Gaining insight into educators' understanding of digital technologies: three models for the analysis of multi-dimensional concept maps.

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I dedicate this work to my two grandsons,

Alexander and Morgan,

because they offer hope for a bright future beyond my horizon.

Abstract

The thesis explores the hypothesis that an analysis of a Multi-dimensional Concept Map (MDCM) provides educators and researchers with different and possibly richer and broader insights into understanding of an issue – in this case that of digital technologies in education - than written responses alone. 'Multi-dimensionality' refers to the characteristics of multimodal hand-drawn or digitally produced concept maps, namely multi-layering and (remote) multi-authoring.

Forty-eight pairs of concept maps were collected, in three case studies based in England and South Africa, all focusing on gaining insights into educators' understanding of the use of digital technologies in teaching and learning. The three groups of educators were undertaking one-year courses about using computers in classrooms, underpinned by three different perspectives on learning: information transmission, constructivism and social interaction.

This study of pre- and post-course concept maps aims to answer the Research Question:

> How does multimodal concept mapping provide insights into
> educators' understanding about digital technologies?

Both benefits and challenges were evident in the use of the three different methods of analysis that were used. Given the relatively low numbers, a qualitative analysis of scores is revealing whereas a quantitative analysis is unreliable; 'words', where they are used, provide a useful insight; a more encompassing semiotic analysis revealed some underlying 'positions' that surprised even the map makers themselves. A key methodological finding was that in social interaction contexts, concept maps are most valuable used as scaffolds for conversations between participants within 'communities of practice' to promote shared insights into professional understanding of digital technologies.

The findings were influenced by the four different roles assumed by the researcher: as an objective judge of data; as a community mentor; as an active community member; and as a researcher and community member inviting other members of that community to be co-researchers. The researcher learnt, as the project progressed, that the danger of becoming too close to the 'subjects' to be objective about the data was outweighed by the richness of the insights when the map makers engaged with the researcher and with trusted colleagues in analyzing the meaning of their pairs of concept maps.

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Glossary: abbreviations, definitions

The following terms, used throughout the thesis, are spelled out in full at the beginning of each chapter and thereafter left as acronyms.

AMR	Active Member Researcher
ARs	Action Researchers
Becta	Government agency for England leading the national drive to ensure the effective and innovative use of technology throughout learning- abolished by the UK Coalition government in 2010.
BERA	British Educational Research Association
CST	Computer Skills Training
CMapper	A free concept mapping tools based on Novak's learning theories that is designed and maintained at the Institute for Human and Machine Cognition
CIMW	Computers in my World
CMR	Complete Member Researcher
CoP	Community of Practice
CPD	Continuing Professional Development
DfEE	Department for Education and Employment (UK)
DfES	Department for Education and Skills (UK)
E-lapa	African word, Lapa, -a meeting space updated to mean an electronic meeting place
GTCe	General Teaching Council for England
ICT	Information and Communications Technology
IFS	Institution Focused Study
ImpaCT2 [1]	Project commissioned by the Department for Education and Skills
IT	Information Technology
MAR	Mentored Action Research

[1] A major UK study carried out between 1999 and 2002 involving 60 schools in England - one of the most comprehensive investigations into the impact of ICT on educational attainment so far conducted in the United Kingdom.ImpaCT2 was designed to: a) Identify the impact of networked technologies on the school and out of school environment; b) Find out the degree to which these networked technologies affect the educational attainments of pupils at Key Stages 2, 3 and 4. It is managed by Becta with the aim of evaluating the progress of the ICT in Schools Programme.<http://www.becta.org.uk/research/reports/impact2> Last accessed 29th July 2009.

Mash-ups	Data mash-ups combine similar types of media and information from multiple sources into a single representation that has its own integrity. Mash-ups challenge the notion of cheating by copying.
MM signs	Multimodal sign used in meaning-making
MDCM	Multi-Dimensional Concept Map – this refers to the multimodal affordances of concept maps emphasising multi-layering and multi-authorship that might be remote.
MirandaNet	An international professional organisation founded by Christina Preston in 1992. Details at http://www.mirandanet.ac.uk
Mirandalink	Internal mail list for the membership of MirandaNet
MNMs	MirandaNet mentors
MTeach	A Masters in teaching
NOF	National Opportunities Fund (formerly New Opportunities Fund)
OFSTED	The UK government inspection service for education
PBR	Practice-Based Research
PMR	Peripheral Member Researcher
SA	South Africa
SoT	Spheres of Thinking Used in the ImpaCT2 study to categorise how the map makers defined what computers are used for.
PBR	Teachers as practice based researchers with a scholarly bias
Third Space	An intellectual space where teachers share knowledge on equal terms with their peers and with teacher educators and researchers.
Unconference	A generic term for informal face to face and virtual meetings.: the power relationships in traditional conferences between expert speakers and learners are destabilised and everyone collaborates equally. A range of free technologies are used to record the knowledge like collaborative remotely authored concept maps, wikis, ichat, microblogging and video conferencing.
VLE	Virtual Learning Environments
WLE Centre	Work-Based Learning for Education Professionals (www.wlecentre.ac.uk)
World Ecitizens	The charity founded by MirandaNet Fellows after the events of 9/11
ZoU	Zones of Use

Context

The context of this study is the MirandaNet Fellowship[2]. I founded this international professional organisation in 1992 in memory of our daughter, Corinna who died of a virus when sixteen years old. With colleagues I chose the name Miranda because in the Shakespeare play, The Tempest, Miranda, the heroine, nearly says, 'Oh brave new world that hath such people in IT'[3]. My excuse for this slight rephrasing is that Shakespeare was a consummate multimodal communicator through his actors. I often speculate on how he might have used digital technologies to amplify his message had be been born in the computer age.

The MirandaNet Fellowship is a not for profit professional organisation that aims to support educators who want to make greater use of opportunities that digital technologies offer to make teaching and learning more enriching for students. Often known as the 'Facebook' of ICT professionals in international education, it has more than seven hundred active members in seventy countries and a reach of two thousand professionals. Wenger (1998) first defined this kind of informal learning group as a 'community of practice'. He has said to MirandaNet members[4] that he sees our efforts to use our shared knowledge as a means of influencing educational policy at local, national and international levels as the next logical stage in his own developing theory.

The members are drawn from international ICT policy makers, teachers, teacher educators, staff trainers, regional educators, commercial developers. All are passionate about using technologies to promote cultural understanding and democratic participation. Joining MirandaNet is free and is supported by the voluntary efforts of more than one thousand professionals from over fifty countries, by commercial companies, universities, professional bodies and government agencies who have

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[2] www.mirandanet.ac.uk
[3] The actual quote is 'O brave new world! That has such people in't.' line 182 *Oxford Standard Authors Shakespeare.*
[4] 22nd September 2009 MirandaMod www.mirandanet.ac.uk/mirandamods

funded the many practice-based research projects that inform this present study. Their support has enabled other members to take post-graduate qualifications and share their knowledge with fellow MirandaNetters. This occurs through peer-reviewed articles published in the Braided Learning E-journal section of the website[5] and the two volumes of Reflecting Education[6]. MirandaNet members engage in many other kinds of knowledge-creation activities that are underpinned by new modes of social interaction like 'unconferences' - democratic gatherings where all the participants have the power to choose the theme and present their work as to each other rather than listening to 'experts'. Miranda has given her name to a particular kind of 'unconference', a MirandaMod, that allows members to engage with each other in sharing professional knowledge all over the world in real time. The last MirandaMod in real time had fifty six contributors at a meeting in Korinthos, Greece and contributors engaging with the debate online from twenty five countries[7]. This kind of communication is unlike previous practices of knowledge construction because the members are not confined by meeting costs, location, work commitments or family responsibilities so long as they can access the internet. These and other initiatives are documented on the community website[8].

My role as Founder Director has been rewarded and enriched by the unparalleled enthusiasm of the community. I owe a significant debt to members who have collaborated with me in many events and papers: to MirandaNet collaborator, John Cuthell, who has worked in intellectual partnership with me over fifteen years on many joint papers and projects; and, Francis Howlett, MirandaNet web editor, who diligently keeps our website current.

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[5] <http://www.mirandanet.ac.uk/ejournal/> last accessed 29th July 2010.
[6] <http://reflectingeducation.net> last accessed 29th July 2010.

[7] www.mirandanet.ac.uk.mirandamods: last accessed 29th July 2010.

[8] at http://www.mirandanet.ac.uk/

I must also thank the academic community who have supported me: especially my supervisors, Gunther Kress and Carey Jewitt, who been encouraging whilst still remaining rigorous. The wider academic community, some of whom are members of MirandaNet, have also generously supported my research apprenticeship by taking time to comment on the research projects and papers that have been inspired by this study. I thank them for stimulating my thinking in all kinds of enriching ways.

Last, but vital, I am grateful for interest my family have shown in the MirandaNet enterprise, especially my mother who learnt to scan concept maps; my sister and my brother-in-law, my son and my daughter-in-law who have all cheered me on. And most of all John, my husband, who has supported me wholeheartedly, despite living with this elephantine thesis in the home for several years. This is the context, professional and personal, that underpins this thesis.

My Doctoral Journey

Background

The orientation of the doctorate in education toward professional practitioners has offered me an ideal opportunity to reflect on the theory and practice of Continuing Professional Development (CPD) in digital technologies, the field I have been engaged in since the late 1980s. My interest in effective CPD programmes began almost as soon as I began teaching in secondary schools in the 1970s. I soon had a school-wide responsibility for the Continuing Professional Development programmes as well as teaching English, Drama and Media Studies. This remit included the introduction of Information and Communications Technology (ICT) CPD at a time in the early 1980s when teachers were given funding, as of right, for twenty-day courses as well as part-time Masters and Ph.Ds. In 1987, I was seconded to the Education Computing Unit (ECU), King's College, University of London, to author an educational adventure game and a newsroom simulation with a group of cross-curricula teachers funded by BT. Many of the teachers in the groups were seconded on a twenty one day course entitlement that allowed teacher to pursue an interest related to their teaching. I was seconded to the project for a year.

The team at the ECU were driven by the belief that educational software should not be designed for drill and practice purposes, but should develop the users' negotiating skills and problem solving capacity. These days we would define these pedagogical approaches as constructivist and social interaction strategies that underpin the approach to learning in this doctorate where they are defined. Since ECU was of this pedagogical persuasion, we were designing educational software in an international group in which the exchange of knowledge was important. This exhilarating CPD experience as a classroom teacher convinced me that educators need hands-on experience of designing, using and evaluating digital technologies in order to translate their value into their own classrooms. This presupposed that the classroom itself was

orientated towards learning in groups rather than rows of pupils sitting in front of computer screen in IT suites engaged in the kind of drill and practice exercises that we now call 'information transmission'[9] (Preston and Squires, 1988; Preston, 1989; Preston, 1995c).

Conditions for CPD were changing dramatically in 1989, however, when I started as an ICT adviser in London. The twenty-one day CPD entitlement was gone. Suddenly I was teaching groups of teachers from all over London with varying levels of knowledge who had only one day of support cover every year. Often they had no personal access to computers either at home or at school. This training model, short on time and funding, contrasted with my conviction that teachers need CPD programmes designed help them engage for a lifetime in learning about digital technologies.

By 1992 my 'constructive' and 'social interaction'[10] learning approach, demonstrated in my own software titles, had resulted in an invitation to work in Chile and the Czech Republic. We were all passionate about the ways in which digital technologies could be used to democratise teaching and learning. After some significant transnational discussions about learning in social groups my English, Czech and Chilean colleagues joined together to found the first international community of practice (CoP) for teachers, the MirandaNet Fellowship[11] (Preston, 1993; Preston, 1995 a & b; Preston, 1999; Lengel, Preston and Mannova 2000). Since then, academic members have developed theoretical and the practical underpinnings, building on Lave and Wenger's (1991) research into CoPs in education and business. These MirandaNet academics include Allison Allen, John Cuthell, Margaret Danby, Niki Davis, Bryn Holmes, Christina

[9] A type of traditional pedagogy where the teachers is the expert discussed in Chapter two.

[10] Two more types of pedagogy discussed in Chapter two where the learners, a individuals and as groups have more engagement in the learning process.

[11] www.mirandanet.ac.uk

Howell Richardson, Marilyn Leask, Bozena Mannova, John Potter, Bronwyn Stuckey and Sarah Younie, whose papers are discussed, as relevant, in more detail in the thesis. Colleagues from industry who have generously supported the MirandaNet ideal of partnership with teachers include Richard Allen, Ray Barker, Chris Binns, Rachel Jones, Dominic Savage and Chris Yapp. MirandaNet has also had the support of many policy makers such as Doug Brown, Niel McLean and Tim Tarrant who remain in the professional organisation after they have supported particular research projects.

Bridget Somekh, who has supported MirandaNet from the first, gave early workshops in action research in 1994 that supported the constructionist philosophy. The key idea of a progression from Scholar to Fellow was that of Harvey Mellar. Caroline Daly and Norbert Pachler have furthered our understanding of effective knowledge-building and community development in Continuing Professional Development pursuing the same idea that learning is a form of social interaction and not about content first and foremost. My experience over the last thirty years suggests that teachers need to be engaged in this kind of social interaction with digital technology at an intellectual level, rather than a focus on skills alone, so that they can guide pupils in making complex decisions about academic, cultural and social uses of digital technologies and multimodal texts in different contexts.

The digital context

By 2004 I was publishing the evaluation of the New Opportunities Fund (NOF) UK national training programme in ICT for teachers. What emerged in the NOF research was that the lack of appropriate accreditation or formative evaluation was a major factor in the relative failure of this programme (Preston, 2004a). In my doctoral research, I wanted to advance understanding of innovative multimodal methods of assessing teachers' learning, methods that were formative, which reinforced social interaction and provided models for the teaching of children. Multimodality in this context denotes meaning-making through signs that include speech, gestures, animation, images, 'body language' and other forms of non-verbal communication.

Very little assessment of learning of the multimodal kind is happening in schools. However, multimodal learning now includes the informal social networking spaces in which learning takes place outside school like Bebo[12] and Facebook[13] – those liminal spaces that those who are pushing on the boundaries of digital possibilities inhabit intellectually (Preston and Cuthell, 2009a).

The professional doctorate

There are three parts to the doctorate: the portfolio, the Institution Focused Study (IFS) and the final thesis. My first aim in designing my doctoral research across these three parts was to work with teachers to develop their action research publications and tools that would develop their own powers of reflection as co-researchers. My second aim was to reflect on my practice as a teacher adviser. My objectives were to increase my understanding of different research methodologies; to improve my understanding and competences in academic writing; and, to increase my publications in established academic journals.

At the beginning of the doctorate programme I expected to settle into academic disciplines immediately. The portfolio lectures by some academic luminaries were stimulating: exploring professionalism, research methods and globalisation. However, this first portfolio phase deflected me from the aim of learning to write in an academic style. However, I had developed strong writing habits already because, with the confidence derived from my first degree in English, Drama and Media, I had published short stories, poetry and articles in newspapers and professional magazines. This confidence led me on to experimentation with style and forms of argumentation before I had fully mastered that academic genre. However, this is not a counsel against

[12] http://www.bebo.com/

[13] http://www.facebook.com/

the portfolio approach because fellow students who had a more restricted writing background flourished under the four different supervisors in this phase of the Ed.D.

My experimental tendencies continued into my Institute Focused Study (IFS). At this late point in my career I needed to consider the succession for the MirandaNet CoP. The international outreach has given me an invaluable global perspective on the socio-cultural changes in multimodality realized information and communication practices that are having a profound influence on our lives. The resulting ethnographical study, called Etopia[14,] compared and contrasted my learning about computers from my childhood with similar periods in MirandaNet's growth; over the years MirandaNet has grown from fifteen members in the UK and the Czech Republic to more than seven hundred members in seventy countries. The evidence for the Etopia study was taken from my journals and articles in which I had identified key incidents that had shaped my own learning and MirandaNet's development as a learning organisation (Senge,1990).

The Etopia study traces the ways in which the Fellows, who have shared their expertise through MirandaNet e-journals, continue to develop leading-edge uses of digital technologies that promote collaborative knowledge building as well as professional impact on policy. These new approaches are underpinned by an emergent model for online learning called Braided Learning (see definition in Chapter one) developed through the observation of the practice of communities of practice like MirandaNet, The Association for Information Technology in Teacher Education (ITTE)[15] and Naace[16,] which is the professional association for those concerned with advancing education through the use of ICT.

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[14] The Etopia study can be found in www.mirandanet.ac.uk/blog

[15] <http://www.itte.org.uk> last accessed 29th July 2009.

[16] <http://www.naace.org/> last accessed 29th July 2009.

The IFS was a productive period in which I co-authored a paper about six international models of online learning, published in a free online journal called First Monday (Haythornthwaite, 2007) and published one academic paper about Braided Learning in The International journal of Web-Based Communities (Preston, 2008a). Although these publications were not derived directly from my doctoral research, they were a direct outcome of the detailed and consistent feedback about fundamental academic principles and appropriate writing styles that I was now receiving from my supervisors.

The chronological framework that resulted from the Etopia study became the focus of an international conference on CPD models funded by the WLE Centre at the Institute of Education, University of London, where MirandaNet research about the vision which CPD experts in England had for teachers' learning was reported (Preston and Cuthell, 2007). MirandaNet researchers and practitioners in the US and the UK joined in the discussion in London called "What Works Where?", covering the varied modes of CPD in their country. Key incidents in the learning lives of the delegates, inspired by the framework were reported and these reports were videoed for the Etopia knowledge hub.

A key contributor to this conference was Niki Davis, a founder member of MirandaNet. Of particular relevance was her academic partnership during this period in revisiting the statistics from the MirandaNet evaluation of the UK ICT national CPD programme funded by the New Opportunities Fund from 1999-2003 (Preston, 2004a). A sequence of two papers, investigating the value of Guskey's five principles for successful CPD programmes, both of which accepted by the British Journal of Education Technology, emphasised the need for an ecological approach to CPD (Davis, Preston and Sahin, 2009a and 2009b). Under the tutelage of one of my co-authors/colleagues I gained helpful insight into handling statistical information as well as into the process of responding to detailed peer reviews from an e-journal. A further contribution to the Etopia conference was a model for professional engagement developed in the third paper in the ecological series (Davis, 2008). The delegates suggested that this model

should be built as an amphitheatre in Second Life,[17] a free 3D virtual world where users can socialize, connect and create using voice and text chat. Educators can comment on practice in this environment, thus constituting another resource being developed by a MirandaNet Fellow, Leon Cych[18].

The evidence presented in this thesis has reinforced my confidence in the validity of my approach to CPD. The experience enabled me to become more explicit in welcoming teachers and students as co-researchers in a collaborative effort to understand learning in multimodal contexts (Leask and Preston, 2011, in press). The study has presented opportunities for some teachers to develop as confident writers for other teachers. Finally, this study has provided me with evidence to challenge mono-modal forms of assessment at all stages of professional learning including the doctoral level.

In contrast to my aspirations towards multimodal assessment, doctoral students participating in a study of Ed.D., assessment expressed some concern about the lack of rigour in the portfolio, but showed no enthusiasm for a shift to a 'second generation' models of assessment (Brown, Carnell et al., 2006). My contention is that the majority of students taking doctorates may be hesitant about multimodal assessment: firstly, because they cannot imagine the value of exploring other modes of communication and, secondly, because they fear that other modes may not bring success. The only way to spread the experience, in my opinion, is to begin some well-designed pilots that prepare post-graduate students for changes in teaching and learning.

During this study I have presented my emergent findings at Bath Spa University, Bristol University, Brunel University, Cumberland Lodge, Coventry University, Helsinki University, Leicester University, the Institute of Education and King's College,

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[17] <http://secondlife.com/> last accessed 29th July 2009.

[18] *<http://www.l4l.co.uk/> last accessed 24th July 2009.*

University of London and the University of Tallinn. Papers have also been presented at other institutions in Australia, Czech Republic, Greece, Japan, New Zealand, Portugal and the US. Lively discussions have taken place amongst doctoral students, teachers and researchers; about research techniques, learning in communities of practice and the value of multimodal assessment as well as the forms it should take. The emerging literature study provided the editorial of the Reflecting Education Editorial on multimodal concept mapping[19], a chapter of an international handbook on collaborative mapping (Marriott and Torres, 2009). This handbook that covers the emerging potential of collaborative mapping was prefaced by Novak and Cañas, the famous developers of concept mapping whose work is discussed in this thesis.

Further research

Whilst I was completing my doctorate, MirandaNet, colleague Marilyn Leask and I were funded by a UK government agency, Becta, to take these concept mapping theories and practices further by testing out the value of multimodal concept maps in the context of teachers' professional development in England (Leask and Preston, 2011, in press).

In a second opportunity granted by the WLE Centre at the Institute of Education, University of London, John Cuthell, a MirandaNet colleague and I, explored how remotely authored digital concept maps can be analysed to provide a deeper understanding of the dynamics of collaborative knowledge creation that has involved map makers internationally. To date collaborative concept maps have been explored in the context of a MirandaNet activity called a MirandaMod[20]. This is a virtual form of an 'unconference' - an event where the participants decide the learning agenda themselves. Everyone who wishes to can present on the topic and joins in the sharing

[19] <http://reflectingeducation.net> last accessed 29th July 2009.

[20] www.mirandanet.ac.uk/mirandamods

of knowledge face to face or online. Digital technologies make MirandaMods possible through the use for example, of instant messaging software, microblogging, streamed video and digital concept maps in remote knowledge creation (Preston, 2011, in press: Cuthell, Preston and Cych, 2011, in press). Learning through social interaction gains an international dimension in this context.

The value of the doctorate

The professional value of this study has been to validate theoretically, the change I have perceived in my professional stance from expert lecturer to facilitator and lead-learner. In this latter role I have supported professional co-researchers in a community of practice where all expertise is equally valued, even the expertise of the pupils. More importantly, the doctorate has given me the sense of belonging to a community of supportive academics who have voluntarily engaged in my apprenticeship with countless gestures of support and encouragement.

Chapter one: background to the research

The UK government has been investing in ICT in schools since the 1970s. Since the National Grid for Learning was introduced in the early 1990s, this government has spent £5 billion on digital technologies in education (DfEE, 1995). Nevertheless, there is official concern that, despite this expenditure, only about 15% - 25% of schools are using Information and Communications Technology (ICT) effectively (Richardson 2007). Despite considerable resources being dedicated to developing the use of ICT in schools in the UK in recent years, there is a lack of impact on teachers' everyday practice, or what Becta, a government agency for ICT, has described as a 'significant deficit' (DFES, 2008). This is despite the vast majority of teachers receiving some form of Information and Communications Technology (ICT) continuing professional development (CPD) according the DFES national survey. A recent review of the current literature represents an emerging evidence in a situation where ICT CPD provision has become devolved, with a very varied provision which has grown ahead of a comparable rate of research into its effects (Daly, Pachler and Pelletier, 2009a). In 2010 a further government agency survey of the UK ICT CPD Landscape indicates that diversity of ICT CPD provision is growing and too many programmes appear to be designed at a skills level only (Pachler, Preston, Cuthell, Allen and Pinheiro Torres, 2011).

In this doctoral thesis, in my role as a teacher of teachers and as an educational researcher, I focus on this 'deficit issue' in the field of digital technologies education in an effort to provide more research findings about how the design of ICT CPD impacts upon educators' understanding. My aim in undertaking this research is to explore methods of gaining insights into how teachers understand digital technologies, formally and informally. In this endeavour I have looked for methods that promote the notion that these two professional roles, teacher educator and educational researcher, can be mutually supportive rather than unrelated or divisive. My objective is to provide research tools that other professionals will be able to use with their students

in undertaking their own research. The intention is that these tools will provide the 'expert teacher' and the 'students' as well as the 'researcher' and 'the object' of her research with equal insights into the development of understanding that is taking place during a learning episode. These oppositions between 'expert' and 'learner' and/or 'research object' are also contested in this thesis.

This first chapter is about my background as an educator over the last four decades and about the potential of digital technologies in teaching and learning that has informed the design of this thesis. Firstly I identify the groups of educators that this study concentrates on. I then explain how I define the subject of digital technologies seen from the vantage point of different subject specialisms and from different countries. I then explain how the topic of this thesis sits within the context of an emerging professionalism amongst teachers, explaining how I see the challenge of teaching teachers about digital technologies. I also explain the influences that led me to choose concept mapping as an alternative method of data collection rather than the traditional research methods of questionnaires and interviews that I knew well. At the end of this chapter, I describe how the rest of the thesis is structured.

The complex role of educators today

Teachers in all their guises, career levels and educational phases are considered to be central in England to the successful achievement of national educational priorities for enhancing learning and teaching with digital technologies (DfES 2003; DfES 2005; DfES 2006). However, despite the government's acknowledgement of their important role, a key reason for the deficiency in the use of digital technologies has been identified as the significant lack of appropriate Continuing Professional Development (CPD) programmes for those who are charged with the responsibility of designing and running programmes for teachers in all subjects and all phases. This study concentrates on the lack of teacher educators who have advanced training in pedagogical approaches to designing CPD programmes in digital technologies in

particular and in implementing them effectively (Preston, 2004a;Ofsted, 2001; Ofsted, 2002; Preston and Holmes, 2002; Preston and Cuthell, 2007; Daly, Pachler and Pelletier, 2009, a & b; Pachler, Preston, Cuthell and Allen, 2010, in press).

The term 'educator' has been chosen as a collective name for the 'subjects' of this research and embraces the multifarious roles of teachers of teachers in this field of digital technologies. Teachers of teachers in the field of digital technologies often now have a variety of roles in a school, in a region, in a company, or in a university or college. For example, these teachers of teachers might be education researchers engaged in supporting teacher-led projects in schools; senior managers with an Information and Communications Technology (ICT) training role; teacher educators in universities; teachers who are staff trainers or network managers; regional advisers; independent consultants; company trainers promoting a product or service; supply teachers and teaching assistants; and even talented students. In this study the education researcher is also seen as a teacher educator particularly if their research engages the teacher in the topic and supports them in becoming a co-researcher (Leask and Preston, 2011, in press).

This strategy of involving the practising teacher in research about their practice as a co-researcher marks important progress in breaking down the cultural barriers that still exist between the expert teacher and the learner, and the expert researcher and their subjects- in this case teachers. The learning potential in new relationships between researcher and teachers are best explained through the lens of Adler and Adler (1987) whose partnership in social anthropology is now thirty years old. However, their observations about the different grades of membership of the communities being researched are the best fit with the complexity of my role and the MirandaNet Fellows role in the three case studies that are described in Chapters four, five and six of this thesis.

Adler and Adler (1987) identify three kinds of researcher:

- the objective researcher is called a Peripheral Member Researcher (PMR);
- the Active Member Researcher (AMR) is only engaged actively with the community for the duration of the study;
- the Complete Member Researcher (CMR) is characterised by complete immersion before and after the research event.

Interestingly, although Adler and Adler admit that although objectivity is sacrificed in this research stance, they believe that the 'greatest truths' are revealed when the researcher experiences the challenges from within the relevant community and is trusted by that community. The Complete Member Researcher (CMR) approach is often referred to as an ethnographical stance as opposed to a positivist approach (Denzin and Lincoln, 2000).

In each of the three case studies, I took a different role in relationship to the communities involved. My overall aim was to empower the educators on the courses to take ownership of their own professional learning. During this study, I explore all these levels of engagement from the perspective of the teachers in the study who are largely already teachers of teachers or working towards this role either in England or in South Africa. I also reflect on my own role as an objective evaluator in the first case study. This is followed by a more active role in the second two case studies which includes, designing the ICT CPD programmes; being a teacher of teachers as well as a learner; operating as a leader in the informal learning community that is built between the educators as they learn from each other; and being a researcher in terms of the doctorate study. It is the blurring of all these roles in different learning episodes that becomes the theme of this research. As a result the insights into how professional understanding can be achieved are not only the prerogative of the researcher, and the teacher of teachers, but of the community of educators as well.

Digital technologies in global education

The term 'Information and Communications Technology' (ICT) is generally used both in England and Wales and in South Africa for the subject as it is taught in the classroom. However, in other countries, this curriculum subject is often called Information Technology or Informatics. Internationally these terms imply a concentration on the computer science aspects of computer application: the implication in England and Wales is that ICT refers to the ways of using computers for information retrieval and communications rather than how they are controlled through programming and how hardware operates. Across the world, however, computer science is still taught in schools where learning to programme a computer as well as learning to use the packages in detail are key elements in computer lessons although computers are not deployed elsewhere in the curriculum.

The global term 'digital technologies' in this study is used to encompass all electronic technologies that educators might use for teaching and learning within their classrooms rather than what is delimited by curriculums and examination syllabuses. The term 'digital technologies' refers to technologies that are used for teaching and learning remotely like Virtual Learning Environments (VLE), sometimes called Learning Platforms. There are also a range of Web 2.0 technologies that can be available free like: wikis, remote messaging, remote video conferencing, micro-blogging, blogging and remotely multi-authored digital concept maps that are to build professional knowledge used in the 'unconferences' designed by MirandaNet Fellows, called MirandaMods[21] (see the Glossary p.9., Context p.11. and Doctoral Journey p. 14).

[21] www.mirandanet.ac.uk/mirandamods

This social interaction online, now being observed virtually, was first recorded face to face in the process of building 'communities of practice' as a means of informal learning (Lave and Wenger 1991). In Braided Learning theory and practice (Haythornthwaite, 2007: Preston, 2008a: Preston and Cuthell, 2009a). Fellows are tracing informal dynamic knowledge creation in collaborative contexts as the participants move from textual debate in a conventional listserv to video conferencing, microblogging contributions and collaborative concept maps. Fellows see this collaboration taking place in a "liminal space" - a term drawn from anthropology that describes a rite of passage, in which a person moves from one state to another. The Braided Learning emergent theory and practice is drawn from the practice of MirandaNet debaters who make frequent use of MirandaMods and mirandalink, the closed listserv of the community. The image of braiding is intended to denote the concept of ideas being woven together by individuals to develop a strong intellectual argument. It is reminiscent of the apparent chaos observed in a hive until the perfectly shaped wax cells appear as a result of the honey bees collaborative activity. In the MirandaMods a key visual building element is now a remotely authored digital map.

