bring all these things together for a real audience and with peer review.

> **Contribution**: I exercised analytical and visual design skills in the construction of the conceptual diagram and contributed the statements about the complex, contested and dynamic nature of learning theory. I also tidied up and commented on the stakeholder analysis for innovation designers. My part: 80%

> **Originality, impact and importance**: This work is a new synthesis of key theorists and their ideas. It has been widely reported as part of the Hotel EU project and through my blog achieved considerable impact. It is intended to address an EU identified problem of technology innovators who are actively developing without a full understanding of the scope of learning theory and its problems in relation to technology. (Millwood, 2013a)

Filed under: claim publication

Appendix 2 - People

Colleagues who have collaborated, influenced and led my practice

Bob Lewis

Bob employed me in 1990 to join the Computers in the Curriculum Project at Chelsea College in the University of London

Although Bob was my director for only one year, he made a great impact on me in my first year as a researcher working in higher education. He was an inspirational, technically-minded, hands-on person who could also reflect and theorise the issues we faced very effectively. His approach to managing the team was empowering, but also he had clear ideas of the action research process we should be engaged in.

He impressed me with his early grasp of the problems of interoperability and his determination to solve them. He also clearly analysed the challenges of artificial intelligence, pointing out that the difficulty of modelling the mind was immense and not likely to be solved soon and that our computer resources were not technically advanced enough to match the complexity of such a model (as might be speculated).

Bob invited me to collaborate with him after he left Computers in the Curriculum, in teaching on residential courses and, most enjoyably, on an international UNESCO summer school in Yugoslavia.

> **Reflection**: Bob's analysis of the reasons for lack of progress in artificial intelligence was prophetic and helped me to avoid spending too much time investigating intelligent tutoring at a time when it was under serious consideration and instead encouraged me to focus on the decision-making and responsibility of learners in using the computer as a tool.

Margaret Cox

My director from 1981 to 1990 and collaborator in more recent times, Margaret has inspired me with her criticality, intelligence, knowledge and her faith in people.

Margaret replaced Bob Lewis as head of the Computers in the Curriculum project in 1981 and I worked with her closely until 1990. Her experience of developing software extended into the seventies as part of the National Development Programme in Computer Assisted Learning funded work at the University of Surrey.

We often debated about the best strategies and on one occasion I called her 'Mum' in the heat of an argument!

> **Reflection**: Margaret taught me to be pragmatic, caring and nevertheless concerned to do the right thing at high levels of quality. I learnt how to formulate research with rigour through her advice.

Royston Sellman

Royston shared an office with me for much of my time in the Computers in the Curriculum project at Chelsea College and made an excellent colleague and critical friend.

Royston is the most down to earth character who loves his work in solving simulation problems and designing software. His talents ranged from mathematical analysis to a real understanding of the nature of programming. Royston raised my game with respect to the best way to programme and opened my eyes to a theoretical world of computing that I had not encountered. We would argue about the relative merits of Pascal, Smalltalk, Lisp, Logo, Basic and Hypertalk. Royston's groundedness also helped me avoid the worst excesses of naivety and idealism

> **Reflection**: It was discussions and debates with Royston that deepened my knowledge of quality in programming and a pedagogy of computing.

David Riley

I worked closely with David from 1983 until 1990 - his friendship, together with an inquiring and methodical mind gave me opportunity to discuss many ideas in depth ranging across pedagogy, design and management.

David had a particular interest in modelling and background in geography leading simulations of gas pipelines, software for evaluating location decisions and ultimately to the proposal to develop the Planet Earth CD-ROM as part of the Renaissance Project.

Together we explored how best to offer the learner a toolkit to work with multimedia in a constructivist sense.

We also worked to offer design advice to colleagues in the Computers in the Curriculum project.

Finally we saw that simulation, although valuable, did not achieve the depth of understanding that modelling could.

> **Reflection**: The decision making inherent in simulations we created was important but the creativity and analysis demanded in modelling itself was more powerful for learning.