Bees die when their tasks are complete, but the MirandaNet debaters are observed to be transformed in the liminal space by acquiring new knowledge, a new status and a new identity in the community. The view is that this change is of critical importance if learning is to be successful. Whilst learning remotely and informally is largely is what has been understood about mobile learning, the concept can now be extended to include these informal spaces in which learning takes place – the liminal spaces that those who push the boundaries of digital possibilities now inhabit intellectually (Preston, Cuthell, Kuechel and Cych, 2009).

Equality of professional sharing is the essence of the 'Third Space' which is a space shared by teachers, teacher educators and researcher where their professional equality and value is endorsed (Leiston and Zeichner 2006; Zeichner 2008 – see p. 25). However, Braided Learning, theory and practice, looks more closely into how this

liminal space is actually developed by members who are seen as equals. The data is being collected from the listservs for several professional organisations and from MirandaMods. where the visual representation of meaning currently focuses on the collaborative digital concept map – a multidimensional artifact.

The term 'digital technologies', also encompasses the mobile technologies movement that aims to chart this new conceptual space they call the 'Mobile Complex' (Pachler, Bachmair, Cook, 2010). To provide background to this term, I need to explain that the reason why the leaders of this movement are researching this area is because of their concerns that 'education systems are failing to keep pace with the social development and the life-worlds of young people, both of which include the shape of the media landscape' (p. 3). What the authors most fear is a potential disconnect between educators who are working in the face to face paradigm and young learners who are comfortable operating in 'liminal spaces'. The Mobile Learning movement can see that 'educators will have to face up to the challenges of the normalization of mobile devices and technologies and the integration of these into everyday lives and professional practices (p.3.)'

Such warnings about the pervasive impact of digital or mobile technologies in society where Web 2.0 and Web 3.0 are now prevalent are true in the two countries that are featured in this research: England and South Africa. In England, an advanced Western democracy, between 85% and 75% of teachers are still not using digital technologies well in school: figures that are being quoted after 30 years of computers in schools and a fifty billion pound investment (Richardson, 2007). In this study however, English educators from twelve schools in the 15% - 25% band who do have high levels of skill and understanding were mentoring educators in twelve schools in Free State, South Africa where computers were being installed.

Free State, where the continuing professional development programme took place, is one of the two poorest provinces in South Africa where there are no natural resources.

This study tracks one element in a large project set up to introduced computers into the educational system, at significant expense, in the belief that competence in digital technologies would give a new direction to a local economy by offering computer service to the rest of the world on the Indian model. New insights into building educators' understanding of digital technologies were, therefore, essential in this project if the value of this investment in new opportunities for employment for the whole province was to be fully realised.

Emerging professionalism

During the time since the late 1980s when I have been teaching teachers, there has been a growing impetus in a small segment of the profession, for teachers to learn actively rather than the passively and to take charge of professional issues. Sachs (2003) calls this phenomenon The Activist Teaching Profession and this position sums up the overarching approach of this research study in finding evidence of change.

'Professional learning' is a term widely used in the UK to cover the activities in Continuing Professional Development (CPD) programme designs that put educators in control of their learning agenda (Johns-Shepherd and Gowin, 2007; Pickering, Daly and Pachler, 2009). The interplay between the teacher and their environment that allows them to manage their learning agenda is also important for many researchers in this decade (Guskey, 2002: Zhaqo and Frank, 2003; Hammond et al., 2008; Davis, 2008; Davis, Preston and Sahin 2009 a & b). The underlying intention of this kind of programme that gives ownership to the teachers is to promote change in teaching and learning based on evidence. In the ICT CPD Landscape: Literature Review (Daly, Pachler and Pelletier, 2009a) the phrase, 'professional learning', is used frequently in different iterations to define the point at which educators reach a new point of professional understanding at the end of a learning intervention. In this context, the ICT CPD landscape researchers draw out the challenges that impact on the design of good ICT CPD for professionals, and aid or impede professional learning in this quotation:

> ICT CPD, therefore, needs to be recognised as a complex, social, intellectual and practical activity which brings about change in teachers' beliefs and understandings in relation to changing practice and developing skills. It takes place within a range of locations and modes which provide cultural contexts in which to learn. It involves re-evaluating learner – teacher roles and overall classroom pedagogies. It brings changes in aspects of professional identity. For these reasons, simplistic models of ICT CPD are not helpful – it is highly situated and success is subject to many inter-related human and social factors which vary across locations, strategies and relationships (p. 70).

This sophisticated explanation of professional learning shows how understanding, at its best, brings about changes in professional identity. However, professional learning is a complex process that takes place at many levels and is both flexible and fluid.

Up until the late 1980s, when I began to teach teachers, traditional modes of information transmission were the main way in which learning took place and the context in which learning was judged was largely by written tests and examinations. Professionals went on courses where they listened to lectures on the experts and wrote essays about what had been imbibed. They also undertook the same practices in schools that they had experienced themselves. But there was often a disjunction between the theory learnt in higher education and the practice in the school.

However, these traditional ideas about professional learning that I had both experienced and promoted, were revolutionised by Schön in 1987 when he published, The reflective practitioner- how professionals think in action:

> I begin with the assumption that competent practitioners usually know more than they can say. They exhibit a kind of knowing in practice, most of which is tacit…Indeed practitioners themselves often reveal a capacity for reflection on their intuitive knowing in the midst of action and sometimes use this capacity to cope with the unique, uncertain, and conflicted situations of practice (p. 8-9)

This quotation emphasises the complexity of learning how to practice and the value of tacit knowledge, understanding, conflict and lack of certainty that go beyond what can be expressed in conventional academic prose.

Schön advocated 'action research' as a process for stimulating learning. This term describes a process in which professionals research new theory and practice in their work place and then implement them if the evidence is positive. These ideas were developed in England by educational researchers like Elliott (1991) and Hargreaves (2000) who saw the potential for educational change. In this following decade, these new learning strategies are being refined by the development of new designs for professional learning that focus on three key themes: shared practice, collaborative continuing professional development (CPD) and scholarly reflection (Pickering, Daly and Pachler, 2007).

Somekh (1989; 1995; 2005; 2007) developed Schön's action research approach with particular reference to professional learning in digital technologies that developed into a partnership with Davis (1997) who both become MirandaNet Fellows in 1995 (refer to Context p.11). When I founded the professional organisation for educators, the MirandaNet Fellowship, in 1992 little was available in either practice or theory, about the use of digital technologies in classrooms. As a result MirandaNet Fellows invited Somekh to run a workshop in 1995 so that we could establish action research processes within the organisation. Our intention was to build a repository of practitioners' action research case studies in order to promote a sense of ownership and collaboration. It was the beginning of the MirandaNet Fellows' conviction that teachers should be reflective and activist professionals influencing policy through research evidence (Preston, 1999: Sachs, 2003: Leask and Preston, 2011, in press).

This view of teachers as activist professionals runs against the trend of governments in the UK of telling teachers what to do. Running alongside this view at the beginning of

the twenty first century were research arguments that teachers were 'digital immigrants' and students were 'digital natives' (Prensky, 2001). However, these stark labels tended to reinforce a deficit model of teachers and ignore the complexity, the fluidity and the progression of learning. Krause (2007) argued that this simple opposition between 'immigrants' and 'natives' obscured the complex factors that affected both teachers' and students' attitudes and competence like different socio-economic backgrounds, class and gender. In the same year, Bryne and Ross argued in conference, that this reductive binary state of immigrant and native ignored the opportunity for teacher and learner agency and the complexity of the relationship between teachers and learners and technology.

Pachler and Daly (2006) refer to this simplistic contrast as 'the conventional utopia, dystopia polarization (p.2)' with which they do not concur. The context is about online communications as a tool in professional learning, but my contention, developed in Chapter two, is that collaborative multidimensional concept mapping provides a similar tool that teachers as professional learners can use to externalise their knowledge and engage in shared knowledge construction and co-construction. Furthermore the Daly and Pachler standpoint is that 'it is impossible to enter into a debate about new technologies and teacher learning without having an ethical orientation towards the purposes of the technology in relation to the purposes of education (p.3.)' This is also the underpinning approach in this thesis and relates closely to how the researcher and the teacher educators see their relationship to the teacher as a professional learner. Is their view as 'expert' to teacher as learner, or, lead learner/mentor/facilitator to teacher as learner? These are important distinctions in, for example, designing ICT CPD programmes.

In the recent series of three reports about the Information and Communications Technology (ICT) CPD Landscape in England (Pachler, Daly, Pelletier 2010a and b: Pachler, Preston, Cuthell and Allen, 2011) in which both Pachler and Daly have been involved, they continue to highlight the complexity of the ways in which teachers now

learn in contrast to the reductive binaries that are presented. They indicate that informal learning, particularly in professional groups, is beginning to emerge as a factor just as opportunities for formal learning become more fragmented. Informal learning about digital technologies may indeed, become more prevalent as the proposed educational cuts begin to take effect. These trends in professional learning will be developed in more detail in Chapter two: literature survey.

The challenge

My first degree from the early 1970s was in English and Dramatic and Telecommunication Arts. From the time that I began teaching teachers about digital technologies in the late 1980s it was clear to me that the subject demanded more practical and application skills than English, the subject I was trained to teach. At that time computers were not as user friendly as they now are and teachers' reluctance to master them was understandable. However, my study of Dramatic Arts a version of theatre and film studies convinced me of the value of using more than words to convey feelings and the potential of the computer in two-dimensional story telling (Preston, 1995). The Telecommunications Arts course, one of the first Media Studies courses, provided me with a grasp of the broader socio-cultural issues that were emerging in the use of mass media like television and radio. Not in the 1970s, however, was media theory pointing towards the convergence of television and computer screens that is now so prevalent.

By the turn of the twenty first century when it was clear that educators were still not comfortable with digital technologies, I was convinced from my own experience that Information and Communication Technology programme designers needed to know more about educators understanding about computer concepts generally in order to meet their needs. This conviction strengthened when I was undertaking the evaluation of the National Opportunities Fund (NOF) national training for teachers in the UK between 2002 and 2004.

The NOF training programme, in question, begun in 1999, was for the whole teaching community in England except supply teachers. It was a major national enterprise involving forty-seven commercial companies, the Approved Training Providers (ATPs). In the past universities had been expected to run teacher training, but this time commercial companies, not rather than the universities, were tasked with setting up consortia to include teacher educators and advisers. The focus on the learning principles underpinning ICT courses rather than concentration on training in skills seemed commendable, although there were protests that the universities were not put in the lead.

OFSTED, the inspection body, however, did not understand the complexity of professional learning, nor the time that professional change requires to be effective. They tried to measure the impact on children's achievements in 2001 and 2002 and, not surprisingly, found virtually no evidence of impact on learning stemming from NOF. The newspapers reinforced these perceived failures. The phrase that was often repeated by teachers from an article in the Times Education Supplement was 'NAFF NOF' (Kenny, 2001). This was a label that was not easily removed from the professional consciousness.

By the time the MirandaNet Fellowship were asked to begin the evaluation of this four-year programme in 2002 the common view amongst the education community was that this programme was seriously failing. The invitation to evaluate the NOF programme had come from the Teacher Training Agency (TTA now the TDA), a government funded organisation responsible for the training of teachers. This organisation was in charge of quality assurance and evaluation; in this position they were aware that there were many complex reasons why this NOF programme was considered to be so ineffective. The problem for them was that, although the biggest two companies had misjudged what was required, there were many smaller organisations who had had some largely unreported successes because they employed

better pedagogical models where the educators had more ownership of the NOF programme design.

The MirandaNet Fellowship that won the tender for evaluation questioned one thousand teachers and visited fifteen schools at various stages of the NOF programme. Elements that were emerging as vital to success were: the culture of the school and the attitude of the leaders; the quality of the advisers who were largely undertrained; and access to digital technologies that worked seamlessly. Many teachers were, in fact, less willing to use digital technologies in the classroom after the training because of the failure of equipment, particularly the NOF learning platform that one of the largest commercial companies had launched (Preston, 2004a).

What was clear from the NOF data was that most teachers were 'unhappy'. The nature of this 'unhappiness' seemed to be the dominating use of the 'deficit' model of ICT CPD progrmme design. Not only were many teachers made to feel passive recipients of information in this NOF programme, but also the teachers were not given any free time in which to undertake these studies. It was at this practical level where many busy teachers concentrated their anger. As I explain in My Doctoral Journey it was only ten years before when teachers' entitlement to twenty-one day CPD courses had been stopped. Some of the teachers would remember this. Other key obstacles to teachers' learning that emerge from NOF research were: a lack of targeted funding; absence of formal assessment of Information and Communications Technology (ICT), implying that digital technologies have no value; and a prevalence of summative, mono-modal testing and assessment methods that emphasis technical skills rather than understanding of the potential of digital technologies (Preston, 2004a).

Towards the end of this decade there has been a growing consensus that issues of supply cover and funding have become major issues with regard to teachers attending courses, their ability to learn or to find uninterrupted time to develop what they had learnt. Pachler and Daly (2006) touch upon one possible reason for teachers'

continuing malaise in their description of the 'default' mode of teaching teachers about digital technologies that denies teachers professionalism. They talk about the impact of managerial CPD in their paper in discussing using online communications in teacher education.

> Teachers can now download an entire corpora of content information for teaching, minimizing the autonomous and critical thinking dimensions of their role (p.3.).

Towards the end of the NOF evaluation I became frustrated with the results from the traditional evaluation methods we had used: the questionnaires and the interviews. An underlying malaise was palpable in the NOF evaluation, and yet the written answers were not revealing the detail of why this was. Recently I had the opportunity drill further into this malaise by interviewing teachers who were hesitant about the use of digital technologies in depth (Pachler, Preston, Cuthell and Allen, 2010 in press). In this ICT CPD Landscape study I interviewed these teachers, who had been identified as reluctant to use digital technologies in the classroom, face to face in an environment of their choice - often their homes. These visits were very revealing because they were often well equipped with computers in the home environment and comfortable in their use. However, they expressed sophisticated and valid reasons why they were not convinced about the use of ICT in school across a range of subjects. Some practitioners felt that issues about the use of ICTs in classrooms were not being addressed by providers or leaders. These issues ranged from reliability problems to concerns about e-safety, unreliable equipment and web services, poor support services, ethical and moral concerns, poor pedagogical practices and fears about social isolation, lowering achievement and celebrating limited achievements too highly. Many of the teachers who were reluctant to use digital technologies in classrooms said they would welcome more professional debate at a higher intellectual level about the role of digital technologies in education and more evidence about their effectiveness as well as discussions about good practice (Pachler, Preston, Cuthell, Allen, 2011 in press).

Providers, ICT CPD leaders and practitioners in this study had divergent views about the future of ICT CPD. Providers interpreted the lack of release time as an opportunity for individualised learning platforms in a blended situation that would include online and self-directed activities and less and less face-to-face training.

Leaders in ICT in schools, who were mostly providing the ICT training, described a significant move towards in-house ICT CPD provision, provision through communities of practice and learning informally using Web 2.0 applications. The majority of ICT CPD leaders considered themselves to have high levels of skill in the application of digital technologies. Most of these leaders were satisfied that they did not need training themselves. A small minority was taking any courses themselves. However, a few leaders of ICT CPD in schools suggested that they are not receiving enough CPD at a high enough intellectual level to deal with the dangers and demands that digital technologies can present. These few leaders also wanted provision that focused on the innovative pedagogical opportunities that digital technologies offer, the management of change and media issues. Some leaders also thought that some senior management teams might do more to tackle the issues that make teachers reluctant to use ICT in classrooms.

Practitioners in the same study did not feel they were being treated fairly at all and complained about the lack of entitlement to CPD in general. They also observed that a number of in-house CPD leaders appear to be ignoring the desire of some practitioners to pursue formal qualifications through external courses as a career enhancement move. More practitioners than leaders expressed a keenness to learn and to belong to communities of practice in order to fulfill this learning desire. This is an interesting observation because it may reveal the fact that the leaders in ICT CPD are reluctant to lead accredited courses, especially at Masters level because they do not have these qualifications themselves and, therefore, are more comfortable at the level of skills and implementation in the classroom rather than issues and theory. It would appear that many courses are functioning at a rather low level of scholarly reflection.

The ICT CPD Landscape study noted the new trends to develop informal learning models, like 'unconferences', blogs and micro-blogging. Such practitioners who are amongst the most able users of digital technologies stated that the most effective CPD they had attended varied enormously. Several cited the face-to-face and online meeting through professional communities and micro-blogging as being effective forms of CPD compared with one-off courses.

One emerging trend from the Landscape study and the NOF study however, endorsed a finding from a report in 2000 (Preston and Cox) about the value of emerging communities of practice that were using digital technologies to underpin understanding through social interaction. This was picked up again in the second MirandaNet evaluation of the existing data that looked more closely at the smaller organisations that had not received much coverage in the first report (Davis 2008: Davis, Preston and Sahin 2009 a and b). These studies indicated that successful models offer teachers opportunities to create the professional freedom to decide their own transformational agenda within their local ecology. The use of action research and communities of practice scored highly in these studies.

To recap: in the early 2000s, I was dissatisfied with the piecemeal approach to digital technologies in the design of the two NOF programmes that had the widest coverage amongst the forty-seven offerings that were accepted. Although they were designed from the point of view of appropriate learning theory as NOF had requested, the material had to be learnt in an information transmission way rather than promoting constructive or social learning amongst the teacher participants. In this way more active modes of learning, even if they were being taught in the course materials, were not being modelled in the way the teachers themselves were being taught.

What became clear to me as I analysed the data in the first TTA commissioned NOF evaluation was, as I have explained, the lack of ownership the teachers felt in being

asked to use computers. Although teachers often blamed other external factors in many of the answers they gave in interviews and on questionnaires, I sensed an undercurrent of fear and resistance. I began to look for some other data-gathering tool that would go beyond the superficial responses in words and drill deeper into the sense of threat I perceived within a sizeable group of the profession about digital technologies and their applications. I was also interested in a tool that could be used to develop the professional insights into their understanding of digital technologies. What I was looking for was a research tool that allowed the subjects to present their ideas about digital technologies in pictures rather than text.

Identifying a multimodal research tool

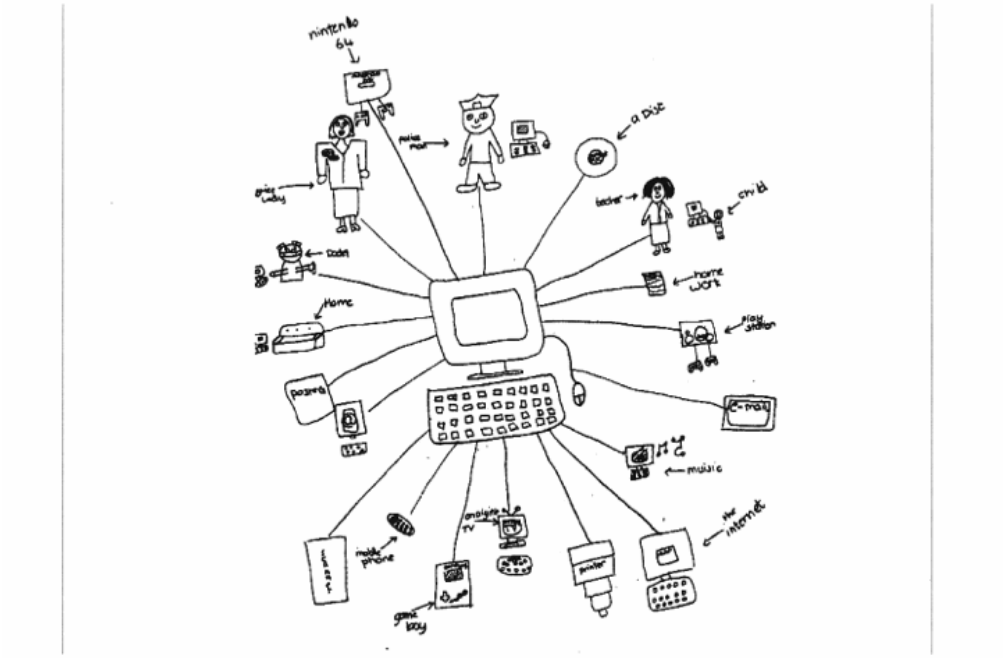
An opportunity to investigate the value of innovative multimodal research tools appeared through an invitation to evaluate the pilot of a one-year computer based skills course for teachers that was to be distributed internationally on CD-ROMs and in course books. This opportunity to investigate an initial skills training programme was relevant to the NOF findings because a key discovery was that 'despite 12 UK government ICT initiatives since 1974, not enough teachers had adequate ICT tools and/or competence to make full use of the programme about the pedagogy of ICT (p.66).' As a result it seemed as though teaching computer skills well might be one way to increase professional engagement.

In the early 1990s software for the visual mapping of stories had begun to appear which interested me as an alternative to planning essays as a series of linear headed paragraphs (Preston, 1995). I was therefore, drawn to the work of MirandaNet colleagues taking place from 2000 - a longitudinal study of achievement related to digital technologies called, commissioned by the English government agency, Becta (Mavers, Somekh et al., 2002). The methodology of the first ImpaCT1 report had been criticised because it had failed to provide evidence of learning over a year in English, Geography and Maths (Watson,1993). The methodology was considered to be at fault because the only evidence was the studying of hand-written essays produced at the

beginning and end of the year when computers had been introduced to the class. The use of computers in the cohorts had not been comparable and hand writing was not felt to be a means of showing the impact of computer use in one year. The result that English and Maths achievement levels decreased over the year was not considered by many educators to be valid.

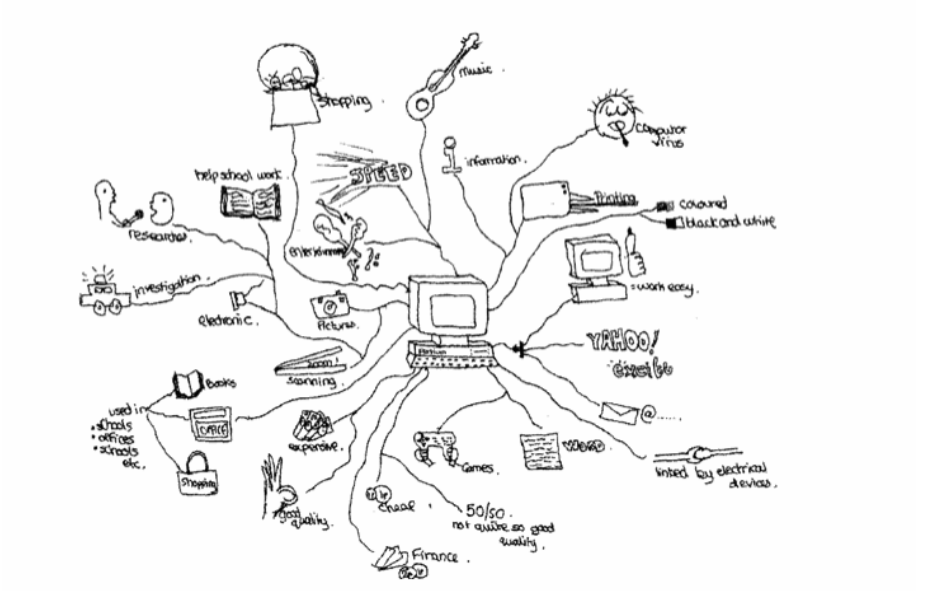
The distinguished team of researchers in the second ImpaCT2 report (2002) was looking for methodologies that were better suited to representations of thinking about computer systems. They had alighted on concept maps as presenting new communication possibilities. The evaluation had two strands. The first strand had been mandated by the UK government as it had been in ImpaCT1: this was to provide quantitative evidence of the relationship between ICT use by pupils and their attainment, using recognised measures such as SATs scores and GCSE examination results. The questionnaire evidence was expected to endorse the investment that had made in computers in schools up to this point. It would also provide the impetus for ensuring further funding in this field.

Concept mapping data in the second strand was a ground-breaking methodology implemented to record possible new kinds of understanding that might be arising from new learning contexts such as networked technologies using multimodal affordances. In particular, there was an interest in the results of prolonged use of multimedia technologies and the Internet available to a proportion of pupils in the home. This strand also recognised that many children had better access to computers outside school than in school, as did their teachers (Facer, Sutherland, Furlong and Furlong, 2003; Somekh, 2004; Downes, 2004; Pachler, Bachmair and Cook, 2010).



Impact2 (2002) Becta Mavers, M., B. Somekh, et al. (2002). "Interpreting the externalised images of pupils' conceptions of ICT: methods for the analysis of concept maps." Computers and Education 38: pp 187-207. (Permission to reproduce granted March 2006).

Figure 1.1. A 'Computers in my World' Map drawn in pencil by a 10 year old



Impact2 (2002) BectaMavers, M., B. Somekh, et al. (2002). "Interpreting the externalised images of pupils' conceptions of ICT: methods for the analysis of concept maps." Computers and Education 38: pp 187-207. (Permission to reproduce granted March 2006)

Figure 1.2. A 'Computers in my World Map' drawn in pencil by a 14 year boy

In this futuristic spirit the ImpaCT2 team chose concept maps as one of their key data collection tools in their second strand. Basically concept maps are created from circles, ovals or squares that are content frames called 'nodes' linked by lines called 'links' that sometimes have directional arrows on them. The children's maps, entitled Computers in my World, were surprisingly complex and informative, despite the fact that they had been drawn in only 20 minutes.

> The researchers clearly had great respect for these artifacts: 'the concept maps are fascinating cultural objects, full of unique detail and often aesthetically pleasing (p.191).

A key element in understanding the maps was the gentle open-ended interview technique that was respectful of the map makers existing knowledge. No sense of deficit was permitted. Here is a quotation from one of the learners that encapsulates thoughtful development of understanding;

> Pupils' talk about their concept maps sometimes focused on in-depth detail about specific nodes or explanation of particular links. Sometimes they gave more general overarching statements. Personal experience formulated many of their responses, for example, 'I downloaded a lot of pictures off the internet once... and I saved them all onto a floppy disc, about three floppy discs. […] I drew' an outside modem because, uhm, because you can have an inside modem inside your computer or you can have it outside your computer' (Year 6 boy, March 2001)

The detailed concept maps drawn by children suggested to me that this tool might be valuable for the evaluation of the computer skills course I was designing. It seemed this tool might have the potential for providing insights into educators' understanding of computers in more visual modes than was possible ways in questionnaires, linear written responses and structured interview discussions where concepts had to be described in words only.

With the aim of using concept maps in my own research, I looked more closely at how the ImpaCT2 team had drawn on socio-cultural psychology for their rationale about concept maps as research tools as well as a scaffold for learning. They quoted Cole (1999) who had suggested that learners needed to develop cognitive tools that were an essential, integral part of the use of the tools themselves. These included routines, patterns of use and ways of doing things as well as representations, or 'secondary artifacts', which allow us to envision the possible uses of the tools or 'primary artifacts', and thus to use them in ways that change and extend our capabilities.

> At present there is no policy that directly addresses the need to develop learners'—or teachers' mental representations of new technologies, and this may be an important missing element in changing the nature of learning with ICT in schools (p.188).

The ImapCT2 researchers decided on three methods of analysis: two quantitative and one qualitative. Drawing on semiotic theory, which is the making of signs in communication, the three elements used in meaning-making in the concept maps were numbers, words, and the maps as a holistic semiotic sign using two modes, images and words. To explain in more detail, the analytical methods were:

Number: The first method focused on the number of links and nodes. The researchers produced a simple 'connectivity' score, derived from dividing the number of links by the number of nodes. This gave a ratio score of 2:1 for the most simple maps and up to 4:1 or 5:1 for complex 'spaghetti' type maps. The connectivity score was expected to provide a measure of the cognitive activity in order to see which children knew most about the interrelationships of computer networks.

Words: The researchers devised a scoring sheet that allowed them to count up words under different categories in order to see the patterns that were emerging across 2,000 maps. The original scoring sheet can be seen in chapter three on methodology.

(In Chapter Three the differences between the original scoring sheet, Figure 3.1.a. and the revised score sheet in Figure 3.1.b. are discussed).

Complex multimodal signs: In this study I was planning to use the ImpaCT2 interview technique to question the map makers about the reasons for their concept map design and what the map signified.

This notion that concept maps needed to have the potential to represent the affordances of computers was a key argument in the context of representation theory, a branch of semiotics that I critique in Chapter two - the literature survey. I investigate and adapt the methods used for analysis in ImpaCT2 in Chapter three - methodology. The maps were referred to as multimodal, because they were not just composed of words as one mode, but words were often combined with images, which is another mode. The words to often had a multimodal design element that reinforced meaning with the size of the word or the colour.

In 2002 when the ImpaCT2 was beginning to publish their methods and early results, the first edition of Reading Images: The Grammar of Visual Design, Kress and van Leeuwen (2002) devoted a section to concept mapping in which they surmised that the design of a network that concept maps presented might be more akin to the kinds of layered thinking that is privileged in the internet age over linear communications about understanding.

These were significant influences on the research design of the three projects MirandaNet Fellowship were developing in parallel from 2003 – 2007. In each of these we decided that the concept maps would provide an alternative methodology to the language based methods we were also using: the first project was the evaluation of a pilot of a year-long international computer skills based course for educators; the second was a year-long Master's module in which educators would develop action research projects in their classrooms in e-learning; the third was the mentored ICT CPD

programme designed and run by MirandaNet educators working alongside South African educators. This last project was called E-lapa - an electronic meeting place in the jungle in one of the African languages. This thesis concentrates on the concept mapping aspects of these projects, rather than the other elements of the research design.

In the case of South Africa, another advantage of using concept maps was that English was not the first language of more than half of the South African educators who were participating. Concept maps, that did not rely entirely on words, unlike the more traditional data collection methods, were seen to offer a communication environment that might empower those educators to evaluate the ICT CPD programmes effectively despite their lack of practice in English.