Sam Deane

Sam worked with me as a school student in a summer job in the late eighties and later as a colleague in the mid-nineties.

Sam accompanied his friend from Hampstead School to meet me at the Computers in the Curriculum Project in Chelsea around 1990. His friend had been recommended to me by my first wife Ursula, then head of mathematics at the school, to consider a summer job as a programmer with us. In the end Sam came instead!

Later, after completing his degree in Computer Science at Bristol University, Sam joined Ultralab to program some of our most innovative pieces of software for learning. Together with Alice Mitchell we designed immersive software for language learning.

He left to continue a career developing substantial games software for some of the major industry players and remains just in touch even now.

> **Reflection**: Sam's influence on me was profound, because he had delved deeper into the issues of software development and yet remained in touch with the wider issues of designing tools for learning. I began to understand some of the profound challenges of developing software in a team and how to manage a quality process.

Stephen Heppell

I first met Stephen in the days of HEADNet (the HyperCard Educational Application Developers Network) in 1988. Subsequently we worked on the Renaissance project to develop CD-ROM multimedia. I then joined Stephen at Anglia Higher Education College in 1990 and worked alongside him to develop the Ultralab as a research and development centre until he left in 2004.

It is safe to say that Stephen Heppell's thoughts and actions are the biggest influence on my mature practice.

I consider the agenda he set for Ultralab as one I fully subscribe to, and his clarity of purpose to be simply inspirational.

The values he proposed of inclusiveness and caring have become my own and the example he set in practically exhibiting such values is the standard I aspire to. His willingness to roll up his sleeves and make things happen was infectious and his ability to leave the past and look forward unparalleled. It has been my pleasure to have been his critical friend, but rarely have I found fault beyond the trite. He was always generous in listening to my sometimes overly analytical perspectives, but our partnership was at its best when I found myself complementing his talents with my own.

> **Reflection**: Stephen introduced me to concepts of social justice, learner-centredness, multi-modality, vision, the benefits of neologism (!) and the confidence to take action. I learnt how to manage change, manage people and direct innovation under his leadership.

John Davitt

John has been a family friend and a professional agent provocateur for my thinking. His analyses are creative and insightful, but he has always welcomed my critical friendship.

John's first book 'New Tools for Learning' is subtitled 'Accelerated learning meet ICT' which describes perfectly the effect of good conversation with him. I have been learning with him for twenty years now, and every time new ideas blossom. His sense of overview of the ICT scene is profound and clarifying, with useful critiques and clever catch-phrases which act as aide -

memoires. My favourite is 'S&N' which stands for subtlety and nuance - a lens for examining technology which so often is more like a digitally blunt instrument compared to the refined perception of human touch, hearing, sight and vision - to sniff nothing of smell!

> **Reflection**: John has helped me develop practitioner theories for my design work and hone them with critical debate.

Carole Chapman

Carole collaborated with me from 1990 to 2006, working together to design educational materials, implement creative online projects and develop large-scale action research. She understood management as a service in the support of many of the projects that Ultralab undertook.

Carole's finest asset was her ability to see things from a young person's point of view and to appreciate the power relationships inherent in schools and institutions. She anchored many people in Ultralab, supporting them with critical friendship and moral support. Her determined willingness to take on sponsors and civil servants and argue the case for the radical innovation that she proposed was inspiring.

> **Reflection**: Carole inspired me with her no-nonsense hard work, unwavering learner-centred perspective and values-oriented thinking. I learnt from her about social science, gender and social justice.

Dai Griffiths

I first worked with Dai in 1992, translating our Workrooms software into Welsh, Catalan and Spanish. We subsequently worked on the Etui project to invent a toy, and finally came together again at the University of Bolton in 2007, and Dai is now my director of studies!