In the Context (p11), the Doctoral Journey (p.13) and this first chapter the design and delivery of CPD programmes since the late 1980s has been described through the lens of my professional experience; moving from a teacher of Information Technology (IT), Media Studies, Drama and English to an ICT and English staff trainer in school, a regional adviser in London, England, a teacher educator in a university and an educational researcher. My professional trajectory also traces the changing nature of the educators' role and the lack of obvious CPD routes unless they are self-funded. The effect of the Coalition Spending Review (2010) is likely to worsen this deficiency in the UK. Although spending on education has been maintained in the face of the national deficit, the attitude towards CPD is unclear. Cuts to university grants for teaching teachers and cuts in local authority services means that there will be fewer lecturers and adviser to support professional learning. Becta, the government agency for Information and Communications Technology in schools has been closed. Increasingly the informal routes that MirandaNet and other professional organisations offer are being taken up as professionals look for informal CPD means of sharing knowledge with other professionals who suffer the same lack of funded professional support.

What this experiential history also records is the changing nature of professional status and the desire of a few teaching professionals to take charge, not only of the agenda of their own CPD programmes, but also of the professional publishing agenda. In this way some groups of professional teachers are intending to influence policy at local, national and international agendas.

What follows now is the more formal academic approach to educational research. In Chapter two: the literature review, professional learning is explored in relationship to the three case studies that have been undertaken, the pedagogical theories underpinning these three ICT CPD Projects are outlined and the concept maps that are used in the research are discussed in more depth. Chapter three: methodology - covers the research question and themes, the data collection techniques and the methods used for analysis. In Chapters four, five and six the details of each of the three case studies are explained; how the methods are adapted for the situation; what the findings are, and what conclusions are drawn. In Chapter seven: conclusions the findings from the three case studies are compared and contrasted; the changing status of the educator is discussed and three different resources tools are offered for the use of educators and their students that might provide new insights into understanding. Finally in the postscript I talk about the material limitations of the study and the ways in which it has stimulated me to reflect on my practice as an educator.

Chapter two: the literature review

In the context of my own professional development, described in The Doctoral Journey (p.13), and in Chapter one (p.21), I have looked at the profile of the 'educators' in the title who are working with teachers to help them take ownership of the power of digital technologies in education as well as the ways in which educational researchers can contribute to professionals' understanding rather than just observing learning processes. I also investigated theories about professional learning that help to define what constitutes the professional 'understanding' that is cited in the title of this thesis: Gaining insight into educators' understandings of digital technologies. The evidence of understanding, at its best, is a change in professional identity. This change is, in itself, empowering.

In summary, there appear to be three trajectories in professional learning emerging since the 1980s that have impacted on teachers' sense of autonomy and their personal identity: a significant loss of entitlement to professional development; an increasingly fragmented market with a lack of established standards and a large proportion of course content that tends to be skills and product based: and, a prevalent deficit model that assumes that teachers are either unable or unwilling to engage with digital technologies in teaching and learning. In contrast there is evidence that a small number of technically competent teachers are joining together to learn, managing their own learning agendas and publishing - thus, fulfilling Sach's call for activist professionals (2003). Much of this informal CPD activity has been encouraged by the general availability of Web 2.0 and 3.0 that has already been discussed in Chapter one. In the first section of this chapter, I set out the research question and the theme that guide the rest of this study from the research point of view. I then explore the literature that investigates the different kinds of perspectives on learning underpinning ICT CPD programme design. These perspectives on learning are evident in the three case studies in Chapter three.

In the second section of this chapter I outline the literature on concept mapping with particular reference to the subheading of my title: three models for the analysis of multi-dimensional concept maps. The emphasis here is on how educators have used the maps in different pedagogical contexts. This study is to explain the choices made in Chapter three.

Research question and theme

The map makers in the study are educators, the collective term being used for teachers of teachers in a range of roles as explained in Chapter one. The focus is on the evidence of the educators' multi-literacies, rather than their computer skills and their resultant capacity to use multimodal forms of communication to make meaning.

The aim is to develop insights into educators' professional understanding of digital technologies with observations about the pedagogical approach underpinning their programme. The objective is to compare the analytical approaches focusing on numbers, words and complex MD signs in order to see which provide the richest insights into the educators' professional learning.

An overarching research question guides the collection of evidence:

> How does multidimensional concept mapping provide insights into educators' understanding about digital technologies?

The answers to this question are explored in the context of three case studies where multidimensional concept maps are collected at the beginning and end of three ICT CPD programmes. These three programmes were all designed to improve educators' understanding of digital technologies in order that they can teach others. The programmes all lasted one year and were held in England and South Africa. But the

content was different and each programme was designed differently from the pedagogical point of view.

There are three stopping points on this research journey that concentrates on the map makers' understanding. This first is to understand how scoring concept maps might provide insights into educators' understanding, the second is to investigate the value of the words used in the concept maps and the third is to explore the effectiveness of a more holistic approach to the multimodal analysis of concept maps as complex multi-dimensional signs. In this final section there will also be an interest in investigating whether using the concept maps as a data collection tool is one way of helping the educators to look beyond digital technologies to other kinds of socio-cultural modes of communication. Throughout the thesis the phrases, 'professional understanding', and sometimes 'professional learning', are used to refer to: the map makers' starting points and end points during these learning episodes.

I am, therefore, both as a researcher and as an in-service teacher adviser investigating the changes in understanding that implicitly point to and are the effect of professional learning. What is investigated is both the expertise that the educators bring to the CPD episodes and what use and sense they make of the mapping intervention in developing their own understanding.

Pedagogies underpinning ICT CPD programme design

This section investigates the pedagogical models that have underpinned CPD programme design since the late 1980s when my professional life as a teacher of teachers began. I frame the discussion using three key pedagogical approaches that underpin CPD designs based on Pachler's (2005) learning principles, simplified for student teachers:

information transmission;

constructivism;

social interaction.

An explanation of how these terms are used in this thesis follows.

Information transmission

'Information transmission' is a popular phrase used to denote the mechanistic communication of expert knowledge that is one way only. The critique of this mode of teaching has become increasingly sophisticated over the years as knowledge about the complexity of communication grows. The phrase was first coined in 1949 by Shannon and Weaver who wanted to mirror the functioning of radio and telephone technologies in human communication. However, Crawford and Sobel, (1982), pointed out that information transmission only works when the expert speaker is motivated to give a full account of their expertise and when the learner has a common interest in the knowledge being offered and is, therefore, prepared to listen. Without common interests, information transmission is heard as 'noise' by the learner who does not retain the information given. Chandler (1994) complained that the information transmission model assumes communicators are isolated individuals. No allowance is made for differing purposes, differing interpretations, unequal power relations and situational contexts often called differentiation. Information transmission is, still, still the most widely implemented perspective on learning in schools across the world. Indeed this can be an effective mode of passing on socio-cultural information, if the factors noted above are taken into account. The traditional role of expert educators around the world is to on their expertise to students who learn the information and reproduce it for examinations and tests. However, in relationship to ICT, Pachler (2005) warned of a general tendency to perceive the value of the new technologies only in terms of traditional information transmission: that is as a means of delivering facts to students. The key disadvantage of using this model with educators, who are the subject of this study, is that it reinforces the 'deficit' model of expert teacher of

teachers giving new information to teachers who are only students. This mode of ICT CPD makes little concession to what the educators may already know.

Constructivism and Constructionism

I argue that the constructivist approach is preferable in the ICT CPD context, because pedagogical design acknowledges the human need to generate knowledge and meaning from their own experiences. Constructivism is not a specific learning theory and, in this chapter, it is more appropriate to talk about constructionism, another theory developed by, who was inspired by constructivist and experiential learning ideas of Jean Piaget (1928; 1951). Papert's ideas were becoming well-known when I first took up teacher training in ICT through the publication of his seminal book, Mindstorms: Children, Computers, and Powerful Ideas (1980). Papert's views about learning are particular relevance as he developed the Logo language, a computer language that children could use to build mathematical concepts. He wanted the pupils to draw their own conclusions through creative experimentation and the making of social objects. The constructionist teacher takes on a mediational role rather than adopting an instructionist position. Teaching 'at' students is replaced by assisting them to understand—and help one another to understand—problems in a hands-on way. Teachers who are themselves taught in this way with colleagues acting as mentors rather than experts are more likely to model this kind of teaching in the classroom.

Too often student teachers are still are lectured about learning 'by doing' rather than being given the chance 'to do'. However, in in-service professional development, during the 1980s and early 1990s, the constructionist approach gained ground with the introduction of action research and practice based research as a methodology for teaching. But the constructivist practices of action-research and practice-based research differ in detail. In action research the teacher is encouraged to construct an understanding of the role of digital technologies in school, for example, by undertaking a negotiated project that tackles a perceived challenge (Schön, 1983). As early as the 1980s, Somekh saw the potential for action research as a means of embedding digital

technologies into teachers' professional practice as well as influencing their school, regional and even national policy (Somekh, 1989; Somekh, 1995; Somekh and Davis 1997; Somekh, 2005; Somekh, 2007). Hopkins described this process as turning reflection into a form of disciplined enquiry where the professional aims to understand, improve and reform (Hopkins, 1985, reversioned 2001).

Criticism of the action research approach of the 1980s focused on the isolation of the teachers who were only involved in the design and production processes of a project in their own classroom. Government funded projects promoted the notion that teachers could reflect on their practice without leaving the classroom. Critics warned that lack of scholarship in these solitary programmes could result in teachers being unaware of relevant developments in their area of study (Saunders, 2002; Whitehead, 2006). For these reasons the term 'practice-based' research began to be used (Lamb and Simpson, 2003). This theory militated against the prevailing view of teachers as business managers rather than reflective and activist professionals influencing policy through research evidence (Sachs 2003).

In the case of practice-based research the teacher as the active agent forges together theory and practice into 'praxis', a high-level mode of professional operation where the practitioner does not only possess skills, but a deep knowledge and understanding of the theories that underpin practice. In The Pedagogy of the Oppressed (1968), Freire defined 'praxis' as "reflection and action upon the world in order to transform it." In this interpretation, oppressed people can join together to acquire a critical awareness of their own condition, and, with their allies, struggle for liberation. 'Oppressed' in this sense means those who are excluded from power structures i.e. those who are the objects of a top-down process, rather than subjects in their own right. 'The oppressed' might seem a strong term to apply to education professionals, yet there is a sense in which globally teachers have their autonomy restricted in their classrooms as other governments take a lead from the UK in defining national curricula and implementing examination league tables as a measure of teachers' effectiveness.

Constructionism was widely taken up by the profession in the 1960s and 1970s in order to break away from the paradigm where the teacher pontificated from the front watched by rows of pupils. But Askew and Carnell point out that in those decades the relationship between teachers and children was too cosy. World issues rarely intruded. In contrast, for Askew and Carnell, constructivism meant promoting transformative change both in the professional learning of the individual and within groups of professionals across schools, regions or even nations (Askew and Carnell, 1998). However, in the same decade managerialism in schools across the world halted some of these collaborative advances (Sachs 2003).

Social Interaction

The third learning perspective, 'social interaction', expands Freire's notion of the wider value of collaborative learning in social and cultural contexts in order to take charge of the agenda (1967). One of the approaches to ICT CPD recommended by the Landscape Review is a greater concentration on the role of groups of professionals who meet informally to exchange the theories and practices (Daly, Pachler and Pelletier 2009a). A key term for this kind of collaborative exchange is 'community of practice' (CoP) first coined by Lave and Wenger (1991) to denote professional groups of people who:

> engage in a process of collective learning in a shared domain of human endeavour: a tribe learning to survive, a band of artists seeking new forms of expression, a group of engineers working on similar problems, a clique of pupils defining their identity in the school, a network of surgeons exploring novel techniques, a gathering of first-time managers helping each other cope. In a nutshell: communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly (Wenger 2004).

Scardamalia and Bereiter (1996) developed the idea further by bringing into the learning community a knowledge creation tool. They developed a learning platform, called the Knowledge Forum, designed to assist CoPs of young people to think collaboratively about key questions in the curriculum. Their combined contributions

led to identification of gaps in their group knowledge that they fill as a team. The knowledge base is left for the next group. Instead of learning the same information, the new class absorbs the knowledge that is there and digs deeper. This way the school owns a knowledge base in which has pupil ownership. Unfortunately, Scardamalia and Bereiter had difficulties in finding enough schools willing to pilot the software because it does not fit in with the information transmission model that national curricula tend to support.

MirandaNet Fellows have been recording this process for collaborative engagement on knowledge creation in the development of Braided Learning theory and practice which is discussed and referenced in chapter one of this thesis in the context of the liminal space where collaboration takes place (Preston and Cuthell 2011 in press: Cuthell, Preston and Cych 2011, in press). As CoPs learn to use digital technologies in sophisticated ways, an interesting form of social learning is emerging that is underpinned by the use of technologies. This is collaborative, community-focused and voluntary, in contrast to focusing on the learning progress of individual learners towards accreditation on a course. Two related theories expand Wenger's vision about CoP practices: Communal Constructivism and Braided Learning. Communal Constructivism emphasises teachers' knowledge building role as they work together often across national boundaries (Lave and Wenger 1991; Wenger 1998; Holmes, Tangney et al. 2001; Leask and Younie, 2001; Wenger, McDermott et al. 2002; Leask and Younie, 2002; Stuckey, 2005). Much of this communal cross-national work is online. Braided Learning is an emergent theory that is also tracing how dynamic knowledge creation works in a collaborative online context (Preston, 2007: Preston, 2008 a).

Braided learning refers to a meaning-making process that is emerging from the observation of online communication as communities of professionals mature in digital competence (Haythornthwaite, 2007). These first three stages of Braided Learning were established when the communities being researched were only using email. The

process showing how social interaction can translate into professional action relates to the four socio-cultural communicative strata identified in multimodal theory: discourse, design, production and distribution (Kress and van Leeuwen, 2001).

'The universality and ubiquity of concept maps'[22]

In this section, I explore concept maps from the vantage point of two strands of semiotics that I discuss in detail below: representation and multimodality. This division helps to identify two types of educators: those who mostly think about concept maps as a means of presenting existing knowledge and ideas in a visual way; and those educators who are more interested in how the map maker has presented new and original connections in creative ensembles. This second position indicates an interest in what the map makers know already rather than what has been retained of has been taught. Of course, some educators, like the ImpaCT2 team, see the maps from both perspectives: representational and multimodal.

The focus in the discussion is mainly on how the concept maps are used as research tools and, therefore, comments are made on how various theories relate to the methodological position taken by the ImpaCT2 team. During the discussion I also comment on how the use of the maps in the literature relates to the four different pedagogical perspectives identified in section one: information transmission; constructivism; and social interaction.

What also emerges is how the academic definitions play out in various contexts. The key terms are 'concept maps', 'mind maps' and 'multimodal maps' and their relationship with 'multidimensional concept maps' that are defined as complex multimodal signs in terms of makers, production, levels and modes. Overall the

[22] The title of the Canas and Novak keynote at the Fourth international concept mapping conference in Chile 2010 www.itmc.us

literature study moves from positivist approaches to concept map analysis that stem from a representational viewpoint towards qualitative strategies that are more considerate of the map makers' perspective. The latter tends to be the stance of those interested in multimodality, meaning making and qualifiable multimodal meaning-making. Thirdly the review analyses the literature that covers concept maps as complex multimodal signs. In this section the multimodal affordances of concept mapping software are discussed. Finally the chapter turns to the multiple relationships that are facilitated when concept maps are used between the educator, the researcher and the map maker.

Two semiotic branches: representation and multimodality

The build up to the publication of the ImpaCT2 paper in 2002 first drew my attention to the potential of concept mapping in education (ImpaCT2 is described in Chapter One). However, concept maps have a long history in teaching and learning reaching back to the third century. The focus in this second section of the literature review is to explore concept maps from the perspective of semiotics, first defined as the science of the life of signs in society (Saussure 1916; translated 1974). Semiotics is now established as an all-encompassing term for the study of any sign that is used in a society or culture to communicate meaning. Signs can be realised in many different modes including sound, animation, graphics, gaze and gesture.

Signs are often, therefore, described as multimodal and the capacity to read these signs as multimodal literacy (Jewitt and Kress, 2003). Kress and Pachler (2007) argued that the close connections between meaning making and understanding can be described in semiotic terms as the connection between the making of signs and the making of concepts. In this section concept are explained in terms of two branches of semiotic theory: representation and multimodality.

Concept maps as representational signs

Representation is a theory about the signs that stand in for and take the place of something else. It is through representation that people know and understand the world and reality through the act of naming it. Signs are manipulated in order to make sense of the world (Mitchell, 1995).

Concept mapping has a long history in terms of representation. Aristotle, for example, a Greek philosopher from the third century, considered that man was distinguished from animals by his ability to create and manipulate signs. Aristotle's capacity to use logic to sort human beings into categories is represented in the first branches of this topological map, The Tree of Porphyry (Figure 2.1). The tree is named after the third century Greek Porphyry, who wrote an introduction to Aristotle's Categories. Until the late 19th century, this was still being taught to students of logic (Ålhberg, 2007).

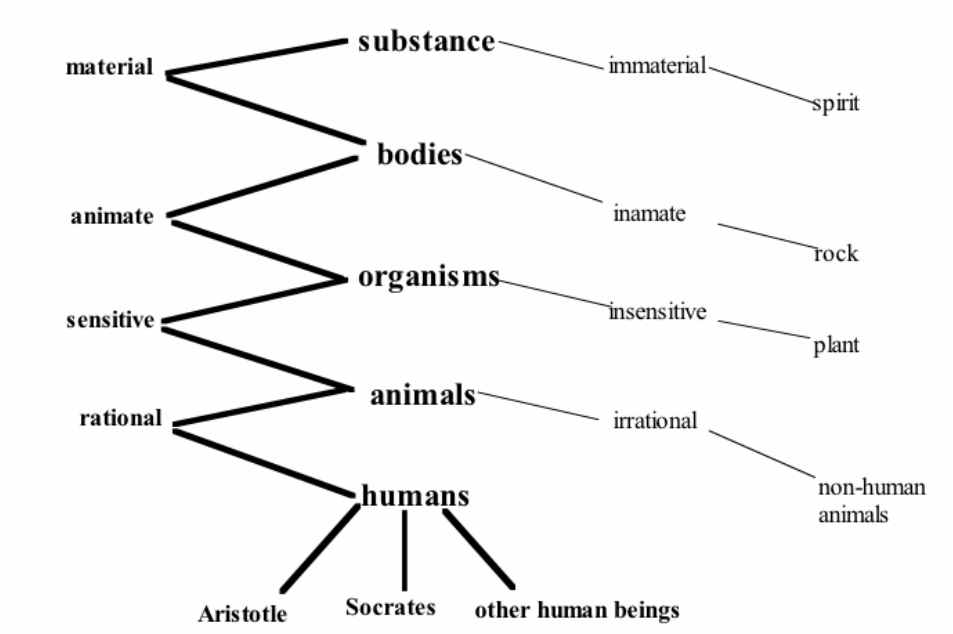


Figure 2.1. The Tree of Porphyry Third century

Common twenty-first century terms for concept mapping used in meaning making as representation include: spider diagrams, knowledge maps, clustering, graphical

organisers, consensual maps, spider grams, scaffolds, mind tools and flow diagrams. In the ImpaCT2 study they plan the analysis of the maps on the shapes of maps they had already identified in a European Union study between schools in six countries called Project REPRESENTATION: this name came from the underlying semiotic theories of representation. A variety of map shapes were identified in terms of organizational types: unconnected, (consisting of objects with no links); linear, (where the nodes are linked to only two other nodes in a sequential fashion like the stops on an underground map); one-centred, (with a clearly discernible central node from which links to other nodes radiate outward); several-centred, (two or more nodes acting as centres of interest); and spaghetti (highly complex and multi-lined) (Pearson & Somekh, 2000).

The shadow of Novak

Novak who began his studies in the 1970s is the best known of the concept mappers in education with a very prescriptive approach of the shape of a map should look. Figure 2.1. shows the hierarchical shape he favours – sometimes called a tree arrangement. Novak is now a distinguished octogenarian who has built a research team at the Institute for Human and Machine Cognition (IHMC) in Florida. He acknowledges that his concept maps differ from other types of mapping systems, such as knowledge maps, conceptual graphs, and mind maps because of: their grounding in Ausubel's Assimilation theory of learning; their semantic and syntactical (structural) organisation, the nature of concepts that comprise the nodes in a Concept Map, and the unconstrained nature of linking phrases. A standard procedure for Concept Map construction involves defining the topic or focus question, identifying and listing the most important or 'general' concepts that are associated with that topic, ordering the concepts from top to bottom in the mapping field, and adding and labeling linking phrases. Once the preliminary Concept Map has been built, cross-links are identified and added, and review of the map for completeness and correctness is performed (Cañas et al., 2003).

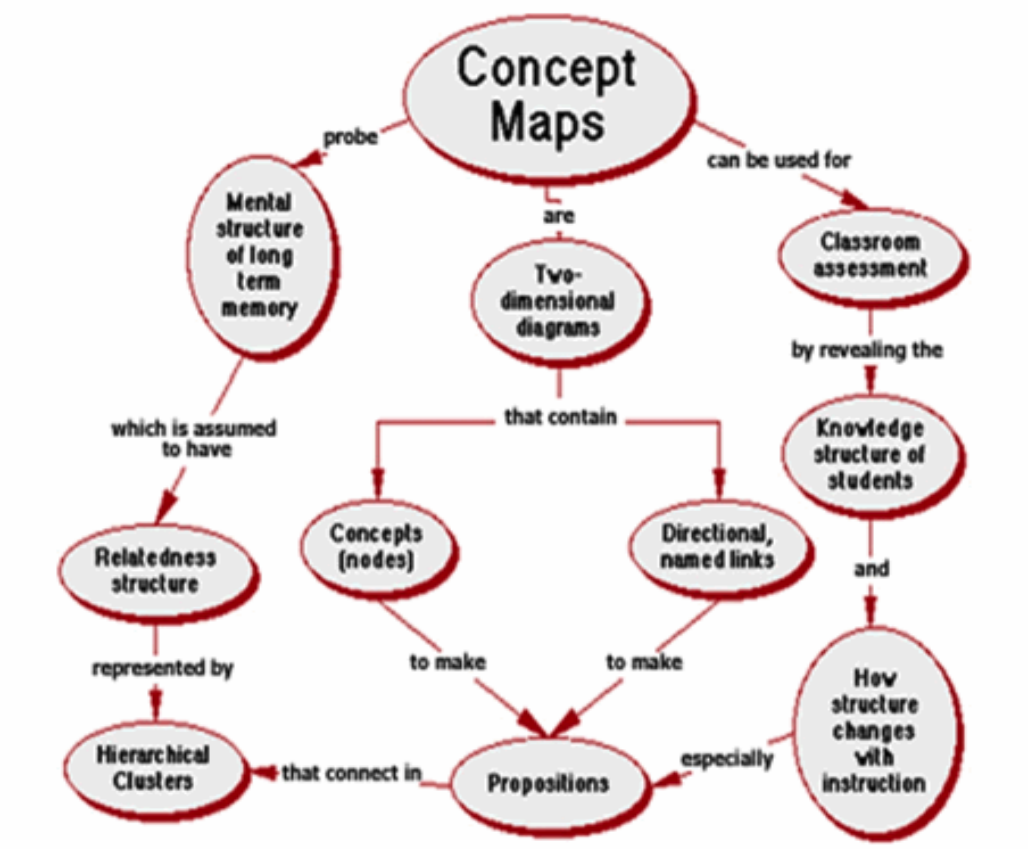


Figure 2.2. A Novakian concept map about concept maps

For Novak meaningful learning requires three conditions: the material to be learned must be conceptually clear and presented with language and examples relatable to the learner's prior knowledge; the learner must possess relevant prior knowledge; the learner must choose to learn meaningfully (Novak and Godwin, 1984; Novak and Musonda,1991; Novak and Cañas, 2006a; Novak and Cañas, 2006b). Novak's early instructions for teachers prescribed exactly the way in which they should teach so that the maps were constructed precisely according to his method. Daley et al. (2010) who draw a literature review of the 300 papers at the 2008 Third Biannual Concept Mapping Conference (CMC) conference in Estonia and Finland[23], group preface their

[23] http://cmc.ihmc.us/cmc2008/cmc2008Program.html last viewed September 2010

report by quoting Novak (2004) on his first study at Cornell University: 'our ideas developed into the invention of a tool we now call the concept map' (p. 460)'. Novak did not, in fact, invent the concept map, as we have seen from the history, - but the influence of his particular approach to mapping has been immense.

The most relevant case study to consider from the point of view of this thesis is the very first use that Novak made of concept maps - as a research tool. The concept map was developed by Novak's research group at Cornell University in the early 1970s as a response to the necessity to find a better way to represent children's conceptual understandings and to be able to observe explicit changes in the concept and propositional structures that construct those understandings, as part of a 12-year longitudinal study following a 2-year instructional period using audio-tutorial instruction in grades one and two (Novak, 1972). This research program was based on Ausubel's (1963; 1968) assimilation theory of cognitive learning and an emerging constructivist epistemology that viewed knowledge as a human creation involving the construction on new concepts and propositions through the process of high levels of meaningful learning, as described by Ausubel, and Novak's human constructivist epistemology (Novak, 1993, 1998). What is notable about Ausubel and Novak when they began to ask students to create concept maps in classrooms is that they were focused on a desire to understand learners' thinking. They promoted constructive learning rather than information transmission, and encouraged the pupils to interact socially to construct the map.

Novak (2002 and 2004) was also influenced by the translations of the work of Russian theorist, Vygotsky, a towering figure in sociocultural educational theory, who has had a profound influence on pedagogy in classrooms. In Russia his varied publications span from 1925 to 1935 when he died. But his influence grew in the West from the 1970s when his work was translated into other languages. Discussing the Zone of Proximal Learning, one of his best known metaphors for learning, Vygotsky argued that, rather than examining what a student knows to determine intelligence, it is better to examine

their ability to solve problems independently and their ability to solve problems with the assistance of an adult (1995). Like Vygotsky, Novak saw concept mapping as a constructive means of solving a problem in groups. In addition, he sees language as the basis of cognitive development and social relationships as a vital element in forming concepts.

These were ground breaking perspectives on learning in the 1970s. What is particularly significant for this study, however, is that these first concept maps used in education were not made by the pupils, but developed as research tools to help the researchers. Novak and Cañas explains how concept maps were tested as a means of understanding pupils learning patterns when interviews were not providing the answers:

> While we found structured interviews to be useful in capturing children's understanding, it was difficult to discern specific changes in the children's concept and propositional ideas as they progressed through schooling. Working with a talented group of graduate students, Novak and his colleagues came up with the idea of transforming interview transcripts into a hierarchically arranged set of concepts and propositions representing the knowledge expressed in the interview. Mapping a child's interview transcript often revealed ambiguities not seen previously that required more careful listening to the interview tape to discern additional cues for the child's thinking. Thus was born the concept map tool for representing human knowledge(p.1. Novak and Cañas 2010).

In the next section, I now consider how Novak analyses the maps through the value of the words on the labels and how he scores his maps concentrating on a numerical approach to the links and nodes.

Analysing representational maps

In this section I have covered some of the literature from researchers and educators who see concept maps as representational signs. Those interested in maps in terms of representation tend to see the maps from the semiotic perspective of numbers and words. Numbers, the first semiotic perspective, provide information about map

features like the numbers of nodes or links or the frequency that particular words appear. Early Novakian procedures provide quantitative information through scores.

Scoring Novak's maps

Novak claimed that if his system was undertaken exactly according to the procedure, then concept maps would provide an accurate, objective way to assess students' understanding of concepts they have been taught. This is why he had the confidence to devise such a detailed scoring system. This system has been added and modified by his followers depending on the nature of the task as the ImpaCT2 team did in 2002. In 2010, after many more development of scoring systems the Daley et al. literature review records the challenges in applying consistent and reliable scoring methods to the various concept mapping tasks, highlights the variability in types of information about the learner gained using different types of concept mapping tasks, and emphasizes the need to align the content and processes measured by both concept maps and alternate assessments, in order to making inferences about concept maps as valid, reliable measures of science learning. They concluded that reliability and validity are still important issues for considering the use of concept maps as assessment tools. In their view, these problems are exacerbated in 2010 by the presence of different concept mapping formats/techniques, different forms of traditional testing methods and a plethora of concept map scoring systems that add complexity to the act of linking student concept map scores to meaningful learning outcomes.

Meanwhile Novak himself has also moved beyond the emphasis on strict rules and prescriptive scoring still pursued by some of his followers who emphasis the scoring aspects of mapping. In contrast, Novak and Cañas use the internet to build electronic portfolios. Their paper, *A New Model for Education*, put the student at the centre of knowledge creation (Cañas and Novak, 2007). In this model they moved away from information transmission aspects of concept mapping towards 'constructivist' and 'social interaction' perspectives on learning (Bowen and Meyer, 2008).

There is a danger that the ways in which Novak is being translated in classroom contexts can become too prescriptive and formulaic- a mere repetition of what has been taught in a new form. Nevertheless, there are clearly merits in this system which suits well to teaching facts about science, maths and language structures. For example, Riley, a classroom practitioner, has authored papers that explore the meaning of words children use in Novakian maps to develop understanding of language structure (Riley 2005; Riley 2007). His class was well trained in Novak's hierarchical concept mapping system, but Riley avoided the dangers of mere information transmission and reproduction in two ways. He ensured that the young learners have an explicit understanding of the scoring systems and he involved them in the research and reflection process as co-researchers. In this way the maps became useful tools for learning for the map makers as well as the researchers. In fact, the children became action researchers working in partnership with their teachers. This point is returned to at the end of this chapter in the section: multiple researcher perspectives.

Novakian strategies for using words

A key component of the Novak map is the use of language to label the nodes and sometimes, the links. He also prescribed the use of language by the teacher. The sequence of teaching tasks that he advised, move from a teacher's carefully formulated focus question, to a brainstorm when related concepts are placed in a 'parking lot' as words or phrases until they are required by the map makers. The links between two or more concepts are labelled by words that describe their relationship. Because Novakian maps are language-based the level of prescription has become a problem as concept mapping is adopted internationally. For example, some of the detailed scoring prescriptions that rely on English grammar cannot be used in languages with different structures (Khameson, 2008).

Some stronger arguments emerge against Novak's level of prescription in describing how concept maps are to be scored when Mahn and Aguilar-Tamay (2010) collaborate to compare Novak approach to learning with Vygotskian theory. As Mahn and Aguilar-

Tamay agree that Novak was influenced by Vygotsky's work on the social value of learning, but as they worked together they realized that the application of Vygotskian theory could expand Novak's work on cognition. Their critique is that Novak and Ausubel believed that the relationship between word and concept as primary. Novak believed that the concept has been understood when the map maker labels a node: there is no more work to be done. Mahn and Aguilar-Tamay (2010) argued that Vygotsky (1986) may have had a more plausible theory about learning: that the naming of a concept leads to a deepening understanding and further efforts at representation over time. They are now developing research projects to look into the similarities and differences between the Novak and Ausubel approach to language and that of Vygotsky in order to see what can be learnt about the origins, nature and growth of concepts through maps.

The ImpaCT2 score sheet (Figure 1.3) indicates an intention, like Novak, both to count relevant words and to consider if the concept is correct - but these score sheets were intended to collect together the evidence of knowledge about computer networks from 2,000 pupils. Only in the interviews was it possible to gain any qualitative perspective on what each individual map maker had had to say.

The socially interactive aspect of the words on the maps is also important. In some of the case studies the map makers were particularly conscious of their audience. Halliday (1978), probably the most relevant linguistic theorist in terms of mapping, believed that a semantic system is shaped by the social functions of the utterance or verbal sign as a representation, an interaction and as a message to an audience. Each of these three social functions is called a metafunction. The three metafunctions identify: potential meaning; what can be meant; and, what can be done. Explained in terms of mapping, the first metafunction, the ideational meaning, refers to the subject matter of the map; the interpersonal meaning refers to the imagined audience the map maker envisages during the process of production; and, the textual meaning is map maker's awareness of the map as a communication with an actual audience.

Halliday was only looking at language as a means of communication whereas Mavers, the concept map researcher from ImpaCT2 explained from this metafunctional point of view the maps have a threefold role as a multimodal ensemble: as a product; as a process; and as a multimodal sign to convey meaning to an audience (Mavers' personal communication, June 2008). This is when words have a socially interactive function in 'learning with others in mind'. The phrase 'Learning with others in mind' is in the title of a paper by Daly and Pachler (2007) that examines verbal exchanges between educators taking a practice based Masters' course who are encouraged to share knowledge online as a 'community of practice.' Their formula for analysing the depth of online exchanges between educators is discussed in Chapter three: the research environment and design.

The third analytical strategy, discussed, in the next section is the map as a complex multimodal signs. In this context, the third sign is described as 'multimodal' to differentiate the meaning because numbers and words are also semiotic signs. I argue that those who see the maps primarily through a multimodal lens think differently about the value of a map in learning from those who see maps as a representational tool.

Concept maps as complex multimodal signs

The third semiotic perspective is the concept map as a complex multimodal sign. Researchers in this literature suggest that in contrast to a written essay, concept maps are particularly suited to expressing understanding of digital technologies because computers connect in networks and internet navigation is not a linear exercise (Somekh, Mavers and Rosterick 2002). Kress and van Leeuwen (First edition 2002) explain that concept maps allow a more 'horizontal' view of the ways in which ideas link in contrast to the hierarchical approach of a linear essay. Although this is true of some maps, however, Novak promotes a hierarchical approach to the mapping of ideas. This only confirms that the maps themselves are neutral – they can be used to develop a hierarchy of concepts, or to a flatter and less organised approach.

Concept maps offer the map makers more ways of connecting ideas than an essay. In particular they allow map-makers to define their concepts about digital technologies from a visual as well as a textual perspective. In some cases there will, in fact, be no words only images connected by lines. In this section I also extend the term in the context of concept maps to 'multidimensional concept maps' (MDCM). This term is intended to emphasise the fact that concept maps can be collaboratively designed and remotely authored as well as being produced in many different media.

From these perspectives, I aim to draw out from the literature evidence of the value of concept maps as evidence of understanding and also as a scaffold in developing understanding of digital technologies. I have then reinforced this at several points in this section on the literature'. Seeing concept maps as a holistic multimodal sign highlights a key difference emerging between the traditional Novakian followers and multimodal theorists. Traditional teachers of mapping provide the content of the map, the means of production, the structures to be used and the marking scheme to follow. Then they look for deviations from the norm and judge the value of the map on the strength of the reproduction of given concepts.

The multimodal school, in contrast, value the creativity of the signs they are given. These researchers are learning from the map makers and their interpretation of reality, rather than judging them on what is 'right' and 'wrong'. In this context an analysis of concept maps by a multimodal expert will tend to emphasis an understanding of the map makers' choices rather than testing their recall.

For the educators discussed in this study, multimodality is an important emerging study because it is an illustration of contemporary hybridity and expands across subject disciplines and learning environments.

> Multimodality is central to contemporary conceptions of learning and learning environments (Bezemer, Jewitt, Kress and Mavers, 2008 p. 2.).

Multimodality proves a new perspective on knowledge and communication across the curriculum that extends beyond language. Specifically multimodality includes visual, audio, kinaesthetic communication and representation in linguistics and more broadly the humanities and the social sciences. An understanding of multimodality opens up opportunities for educators to develop their students' capacity in multi-literacies (Jewitt 2002 and 2003). In this comprehensive book, Jewitt brings together a wide range of international theorists that cover the emerging spectrum of multimodality. In terms of multi-literacies the first assumption of multimodality that emerges from this collection of papers is that language is just one part of a multimodal ensemble:

> Multimodality proceeds on the assumption that representation and communication always draw on a series of modes, all of which have the potential to contribute equally to the meaning. The basic assumption is that meanings are made, distributed, received, interpreted and remade in interpretation, through many representational and communicative modes – not just through language – whether as speech or as writing (Jewitt, 2009 p.1.).

The second assumption is that each mode of an ensemble has been shaped by its social cultural and historical context. The third assumption is that people orchestrate meaning through their selection and configuration of the modes.

The final assumption is that multimodal signs are shaped by the rules and norms of the social environment and reflect the motivations and interests of sign-makers. That is, sign-makers select, adapt and refashion meanings through the process of reading/interpretation of the sign. These effect and shape the sign that is made (Jewitt 2009 p.1). Reinterpreting meaning in this way is popularly called a 'mashup' (see Glossary p. 9). The sign-maker, in this case, has combined similar types of media and information from multiple sources into a single representation. Multimodal

opportunities for meaning-making in learning are greatly complicated by the introduction of digital technologies, particularly when much of a students' experience in this field usually comes from outside the school curriculum. In terms of assessment, this raises questions for educators about the value of creating new signs from existing resources that young people find on the internet.

Multimodal theorists, like Jewitt and Kress, have an important role to play in helping educators to explore the difference between traditional education, where literacy privileges writing and multimodal learning, a more informal approach, where many literacies are relevant. Today traditional systems are limited in their range because they only nurture the mono-literate capacity required by traditional reading and writing systems. Mono-literate skills are inadequate for creating or reading a multi-dimensional concept map. This is the reason why the emergent theory of multimodality provides the theoretical underpinning for this analysis.

In this study a particular kind of multimodal sign is used, a concept map, in order to investigate many of these questions about multi-literacies, meaning making and assessment. The term multimodality has been modified to 'multi-dimensionality' here in order to emphasis the specific multimodal affordances of digital maps that differ from hand drawn maps. Multi-dimensional concept maps (MDCMs) might be 'mashups' utilising images, sounds and videos from other sources linked to the nodes (Finch, 2006). MDCMs can be remotely multi-authored and multi-layered. These affordances are highlighted in the term multidimensionality because of their potential in education as innovative modes of collaborative meaning-making, knowledge creation and theory development that digital tools provide. The assumption is that interactive opportunities like these are likely to have significant socio-cultural impact on communication within the professional communities under discussion in this study.

In an interview for an article about the value of concept maps for teachers, Kress (interviewed by Preston, 2007) argues the point that teachers have much to learn from

their pupils about semiotics. He explains that in professional terms the link between learning and meaning is very strong – but the full range of semiotic meaning is not just contained in words. Meanings are derived from gesturing, smiling and shrugging the shoulders. Children carry modes of meanings from the world outside school into the school. Kress indicates that concept maps can support learning because they enshrine or encode this world of multimodal meaning that the teacher wants the learners to engage with. Maps are a way to draw attention to the relevance and salient features of the world of the map and the connections of the elements in it. A concept map becomes a particular kind of learning environment – concentrating attention on nuances of meaning in innovative forms.

Buzan's mind maps

The ImpaCT2 team stated that the maps they invite two thousand pupils to draw are more like Buzan's 'mind maps' than Novak's concept maps because they were image based. I contest this point for two reasons. Firstly, the ImpaCT2 team did not teach the students how to draw a radiant map and ask them to stay with this method. Secondly, the pupils only had paper and pencils whereas Buzan was very keen to introduce colour even in the paper maps that his customers have provided over many years.

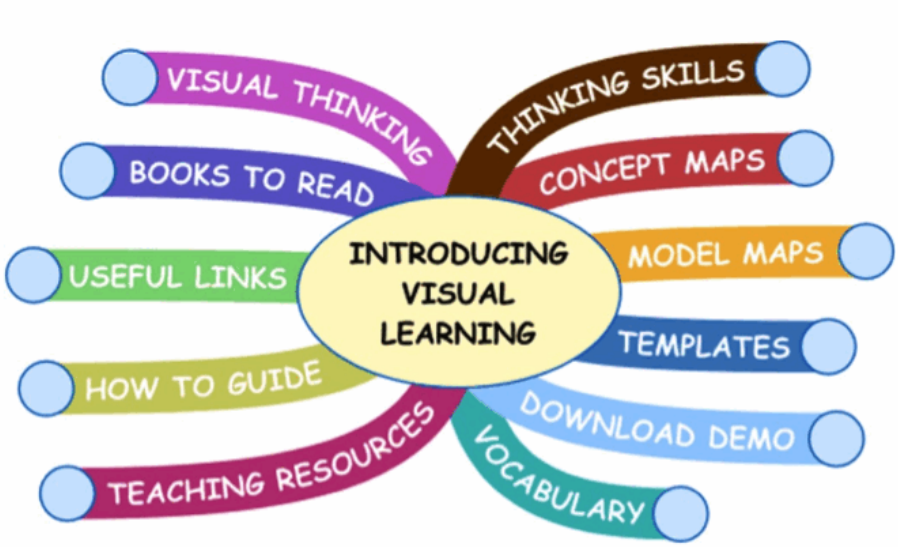


Figure 2.3 - a Buzan style 'radiant map'.

But Buzan did emphasis the unleashing of the map makers' creativity which is what the ImpaCT2 team also wished to do in the Computers in my World paper exercise.

The term 'mind map', trademarked by Buzan (1993) is often used interchangeably with 'concept map' in popular conversation. However, in a 'mind map' ideas radiate in branches from a central idea rather than forming a hierarchical diagram or a network (Figure 2.3).

Buzan was critical of the Novakian method of mapping that he finds too prescriptive (interviewed by Preston, 2007). He saw learning taking place first in images rather than words and insisted that his radiant mind map structure represented the way the mind works (Buzan 1993; Buzan 2002). In his view, the mind map was distinctive because branches radiate from a central node. Each branch can lead to further branches showing how each topic develops in detail. In his theories about thinking, Buzan argued that the brain is a visual image-based thinking organ rather than a language-based organ. In his enthusiasm for the role of shape, colour and curving lines, he argued passionately that images are more important than words in cognition:

> We have been under the misapprehension for many, many centuries both from the philosophical perspective and the psychological perspective that mankind thinks with words. What I'm saying is that humankind thinks with images and the radiant associations from those images and that words are very important, but, nevertheless, a sub routine of thinking (Buzan, 2007, p.10).

There is a strong multimodal current underpinning his view of thinking as image-based and Buzan has some committed followers in business and education. But Åhlberg (2007) offered a word of caution about Buzan's theories on cognition by pointing out that the two research reports about the relationship between Buzan's mind maps and learning (Anderson-Inman and Ditson, 1999; Farrand, Hussain et al., 2002) suggested that the mind mapping process is probably only significantly useful in the field of factual recall rather than higher order thinking.

Multimodal theorists approach to learning

In the interview about the usefulness of mapping for teachers given for this study, Kress questioned Buzan's claim that mind maps detail the workings of the mind (Kress 2007). For Kress this theory was too ambitious. However, Kress did argue that concept maps are innovative because they represent existing modes of thought in new ways. He explained that in the old forms of thinking that emerge from hierarchical organisations, the authority in power tells the learner what they must learn and how. The initial Novakian hierarchical prescription for map construction supported this authoritarian mode of information transmission of scientific or mathematical ideas. In contrast, Kress maintained that power in a contemporary organisation is more horizontal. This means that individuals in that organisation can organise the environment around them according to their own interests rather more like a network than a hierarchical structure. The map makers, in this situation, are not required to reproduce information they have been taught. In the network age learners can set the curriculum agenda by expressing in their maps what they know and what they need to know objectively.

Using scoring for assessing learning

Multimodal theorists are concerned about traditional forms of assessment that purport to be objective, like the scoring of maps that Novak advocated. Kress suggested that concept maps might provide an alternative way to assess meanings that are beyond words and to link assessment more closely to the processes of communication that are prevalent in society (2007).

These ideas about assessment are expanded in Multimodal Literacy, where Jewitt and Kress (2003) contended that new forms of assessment about how learners are thinking should be created. These should pay attention to the learners' interests, in contrast to tests that exercise power over learners' thinking by insisting on what they must learn. Researching into children's learning in science education Kress, Jewitt et al., (2001)

illustrated further this assessment strategy in the significant shift of thinking that takes place in assessing maps about science theories. The researchers began to engage in what underlies and motivates this specific representation of the issue at hand rather than their own preconceptions about what should be on the page.

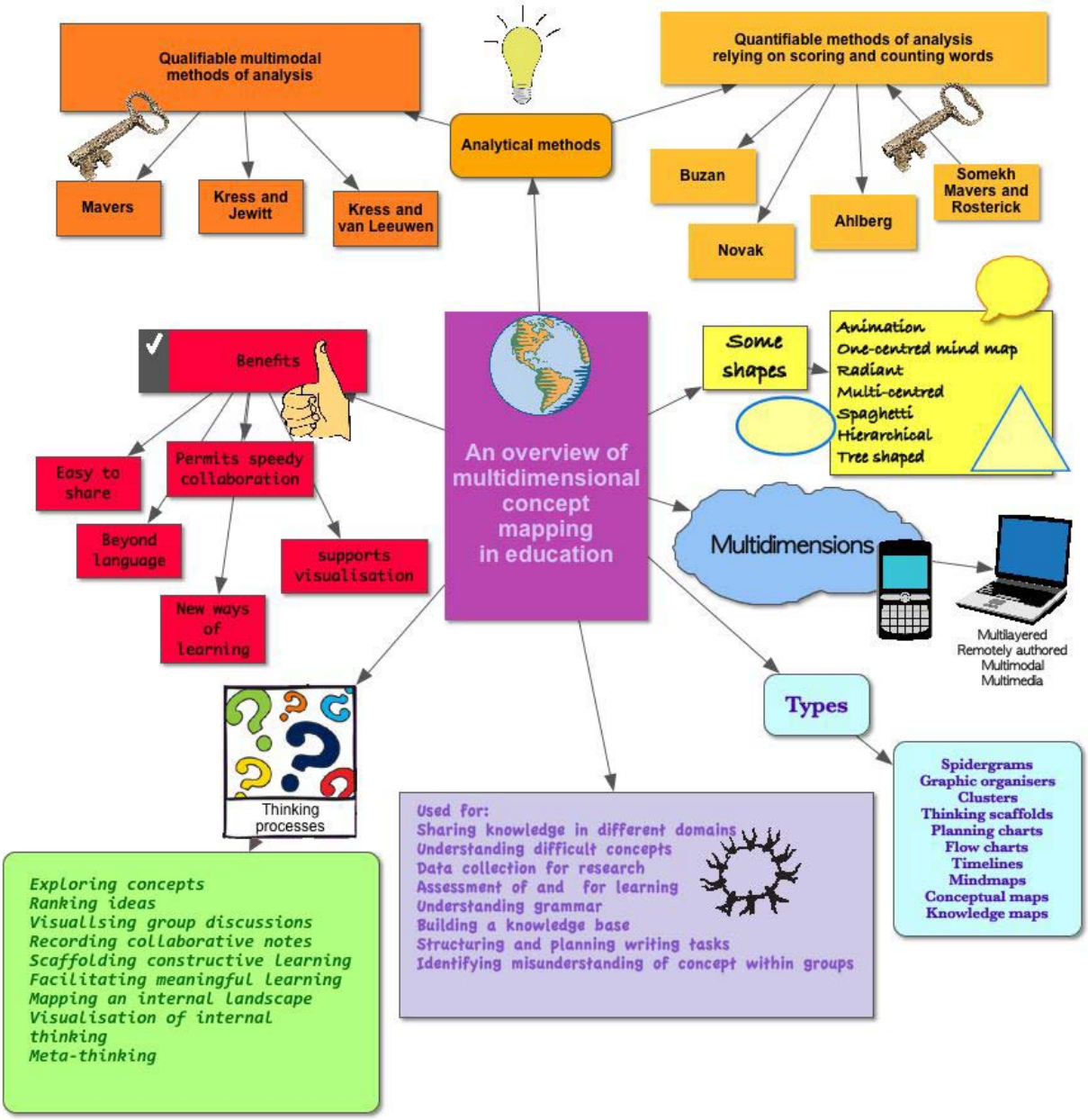


Figure 2.4. A collaborative concept map about concept maps

During their analysis the authors moved from the traditional pedagogical question, did they get this right or not?, - to the learner-centric question – what are the interests the children are expressing here?

Digital multimodal resources

Concept maps can also be produced freely in a wide spectrum of media and in a range of styles as well as in multi-layers of meaning in linked dimensions. They can also be multi-authored remotely which is why I use the phrase multidimensional concept maps (MDCM) to differentiate between what can be reproduced on maps and what can be developed digitally. However, multidimensional concept map is a long phrase and, therefore, in order to help the text flow in this thesis I often used the acronym, MDCM, or sometimes 'multimodal concept map', and, sometimes, concept map or just map. In fact, all concept maps have the potential to be multi-layered and multi-authored depending on what media they are created in. Figure 2.4 shows a multidimensional concept map about concept maps that was developed collaboratively by a group of delegates in my session at the Third Concept Mapping Conference in Estonia and Finland (2008b). This group was interested in the semiotic approach to concept maps that was not, otherwise, in evidence at this 'CMapper' dominated event. This paper version does not permit the demonstration of the layers underneath that hold a variety of notes on the topics. All the notes can be exported into a word processor in linear form to provide the basis of an essay. Figure 2.5 has been reproduced to show, in outline, how secondary school students, working together, have used a Buzan radiant style 'mind map' to develop essay notes on their set play, The Glass Menagerie. The screens are too small to be read in detail, but they are displayed to illustrate how students can manipulate the detail of a collaborative concept map to share different 'takes' on the same information: in this case as a word outline for the planning of an essay and as a diagram that provides a different slant on the relationships in the play. What can be seen is the imaginative use of clip art from the software library as symbols and icons standing in for textual labels that are present even in the outline where text dominates. Pupils who are visual thinkers are likely to find this approach to

marking textual ideas helpful. These opportunities to use professional tools give the students more control over the multimodal processes of discourse, design, production and distribution than has ever been possible in classrooms of the past. The value for collaborative work in the spirit of social interaction on the screen is high in terms of class discussion and sharing (Cuthell, 2007; Hennesssy and Deaney, 2009; Leask and Preston, 2011, in press).

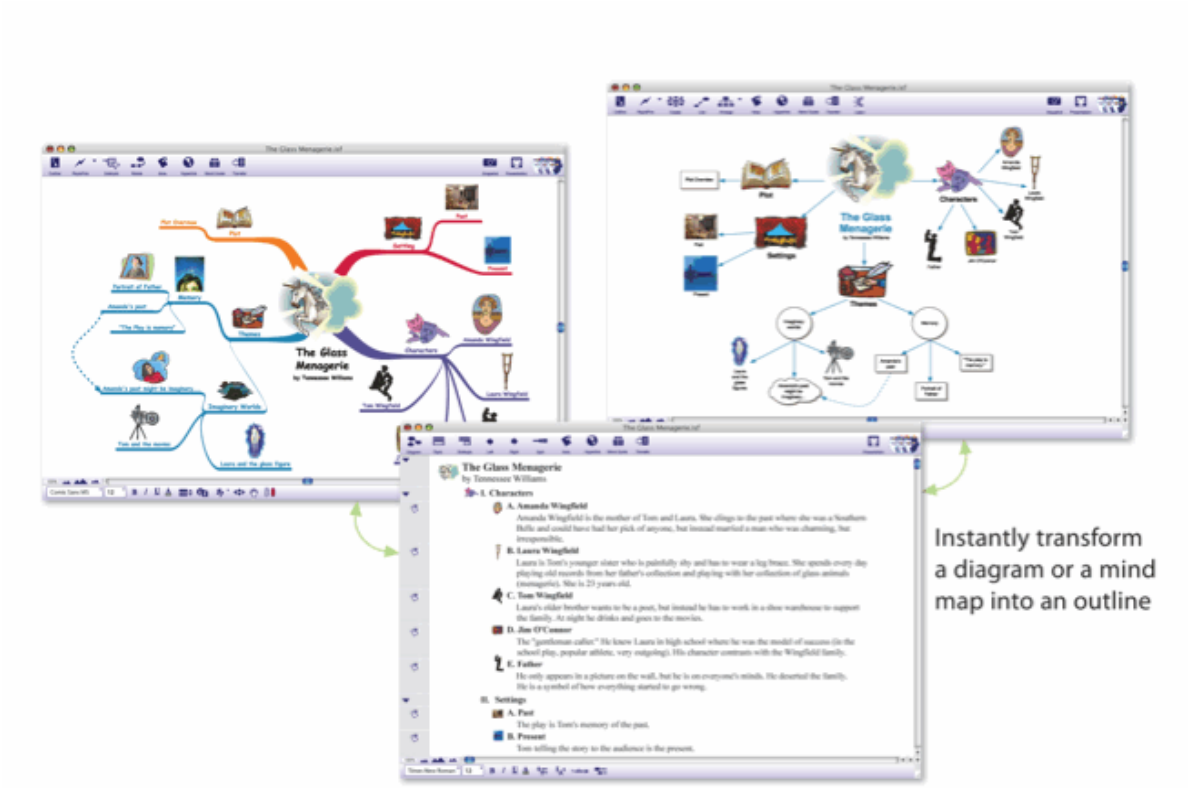


Figure 2.5. Secondary pupils sharing concepts about a play and reproducing them in accordance to the task in hand.

Jewitt (2002) showed that access to digital technologies in classrooms presents learners with multimodal resources for sophisticated meaning making that paper based communication cannot do. Many of the affordances she mentioned are within the scope of a digital concept map. Within the term, multimodal digital resources, she included simulations, virtual learning environments, electronic books, discussion forum applications, spreadsheets, hyperlinks and hypertext. She also cited the range of

representational modes that learners handle in school and at home that make up their multimodal literacy: still image, movement, colour, sound effect, music, speech (voice), writing, photos, graphics, sound, animation, texture and multi-layered diagrams that are challenging the dominance of the written word in meaning-making (Jewitt 2002; Jewitt 2003).

Novak speaks against hand-drawn maps because he feels that paper maps are not durable and cannot be changed easily (2010). His team has developed the free 'CMappers' software[24] which now has the affordances of colour and the addition of pictures on the nodes. The examples on the website suggest that meaning is derived from a study of the relative sizes of the nodes and the words inside them as well as the complexity of the hierarchical links. 'CMappers' tends to specialize in complex and expansive digital concept maps to be thrown onto a high wall in higher education establishments in order to illustrate and discuss complicated theories in science and maths. The teaching appeal of this approach for academics developing difficult concepts is easy to understand compared with a class reporting on their reading of linear papers. These digital maps also reinforce both constructivism and social interactivism in learning if the students are full involved in the creation and critique of the map.

Buzan[25] has a much more commercial following that use these mind maps for personal organisation as much as business gain. On the website, the mind map is promoted for single users and organisations worldwide that can use them 'to revolutionise the way they think, plan, study, create, present and organise.' The marketing language pitches to business offering 'a software solution for boosting innovation and productivity - saving you up to one day a week'. No research is quoted to substantiate this figure.

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[24] http://www.cmappers.net/

[25] http://www.thinkbuzan.com/uk/

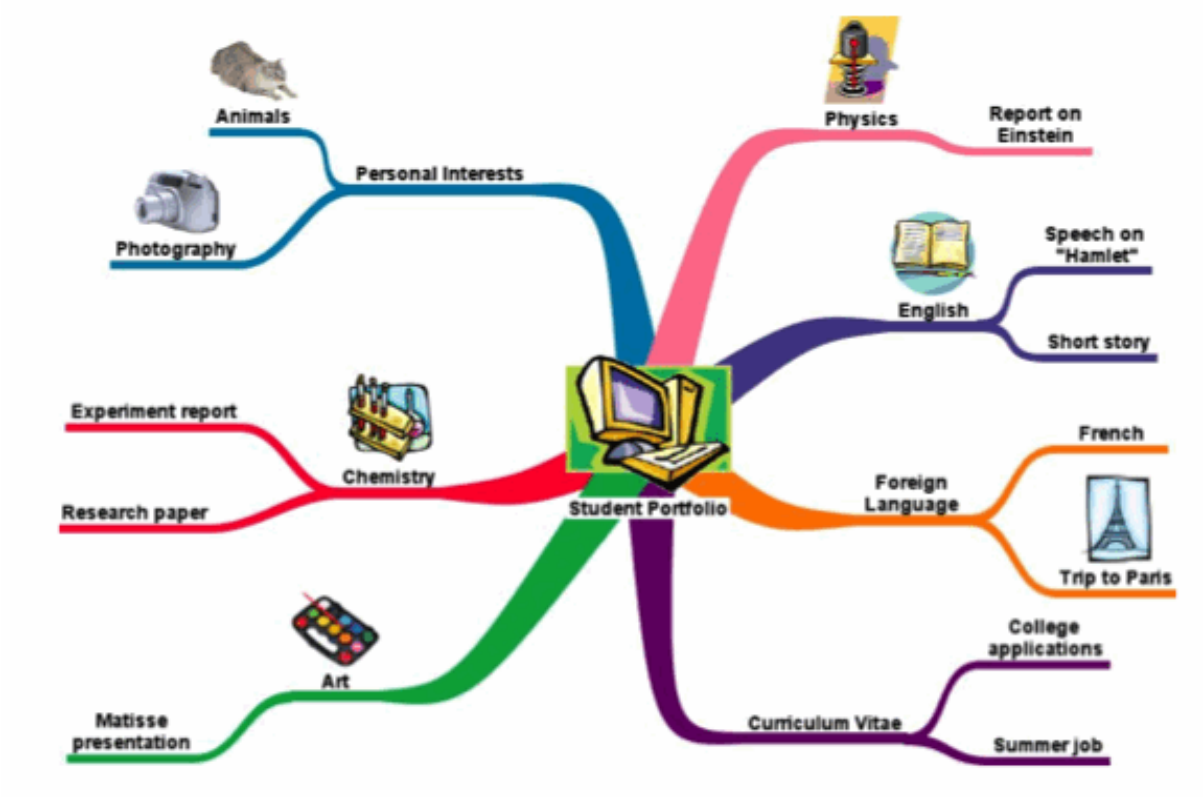

Figure 2.6: a student portfolio in concept mapping style using a Buzan mind map tool

However, the free software that has been developed with Microsoft offers a range of dynamic multimodal features that are persuasive: expand and collapse branches; translate into different views; and, export or import an array of different files, documents and websites. Files, including audio clips and video files as well as urls can also be dragged and dropped onto the Mind Map to make it as interactive and informative as possible. There are galleries of clip art and icons and symbols to make the line of an argument clearer. In Figure 2.6, a secondary student has developed their own portfolio using similar mapping software[26]. This approach to indexing and reporting as a portfolio is substantially different from writing a linear essay on

[26] http://www.inspiration.com/

paper. The addition of photos and sound files emphasise the control over different media that this young person is displaying.

Kress and van Leeuwen (2007) anticipated the ways in which concept maps can be used by the learner when they develop the links between computers and concept maps in seeing an affinity between the shapes of maps of associations and the interconnectivity of the internet. They suggested that the concept map form replicates communication modes that are possibly more relevant to all learners today than the linear essay form.

Kress and van Leeuwen suggested that the opportunity to draw a map freely might be particularly relevant to young people because the world is becoming increasingly interested in making lateral connections and network horizontal links rather than prescriptive tree structures associated with hierarchical and vertical lines. This was one of the reasons that the ImpaCT2 team choose mapping as an appropriate mode in which to ask young people to express concepts about computer networks.