Dai introduced me to a perspective on culture in learning that I had no concept - the separation of nation and language and culture. His linguistic knowledge helped me understand the challenge faced by minority language groups and together with Stephen Heppell and Greta Mladenova we published on this topic. The discussions and designs we made regarding the Etui toy for early learners built a more profound base of practical, developmental research. Dai's work in the TENCompetence project combined well with my own in developing competency frameworks and interactive software for Macmillan Cancer Support.

> **Reflection**: Above all else, discussions with Dai on epistemology provided a valuable reflective debate which has led to a clearer understanding of knowledge for me.

Tom Smith

Tom worked with me in Ultralab in the nineties, bringing a multi-disciplinary no-nonsense approach to design. He had particular talents to create original visual material, understand visual design and 'get' a bigger picture of what it all means.

Tom joined Ultralab as a volunteer after reading about us in a magazine and realising we were just over the road! His determination to create complex and powerful server software mixed with his clarity about design issues inspired me to do the same. We shared much analytical thinking to make sense of the online, multimedia, interactive and participative opportunities that burgeoned in the mid-nineties.

> **Reflection**: I learnt to see through surface meaning and understand the motives and forces that shaped people's behaviour through discussions with Tom.

Alice Mitchell

Alice was the new head of the Anglia Polytechnic University Language Centre when I first met her. She was a close collaborator and friend working on language learning software for business.

Alice was a very articulate and high quality teacher, developer and pedagogue in language learning.

We worked together to advance her concept of TecLab - a re-invented language lab linked to and funded by the Training and Enterprise Council which focussed on vocational language learning. Her determination, clarity of vision and extensive knowledge of what worked in language learning made for a very productive partnership.

We created innovative interactive video materials on the computer using multiple text track movies in Apple's Quicktime software (my contribution) with engaging social and business plots in the style of a soap (Alice's contribution) with a substantial coverage of learning standards in French and German. The resulting comprehensive learning resource was titled Ultra-Language-Lab and was successfully sold to a commercial provider of the time.

Later we worked with Sam Deane for the Teleste company directed by Pekka Lehtiö to create an immersive environment for language learning, which pre-dated Second Life by many years.

Alice has sadly passed away and is much missed.

> **Reflection**: I learnt from Alice a deep understanding of learning languages which clarified for me the need for some rote learning in a motivational context to learn basic facts and correct pronunciation together with a more analytical and creative approach for the deeper structural knowledge.

> **Reflection**: The techniques of multiple text track interactive video materials were completely new, as was the HyperCard fuelled technique for their manufacture, allowing editing of detail and 'recompilation' to achieve accurate results - vital for language learning.

Pekka Lehtiö

Pekka was a director of Teleste, the Finnish company responsible for the development and manufacture of Tandberg language learning labs which were perhaps dominant at the time. He approached Ultralab to invite us to develop a new language learning environment using multimedia computers.

He notably explained to me the idea of a 'Chinese contract' which was designed to offer the most positive outcome for both customer and client even if the project was curtailed.

We negotiated such a contract, and Sam Deane and Alice Mitchell worked with me and others to develop Aardvark - software to allow the development of three dimensional navigable spaces where linguistic challenges would be confronted in relevant and meaningful contexts, but with considerable freedom to explore.

These were very early days for such ideas, especially our intent to make the spaces constructable by language teachers rather than developers. In that sense it was a forerunner to such spaces as Second Life. Pekka encouraged us to be ambitious but also attempted to maintain some control over our delivery milestones! At the end of the project he invited us to Finland to present over two days to the development team based in Turku.

> **Reflection**: Pekka with his patient and generous attitude taught me much about the challenge of large scale development and managing a relationship with a commercial partner.

Stephen Powell

I have worked with Stephen since 2000, when he joined the Talking Heads project and later in 2003 when he led the Ultraversity project. We then continued to work together on the IDIBL project at the University of Bolton.