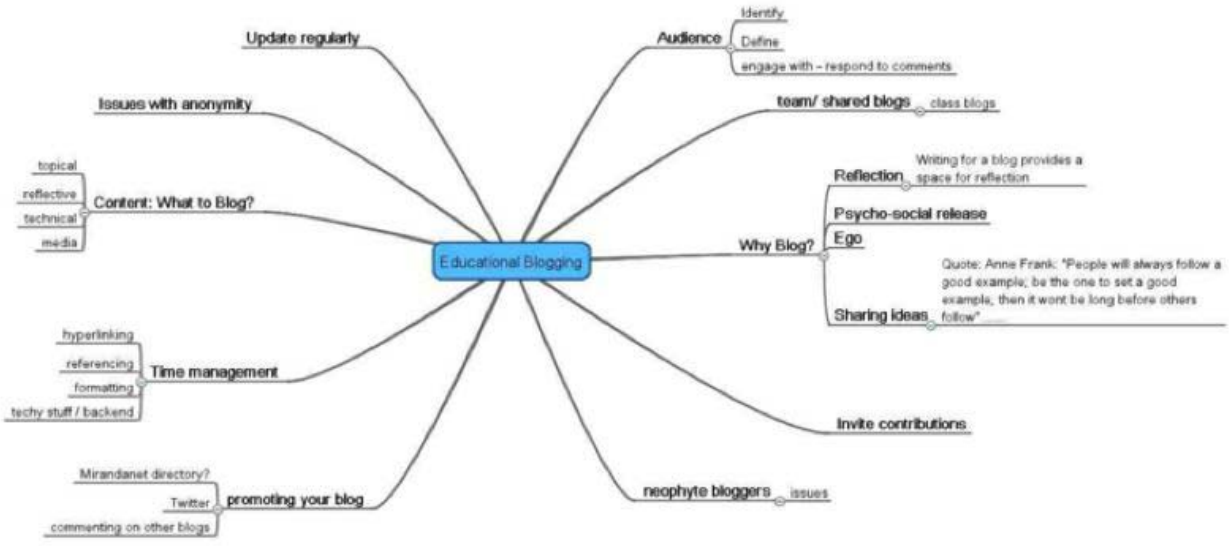

Figure 2.7. A remotely multi-authored multidimensional concept map

Figure 2.7 shows probably the most sophisticated from of complex multimodal sign that has yet been developed. It is best viewed on a screen[27] because maps tend to spread across the landscape are of a screen rather than the portrait shape of a page. On a screen the map maker and the viewer can collapse branches and zoom in and out to read the map more easily. These screen features are beginning to create a communication problem with concept maps used for information that no longer conform to the conventional page.

This multidimensional concept map about educational blogs was developed over a week by educators attending a face to face and online 'unconference' about blogging. At this kind of event social interaction as a form of informal learning is very much in evidence because the learning agenda is decided at the grassroots of the education profession: the power relationships in traditional conferences between expert speakers and learners are destabilised. Teachers in England have led the development of two kinds of 'unconference': the TeachMeet that concentrates on the craft of the practitioner and the international MirandaMod, a themed 'unconference' that encourages a focus on 'praxis' - the melding of learning theory, pedagogy and practice (Preston et al., 2008; Preston 2010).

Mobile digital technologies have made this possible not only in the use of micro-blogging, educational blogs and video connections but also in terms of events facilitated by professional groups. A key element of the MirandaMod digital ensemble is a digital concept map that can be remotely multi-authored by the educators who live in different countries. They use the map to record their immediate professional knowledge about the subject under discussion for other professionals to use. Layers of

[27] www.mirandanet.ac.uk/mirandamods

information are added over the week when the concept map is open that can be in words, images, animation or sound. It is also possible to add notes in languages other than English which is useful if educators are sharing knowledge across national boundaries.

This general trend towards maps that look like networks is spilling over into other kinds of visual representation. In this vein, multi-authored concept maps are created remotely on the web by several map makers in different locations. Collaborative dynamic features were displayed by the Grokker web-service[28], developed by Stanford University. This service, now up for sale, is similar to Google, where searches are presented as mind maps indicating clusters of most prominent and least prominent information as well as information that outside the main field. In a web service of this kind a node on a screen might be linked to another concept map beneath, but each map image will normally be confined to just one more screen. This structure of connected screens, that has become more prevalent with the spread of computers, contrasts with traditional modes of concept communication that favour linear prose.

Multiple researcher perspectives

In this section I draw on three literature reviews associated with Novakian maps completed by Novak and Cañas in 2003, 2010 and by Daley et al. in 2010. These give an indication of how widely concept mapping is used now for learning in education and business.

In 2003 Cañas et al. identified the uses of the maps in a constructivist context as: a scaffold for understanding; a tool for the consolidation of educational experiences; a tool for improving the affective conditions for learning; and aid or alternative to

[28] http://library.stanford.edu/about_sulair/special_projects/stanford_grokker.html (This project has now been closed).

traditional writing assignments; a tool to teach critical thinking; an aid to the process of teaching and a mediating representation of ideas for groups working collaboratively working. By 2010 Novak and Cañas promoted the social interaction approach to mapping and categorised the uses of maps as: facilitating meaningful learning; knowledge management; and organizing and navigating through information largely as a group. Daley et al. (2010) identified the education themes emerging within the Novak community attending the 2008 CMC conference: teaching and learning; assessment and scoring; knowledge development; software development; professional development; and research methods.

The range of applications not only indicates the ingenuity of educators, but also confirms the suspicion that concept maps themselves are pedagogically neutral. What has emerged from the literature review of concept maps is that they can be used within the three main pedagogical paradigms: information transmission; constructivism; and, social interaction. What is crucial is the relationship between the educator and the map maker in terms of developing the learning paradigm. However, in ImpaCT2, I argue that the most important relationship is between the map makers and the researcher in the unstructured interviews. The pupils take some time to begin explaining their maps because they have to be persuaded that, unlike their teachers, the researcher is not requiring a quick, short, correct answer. The culture of information transmission is strong in the schools where these map makers learn. The researcher introduces them to constructivism that is not just a reproduction of what has been taught, but an opportunity to bring out what the pupils know themselves. The element of social interaction is only one on one – but it is democratic and values what the pupils know already. This point is picked up in the next section where ImpaCT2 is discussed through the lens of the literature that has been reviewed here.

Discussion

In this discussion of the literature review I consider the issues that have arisen about the use of concept maps through the lens of the ImpaCT2 study which is the main model for the research design that follows in Chapter three.

Ausubel, who worked with Novak on his concept mapping system, had strongly held views about the autonomy of learning that he expressed in his Epigraph both to his 1968 and 1978 books:

> If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly.

In essence, Novak did not look for this base line of knowledge. This may be because he was usually working with difficult concepts in maths and science that have to be taught from the beginning. The ImpaCT2 team, however, were interested in new kinds of learning that are taking place without the mediation of teachers. In fact, it was the ImpaCT2 team who adhered to this principle by allowing the pupils to interpret Computer in my World in any way they wished.

The ImpaCT2 team represented a wide section from the ICT community of researchers with different talents. The inconsistencies between what was said and what was done in terms of theory that has been picked out in the literature review stem from attitudes towards how people learn that may not have been apparent to the team members themselves. Those who took the semiotic view that concept maps are a representation of a tangible universe developed a scoring chart and a quantitative approach to the value of words. These quantitative approaches were in step with the government funders' request for evidence about a link between investment in computers and achievement scores. In this context the exercise with the pupils was

entirely for the objective researchers' benefit. In using these methods it was necessary to adopt to adopt Buzan's theory about cognition:

> In ImpaCT2 concept mapping has been used rather differently [from Novak], in a manner much closer to Buzan's notion of a 'mind map' as an 'external mirror' of the 'internal structure and processes' of 'radiant thinking' … To do this, ImpaCT2 has drawn on the work of Project REPRESENTATION' (Pearson & Somekh, 2000) and developed a concept mapping task that enables pupils to produce externalised representations of their 'mind maps' (Buzan, 1993) (p189).

In fact, the maps were researched in a way that is far more like the quantitative methods that Novak advocates. However, in the constructivist Novak classroom the pupils gain the benefit of this rigorous approach to a form of action research for learning. They also work in a small classroom community of practice in a mode of social interaction.

The ImpaCT2 team, on the other hand, drew on experience in a European project across six countries when patterns of thinking were explored across a large number of maps, rather than investigating the concept maps as indicators of the thinking of individual pupils or of groups. However, the interviewing techniques used in the more holistic multimodal exploration of a few maps suggest that some members of the team, like Kress, were not entirely of the view that concept maps only represent a mirror of the mind. I argue that interviews with the map makers that were designed to understand new ways of learning were also included as a result of Somekh's pioneering work in action research (Somekh, 1989) and Mavers' emerging work with children in multimodality (Mavers, 2004a; Mavers, 2004b). The interviews ensure that the scores were not the only measure of learning and did advantage the pupils involved in the Adlerian spirit of the researcher as active member of the community for the duration of the project. This was achieved by the democratic spirit in which the interviews were conducted. However, although this is praiseworthy it is important to remember that this research team were not contracted to teach pupils but only to do

research into their achievements and their thinking about ICT. The ImpaCT2 research design is tested in the three case studies that follow in Chapters four, five and six because this could be adapted to the different circumstances of the studies.

In the next chapter I explain that I decided to follow the ImpaCT2 quantitative route in order to understand it more since, realistically, providing quantitative evidence to funders is valuable to them and often leaves enough space for more reflective qualitative research to take place as well if the project is well designed. For example, in one of the following case studies the Free State government who were investing heavily in computers in education was also interested in a means of collecting data from teachers that make allowance for the three dominant languages in the province.

The scoring of concept maps used as a formal testing tool and marking them quantitatively is inimical to the approach of multimodal researchers who are searching to celebrate creativity, not accurate replication of given concepts. They see mapping artifacts as unique expressions of meaning. This qualitative multimodal route is the one that interested me more as I hypothesise that this might be the avenue to understanding the real impact of the digital age on educators.

A question remains about who benefits from the analysis of concept maps. The constituencies are becoming blurred. The educators themselves are researchers, teachers and learners as well. This question about who learns from the findings raises issues about the locus of control in research, which is one of the topics of the next chapter: the research discourse and design.

Chapter three: research environment and design

The research environment and the design presented here have been influenced by my work as the chair of the MirandaNet Fellowship that is a 'community of practice' (see Context p.11). The sections on methodology in this chapter are:

the case study approach;
the data collection procedures;
the three modes of semiotic analysis.

There are three foci in the analysis:

focusing on numbers by counting of links and nodes;
counting words and interpreting words;
analysing the maps as complex multidimensional signs by modifying methods;
supplied by multimodality researchers.

The relationship between validity and ethics is also discussed.

The case study approach

A summary of each of the three case studies is in the first section. The theoretical reasons for choosing the case study method follow as well as a section on the the multiple perspectives of the researcher in these three case studies.

Case study one: international Computer Skills Training (CST)

The first case study focuses on a MirandaNet evaluation that investigated the value of a computer skills course for international educators between 2003-2004. The evaluation was funded by Business Link, a government agency that oversees research and development projects undertaken by small businesses. The one-year course in

computer-based skills training was distributed on CD-ROMs by the British Computer Society (Preston and Danby, 2004b). In this case study, the CD-ROM material was taught in two national centres by Local Authority advisers. The relevant details of this Computer Based Skills Course evaluation, which involved one hundred participants in five English regions, are to be found in Chapter four: the role of concept maps in the evaluation of a computer skills training (CST).

This CST course was based on a UK computer science syllabus that was contextualised by an independent course designer, Aston Swann for The British Computer Society (BCS). In this study I had the funded role of evaluator of the computer skills course. I did not design CST programme or teach on it. Nor did I meet the students as the evaluation was conducted by written questionnaire that included the drawing of a concept map. In this case, therefore, I was an objective researcher or in Adlerian terms 'a peripheral member researcher' (1987).

This course design was based entirely on information transmission principles with formal, external test of what had been learnt at the end. Business Link accepted an experimental concept mapping element in the research design that I reported on briefly in the evaluation, but have developed in more detail for this doctoral study.

Alongside the other data that was collected by questionnaires, twenty-one pairs of pre- and post-course maps were submitted for analysis by the local authority trainers who were delivering the materials on CD-ROM. Because of the low levels of funding it was not possible to include interviews with the students in this project.

Case study two: a Practice-Based Research (PBR) cohort in England

The second project overlapped with the first in design and implementation; it ran from November 2001- November 2003. Concept maps were collected along with questionnaires to provide insights into the learning of students taking a one-year Advanced Diploma module, designed in partnership with the Institute of Education,

University of London. The pedagogical design was based on constructivism and social interaction with a strong theme of practice-based research requiring a scholarly approach.

The map collection was built into the course and after the second map was completed the students were invited to score these themselves using the scoring sheet and to discuss with each other how their maps at the beginning differed from their maps at the end. This was expected to offer a rich seam of insight into the educators understanding of digital technologies at the beginning and the end of the course.

The participants were funded by the UK government Department for Education and Skills (DfES) and the General Teaching Council for England (GTCe). In this second programme, described in Chapter Five, sixteen participants submitted pairs of maps. The emphasis in the course was on a scholarly approach to action research at Advanced Diploma and Masters level, so I have called the group the Practice-Based Research (PBR) cohort. This approach strengthened the constructivist element of the research as they all did an action research project in the classroom.

I had designed the programme, prepared the tutors, managed the practice-based projects and had become a tutor myself for the duration of the programme so that I was also engaged with the teachers after the course when they were reflecting on the findings of their practice-based research project and engaging in two publications. The social interaction element was a strong strand of the online and face to face programme. For example, a large majority of the students were already MirandaNet members or became members, some of the students on this course also joined the MirandaNet project as mentors in South Africa which provided more continuity. This combination of roles meant that I was a complete member researcher after Adler and Adler (1987) characterised by complete immersion before and after the researched event.

Case study three: Mentored Action Research (MAR) in South Africa

The third concept map evaluation ran from August 2004-August 2005 and is discussed in detail in Chapter six. Free State, a South African provincial government had invited MirandaNet Fellows to design a one-year CPD programme in digital technologies. The Free State advisers wanted to break away from an information transmission perspective on learning that was dominant in the schools. The design that was developed with them drew on constructivist and social interaction approaches with a strong action research element to help them to embed these new learning principles into their practice.

The Education Department had chosen the MirandaNet team because of the constructive approach to learning through action research and the social interaction demonstrated in building new communities of practice (CoP). This was one element of a management of change project that was planned to last ten years so the opportunity to provide long term support was excellent as the Free State team gradually took over the running of the project themselves.

During the project the Free State Educators developed their own CoP called E-lapa. In this name they had refashioned one of the African language words, 'lapa' for a meeting in a jungle clearing, to describe the new phenomenon of an electronic meeting place. This was expected to grow and develop as the project progressed with the Free State community promoting their own leaders as knowledge and experience grew. Distances were great between schools and centres so there were plans for 'unconferences' between the Free State team as well as with the MirandaNet Fellows in England in order to develop knowledge exchange between the professionals in each country.

The plan was that Fellows mentor their South African colleagues in the development of action research projects in their schools. As a result the UK educators are called the MirandaNet mentors (MNMs). The South African educators in the project are called

Mentored Action Researchers (MARs). The core of the support for the E-lapa team was planned to be questionnaires, interviews and concept maps that the whole team could learn to analyse in order to discuss their own progress together and to decide what they needed to learn at any point throughout the process of ten years. They would undoubtedly add other evaluation tools as the needs became clear and new methods of evaluation of learning evolved. Clearly this social interaction was intended to create an atmosphere in which the E-Lapa team became activist professionals in the sense that Sachs had intended (2003).

The twelve MirandaNet mentors from England mentored staff from twelve schools in diverse circumstances in one of the poorest provinces in South Africa. The difference between the PBR programme and this third programme was the underlying strategy to use a new form of action research that MirandaNet members called 'mentored action research' (MAR). The research element of Practice Based Research (PBR) that the UK mentors had undergone was not introduced at this early stage. An action project was developed in each of the twelve schools. Two maps from two members of the school were collected in the first stage which equaled twenty four. However, only eleven educators from the twenty-four were able to visit the UK in the second stage so there were only eleven pairs of maps to use in the study.

Theoretical underpinnings

The research design relied on the three case studies illustrating different learning perspectives evident in programmes for educators about digital technologies. These learning principles were described in depth in chapter one:

- information transmission
- constructivism
- social interaction

The case studies in full are developed in detail in chapters four, five and six.

The case study approach appealed to me as I saw this methodology as the best means to get an understanding of the possible uses of a tool for gaining insights into learning; and to see how this tool might be used in my future professional practice – including eventually as a means of the evaluation of learning. Drawing on Yin (2009), I decided on multiple-case studies rather than a single-case. I also chose to keep the three cases holistic, rather than create embedded sub-cases.

Multiple case studies are not always a good base for generalisation, but this in-depth investigation of a situation was appropriate because this study did not aim to produce some kind of representative results – such as 'educators in x environments will tend to have Y interests' or, 'for an audience of professional educators the best form of CPD is X'. My interest was rather, in finding means to test my hypothesis about the underlying reasons for a change in the understanding of an issue that was central to the professional work of educators. The case study approach promised to provide the means whereby a researcher can seek to understand and interpret a corner of the world in terms of the understandings of actors in that world. What appeals to me about the research approach of the case study, as opposed to statistical analysis say, is that in human behaviour, particularly in observing social interaction, 'the whole is more than the sum of its parts' (Nisbet and Watt 1984 p.78).

Case study methodology, a key approach in social science is unapologetically interpretative and subjective (Stake, 1995). This conforms to my experience as someone working in the professional development of adult learners. However, 'interpretative' and 'subjective' is not to be equated with 'lack of principle', an approach of 'anything goes'. The criteria of analysis need to be transparent so that others looking at the results can see how they were arrived at. In the case of this study, these principles reside in the three approaches to concept map analysis. They also reside in my description of my own position as researcher and in the description of the environments of learning – the contexts of the study.

From the materials that I had collected as the result of my professional work, I chose to design three studies in which I could, over the period of a professional development course, identify trends and changes with members of the three groups over the period of a year. This seemed to be a reasonable period in which to observe learning and gain insights into the educators' understanding in the first stage. One assumption about researchers in case study definitions is as a 'participant observer' (Cohen, Manion et al., 2000); though my role was both more complex and different in each of the three cases. The roles have been explored in relation to Adler and Adler's definitions (1987) in the section in chapter two on Multiple Researcher Perspectives.

While the case studies were different, I attempted to ensure that the data could be compared, to the extent that that seemed important for case studies and for my Research Question and aims. I created the same conditions for the collection of the pairs of concept maps at the beginning and end of each the three courses in digital technologies, between 2003 and 2006. I also collected one set of concept maps at the beginning and one set at the end of each one-year study period. The conditions for creating the maps and collecting the maps were identical across the cohorts and at the start and the finish of each course. All the map makers in the three studies were asked for written permission to use their maps in the current study.

There were more than sixty educators in this study, an average of twenty course members in each case study. However, some educators did not complete either the first or the second map because they were absent on the data collection day. As a result there were forty-eight maps overall: twenty-one for CST; sixteen for PBR; and, eleven for MAR. These are not large numbers for comparison and certainly not for statistical analysis: but then my study, as a case study, was not reliant on such numerical issues of validity. In order to ensure that the comparison of the forty-eight pairs of maps was relatively 'secure' across all three projects, these commonalities were identified:

all the educators in the each group had elected to take a course in digital technologies to improve their teaching;

the courses were all free and customised for these educators;

in these work-based projects, the educators identified e-learning challenges and experimented with the implementation of digital technologies in their schools;

each course was designed for international delivery.

There were also key differences between the courses that were expected to affect the results, but not to impinge on the validity of the comparison:

the first course was based on pedagogical principles of information transmission, whereas the other two were based on the principles of constructivist learning and social interaction;

the content of the first course was the mastery of computer skills related to software packages whereas the other two focused on e-learning and encouraged the negotiation of work-based projects;

two courses were held in England, although one was for international learners. The third course took place in England and South Africa.

There was an element of selection of the educators by the course funders in all three case studies: one course had been promoted by regional educators for educators in England who wanted a qualification in computer skills; one was a partnership with the government of a South African Province who funded the free course as part of a change management programme; and the third was funded by the government in the UK in order to be promoted internationally.

There were differences in the research and evaluation approach. The first course, designed by a company in partnership with an international professional organisation for computers, was evaluated by MirandaNet Fellows. The other two programmes were designed and delivered by the MirandaNet Fellowship.

In terms of accreditation, an international certificate award for the CST computer skills course was the requirement for promotion in many schools both in England and South Africa. The BCS skills course was usually used. MirandaNet evaluated the pilot BCS skills course for educators in the first case study here - designed because the parent course was too technical for teachers. The second course, PBR, was accredited at Advanced Diploma and Masters Level by the Institute of Education, University of London. The South African course was to be accredited by government officials who had been involved in the programme design.

Researchers' roles in the case studies

In the PBR programme I trained the tutors, managed some of the action research projects, became a tutor myself for the duration and designed the internal evaluation. My role, in Adlerian terms, was therefore as an active member researcher because I was only engaged actively with the community for the duration of the study (1987).

These three studies showed how researchers can work at different levels of engagement with the community. In the first study, I was a peripheral researcher with no direct contact with the community I was evaluating. In the second, I was a complete

member researcher as I designed the course and tutored on the course. In addition, those who were MirandaNet Fellows continued their informal learning with each other after the course. In the third course, I was an active researcher as I was engaged with the E-lapa community for the duration of the project. There were plans, however, for close links between MirandaNet and the E-lapa chapter of MirandaNet over the ten-year life of the project and potentially beyond. The aim was not to teach the South Africans but to support them in learning how to become community of practice leaders themselves.

Data collection methods

The data collection methods in all three case studies were modified from the procedures used by the ImpaCT2 team (Mavers, Somekh et al., 2002). The research principle of 'triangulation' was the reason for using all three analytical approaches using semiotic signs: numbers, words and the maps as holistic, complex, multimodal signs.

Although the ImpaCT2 scoring methods had been tested already with two thousand children, using the scoring and analysing the words working with much smaller numbers seemed valid as this was entirely experimental and formative. On the other hand, the semiotic analysis adhered to principles of multimodal theory in which the map makers' approach to the task is respected. This provided a contrasting view of the data.

The ImpaCT2 team advised the development of tightly written accompanying instructions to ensure consistency (Appendix One). This was particularly important in the first study, as I did not oversee the exercise. The ImpaCT2 procedures only referred to hand-drawn maps in black and white, as this was the only resource available to the pupils. However, the researcher emphasised that these were just two examples of many possible shapes. The map makers were assured that any interpretation of the

term ‘mind map’ and ‘concept map’ would be acceptable and that there were no right answers.

All these conditions were met, but the map heading for the ImpaCT2 maps, ‘Computers in my world (CIMW), was modified because a key interest was in the differences between how the teachers used computers at home compared with in school. Therefore, the CIMW heading was adapted for the teachers to read: ‘The impact of computers on my personal and professional life’. The word ‘impact’ was also expected to raise some of the more emotive issues about undertaking a course of study in digital technologies. This would provide affective evidence in order to give different insights on the educators’ learning that was not related to how much they knew.

Whereas the ImpaCT2 children were issued with A3 paper and pencils, the educators were issued with A4 white paper so that the concept maps could be easily scanned. The educators in this study were allowed to use any other resources they had to hand if they preferred to do so.

Because the maps were collected in the same way and the same heading was used each time the potential variables between the maps were reduced. The twenty minutes for the task allotted by the ImpaCT2 team was also found in the first CST case study to be appropriate for teachers as well (Preston and Danby, 2004b).

Another area for discussion was the advice about drawing pictures. The younger children, ten to fourteen, were asked to draw pictures only and not use words. However, the ImpaCT2 team were concerned about how much drawing older map makers, 14-15, would tolerate before they began to suspect the value of the exercise. They knew that drawing is seen as trivial compared with writing in the secondary school. In the end the fourteen and fifteen year-olds were allowed to use words as well although the researchers regretted that decision later.

One concern was that educators might consider concentration on pictures to be too simplistic for sophisticated concepts, or too difficult because they do not feel skilled in drawing. This focus on drawing might even seem threatening, as many teachers are not confident or experienced in using pictures to convey meaning. For this reason the educators were given a free choice about whether they used pictures in their concept maps.

Three modes of semiotic analysis

In Chapter one I explained why the multimodal map appeared to me to be a research tool that might provide educators with a means of expressing their thoughts about and reactions to the need to understand what computers can do and how they might be relevant in school. In Chapter two, I have explored the literature on the three different methods: scoring by using a formula to divide the number of links into the number of nodes; two forms of analysis of words, one content-focused and one interpretive; and the analysis of the concept map as a complex multimodal signs.

In this chapter I discuss the five kinds of research tool that I designed for this study or modified for the purpose using existing models: These five tools were:

a scoring sheet to record the numerical scores for 'connectivity'

one content analysis table to plot the words in the nodes used by individuals in each map;

a second content analysis table to plot how words are used by the map makers across the three different cohorts;

a framework based on semiotic theory to guide the analysis of the maps as complex multimodal signs

a framework for the analysis of discussions between the educators comparing their concept maps scores and discussing the accuracy of the scores against their insights into their conceptual mapping of digital technologies at the beginning and the end of their course of study. They would be discussing these views as co-researchers with each other and with myself as the senior researcher.

These tools are discussed under the following headings: meaning in numbers, meaning in words and meaning in complex multimodal signs. In the PBR group the discussions between map makers about the insights they gained from the maps were also recorded, transcribed and analysed (see Chapter five). I planned to do this in the South African case study as well, but, as mentioned before, the whole Free State Province change management project, including the MirandaNet section, was closed down before the final self-evaluation stages.

Meaning in numbers

In this analysis I take the route that the ImpaCT2 team advocate, which is to count the numbers of links and the numbers of nodes and then divide the nodes into the links to gain a 'connectivity' score. This was translated into a ratio score ranging from 2:1 for simple maps and up to 4:1 or 5:1 for complex spaghetti type maps.

This formula is original to this team who plan to measure levels of cognitive activity by looking at the complexity of the concept map, or, as they call it, the 'connectivity' (Mavers, Somekh et al. 2002). The ImpaCT2 team wanted a method that would elicit patterns across a large number of maps, rather than dealing with the maps solely as

indicators of the thinking of individual pupils. In essence, after the nodes and links have been counted, dividing the number of links by the number of nodes results in a simple connectivity score.

I adopted this method in the belief that this score would provide an initial insight into the levels of complexity about digital technologies that the educator can handle at the beginning and the end of the course. It could, perhaps, indicate the weakest students who might needed more support from the educators and mentoring from the community.

This is not the only approach to scoring as is discussed in the literature review in Chapter two. In brief, number of approaches have been put forward that demonstrate how a map can be analysed by using a numerical score (McClure and Bell, 1990; Novak and Musonda. 1991). Most of the techniques relate specifically to the mapping of concepts or propositions – a Novakian strategy that requires the students to be taught mapping techniques first. This did not fit in the kind of approach taken here where as a researcher I am interested in gaining insights into what the educators know rather than what they have been taught.

For example, one Novakian based technique is to look at the hierarchy of concepts within the map, grouping these in order of significance and awarding points depending on whether the concept is positioned at the top, middle or bottom. A second approach awards points based on an evaluation of the validity of a 'pair' of concepts. A third method is to scrutinise cross-links on a map, and add points for links that return to higher level 'key' concepts. A fourth method takes account of the overall organisation of maps, awarding points for creativity in design and the cohesiveness of the overall structure. This final method is nearer the multimodal approach to concept mapping and is developed in the section on multimodal analysis.

Having looked at alternatives the 2002 ImpaCT2 method of analysing individual hand-drawn maps seemed to be the most appropriate for experimentation in this concept map study. Note was taken that the ImpaCT2 team had extensive discussions about how to decide on the numbers of nodes and links and how to moderate the marking because differences in perception and interpretation are significant in a large research team. However, in the study here, inconsistent marking was less likely because there was only one researcher marking the concept maps. However I did involve the same senior researcher who moderated the CST evaluation to moderate the marks in the PBR and MAR groups to ensure the same consistency. In the PBR group the marks were also moderated by the map makers themselves as co-researchers. As neither the course nor this study were a test of teachers' computer skills scoring had no effect as 'assessment'. So there was no detriment to the participants from the methods of scoring. Having only one analyst scoring would not have been acceptable, however, if the scores were being used in a summative assessment of the teachers' learning.

Meaning in words

Because I specialise in the field of digital technologies I tended to look for analytical approaches that focused on texts created by teachers online. Howell Richardson and Mellar (1998) reflect a quantitative trend in the 1990s in the analysis of online discussion on courses for teachers that tends to give as much weight to the analysis of message length, clustering and inter-referential links between messages as it does to interpreting the meaning of what has been said. With a background in English Literature, I already have a strong leaning towards the qualitative social scientific and literary approaches to interpretive textual discourse analysis that concentrates on meaning. Therefore, the semiotics tradition that favours the structural tradition in literary criticism is the one that I use here (Silverman, 1997; 1998: Lieblich, Tuval-Mashiach and Zilber, 1998: Denzin and Lincoln, 2000). However, modifying the ImpaCT2 scoring tool which is content focused was necessary because most of the words on the concept maps were used factually and, therefore, did not allow for much interpretation. The interview texts, on the other hand, provided more substance, but

in this study these texts were very limited and could only be seen as providing evidence of what could be done in a bigger project.

This section focuses on two kinds of content analysis: the content analysis of the labels in the nodes and the content analysis of the recorded and transcribed discussions between the map makers about the value of their scores and their own insights into their approach to digital technologies.

Analysis of node labels

The teaching of science and maths concepts was the main content of Novak, Godwin, Cañas and Åhlberg's work and, therefore, the labelling on the maps was important in terms of checking understanding. In this study a similar content analysis approach was taken to investigate what insights about learning these labels provided. ImpaCT2 (2002) was again the source of the analytical tools. In this study the interest in what the map-makers present that has not been taught. It is their residual concepts that are being sought.

The title of both the concept map makes this clear. In ImpaCT2, 'Computers in my world', the pupils are asked to explain what they know not what they have been taught. The title used in this study, The impact of computers in my personal and professional life, is similarly asking for information that has not been taught. However, this title was made more complex in order to elicit information about differences that educators perceived in their use of the computer at home and where they worked. The word 'impact' was intended to stimulate evidence about attitudes towards the ways in which computer presence was growing in addition to factual understanding.

Pupil's unique code (name if class list or code not yet received)					
School's code (as for school visits but substitute CM for SV)	I2CM1				
Date of CM (Please tick)	Summer 2000		Summer 2001		
Number of nodes			Number of links		
Spheres of thinking 1=1; 2=2; 3=3 etc * Tick spheres in box		computer (e.g. pda, laptop, parts of computer) games (e.g. gameboys, sega, playstation, games such as pokemon, joysticks on computers, CD/DVD if clearly games) TV (e.g. satellite, sky) mobile phone information (e.g. web, Internet, WWW, research) communication (e.g. email, chat, telephone, modem, fax) advanced control mechanisms (e.g. lights, robots, air conditioning, the Houston space computer, airport, x ray machine, microwave, vehicles, till, photocopier, remote control, watches, fridge, lifts, fire alarm, space, washing machine, health monitor, rockets, robots, remote control cars, hospital) music (e.g. microphones, speakers, keyboard, CD players, DJ decks, hifi, radio, CD/DVD if clearly music) images / photos (e.g. cameras, digital cameras, scanners, DVD (if obviously for film) and film making/editing. DON'T INCLUDE: software used for creating images such as dazzle or terms like the following: art, paintbrush, paint, graphs, posters) technical details about computers (e.g. graphics cards, bits and bytes, servers, ftp, HTML javascript, drivers, detailed references to chips. DON'T INCLUDE: floppy disks and common stuff or simple references to chips, processor or virus). teaching / training (teachers' maps) other (specify)			
Zones of use 1=1; 2=2; 3=3 etc * Tick zones in box		home (e.g. homework) school (e.g. school work, lesson, coursework, classwork) workplace (e.g. factory, job, secretary, work if not school work, client, research if scientific) banking (e.g. finance, building society, stock exchange, bills) shopping (e.g. 'take aways/food', holidays, clothes, books, till, shop) transport (e.g. car, plane, train, airport. DON'T INCLUDE rockets!) hospital (e.g. emergency services, helping people) library university/college access to ICT elsewhere (e.g. internet café, youth club, ICT centres) other (e.g. war, arcade, prison)			
Name of scorer (Please tick)	DM	CL	KH	TF	Other (specify)

Figure 3.1.a. The original scoring sheet used by the ImpaCT2 project team to score children's maps

Analysis of the concept maps

Figure 3.1.a. shows the original scoring sheet that was used by the ImpaCT2 team to analysis the children's maps. The title for the pupils was intended to stimulate some factual understanding of computers in their world. In this iteration 'Spheres of Thinking' (SoT) denotes their understanding of how computers are used. Places where computer might be used are entered under Zones of Use (Z0U).

Figure 3.1.b. shows how the scoring sheet was adapted to reflect the greater number of concepts that adult educators were expressing in their maps in the section on Spheres of Thinking. When I modified the scoring sheet for this current study of adults' maps these capacities to categorise how computers are used and where, seemed just as relevant in gaining insights into adult understanding.

These indicators in Figure 3.1.b. have been adapted from the original score sheet shown in 1.3. (Mavers, Somekh and Rosterick, 2002). In 2003 when I first considered this methodology, the original indicators provided by the pupils seemed to be ones educators might know so I adopted these indicators as a starting point: computer systems and networks; information and communication; publishing and correspondence; games; sound; and, learning. I also modified the scoring chart once I had done the first investigation of the maps so that more adult concepts were included. However, this would have been a very different list if the exercise had been done in 2010 as there are no Web 2.0 indicators here. I was not concerned as much about the differences between children's knowledge and educators' knowledge because computing was one area where children sometimes knew more than their teachers, as has already been noted in the literature review (Sutherland, Furlong and Furlong, 2003, Somekh, 2004, Downes, 2004). A completely new area that was added in Spheres of Thinking was a place for observations about the more abstract impact of computers in their professional and personal lives that adults offered. The educators also noted more workplace locations in Zones of Use.

Teacher's unique code					
When Concept Map made:		**Start of training**		**End of training**	
Number of nodes			**Number of links** (only count links emanating from each node)		
Spheres of thinking: **A) How computers impact on my daily life: uses** (Tick spheres and record here how many spheres are represented)		**Computer systems & networks** (e.g. desktop, laptop, parts of a computer, LAN, server, shared printer, data projector, whiteboard, hardware, software, file management) **Information** (e.g. web, Internet, research, search engines, finding/accessing information) **Communication** (e.g. email, chat, on-line communities, telephone, modem, fax, telephone or on-line conference, school and business links) **Publishing/correspondence** (e.g. letters, reports, displays, teaching materials, word processing) **Data** (e.g. spreadsheet, database, assessment if analysis/record keeping, graphs) **Games** (e.g. playstation, sega, joysticks on computers, CD/DVD if obviously games) **Sound** (e.g. microphones, speakers, keyboard, CD players, hifi, radio, CD/DVD if clearly music) **Images/photos** (e.g. digital cameras, scanners, DVD (if obviously for film), image/video making/manipulating, ClipArt) **Teaching/training** (e.g. in class, extra-curricular, staff training) **Learning** (e.g. pupils, self, others, curriculum, assessment if integral to software) **Planning** (e.g. process, guidance) **Administration** (e.g. class lists, labels to organise resources, registers) **Finance** (e.g. school finance systems, personal finance, banking, credit/debit cards) **Shopping** (e.g. on the Internet) **Advanced control mechanisms** (e.g. lights, robots, air conditioning, NASA, microwave, vehicles, till, photocopier, remote control, washing machine, health monitor) **Other** (e.g. mobile phone, TV -satellite, sky, digital)			
Spheres of thinking: **B) How computers impact on my daily life: abstract thoughts** (Tick spheres and record here how many spheres are represented)		Coping with technology (e.g. Concerns about own competence) Reliability (e.g. Concerns about ICT resources, trouble shooting) Impact of technology (e.g. Makes life easier, increases workload) Access to technology (e.g. Organisational issues, lack of equipment/time) Other			
Zones of use (Locations) (Tick zones and record here how many zones are represented)		Home (e.g. own home, pupils' homes – homework) **School** **Workplace** (e.g. beyond school) **Shops** (anywhere where you buy products and services, e.g. supermarkets, public eating places, travel agents) **Library** **University/college** **Access to ICT elsewhere** (e.g. internet café, youth club, ICT centres,) **Other** (e.g. Clubs – scouts, sports etc, transport, arcade, health and civil services)			

Figure 3.1.b. The score sheet adapted from the ImpaCT2 based taking account of the new title and the potential of adult map makers

The frequency with which keywords were repeated in the maps was recorded on a spreadsheet both for the individual and for the group as a whole. The reason for adopting this method was to see whether new concepts about digital technologies and the quality of these concepts were growing amongst the cohort of teachers as the year progressed. The prediction was that because the map maker had been asked to draw on one sheet of A4, the salient words would provide insights into what was being learnt. The indicators developed by the ImpaCT2 team were largely content-led, but a balance was found in this concept map study by looking for qualitative indicators that investigated the more social and collaborative aspects of learning in a CoP.

In the past MirandaNet Fellows have used the 5-stage Salmon model (Salmon, 2002) for analysing conversations between students about the stages of their learning (Cuthell, 2002; 2005; Preston and Cuthell, 2005). These stages are: access and motivation; online socialisation; knowledge exchange; knowledge construction; and development. In the 2005 study Cuthell, a MirandaNet Fellow, found that his students, who were learning how to e-facilitate on line, initially focused on the first two stages of Salmon's model: access and motivation. These are all elements as well in building up learning through social interaction.

It could be said that, by applying for and being accepted on the course, the first step had been achieved, but, in fact, for some students throughout the course this first step kept emerging as a hurdle to be overcome. This social interaction was a constant in each of the thread, and some of the students set up their own threads to pursue this element. The third of Salmon's steps, information exchange, was one of the components built in to each of the activities – and this led to knowledge construction. This was particularly apparent in the fourth task. The final step that Salmon identified, development, occurred at a number of stages in her model, as students participated in online forums as e-facilitators. It was in the area of knowledge construction that the development of the students was particularly marked. The final two tasks, and the

Learning Critique in particular, led to the communal construction of knowledge – and although this was led by five of the group the other three participants all contributed.

However, Salmon herself said that her model relates to courses that have a clear beginning and end. In fact, Salmon said that her students were so busy completing the essays at the end for exams that the further development stage did not take off. Her view was that a community of practice would have a more effective development stage.

When Salmon was developing her model access, motivation and information exchange were a vital aspect of social interaction, but eight years later these elements are more likely to be part of the experience of teachers who are now accustomed to social networks like Facebook.

Newer research by Pachler and Daly (2006; 2007) into the analysis of student exchanges allows more space for the effects of a community of practice on learning and is far more sophisticated in terms of teacher cognition and social interaction.

What is relevant here, are the arguments that Pachler and Daly use to promote the importance of textual interaction in computer mediated communications in developing understanding:

> It is the in the affordances of shared textual authorship that we believe lies the most potential for deepening thinking overtime, and enhancing conceptual transformations for online participants (p.11) (Pachler and Daly, 2006)

These affordances seemed equally present in the concept maps that the CPD participants were expected to share in this study and, therefore, I felt justified in exploring the value of their analytical principles in this different semiotic context. What was particularly important in this transfer of methods was the Pachler and Daly

commitment to the value of constructivism and social interaction in CPD with the addition of intellectual rigour.

In the paper called, Learning with others, in mind that has a particular take on the intellectual value of composing text for others to read. Daly and Pachler 2007 produced a table in which they identified five analytical indicators that they used to look more closely into a range of learning issues that demonstrate constructive learning and social interaction: knowledge construction; community; meta-learning; autobiography; and, cognition (Reproduced in Figure 3.2)[29]. In publishing this paper the authors were arguing for a catalytic role in collaborative online discussion and their interests in the realms of written text were similar to mine in the visual sphere; they were looking for the effects of on teachers cognition in two ways; firstly, 'to do with the effects on teachers of learning as a literate activity undertaken with a high degree of peer presence' and, secondly, 'to do with conceptual transformations which occur as a result of joint thinking' – an idea Daly and Pachler quote from Mercer (1995).

Mercer has been central in the movement that has identified the need to scaffold the group talk in work taking place amongst children in classrooms so that meaningful results are achieved. Daly and Pachler had seen the relevance of Mercer's work in oracy and knowledge building (2000) to teachers building concepts together in words. This was a useful fit with the intention of this study which is to find means to scaffold teachers efforts to share in social interaction episodes the development of new concepts through the maps.

The Daly and Pachler indicators were originally established in the analysis of online discussions between teachers on an MTeach course that was designed in a similar way to the MAR and the PBR programmes under discussion.

[29] Permission received from Bedford Way publishers in July 2007.

Table 2.1 Categories and indicators of professional learning through participation in CMC

Category	Indicators
Knowledge construction	Reassessments New ideas/proposals Questions/enquiries Endorsements/verified ideas Modified ideas
Community	Shared values/goals Seeking/giving support Statements expressing mutuality Practice-based exchanges
Metalearning	Verbalising the learning process Verbalising understanding Verbalising difficulties
Autobiography	Critical incidents Personal reflection Teacher identity Learner identity
Cognition	Statements of understanding: – theoretical – critical – practical References to personal learning

Figure 3. 2. The Daly and Pachler categories and indicators (2007)

This approach matched the MirandaNet social interaction approach to professional learning at Masters that was underlined in the study that this paper came from, New Designs for Teachers' Professional Learning (Pickering, Daly and Pachler, 2007). The indicators provide tools to investigate more deeply into the quality of the learning process and the role of social interaction.

Meaning in complex multimodal signs

The multimodality aspect of concept maps has been discussed at length in the literature review in Chapter two. What emerges from this discussion the fact that those who are developing multimodal theory respect the map maker for the original and creative thinking that they bring to interpreting the map title.

In order to develop a framework to analyse the maps I looked at the best developed approach to analysis by Kress and van Leeuwen (2007). I then supplemented this approach with ideas from a number of studies, which include concept-mapping analysis. The core of the semiotic framework is taken from the elements and dimensions covered in Reading Images: the Grammar of Visual Design (Kress and van Leeuwen 2007) that form the basis of the analytical framework used for the concept maps in this pilot (Figure 3.3.).

The framework is divided into three columns: the theorists; the key features; and, an explanation of each of the categories written in accessible language for practice-based researchers. Three categories also relate to the three pedagogic approaches that have been discussed in Chapter One (Pachler 2005). Under 'information transmission' are the analytical indicators that are content driven. In the constructive (or constructivist) learning section are the indicators that reveal elements of the teachers' action research cycle as they apply concepts, reconstruct and make new constructs and test those (Somekh 1989; Somekh 1995; Somekh 2005; Somekh 2007). What is also important here is the focus on the affectual and the motivational in learning. The dynamics column from the Mavers study (2004) has been added in anticipation of the digital production of a concept map.

Mavers was a key researcher in the concept map analysis in the ImpaCT2 study. Concept maps are just one of the multimodal genres Mavers considerered in a further study about concept maps (Mavers, 2007). Mavers' insights into the children's

meaning-making has been invaluable in guiding the analysis of the adult maps in this study:

> Decisions must be made [by the map maker] about what to include, omit or adjust. For me, analysis demands that even the smallest detail is attended to with seriousness. Shifts in what the children drew and how they drew particular items provided insights into their particular interests: how they viewed the world and how they shaped their representations for (in this case) a researcher audience. Looking across images can also show shifts in interest. Drawing tends to be seen as inferior to writing, and to be less trustworthy than written or spoken words. The drawings in these maps provided fascinating insights into children's interpretation of the world. (Mavers 2007, p.26)

The researcher's respect for the learner is exemplary in avoiding summative or expert judgments on the artifacts they had produced.

Mavers' 2007 study of children's concept maps examines the individual modes of drawing, writing, layout and linkage separately, as well as defining how they are combined in multimodal ensembles. She provides a robust analysis of the differences between the meanings conveyed by word labels and pictures that can be used together to communicate concepts to an unknown audience. Comparing different representations of the internet by pupils, she shows how neither the writing nor the drawing can function without each other. Each mode takes on complementary functions that she calls 'co-fixing'. From Mavers' work a particular analytical category has been identified called 'dynamics'. This is a reference to her analysis of the direction of links and arrows in hand-drawn maps and to the digital animation of images and lettering that she discovered on a young learners' web page.

MCM features	Evidence	Key theorists
information and transmission		
Concepts	Grouping of ideas and themes towards a key summarizing node; symbols used for ideas and how they are juxtaposed and connected in clusters; a classificational or an analytical design with some political implications: a hierarchical shape or network	Kress and van Leeuwen 2007(second edition)
Modalities	The features of the map that promote veracity from the point of view of the map-maker- shading, colour, brightness etc.,	Kress and van Leeuwen 2007(second edition) Mavers, Somekh & Restorick 2002
Compositional elements and their interrelations	Framing. Positions on the page, sizes, foregrounding and marginalising etc.	Kress and van Leeuwen 2007(second edition) Mavers, Somekh & Restorick2002
Materiality of Meaning	Surface textures, inscriptions and additions	Kress and van Leeuwen 2007(second edition) Mavers 2004
Dimensionality	Multilayering and hyperlinking	Kress and van Leeuwen 2007(second edition) Mavers 2004
The third dimension	3-D sculptured maps and virtual worlds	Kress and van Leeuwen 2007(second edition)
Constructive Learning		
Narrative	Trajectories that tell a story	Kress and van Leeuwen 2007
Affectual factors, ludic qualities	Indications that the learning was not only cognitive but affective.	Kress and van Leeuwen 2007(second edition)
Dynamics	direction of links and arrows: animation of images and lettering	Mavers 2004
Social Interaction		
Representations and interactions	Indications of the relationship between the map-maker and the viewer or audience	Kress and van Leeuwen 2007(second edition) Jewitt 2003

Figure 3.3. Research tool: emergent framework for supporting semiotic analysis of multidimensional concept maps

The last category in the framework, 'representations and interactions' is listed under evidence of social interaction, although Jewitt was only referring to audience, viewer or the more active reader engagement here rather than co-construction of knowledge. This attendance to the relationships between the map maker and the viewer were explored more fully in Jewitt's development of multimodal theory based on studies of children learning from digital resources (Jewitt, 2003). In this study Jewitt suggested an alternative to just identifying the conventional roles of modes, like image and sound effect. She suggested that the researcher should look at how these roles are realised in ways that are not rooted in the conventions of writing and reading. A key inference that emerges from a consideration of the representations and interactions category is that communication is not just a two-way process between the map maker and the viewer or audience. In the findings some of the other social interactions are unpicked as well.

Relationships between ethics and validity

Ethics require both sensitivity and common sense from researchers who are working within communities of fellow educators as I have been. This doctoral study has provided the opportunity to explore my own ontological and epistemological assumptions about research in terms of: the power relationships between human beings; the influence of the research context on the behaviour of learners; the quality of the data they provide; and, the importance of the communities they inhabit. I have also discovered the importance of experience in the field as it is hard to predict which ethical issues might emerge during and after the life of the project.

I discuss the ethical issues pertinent to this study under the four headings provided by the British Education Research Association (BERA)[30] :

[30] http://www.bera.ac.uk/ethics-and-educational-research-2/

ethics in the educational research context;
participants' perspectives;
the researcher's responsibilities;
regulating research.

I then move onto questions about the validity of the data.

Ethics in the educational research context

In this section I address how the underpinning politics of research design and implementation relate to the ethical dilemma that arose in this study and the particular ethical issues that emerged for me as a practitioner-researcher.

I came to research rather late in my career with a rather naïve, positivist view about what research could achieve in the pursuit of truth. Early in the doctoral process one of the most thought provoking and practical text on research I read was the Brown and Dowling book for post graduate students: Doing Research/Reading Research; a Mode of Interrogation for Education (1998), The authors critique the lack of knowledge about appropriate methodologies in the media and observe that, in a world where research findings are increasingly presented in absolute terms, there should also be a more informed and sophisticated debate about the integrity of the methodologies used to reach widely publicised conclusions. In this study, my advocacy of professional involvement in action and practice based research begins to redress the balance of power between the researcher and the professional subjects of research.

My changing view of appropriate power balances between researchers and their subjects began in critiquing the basic principles of ethics and validity through exchanges in research methodology lectures and by dipping into two major tomes for post graduate students: Research Methods in Education (Cohen, Manion and Morrison, 2000); and, Real World Research (Robson 2002). In the task of designing this

study and defining the ethical stance, the two most valuable texts were: the Institute of Education doctoral guidance[31]; and, the code of conduct from the British Education Research Association (BERA)[32,]. I joined the latter, the professional association for researchers, in order to keep up with the changing scene in research. This membership has been particularly valuable in the case of ethics as they are now given far more professional prominence than they were in my earlier doctoral submissions because the academic community is increasing their respect for the cohorts they are researching[33].

My main interest is, however, in qualitative research: particularly ethnography and the more complex ethical issues that surround practitioner research. These interests required a close study of the comprehensive handbook concentrating on all aspects of qualitative research edited by Denzin and Lincoln (2000). My views on ethics were informed substantively by the essay on in the section on Locating the Field called Ethics and Politics in Qualitative Research (Christians 2000) in which I was attracted to the Feminist Communitarian Model approach to ethics (Denzin 1997).

> This is a normative model that serves as an antidote to individualist utilitarianism. It presumes that the community is ontologically and axiologically prior to persons. Human identity is constituted through the human realm. We are born into a sociocultural universe where values, moral commitments, and existentialist meanings are negotiated dialogically. Fulfilment is never achieved in isolation but only through human bonding as the epicentre of human formation (p.144).

Although expressed in more elevated prose than I can achieve, this passage sums up the subliminal reasons why I was not comfortable with the ethics of my first study with

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[31] www.ioe.ac.uk/Induction_handbook1011.pdf - 2010-09-24

[32] http://www.bera.ac.uk/ethics-and-educational-research-2/

[33] http://www.bera.ac.uk/publications/guidelines/

the Computer Skills Training (CST) cohort. I will deal with the details of this situation further in this section and in Chapter Four. But in summary the issue was about professional ownership of the data in this desktop study and how it might be used, or not used, to benefit the teaching profession. The key players were: the funders of the project, a government agency called Business Link who support small scale research projects instigated by small and medium-size businesses; the designers of the pilot of the computer skills course under review, Aston Swann; the British Computer Society (BCS) that endorsed and distributed the product and where I was a Fellow; and the MirandaNet Fellowship who undertook the project on the understanding that the report would available to their membership as well as a wide audience and the original subjects.

At the beginning of this project I gained written permission from the CST map makers and the project funders to publish my findings about the concept maps as a public report and in my doctoral thesis for the benefit of the profession in general. However, neither my professional life as a teacher and an adviser, nor my early reading for this doctorate had equipped me to anticipate the ethical dilemmas that might develop.

The reasons that I return to later in this section and in chapter four was that in the event the map makers were not given the promised opportunity to see the report. Also, because in this desktop research there was no contact between myself and the map makers I could not be sure that my reading of the maps matched their intentions. This concern was confirmed by my later misunderstandings of some of the PBR concept maps recorded in Chapter five. These misunderstandings were corrected by joining the discussions between the map makers at the end of the PBR project when the map makers said that they gained professionally from the project. I realised at this point that I should not rely on my own judgements without revisiting the map makers and understanding their professional ambitions as individuals and as a group. This

insight on my part gives rise to issues about validity in the CST study and also the MAR project where the planned final discussions between myself and the map makers did not take place because of the withdrawal of funding for the whole South African Provincial project as a result of the elections. The findings I discuss can only be seen, therefore, as partial and provisional indicating trends from my perspective, not truths. However, this judgement is probably true of most research since partiality can never be entirely expunged in human affairs.

Participants' perspectives

Looking now in more detail at all three studies I was careful to follow the rules for ensuring that I had permission to use the concept maps for publication as explained in chapters four, five and six. I discussed the ethics with my doctoral supervisors before formulating the plan.

All the forty eight map makers gave written permission for their concept maps to be used in subsequent published research reports and papers. The map makers were also told in writing that all the names would be changed. Different English names were used for the CST and PBR groups, and different South African names were used in the MAR group so that the national identity was clear. In the CST group, these forms were distributed by the trainers and returned signed with each map and questionnaire.

The MAR group had permission slips on their questionnaires that were collected with the maps by myself and other mentors. All the papers also had identity numbers. For the PBR group I collected the signed permission forms that were on the back of each concept map A4 page (Appendix).

In the CST and the MAR group, who also had questionnaires to fill in, the permission request was on the end of the questionnaires. The maps could also be related to the questionnaires and the permissions, because the questionnaire and the sheets for the

maps had identity numbers. There were not sufficient funds for me to travel to the CST data gathering sites so I put my email address on the CST permission slips so that they could ask questions about the results if they wished. In the event none of them contacted me. The BCS had also undertaken to send the final report to all their members and the map makers when the study was over.

In the regular meetings between researchers, programme designers and the BCS we reported that the teachers were happy with the course as long as they had passed the examination because they had proof for their employers that they had basic computer skills. However, we pointed out that most of the teachers had the skills already and simply used the free training opportunity in order to be tested. However we were only directed to record the teachers' views of the course which were largely favourable. The BCS officials were pleased when they attended the regular meetings about the analysis with Aston Swann and the MirandaNet Fellowship. One the MirandaNet concerns was that the teachers were not being stretched by the course and many vital aspects of technology were not in the syllabus like email, desktop publishing and the internet. There were no multimodal elements to the packages being learnt at all. The BCS officials refused to discuss this.

Researchers' responsibilities

The BCS backtracked on their promises about publication when the results came in (in greater detail in Chapter Four) because the teachers were highly critical of the public examinations. These tests, entirely multiple choice and accessed at public test centres, often did not test the information given in the modules on the CD-Roms they had used. As this negative data about the exams came in from the teachers the BCS refused to attend the final meetings about the analysis, be involved in the writing as agreed or to distribute the report when it was written.

In fact, the examinations were not set and accredited by the BCS but by a different body altogether. The BCS set about putting right the problems straight way. Aston

Swann were also keen to cooperate because they, as designers, could see how they could correct the programme design issues. A key point was to negotiate with the BCS who were providing a well established computer science syllabus used all over the world that was already seven years old.
As researchers we suggested that we published a formative evaluation that would record our recommendations against the solutions that Aston Swann and the BCS were implementing. Although this was done and the report was mounted on the Aston Swann website under a password[34], the BCS would not inform their members or the participating teachers that the report was there.

I was concerned that this refusal to publish a research report, paid for by a government agency, was not ethical. As a long established Fellow of the British Computer Society, I discussed this with Business Link (who were being closed down at that time) and with the BCS to instigate a meeting to resolve the issue. This meeting opportunity was refused by both parties.

With some foresight, at the beginning of the research project, I had obtained written permission to use the pairs of CST concept maps in this study for my doctorate as well as for the publication. I had provided, as agreed, a short section in the official report on one pair of concept maps, selected by the BCS for publication, that showed most progress within the year (Figure 4.5 Amy's first and second maps p. 130). I made it clear in the report that the scoring and word analysis had taken place at an early stage in the study and this section was experimental. However, I had no anxiety over the publication of the map because my general expectation was that the progress that the educators reported they had made in understanding of digital technologies over the year would be evident in the maps they had provided.

[34] http://astonswann.co.uk/

I would not have allowed the BCS to chose the sample had I been aware of the unhappy results that were to be revealed a year later when I completed the full analysis. Amy's maps were the only maps where understanding of digital technologies appeared to have improved markedly. Generally these findings suggest, in summary, that many of the CST map makers were increasingly frustrated by the content of the computer skills course as the year progressed. This result was unexpected as the result of the evaluation of the national computer training for educators (Preston 2004) had shown that many teachers did need better skills in order to make the best of computers in the classroom. However, the concept map study uncovered a possibility that teaching the Microsoft Office suite related to some administrative tasks in classrooms was not the way to engage many teachers in the opportunities of digital technologies or help them to take professional ownership of these digital opportunities.

When the results of chapter four were established with my doctoral supervisors I asked for a meeting with education specialists in the BCS to discuss what could be done to improve the Educators' Computer Driving Licence (EDCL) course which was now being internationally disseminated. This put the BCS staff in a quandary as their salaries are largely funded by the extensive and growing international sales of the Computer Driving Licence for computer professionals. The new version for educators that had been piloted in the BCS/Aston Swann study was already increasing the income for this professional body. The BCS education committee decided to take no action on the basis of my doctoral findings and I withdrew from membership on ethical grounds. At the end of this experience I would now be hesitant about undertaking any research project using concept maps in which I was likely to be prevented from triangulating my interpretation of the data with the authors of the data and the community to which they belonged.

This negative experience, however, fuelled my conviction that research can be a valuable tool for developing insights into understanding as long as the funders as well

as the subjects and the researchers are ready and willing to learn from the findings. My concern about the ethics of the CST situation was one of the reasons why I began to explore in Chapters five and six the role of the researcher as in-service educator inviting students to be co-researchers in practice-based or action research (terms discussed fully in chapter one; emerging professionalism section p.29). In this situated research approach my aim was that my professional subjects should gain as much benefit from their participation as possible.

In the next two studies, where I was the manager of the research project, the ethics of the studies were much clearer to me. In this context the aim was to comment on the general characteristics of the maps and to identify some statistical trends across the cohorts that did not impact on the map makers as individuals. A further aim of the project ensured that the findings would be of benefit to the profession in general. This aim was to construct tools that educators could develop for analysing concept maps in their own classroom research. In this case the reputation of the map makers was not compromised as there was no attempt to present the resultant findings as conclusive evidence about the individual map makers or to provide summative evaluations of the performance of the groups.

In the PBR case study, the map makers' value was acknowledged as they were included as co-researchers in the examination of their own data. This was done in order to: extend their learning opportunities; explore their views about the validity of the data; and, to contribute CoP mediated knowledge for other educators. I shared my analysis of the maps with the map makers wherever possible so that they could critique my approach. This was the most instructive, and the most humbling exercise of all.

Regulating research

The BERA advice indicates that some ethical issues are important considerations in all types of research (e.g. desk-based research), while additional, and more complex,

issues arise in research involving human participants. This was certainly true in the case of the CST research that was, in fact, desk based, but still involved human activity in the management.

The BERA code says that a number of ethical issues impinge on both the design and conduct of research. At the beginning of the CST project all the procedures related to ethics were agreed with my doctoral supervisors as BERA recommends. BERA points out that also at the design stage there are such matters as the balance of advantage to researcher and participant. In hindsight, I do not think we gave as much consideration to the balance of advantage to researcher and participant.

However, another greater problem was that none of the key players anticipated the serious criticism from the teachers. This was because the same course had been running for computer professionals internationally for many years with apparent success. In fact, the early criticisms of this version for educators were not too difficult to resolve. The challenges that my own concept map study raises later could also have been addressed if the BCS had been willing. With more experienced might have foreseen the problems that would arise from being employed in a research project when there was no intention to improve the product under review. If this had been explicit from the start would I have refused the project at the beginning? However, I think the BCS had not planned for such an event in advance and did not, themselves, understand the ethical issues involved in overseeing research into their own products.

The BERA code is actually very helpful in this ethical conundrum. It explains that whilst it is not too difficult to set up the right procedures at the start, once a project is under way other considerations emerge, like privacy, confidentiality and anonymity, risk or harm, and trust that are not easy to anticipate or manage. Towards the end, or after, a project, more ethical issues are raised, such as ownership of the data and results and the integrity of the findings in representing participants' views or experience and the use of results. Two of the issues that BERA list are relevant here: ownership of research

and its outcomes; and, the rights to receive feedback. It was a hard lesson, that despite written assurances at the start from the BCS, participants were not provided with feedback on the outcomes of the research, particularly as the motivation to take part is quite often a desire to help improve a situation, to 'put something back'. As the BERA Ethical Guidelines for Educational Research points out participants are entitled to receive feedback on the outcomes of the research. It is also good practice for researchers to debrief participants at the conclusion of the research and to provide them with copies of any reports or other publications arising from their participation. Where the scale of the research makes such a consideration impractical, alternative means such as a web site should be used to ensure participants are informed of the outcomes (BERA 2005).