2011 Stephen Powell.jpgStephen's inquiring, direct and business-like manner has helped immensely to focus on publication and the completion of this thesis - he has acted as my main formal and informal supervisor (as the university changed its mind about the legitimacy of that rôle when you are colleagues and students). His interest in the systems of higher education has expanded my knowledge through the debates, planning and co-research we have undertaken. As a supervisor of my PhD he has helped me to plan milestones, provide moral support and shared his enthusiasm to see it completed. There are few people who have such a good and objective knowledge of the working of a university as an enterprise.

> **Reflection**: I am particularly pleased to have developed my knowledge of Cybernetics through working out the ideas with Stephen and applying them to our mutual experience and practice. We also tackled several social science and design research methods together, gaining confidence from sharing the challenge.

Others

There are many more who have been mentors, close collaborators and influences, but I have had to limit detailed reflection to some of the most influential. Those listed here (and others I am sure to have missed as my memory fails - tell me and I'll correct this!), have provided moral support, critical friendship and intellectual stimulation. Sometimes even the briefest connection has made a major impact!

Abject apologies to anyone who I have left out or misrepresented - it probably means you were so close, I have failed to notice, like water to a fish :)

Thanks to:

My supervisors, formal and informal: extra-brother Stephen Powell, Keith Alexander, Dai Griffiths, Bill Olivier, Margaret Nelson, Gill Green.

My family

My mother Elizabeth and father Richard who laid the foundations of a life-long passion for education, mathematics, science and appreciation of the arts, crafts and music (to say nothing of some manners, reading and writing, commitment and confidence).

My sisters Elizabeth and Bridget and brother Seán, who debated minutiae for every minute of my childhood and still haven't given up, making me what I am.

My teachers at school, too many to mention, who made me think and gave me confidence.

My companions in my teens in Dumfries (Scott Kerr, Chris McKinnell, Judith Gallon, Jimmy Archibald) and in my late teens in Barking (Terry H).

My flatmates at Kings College London, Steve Robson and Steve Wood (Wilf) and student friends John Hughes, Cathy Sims, Susan Beacham & Richard Wakeford.

Ursula Millwood, my first wife, who suffered my obsessions for the first half of my career and partnered me in many adventures both professional and personal including the gift of my first two children, Patrick and Ben.

School teaching

Alistair Buckenham, Mathematics teacher at St Marylebone Grammar School in 1976, who inducted me into teaching and helped me find the attitudes, values and practices which have endured ever since.

Oleg Liber, Mike Humphries, Europe Singh, Brian Harrison, Keith Philip - the mathematics department at Scott Lidgett School who supported my growing interest in developing learning materials and assessment.

Computers in the Curriculum

Bob Lewis, Peter Smith, Margaret Cox, David Riddle, Deryn Watson, David Riley, Grant Alderson, Royston Sellman, Angie Donoghue, Sophie McCormick, David Squires, Keith Shaw, Diane Moody, Eva O'Donoghue, Colin Smith, Alan Edis, Marianne Atherton, Jean Seechurn, Terry Hinton, David Johnson, Jonathan Osborne, Joan Bliss, Paul Black, Margaret Brown, Kath Hart, Jon Ogborn, Ian Kilberry, Angus Willson, Steve Hurd, Ken Randall, Margaret Brown, Kath Hart and many others in the Computers in the Curriculum Project, Educational Computing Unit and Centre for Science and Mathematics Education at Chelsea College (subsequently King's College) throughout the eighties as I grew from school teacher to education lecturer and researcher.

Long term friends amongst colleagues I met in the '80s and '90s including Ian Sillett, Gary Stevens, Tony Parkin, Steve Oram, Mike Aston, Diana Freeman, Mike Bostock, Peter Bratt, Tony Kiddle, Vivi Lachs, Phil Langshaw, Norbert Pachler, Mary Webb, David Hassell, Bill Tagg, Tony Wheeler,

Ultralab

Stephen Heppell, Ann Constable, Stan Owers, Sheila, Andrew Wood, John Sharkey, Sam Deane, Anne Bradbury, Nikki Gamble, Nick Easingwood, Heather Crouch, Chris Curran, Geoff, Sue Clacher, Tom Smith, Lys Johnson, all from early days as Ultralab was formed and then all my colleagues in Ultralab in the period until 2006 when it closed, some of whom are in this photo:

My best list of all of them is:

James Brain, Tony Browne, Lori Camm, Craig Carey, Carole Chapman, Ann Constable, Mark Constable, Antonia Coppen, Andy Cunningham, Sam Deane, Martin Doherty, James Dorling, Jonny Dyer, Matthew Eaves, Tim Ellis, Colin Elsey, Jonathan Furness, Alison Gee, Jean Gray, Claire Gregory, Andy Grey, Maureen Gurr, Rhys Harries, Colin Harrison, Graham Hart, Michael Hartley, Melissa Heppell, Stephen Heppell, Clare Ingram, Jean Johnson, Lys Johnson, Sarah Jones, James Kadirire, Ioanna Kita, Kostas Kokkinopoulos, Geraint Lang, Hal MacLean, Paul Martin, Lesley McGuire, Hilary Messeter, Alice Mitchell, Greta Mladenova, Malcolm Moss, Gerome Oldfield, Stan Owers, Simon Patton, Shirley Pickford, Nick Platts, Stephen Powell, Leonie Ramondt, Gina Revill, Gill Roberts, Anthony Russell, Hamish Scott-Brown, Alan Seargent, Teresa Selvey, Beverley Simpkin, Andy Simpson, Matt Sisto, Manoah Smiley, Tom Smith, Tom Stacey, Vicki Swan, Gail Taylor, Ian Terrell, Kevin Thompson, Craig Tindal, Ian Tindal, Richard Tydeman, George Variopoulos, Alison Wade, Weiya Wang, Jean Whitehill, Tim WIlliams, Lindsey Wingate, Rex Wingate and Kirsty Wooldridge.

Greta Mladenova, colleague at Ultralab and my second wife who inspired much creativity, worked tirelessly, suffered my pedantry and raised the third gift, Sasha.

My PhD students (and colleagues), from Ultralab days - Carole Chapman, Abraham Doron, Nili Naveh, Anthony Russell, Geraint Lang, Lesley McGuire, Mark Penny and my supervisor colleagues Gill Robinson and Vernon Trafford.

Colleagues at Anglia Ruskin University - Roger Clark, Colin Harrison, Woody Caan, Mike Salmon, Dawn Hillier, Diana Powell, Tony Powell, Robin Smith, Michael Haynes, Mick Betts, Gina Wisker, Richard Winter, Maidi Brown, Sharon Waller and many others, and those on projects - Marc Blasband, Josep Blat, Mimo Caenepeel, Steve Lay, Robert Harding, Joachim Wedekind.

Nick Billowes, Vince Ham and Derek Wenmoth who built and sustained Ultralab South which become Core Education in New Zealand with Ali Hughes, Ronnie Davey, Julia Atkin, Carole Moffatt and others at Core having a huge influence on my thinking. Also Paul Rodley at Christ's College, Paul Cathro, Murray Leach and many other New Zealand colleagues.

Core Education UK

Maureen Gurr, Malcolm Moss, Alison Gee, Sarah Jones, Rex Wingate, Graham Hart who helped form Core Education UK, and Steve Capper who helps sustain it still.

University of Bolton

Oleg Liber, Julie Halliwell, Mark Johnson, Paul Hollins, Stephen Powell, Bill Olivier, David Sherlock, Scott Wilson, Simon Grant, Wilbert Kraan, Adam Cooper and all the others in the Institute for Educational Cybernetics at the University of Bolton, including PhD students I help supervise - Ian Wilkinson, Michelle Singleton, Lynn Campbell, Tim Goddard, Kesiena Clement-Okooboh, Roz Fox.