Validity

The picture is better in terms of the validity of the data. There were significant differences between the contexts of the CST, PBR and MAR courses and the kinds of participant groups. However, in terms of validity the data collection method was kept more or less the same for each cohort so that there could be useful comparison between the three sets of data. Nevertheless, changes were permitted because the collections of the concept maps were, where possible, expected to advantage the map makers. For example, the PBR group wanted the title to reflect their specific interest in e-learning. This opportunity to change the title to fit their learning agenda helped them to feel more involved in the research aims and more engaged in the map analysis.

Discussion

In this chapter I have outlined the context of the three case studies undertaken in the UK and South Africa with reference to the different pedagogical underpinnings which might be expected to impact on the composition of the concept map data.

I have discussed my complex role as a researcher challenging the traditional notion that researchers should maintain an objective distance between themselves and their subjects.

The methodological discussion seeks to establish tools for analysing understanding rather than the 'acquisition' of content. Scoring procedures are drawn from existing research projects as well as a new framework for analysing multimodal maps, which aligns the work of social semiotic theory in the context of different pedagogical paradigms.

Even though the numbers of maps are small, care was taken on the one hand, that the map makers' experience would be enriched by their participation and their understanding of their own learning deepened, and that useful work might be done in extending a method of using a potentially useful pedagogic tool.

In the next three chapters the application of this design is described from the perspective of three different CPD programmes in digital technologies.

Chapter four: the role of MDCMs in the evaluation of international computer-based training

The first opportunity to test the value of concept maps to gain insights into teachers' changes understandings as a result of taking course of CPD in digital technologies arose in 2003 when MirandaNet Fellows were invited to evaluate the pilot of a Computer Based Training (computer skills training) course in computer skills. This pilot was set up by the designers of the programme, Aston Swann, in partnership with the British Computer Society (BCS). MirandaNet were working with the trainers in the local authorities and the teachers undertaking the course in order to evaluate the pilot course and suggest modifications. BCS and Aston Swann selected the local authorities who would trial the new materials.

This opened the possibility of comparing findings from traditional methods of evaluation of a CPD course are with results from this – at this stage for me - experimental concept map analysis. However, as there were no digital concept maps in this data collection, the maps from this cohort will not be referred to as multidimensional maps (MDCMs) but as concept maps (CMs).

Of course, as I point out below, the 'traditional form of assessment' was focused quite differently to my use of the concept maps as data for this doctoral research. The contrasts between the results from the traditional evaluation and the results from the parallel CM analysis proved illuminating for me. This was my first intimation that CM could provide a different kind of evidence about learning than other traditional forms of assessment like questionnaires and multiple choice testing.

This step-by-step computer skills training course for an international group of educators, was designed either for personal study or for 'delivery' by a trainer. The

evaluation was requested by the course designers and the professional accreditation body in order to gain academic validation before the course was marketed internationally (Preston and Danby, 2004).

This evaluation opportunity arose at a time when MirandaNet was engaged in a parallel evaluation project funded by the UK Teacher Training Agency in 2004. The national training programme for all teachers focused on the pedagogical uses of computers in classrooms (Preston, 2004). This programme, funded by lottery money by the UK National Opportunities Fund, had been intended to develop pedagogical approaches in classrooms. The MirandaNet evaluation showed that in many cases a basic lack of computer skills was one of the reasons for the failure of the programme.

Such findings suggested that an international computer-based training (computer skills training) programme for teachers was well timed. The subject matter has been modified for educators from an existing course for computer professionals. Mapped onto a computer science syllabus that was already four years old, the seven modules to be studied in any order, were: Information Technology (IT) concepts; using the computer and managing files; word processing; spreadsheets; databases; presentations and information and communication. The final module mentioned email, but did not include the internet. There were no modules on any established multimodal software applications like desktop publishing or animation. Also there was no reference to communication modes other than words and spreadsheets. Exercises had been designed intended to assist the educator in implementing what they had learnt within the school environment. These exercises were not based on pedagogical approaches, but on administrative tasks like the creation of a register of names or the mastery of spreadsheets to make the collection of money easier.

For each module, the resources consisted of a paper-based step-by-step guide and associated data files on a CD-ROM. The course was designed for varied and flexible delivery through self-study, face-to-face training, and tutor-led training online via a

Virtual Learning Environment (VLE) or through a combination of these. The full programme was expected to take about sixty hours to complete and one year was recommended as a reasonable time scale. In terms of accreditation the course provided teachers, teaching assistants and other educators with an internationally recognised accreditation of their ICT competency. Multi-choice tests were set by an independent professional organisation operating internationally. Similar accreditation was available for students in schools and colleges.

The 'formal' or 'traditional' evaluation methodology

In this section the methodology of the formal evaluation of the first CPD in my study is explained and the conclusions discussed. As mentioned above, these conclusions became useful as insights in the evaluation of the concept maps (CMs) as part of this doctoral study.

The insights gained from this study provides the reason for giving some extended detail of the course, even though they are not immediately or directly pertinent to my Research Question: they do provide background material of a relevant kind because a clear picture of the impact of information transmission courses is gained here. The other two courses were designed on constructivist and social constructivist principles.

The questions to be answered for the end of course evaluation of the CPD were:

What draws educators to this course?
How relevant do they find the course?
What are the main gains?
How does the course fit in with their professional lives and goals?
How does the course impact on their practice?

It is clear that these questions overlap, in some part at least, with the aims of my doctoral study.

The 'CPD sample' consisted of one hundred educators who were chosen by five Local Authority trainers in England. They were asked to find teachers who would be training other teachers, here called 'educators'. The educators and their five trainers answered questionnaires at the beginning and the end of the course. All the educators had also been asked to complete a CM at the beginning and at the end of the course. Actual names are not used to preserve anonymity. All the map makers had been asked for permission to publish in writing on their questionnaires.

A small group of twenty educators was then interviewed by telephone on points that had arisen from the initial questionnaires. From these responses a representative group was selected for five case studies, who were asked to fill in questionnaires and take part in telephone interviews. The aim was to have material that would help establish relations between the results from the pre-and post-questionnaires and, where this seemed useful, the transcripts from telephone interviews. All the participants were asked for permission to use the data for publication. The returns were lower than expected because the training had taken longer to set up in some local authorities than was originally anticipated.

The evaluation, conducted by MirandaNet, concluded overall, that educators thought the course was successful in its published objectives. All the candidates claimed to have gained in confidence particularly those who had claimed low levels of skills at the start. This was most pronounced in spreadsheet and database skills. Women tended to have a lower opinion of their capacity than men although this was not borne out by their comparative performance. The educators rated the quality of the resources highly, although they questioned the relevance of the course since graphics, web design, and desktop publishing were not included. However, their main complaint was that the multiple-choice written tests were not set by the course designers and did not

examine key elements of the syllabus. Questions were also asked about important topics that had not been taught in the course. This suggested that there was not enough communication between the designers and the organisation setting the tests.

These findings from this evaluation contained some significant contrasts between the educators' opinions of the value of the year-long course and the views of ourselves, the MirandaNet evaluators. The course based on an information transmission learning perspective had been designed for complete beginners in using computers; it used step-by-step teaching, beginning with plugging in and switching on. What was unexpected, therefore, in the main report findings was the discovery that 64% of the participants knew the software packages and applications offered already. More than half were actually running the school network system or managing the staff training in the school, although our main impression was that the decision to join the course was an individual one rather than being instigated by the needs of the school. This may have been explained by the fact that two thirds of the participants who already had significant skills explained that they wanted recognition of those skills through accreditation, in order to qualify for the government's new 'Threshold Promotion' payments. The examination results clearly mattered financially. Multiple-choice tests for each module could be taken at a centre as soon as the candidate felt ready, ensuring that the teachers could progress at their own pace.

As object researchers or 'Peripheral Member Researchers' (Adler and Adler, 1987) we were constrained to the mutually agreed evaluation design that concentrated on the internal aims and objectives of the computer skills training. Even within this constraint, we suggested that, although the educators had been generally content with their results, they had not been introduced to a wide enough range of topics or conceptual thinking. This included the minimal references to email and the internet, as well as the fact that those references stressed dangers rather than benefits, and provided no practice of skills; and, the lack of information about the role of digital technologies in multimodal communication. Strong concerns were also expressed that the module

called ‘ICT concepts’ was not, in fact, about ICT concepts, but about the mechanics of operating a computer. A more accurate name for this introductory module would have been ‘Information about computer hardware, software and security’. The greatest concern was that there was no evidence that these skills would have impact on teaching and learning practice. Our findings also showed widespread negativity about the testing regime which was overseen by another body separate from the funders of the evaluation.

In the light of these concerns, the MirandaNet team suggested that a formative evaluation should be published first internally, in order to provide the funders with an opportunity to explain the actions they might take in response to the recommendations. The testing regime was, indeed, improved during the course of the evaluation at the instigation of the evaluation funders who were the designers of the course and the accrediting body.

‘Innovative’ concept map methodology

In discussions with the funders it was clear that we, as objective researchers, had significant differences in opinion about the efficacy of this computer skills course. In our traditional evaluation that was based on the requirements for information of the funders it seemed that the participants themselves were pleased with the course if not the testing regime. However this seemed to be because they gained a qualification for knowledge and skills they already possessed. We suspected that the course had not, however, challenged them or led to changes in professional practice.

The basis for our thinking about the value of this particular computer skills training for education professionals was the absence of study of key concepts, the level of detail about skills only, the limited objectives and the excessive time commitment. At the core of our concerns was the observation that the course had been designed on information transmission principles (Pachler, 2005). The information transmission

model was reinforced by the fact that the teachers were not involved in the design or delivery of the course or in projects that impacted on their schools. These factors alerted the MirandaNet team to the likelihood that this kind of course would not act as a catalyst for changes in professional practice within the participants' institutions because constructive learning and social interaction had not been built into the learning process. The rationale for the CMs that were collected alongside the main evaluation data was that they may offer some support for our concerns.

The case study of the twenty-one pairs of CM maps provides a different insight into the educators' understandings and views. The analysis of these twenty-one pairs of pre- and post course CMs followed the funded evaluation, to test the hypothesis that a study of CMs might provide richer and broader insights into teachers' learning than the traditional methods had revealed. The analysis of the CMs, below, does indeed, provide evidence about the value of the course that contradicts that of the 'traditional' evaluation.

Traditional methods were not without value as they provided an overview of the cohort. Looking more closely at the questionnaires from the twenty-one educator-maps, collected from fourteen women and seven men – I found that fifteen of them had been longer than two years in post; three over eight years and one for twenty-five years. This shows the wide range of practitioners who had accepted the invitation to join the national pilot.

Three modes of analysis

In this section the findings from the three different modes of analysis are discussed.

Scoring links and nodes

The first findings were derived from applying the modified ImpaCT2 (2002) scoring system to the twenty-one maps created by these adult learners. The use of

spreadsheets ensured that the data could be manipulated easily and presented as a chart as well as a table. In order to convey a sense of scale the children's connectivity scores are first displayed in Figure 4.1. This table provides the minimum and maximum scores achieved by the young learners and the ratio score. Despite the real differences – of age, of scale and of the criteria for comparison - the comparison does provide a sense of how other groups might score.

Keystages	Minimum score	Maximum score	Connectivity average
Keystage Two 8 -10 years	0.00	8.64	1.9
Keystage Three 11 -13 Years	0.00	7.38	2.00
Keystage Four 14-16 years	0.00	6.59	2.1

Figure 4.1. Children's connectivity scores from ImpaCT2

Figure 4.2.a. is a table of all the scores collected together for the CST cohort. The first column, after the name and the map makers' number, shows the map makers' own estimate of their computer confidence that they offered in the questionnaire. They were asked to rate themselves in their questionnaires from 1-3 – 1 being top competence. The next four columns show the numbers of links and nodes in the two maps. The score as a ratio for the two maps is in the pink column, six and seven.

In the second half of the map the numbers represent the quantity of spheres of thinking and zones of use the map maker has presented. This number does not tell represent, however, the quality of the concepts. The final two columns show the numbers of concepts the map maker has accumulated over time which I have called an activity score. This was my attempt to see if this other cumulative approach was relevant.

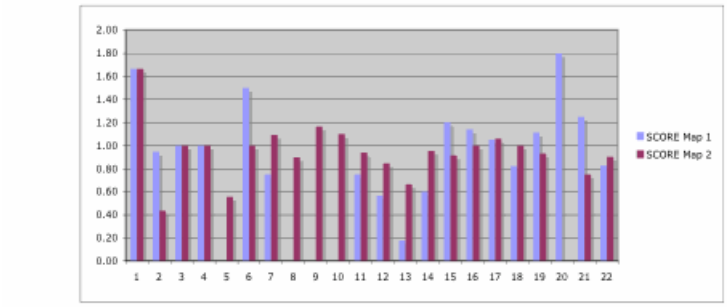
Both groups include some map makers who do not score at all (Figure 4.2.a.). This is usually the result for a map that cannot be scored because the conventional approach to drawing links and nodes has not been used. These low scores could be avoided if the map makers were told how the maps were being scored as Novak's followers advocate.

However, the adult and child scores diverge in the highest connectivity scores. The range of young learners' score move from 2.1 to 1.0 and their ratio scores range from 2.1:1 to 1:1. Keith, one of the computer skills training adults, achieves the highest score of 1.80 on his first map. Amanda achieves the highest score of 1.67 on her second map, which suggests that the group are recording fewer concepts about computers at the end of the course than they did at the start. The average connectivity score goes up from 0.83 to 0.90. The chart in Figure 4.2.b. shows that nearly one third of the adults have a lower connectivity score on the second map.

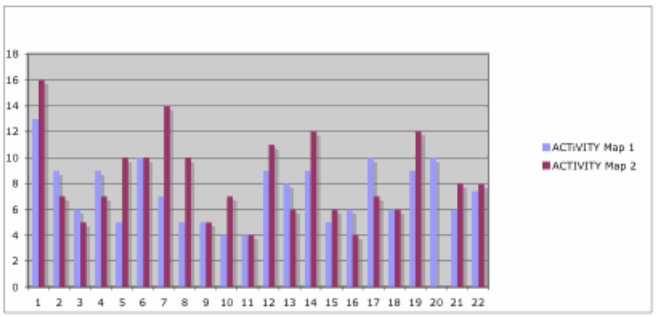
*SOT = SPHERES OF THINKING

ID	COMPUTER CONFIDENCE	LINKS Map 1	LINKS Map 2	NODES Map 1	NODES Map 2	SCORE Map 1	SCORE Map 2	SOT*:USES Map 1	SOT*:USES Map 2	SOT*: ABSTRACTS Map 1	SOT*: ABSTRACTS Map 2	ZONES OF USE Map 1	ZONES OF USE Map 2	ACTIVITY Map 1	ACTIVITY Map 2
0001 Amanda	3	10	10	6	6	1.67	1.67	5	6	5	6	3	4	13	16
0002 Barbara	3	18	10	19	23	0.95	0.43	6	4	0	1	3	2	9	7
0003 Theresa	3	3	3	3	3	1.00	1.00	3	3	0	0	3	2	6	5
0005 John	4	8	5	8	5	1.00	1.00	6	4	0	1	3	2	9	7
009 Bridget	2	0	5	6	9	0.00	0.56	2	8	2	1	1	1	5	10
0010 Christine	3	9	5	6	5	1.50	1.00	7	7	0	0	3	3	10	10
0012 Amy	1	3	12	4	11	0.75	1.09	4	9	2	3	1	2	7	14
0015 Evelyn	3	0	9	0	10	0.00	0.90	2	8	2	1	1	1	5	10
0019 David	3	5	7	5	6	0.00	1.17	2	3	1	0	2	2	5	5
0022 Michael	3	14	11	11	10	0.00	1.10	3	5	0	0	1	2	4	7
0023 Freda	3	6	16	8	17	0.75	0.94	2	3	1	0	1	1	4	4
0079 Winifred	3	17	44	30	52	0.57	0.85	4	7	1	0	4	4	9	11
0080 Tina	4	3	2	17	3	0.18	0.67	5	4	1	0	2	2	8	6
0082 Jim	4	12	21	20	22	0.60	0.95	7	10	0	0	2	2	9	12
0085 Harvey	2	12	11	10	12	1.20	0.92	4	4	0	0	1	2	5	6
0089 Dina	2	8	5	7	5	1.14	1.00	5	3	0	0	1	1	6	4
0092 Patrick	4	20	17	19	16	1.05	1.06	8	5	0	0	2	2	10	7
0095 Irene	2	14	9	17	9	0.82	1.00	5	4	0	1	1	1	6	6
0096 Josephine	3	10	14	9	15	1.11	0.93	6	11	1	0	2	1	9	12
0098 Keith	4	18	0	10	0	1.80	0.00	7	0	1	0	2	0	10	0
0099 William	2	5	6	4	8	1.25	0.75	4	7	1	0	1	1	6	8
AVERAGE	2.90	9.29	10.57	10.43	11.76	0.83	0.90	4.62	5.48	0.86	0.67	1.90	1.81	7.38	7.95

Figure 4.2.a. Connectivity and activity scores for the computer skills training cohort



b. Connectivity scores



c. Activity scores

Figure 4.2.b &c. Charting confusing patterns of understanding between the first and the second CST concept maps

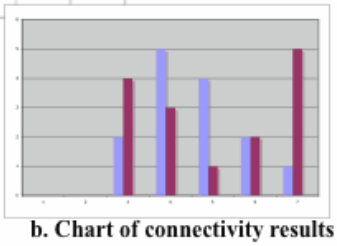
Given the – at that stage – surprising results, I developed another formula, which I called an 'activity score' in order to avoid making judgments on one set of criteria alone. One assumption made here is that the map makers have not forgotten their earlier concepts, but for reasons to be understood not recorded them the second time around. In the activity score approach, the two scores for the Spheres of Thinking and for the Zones of Use are re-examined to see whether these offer more insights into the learning than the connectivity score. In the columns in Figure 4.2.a headed Spheres of Thinking and Zones of Use, points are awarded for concepts that indicate the spread of the learners' concepts across different categories.

The activity score quantifies the accumulation of concepts across the two maps that are shown in the chart in Figure 4.2.c. These scores for Map One and Map Two provided a rough guide to how many concepts are presented by the learner overall. From the perspective of the activity score two thirds of the participants cite fewer computer concepts than they did at the beginning of the course. This result follows the lower results for the connectivity scores in the second map.

In order to explore the differences in the scoring in some depth and perhaps more clearly, the different trajectories of five individuals were chosen to attempt to explore and explain the lack of coherent pattern and the wide spread in the scores. Here the choice was made to use the questionnaire replies, where each of the participants estimated their computer competence chosen as level one, two, three or four.

ID		COMPUTER CONFIDENCE	LINKS Map 1	LINKS Map 2	NODES Map 1	NODES Map 2	SCORE Map 1	SCORE Map 2	Connectivity Positions	
0005	John	4	8	5	8	5	1.00	1.00	3	2
009	Bridget	2	0	5	6	9	0.00	0.56	5	4
0012	Amy	1	3	12	4	11	0.75	1.09	4	1
0096	Josephine	3	10	14	9	15	1.11	0.93	2	3
0098	Keith	4	18	0	10	0	1.80	0.00	1	0
	AVERAGE	2.90	9.29	10.57	10.43	11.76	0.83	0.90		

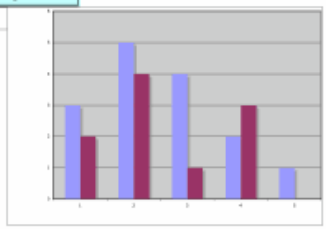
a. Table of connectivity results



b. Chart of connectivity results

ID		SOT*:USES Map 1	SOT*:USES Map 2	ABST Map 1	ABST Map 2	ZONES OF USE Map 1	ZONES OF USE Map 2	ACTIVITY Map 1	ACTIVITY Map 2	Activity Positions	
0005	John	6	4	0	1	3	2	9	7	2	4
009	Bridget	2	8	2	1	1	1	5	10	5	3
0012	Amy	4	9	2	3	1	2	7	14	4	1
96	Josephine	6	11	1	0	2	1	9	12	2	2
0098	Keith	7	0	1	0	2	0	10	0	1	5
	AVERAGE	4.62	5.48	0.86	0.67	1.90	1.81	7.38	7.95		

b. Table of activity results



d. Chart of activity results

Figure 4.3. Five journeys of understanding: a & b CST connectivity scores: c & d CST activity scores

Amy is level one; Bridget is level two and Josephine level three. Keith and John are both level four, where more participants were clustered. In the diagrams these levels have been indicated by shading. Figures 4.3 a. and b. show the extreme variations in connectivity. Figure 4.3. c. and d. show how the activity scores vary significantly and without a discernible pattern.

Without the maps to hand, these scores are difficult to interpret. The numbers do not give any information alone on the reasons for these variations. Triangulation with other methods is required that is followed up in the next two sections. I will deal with some of these questions under Conclusions at the end of this chapter.

Classifying word groups

Here two approaches are used to analyse the 'value' of the words in the twenty-one CMs. In the first approach the column headings were taken from the ImpaCT2 (2002) score sheet that can be seen in Chapter one, Figure 1.3. The version modified for this exercise is in Chapter Three, Figure 3.1.

These headings were: computer systems and networks; information and communication; publishing and correspondence; games; sound; learning. The same columns were used for all three cohorts. The second method employs the Daly and Pachler's indicators shown in Chapter Three Figure 3.2 : cognition, knowledge building, autobiography, community and meta-learning. These headings were added to the spreadsheet.

When the repetitions of concepts expressed in words are counted, little in the way of vocabulary development or change is discernible. An important finding (here too) is that half the concepts and ideas about computers expressed in the first map were not repeated in the second map. In particular, references to the internet in the first maps are dropped. The most significant detail in this computer skills training table appears in the last two columns about 'learning' with computers (Figure 4.4).

In the first maps, the words covering learning experiences are rich in their promise. The teachers talk about creating online communities; software like 'Talk to Learn', designed to create e-communities for leaders about the role of computers in underpinning and extending children's learning. In the column for learning in the second map only one participant out of the twenty-one mentions children's learning.

START LEARNING	FINISH LEARNING
Online communities x 1	0
Talk2Learn x 1	0
Class activities x 1	0
Class practicals x 1	0
underpin and extend learning of children x 1	Children interacting with IWB x1
Children using the PC x	0
0	Children working

Figure 4.4. Extract from group discourse analysis sample sheet.

What is substituted for learning by one map maker however, is the phrase 'children working'. This phrase seems to move from the notion of learning to the notion of working – a word that has a more mechanistic and vocational ring. The same kind of underlying trend was present under all the other ImpaCT2 headings.

How to assess or judge the concept was the crucial issue in this form of content analysis: particularly in the discussion of the Daly and Pachler indicators. It proved difficult to find enough manifest or latent indicator words in the Daly and Pachler categories to show evidence of group learning through cognition, knowledge-building, autobiography, community and meta-learning. Here I indicate, briefly, what the analysis reveals in the case of two individuals, Amy, a primary school teacher, and John, a network manager.

Amy's maps show seeming inconsistencies in the scores of links and meaning of words. Amy doubled her score on links in her second map, while an analysis of the words she employs indicated that her computer concepts tend in a direction associated with 'use' rather than knowledge and interest in 'technical domains' (Figure 4.5).

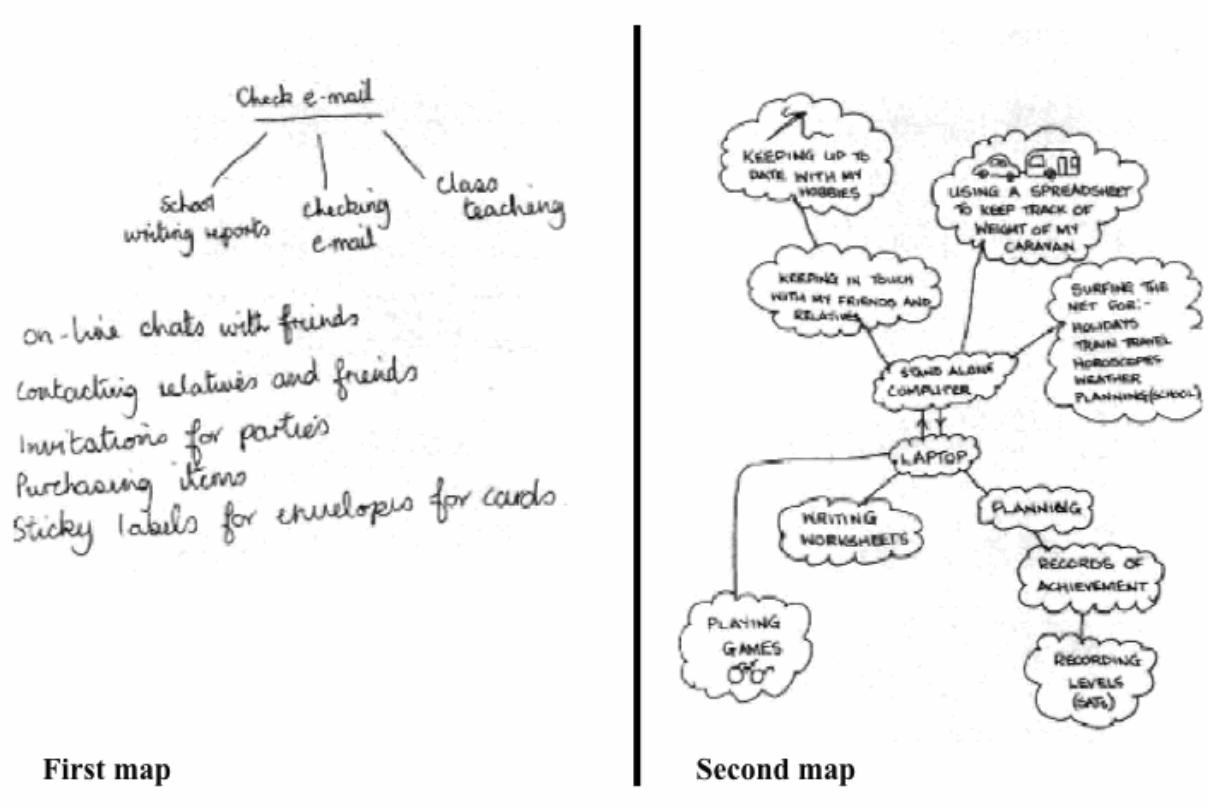


Figure 4.5 Amy's first and second maps

She wrote about 'using a spreadsheet to keep track of the weight of my caravan', and 'writing worksheets'. These tasks are related a wider notion of systemic used in her school – such as 'records of achievement' etc. In terms of the Daly and Pachler indicators, Amy's understanding of computing was related to communicating with friends and family, and to certain tasks at work. She was more articulate about the task she could do in the second map, but this suggests the level of cognition rather than meta-learning.

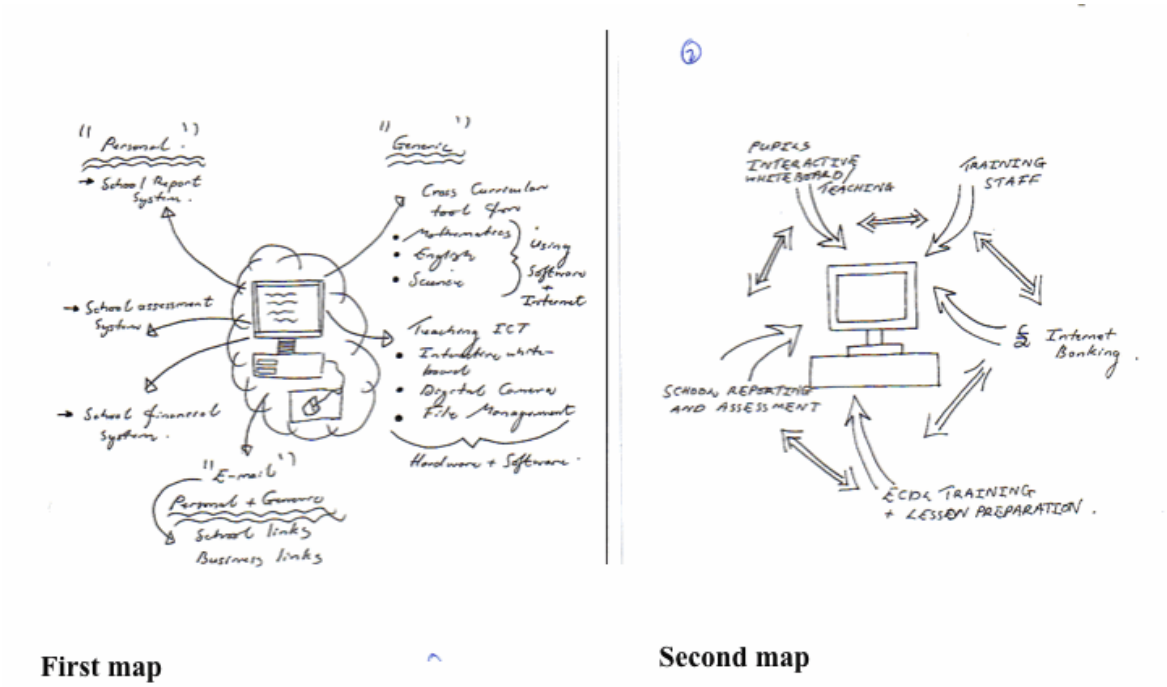


Figure 4.6. John's first and second maps

In contrast, John, whose scores in his second map were lower than those of Amy, showed a work-related conceptualisation of computers and networks in school (Figure 4.6). He made several mentions of the way his school used computers, referring to concepts like the 'school reporting, financial and assessment systems'. His reference to 'training staff' could be interpreted as an intention to build knowledge and to develop a school community. The word 'training' tends to refer to information transmission forms of teaching. There is a problem in interpretation because the scoring system only makes allowances for the graphical connections, not for an impact of the 'weight' of his words.

In his second map John also made some strategic points by mentioning the need for pupil interaction in the use of the whiteboards and the requirement for training staff. These indicated his grasp of the use of computers as a secondary school network manager, while Amy was at the stage of a user mastering skills. Some of these differences in vocabulary can also be explained by the differences in the ways in which computers are used in primary and secondary schools. What emerged in this analysis

of the words used by Amy and John is that their connectivity scores did not relate directly with the results of the word analysis. Amy had a high connectivity score but her use of the computer focused on a certain range of uses. John's second connectivity score was lower, but his understanding of uses, judging from the words on the CM, had become wider in the interim.