Margaret Nelson has offered her experience and support freely as I have struggled with this PhD, and acted as a critical friend too many times to count and connected me to my supervisor, Keith Alexander. Other influential colleagues at the University of Bolton include Ebun Akinsete, Mohammed Tammo, Bobby Nisha, Donna Vick, Grainne Gordon, Hilary Birtwhistle, Rob Campbell, Paul Birkett, Gill Green and Sue Burkinshaw, Mike Lawrence, Mike Lomas, Peter Marsh, Marie Norman, Patrick O'Reilly.

Professional

Information Technology in Teacher Education (ITTE) colleagues of long standing including Martin Owen, Avril Loveless, Sarah Younie, Tony Fisher, Bob Fox, Mike Hammond, David Benzie, Graham Jarvis, Bill Gibbon, Jon Coupland, Roger Keeling, Sue Brindley, Steve Kennewell, Chris Higgins, Peter Twining, Michelle Selinger, David Longman, Libby Jared, Suresh Jethwa, Margaret de Jong-Derrington, Angela McFarlane, John Potter, Bridget Somekh, Neil Stanley, Peter Twining, Jean Underwood, John Woolard,

Other colleagues in the world of education that have provided support, advice and provocation include Gabriel Goldstein, Brenda Gourlay, John Davitt, Merlin John, Eileen Freeman, Bryn

Holmes, Brendan Tangney, Clive Holtham, Sergei Christochevsky, Andrei Fedoseyev, Todorka Damianova, Leo Højsholt-Poulsen, Paul Clark, Eddie Gulc, Andy Black, Terry Freedman, Steve Moss, Charles Crook, Leon Cych, Doug Brown, Roberta Weber (who I should have got to be my supervisor), Roger Carlsen, Elizabeth Oldham, Thomas Winkler, Marilyn Leask, Darren Leafe, Sandra Crapper, Sue Owen, Keri Facer, Dylan Wiliam, Christina Preston, Mary Ann Kernan, Hidayah Amin, Stephen Carrick-Davies, Drew Buddie, David Garland, Stephen Capper, Linda Thompson, Hannah Davies, Richard Green, Mary Harris, Tina Preston, Dave Smith, Tore Hoel, Vana Kamtsiou, Joy Hooper, Bill How, Simon Humphreys, Paul Lefrere, Gillian Lovegrove, Peter Maher, Tim Marshall, Harvey Mellar, Peter Mitchell, Sean O'Sullivan, David Baugh, Ian Wilson, Julian Coultas, Mike Rumble, Seb Schmoller, Jim Shelston, John Siraj-Blatchford, Lampros Stergioulas, Dan Sutch, Ralph Tabberer, Tim Tarrant, Matthew Taylor, Sydney Thornbury, Jamie Tuplin, Sue Walton, Mick Waters, John Williams, Theo Wright.

Partners in the professional and business worlds including Alan Bennett, Chris Binns, Bob Rogers, Alan Matcham, John Rudkin, Michael Ambjorn, Tilly Blyth, Cathy Derrick, Greg Childs, Iona Walters, Andrew Chitty, George Auckland, Alan Greenberg, David Heath, Caroline Hook, Aynsley Jardin, Steve Moore, Andy Pendry, Bob Rogers, Tarek Shawki, Barbara Strebel, Conrad Taylor.

My good friends in Brentwood in the Labour Party, Educating Brentwood, CND, The Brentwood Arts Cinema Club, Brentwood Community Print and pottery at The Fold. The many friends made at the Royal College of Music.

Personal

My extended family of extra-brothers-and-sisters-in-kind: Detty, Stephen Powell, Joy Hooper, Jed Burroughs, Hazel Bartlett, Tony Bartlett, Sally-Anne Maidment, uncles, aunts, nieces - Sineád, Maeve, Caitlin, Tess and extra-special-niece Lily and nephews - Watty, James, Hal, James Burrows, extra-special-nephew Martin Bartlett have all supported me and egged me on.

Finally I must thank my fantastic children, Patrick, Ben and Sasha who have inspired and exemplified so much of what I value in life through their own (and independently developed) moral framework, determination and sheer hard work.