Analysing complex multimodal signs

In this exercise the framework for semiotic analysis shown in Chapter Three Figure 3.3. is in focus. Words are one of the components in the analysis. The categories are supplemented by comments on semiotic evidence of the processes of cognition, knowledge building, autobiography, and community and meta-learning (Daly and Pachler 2007).

The following analysis is intended as an example of this emergent methodology. I will look at three educator/map makers, Bridget, Josephine and Kevin, who had placed themselves respectively at levels two, three and four of computer confidence at the beginning of the course. Their scores are recorded in Figure 4.3. a b. c. and the selections in 4.4 a. b. c. d .

Bridget – the humanist

Bridget placed herself at level two in computer competence in her questionnaire. She put herself at the centre of the map one composition (Figure 4.7.a.). This first map is in 'quasi -narrative' style. She plotted her immediate tasks in a semi-circle round her head. The words were enclosed in thought-bubbles suggesting that these were future plans not current projects.

One year later, Bridget's map referred to her computer exams as well as examinations her family members were undergoing. The graphical references were clear; books,

making worksheets, taking tests, preparing pupils for tests and supporting her family. There was a spatial separation of professional matters and the cheerful reference on the left to family parties, suggesting the balance of computer uses between personal and professional had shifted. In another interesting change in the second map Bridget put the word 'computer' at the centre of the map rather than an icon of herself.

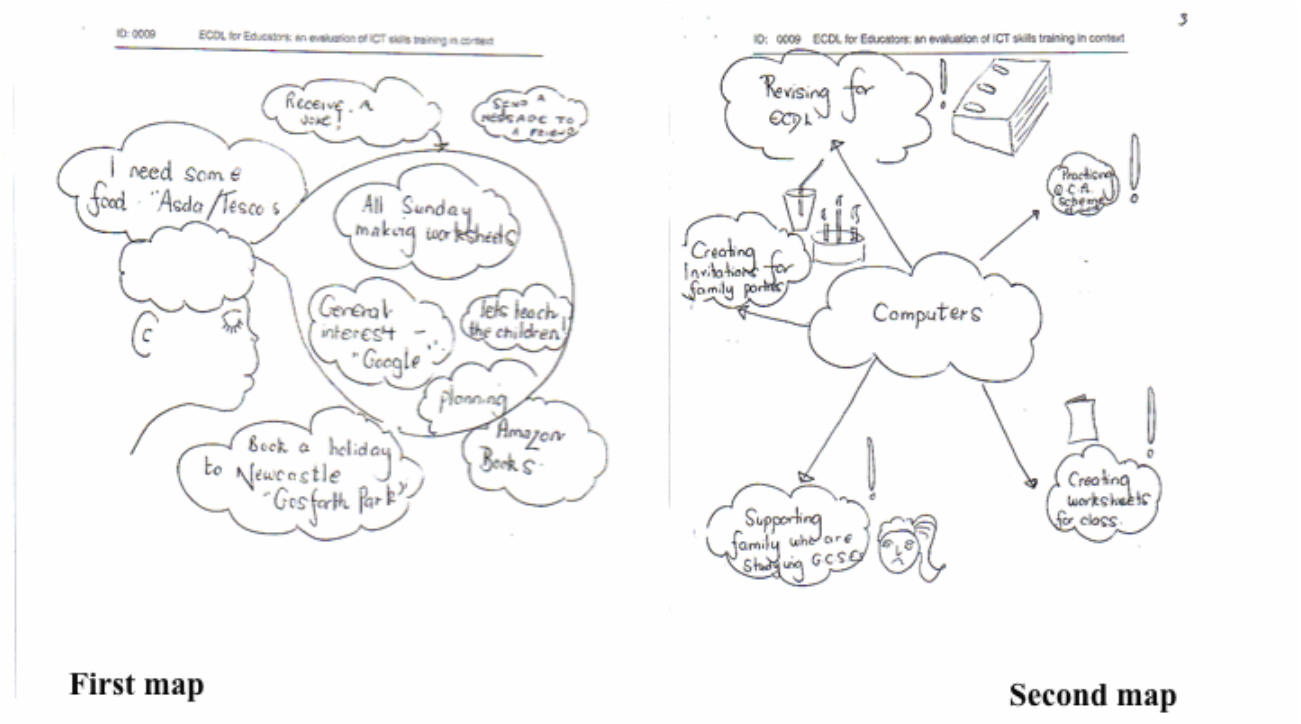


Figure 4.7. Bridget's first and second concept maps

Analysis of the map also drew the researcher's awareness to the need for close attention to 'textual factors' that emerged when the original map was studied. All the MDCMs were scanned to avoid too much handling of the originals, leading to damage or loss. However, although the scans retain key features of the maps, it proved important in Bridget's case to look back at the original paper copy. The scan had obliterated some small black eraser marks. The indentations in the paper showed that the phrase that had been erased was 'Passing a test!!!' This phrase, expressing emotion, had been replaced with the more sedate and formal 'revising for ECDL', the

computer tests to be taken. The marks on the page suggested vigour both in writing the exclamation marks and in rubbing them out.

Josephine – the collaborative learner

According to her questionnaire, Josephine judged her computer experience at level three. She also recorded that she had 'some computer skills' at the start of the course. This seemed to be an underestimation of her skills. In fact, autobiographical details in her questionnaire indicate that Josephine managed the resources in her school.

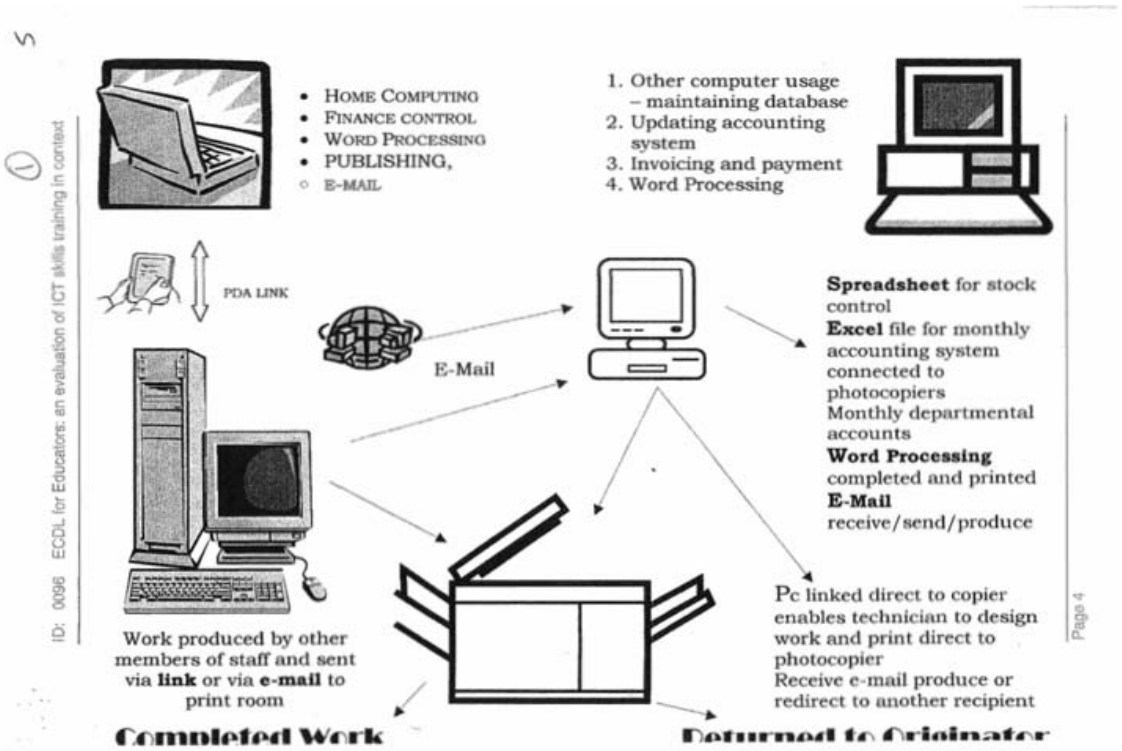


Figure 4.8a. Josephine's first concept map

In both of her maps, Josephine displayed a broad understanding about the tasks that computers can perform (Figure 4.8.a. and 4.8.b.). All the participants had paper and pen to hand for this exercise, but Josephine had chosen to demonstrate her knowledge of the capacities of digital devices by using desktop publishing. Using a desktop publishing package is a clear demonstration of competence in a computer skills

discipline that had not yet been offered as a module on the course. She demonstrated that she was already beyond the range of competence envisaged for participants. Her first (MD)CM showed a variety of modes of connection, with a through-flow marked by links. Printer and photocopier were focal points in the school print room. The production of resources is at the core of the map which appeared to be a team effort. In Josephine's second map, a year later, all activity now radiated from a standalone computer rather than herself. There is evidence of interest in the facilities in the new clip art that is being used.

The personal and the professional were mixed together. Personal uses like shopping, hotel and flight reservations, health and beauty, photographs and the family accounts, route planning and bookkeeping were equally placed at the end of the links along with administrative uses like worksheets, address book and calendar, currency conversions and homework research. Although Josephine said in her questionnaire that she had passed the test in all the package modules, she only mentioned one module in her second map: word processing.

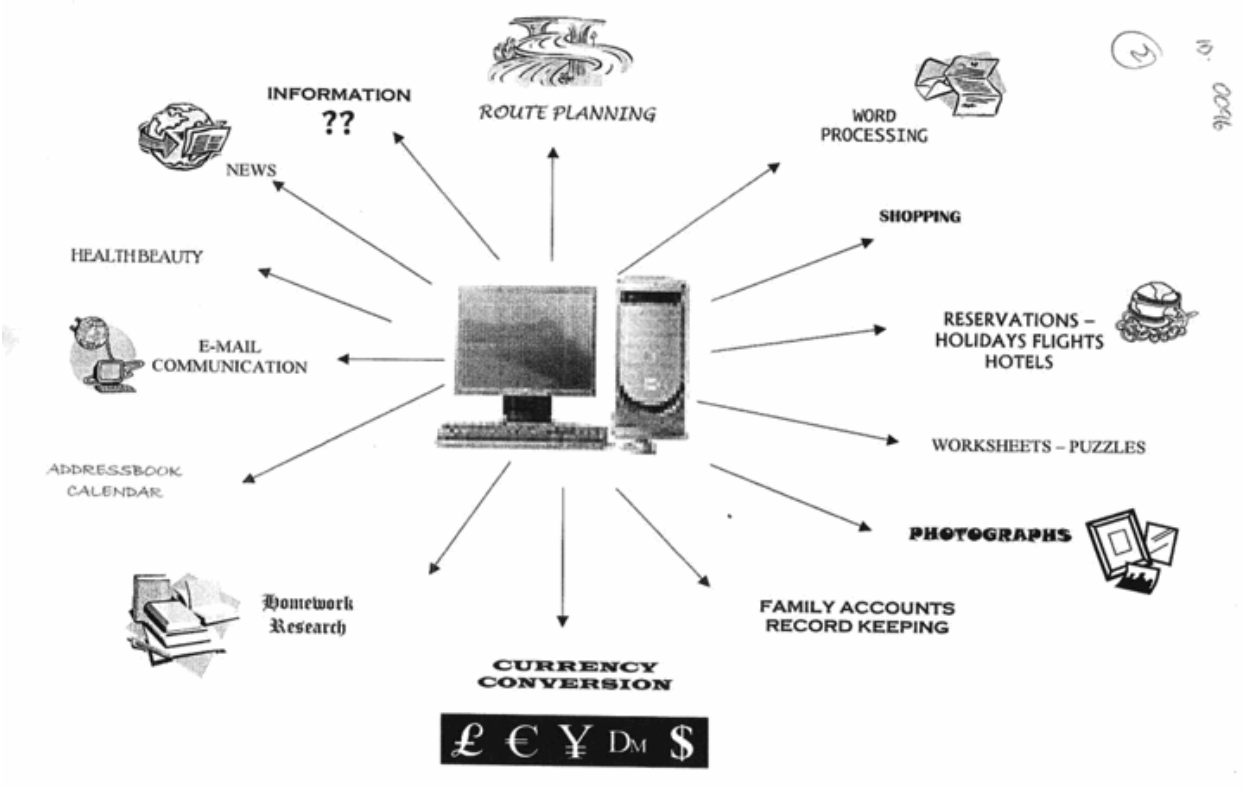


Figure 4.8.b. Josephine's second map

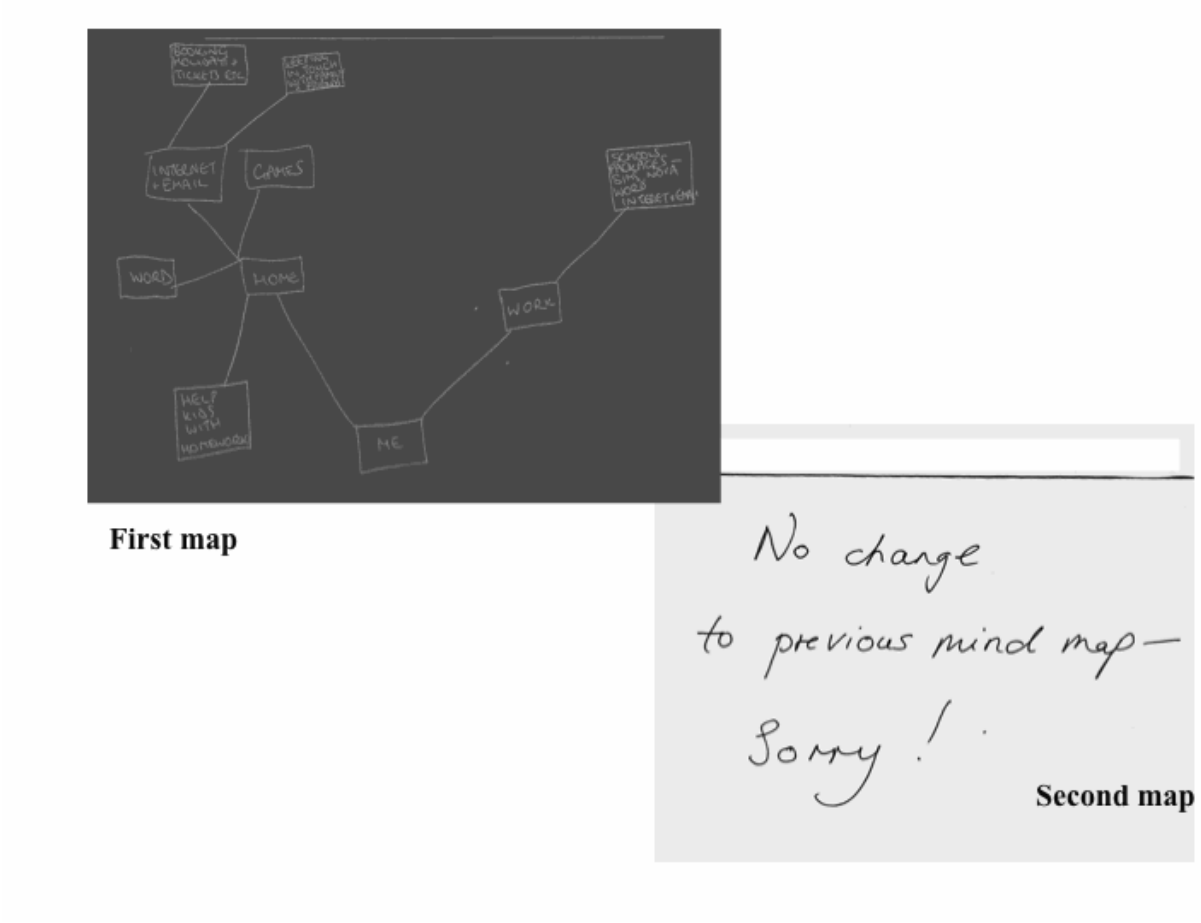
The use of clip art allowed her to present a range of computer activities in picture forms. But there is less sense in this second map that these disparate ideas have been organised into conceptual categories.

Keith – the network manager

Keith is a teacher who identified himself as someone with 'lots' of computer skills at the start of the course: a level four. He felt ready to teach other teachers. He had also chosen to work on his own, using the CD-ROM rather than joining trainer and class in regular workshops. He showed a considerable understanding of the technical words associated with computers (Figure 3.9). The autobiographical aspects in the map show that in his personal life he played games and helped his own children with their homework. At home he also used all the interactive opportunities that the internet offers. In terms of computer concepts in his first map he already mentioned his

professional use of all the packages that he was about to learn on the course as well as the internet and email, which were not offered.

In his first map Keith confirmed his confidence in compositional terms by putting a node called ‘me’ as the point of departure for activities related to work and the more private. Most educators had placed a reference the computer rather than to themselves at the centre of the first map In terms of frequency of words, his first map suggested an imbalance between his uses of the computer at home and at school. The two centres of his home and school, professional and personal were also a long way from each other on the second map suggesting a marked distance between the personal and the professional.



First map

Second map

Figure 3.9. Keith’s first and second concept maps.

Unexpectedly Keith declined to draw a second map. His comment was bland and polite, 'No change to previous mind map – Sorry.' He had not been shown his first map again. In this context, It would have been useful to him and to the programme designers to be able raise some key questions with him: about how he remembered this map so well one year later; what this comment indicated about his view of the course; or about his view of his own competence; or about his view of concept maps.

Discussion

Here I will make some reflective and/or evaluative comments on the use of the three kinds of analysis in the evaluation of teachers' understandings.

By score

The results seem to offer no clear patterns of changes in understanding through learning in the CPD, individually or within the group. There are some perplexing results for individuals across the pairs of maps. Nearly one third of the participants appear to be thinking less about computers by the end of the course than they were at the beginning. If the notion of connectivity is right, the scores would indicate that the teachers knew less at the end of the course than they did at the start. In terms of the question asked in this CM study, connectivity can be interpreted as an accumulation of understanding. In this cohort, however, this seemed to diminish.

This, to me seems an implausible result. It suggests to me a problem in the form of analysis as such, or in its suggested interpretations. Of course, one disadvantage is that the connectivity scores alone do not highlight other learning messages contained in the maps. Nor does it judge the 'quality' of the concepts. But then, that is not what the approach promises to 'deliver'.

One of the reasons for doubting the value of the connectivity formula by itself is that the connectivity scoring does not allow for the possibility that the second map might show a lower score because the map maker has used fewer concepts but at a higher level of abstraction – called higher level-thinking according to Bloom (1956). Zero scores, for example, are not useful unless the maps are revisited because they result from the difficulty of scoring unconventional maps without appropriate links and nodes. Maps that score zero, may, nevertheless, represent a creative approach to the task. But in this strict counting system other approaches to mapping ideas that do not use nodes and links cannot be scored.

A further reason for a lack of confidence in the formula is that this group of adults seems to present overall significantly lower connectivity scores than the oldest ImpaCT2 children who were fourteen.

Efforts were made in this analysis to understand the meaning of the maps better by introducing the activity score. Underlying this is the assumption that the participants already had mastery of significant areas of the course when they started as well as a wider knowledge about computers that the course did not cover. If judgments are based on the new activity formula it appears that two thirds of the teachers are able to engage with fewer concepts about computers at the end of the course than at the beginning. The most useful element of this is the class positions. The progress of five teachers is examined more closely. For example, Amy who had scored highly in connectivity had presented seven different entries in the 'computer use' category in her first map and fourteen in her second. John, on the other hand, had nine concepts in his first map, but only six in his second map. The variations in class position in Figure 4.4 a. & b. indicate that the raw scores provide little insight that is reliable about the five teachers as learners and about what kind of understanding they have about digital technologies.

Overall it seems that if the connectivity approach is accepted in its 'raw' form, the scoring of the maps provides little or no useful insights into the groups of teachers' understanding of digital technologies. It cannot, for instance, identify changes in salience to particular elements in an educator's understanding that has occurred. These findings are not more encouraging for the designers and testing bodies than the multiple-choice tests about the value of the course. However, there are questions that will be pursued later about the value of the numerical formula itself. What can be said at this stage is that the scoring approach is of doubtful value when used in isolation.

It should also be said that some of members of the ImpaCT2 team appeared to come to similar conclusions about the value of the maps for individuals (Mavers, Somekh and Rosterick 2002). They were particularly anxious, in the light of high levels of deviation from the norm in the overall ImpaCT2 scoring, to stress the uniqueness of the maps. They overcame the seeming inconsistencies by interviewing a few of the young people in a sympathetic manner making it clear that their own knowledge mattered. Once Mavers, the interviewer, had established that her aim was to find out what the children knew rather than what they had been taught the students moved from an uncertain silence to articulate and informed explication. The findings from the interviews helped to identify the reasons for the differences in scores and pointed to the creativity of the young learners. This was evidence that the researchers' needed a close, follow up connection with the learner to unpick the full meaning of the maps. This observation informed the methodology for the two case studies that followed where interviews were intended to be followed up with the adult map makers.

By words

In that respect, a study of the 'words' on the maps seems to correlate with the scores. The large majority of map makers create post-course maps that appear to prove that they know less at the end of the course than they do at the beginning. This might be a result of the multiple-choice testing regime, in particular, that all the participants would have undergone by the time of the second map. Their rationale might have

been that they chose to confine their words here to the areas that they think interest those who look at the second map.

There is another point on the difference between the efficacy of connectivity scoring and the 'content analysis'. If a tutor was analysing MDCMs in order to gain insights into a learner's needs at the beginning of a course, the connectivity scores could be quite misleading about a learner's knowledge and skills. 'Words' seem to offer a more rounded picture of competence and the quality of thinking.

The limitations of the analysis of the words used by the ImpaCT2 team were that their list of indicators concentrated on the mechanics of what had been learnt rather than the learning process. They proved useful for looking at understandings across the group whereas the references to learning process adapted from Daly and Pachler were not in sufficient evidence either in manifest or latent form. These latter indicators did, however, begin to provide insights into understanding when the individual maps were considered.

By complex MD sign

Studying individual maps in terms of 'signs' offered some new insights into the educators' understanding of digital technologies. Three maps had been selected to illustrate some pointers about the value of this method of analysis for the researcher as well as some points to look for. In no way, however, is this an exhaustive discussion of all the possibilities. The discussion is divided into: the scoring issues; and the semiotic features. .

Scoring issues

The maps were chosen in particular to show how a fuller semiotic reading differs from the evidence of connectivity scoring. For example, although the quasi-narrative seems clear, Bridget's first map had a score of zero because there were no links and therefore this should not have been seen as a a concept map. Since the analysis suggests that

the meaning is coherent, the lack of 'conventional' links seems to make the connectivity score pointless. By contrast, Bridget's capacity to communicate key concepts was represented effectively in her activity score, which doubled from five to ten in her second map (Figure 4.7.b.).

There seems also to be an inconsistency in Josephine's scores. Although she demonstrated by using desktop publishing that she was already beyond the range of competence envisaged for participants, the scoring system does not value this. Despite this use of desktop publishing, her connectivity score drops from 1.11 to 0.93 even though she engaged in complex thinking about the use of digital technologies.

Semiotic features

In the first place, the maps provide some illustrations of the value of some of the semiotic features: the words, the composition and the affective elements. Firstly, the words in the nodes provide the researcher with some evidence about the computer concepts that were understood and the explicit understanding in the three maps. For example, although Bridget's scores are slightly better than average, her maps suggest she had made virtually no progress either in computer concepts or vocabulary when her words were analysed. Bridget's understanding seemed to have changed significantly in the year, and she seemed less happy by the time that she drew her second map. There are possible indications that she was citing the testing regime. The second map did not have the humour of the first map either. The researcher had to decide how much weight to give this evidence since it is so slight. If Bridget has changed over the year this was unlikely to be caused solely by the demands of the course she had been following. There would have been too many other variables.

Judging by the words, the course did not seem to have improved Josephine's computing concepts either, although she was technically skilled and competent. Her second map does not show any meta-learning or constructivism in terms of reconstructing the information she had been given in her own terms. The 'map

discourse' is about individual positions rather than identifying systematic features, which would have reflected the demands of the information transmission character of the computer skills training. Josephine knew what computers do, but in her account she did not apply the technical terms from the computer skills training course. In terms of 'community' her first map focused on learning with her school staff, whereas personal and home uses of the computer were her priority in the second one. The school seemed to have been sidelined.

If we stay with a simple-minded approach to scoring of whatever kind, the composition of the maps seem to reinforce the sense that the mappers were not as confident at the end of the course as they were at the beginning. Bridget, Kevin and Josephine, for example, all put themselves at the centre of the map when they started; Bridget and Josephine put the computer at the centre a year later. Whereas Josephine's first map suggests a dynamic creativity from the human centre, in her second map, a year later, all activity now radiated from a standalone computer. Was she overwhelmed by the computer a year later? Or did she re-imagine a self in which she stood in a different relation to this device – more distanced, not so involved?

The features of Kevin's first map confirm the confidence he expressed as a network manager in his questionnaire: Like the two women he put himself at the centre. However, in the composition there is a contrast between a keen interest in computers at home that did not seem to be translated into similarly exciting classroom projects. Not only is his list of school applications rather routine, but also they were all crammed into one small box. This cramming effect suggests that software, which seems to be only the Microsoft Office package, might have limited his opportunities in school. Words and composition here provide a sense of the different between his professional and personal experience of computers.

Keith's view of his own understanding between the pre- and post-course map is intriguing. Keith's second questionnaire recorded that he had already passed five of

the modules at the testing centres by this time in the year. It might be that he was merely taking this course because he needed proof of his existing competence to gain his government Threshold payment. One possible interpretation might be that this course had not challenged him in any way, although his lack of – or unwillingness to produce - a second map might indicate that he felt that he had not learnt anything from the course, as he already knew the basics. Another reason might be that he did not want to draw a map because he had the test results he needed. This could suggest any number of things: that he did not like drawing tasks; or that he was suspicious of the task set by the peripheral member researcher whom he did not know; or many other possibilities.

Another feature that a researcher might look for can be illustrated by Bridget's map which reveals some changed decisions during the creation process. These textural features, showing details drawn with vigour and rubbed out with energy, are useful in considering how the resources to hand are used to show, or to conceal, meaning.

The example of Josephine's second map indicates that analysing digital maps as opposed to hand-drawn maps presents a new set of challenges for the researcher. Josephine, it seems, adapted her capacity to communicate her ideas because this package offered a limited library of clip art that promoted a commercial office style. The impression given by the second map is of a place like an office where educational resources were developed, rather than a school. There are other limitations of desktop publishing: for instance, Josephine was not able to make a line curve. As a result, the radiant straight lines on her second map tend to make her thinking look static rather than dynamic. Josephine may have thought that a desktop published map would demonstrate her computer skill, which it does. However, this may have taken longer to set up. She might, in fact, have run out of time to do more to her map, which should be another consideration for researchers considering the length of time required to create a digital map.

Conclusions

Two important areas for consideration emerge from this pilot that compares the results from a traditional evaluation of a course and the contrasting views found when the CMs are analysed. One area of interest is the evidence of the maps themselves. The other is the question about whether the role of the researcher has an impact on the map makers' commitment to the exercise.

The evidence of the MDCMs

What is remarkable is that these particular three map makers reinforce the trend shown in the overall connectivity scoring and the 'content analysis' that less is communicated about computers at the end of the course than the beginning. The CMs provide clues that all was not well, a more subtle approach was needed; more information was required before the learner's real understandings could be known. These affective elements of learning seem to be the strength of the semiotic approach to analysis.

Several points emerge about some of the analytical challenges in this first case study. Firstly the value of the maps is reduced because the map makers had so little experience of map making and no training. Novak avoided this issue by making mapping very prescriptive. However this method relates to material that has been systematically taught. The maps in this study were eliciting opinions about the impact of computers. It might be that too much was being read into these maps about teachers' understandings and the relationship that was developing between these professionals and the computers they were trying to master. It seems that for individuals the maps do not produce scoring reliability, but they might offer evidence of learning. Despite some of the challenges to the researcher, the computer skills training concept maps do seem to offer evidence that expands the traditional methods used in the formal evaluation. What seems to be important is to look closely at each

map as such, in its own terms and at the two maps and interpret their relationship dynamically rather than concentrating on lacks and additions.

The researchers' roles

There are many unsolved questions in this chapter about what these tentative conclusions mean for the researchers, the trainers, and the testers and for the educators themselves. A key point is that the map makers and the trainers had not met the researchers and had no 'ownership' of the research because the report was for the designers and the testers. In these circumstances the map makers might not have felt totally committed to the mapping exercise, as it had no particular value for them. Since the data was collected remotely nothing was known by the researchers about the relationships between the five trainers and the groups they were teaching. There may have been some dissatisfaction with the course delivery.

These new results have been offered to the funding bodies for this computer skills training. Negotiations are progressing about how these results might be used to improve their models for CPD for professionals.

From the perspective of the peripheral member researchers many factors like this about the processes of learning are not known (Adler and Adler 1987). In this case there were doubts about the value of the analysis overall because interviews were not possible. There seems to be much for the tutor, the researcher and the map makers themselves to learn from these maps although analytical methods are still emergent.

For the researcher further discussion with the teachers would seem to be essential to determine what the different kinds of analyses of the maps might 'afford'. This is not a complete account as the issues raised here are dealt with in more detail in the next two studies in Chapter Five and Six. The results from the three studies are compared in the conclusions in Chapter Seven where modifications to the analytical methods are suggested.

Chapter five: the role of MDCMs in a practice-based research CPD programme in England

Introduction

The data of this chapter derives from a practice-based research programme (PBR) about digital technologies run by MirandaNet. The design of this PBR programme was based on what had been learnt by MirandaNet Fellows from the relative failure of this NOF programme. This MirandaNet evaluation of a UK New Opportunities Fund (NOF) programme about digital technologies involved all teachers in English primary and secondary schools and took place between 1999 and 2003 (OFSTED 2001;2002; Preston, 2004). This programme had failed because the teachers did not achieve the computer skills required to make changes in their pedagogical practice. At the same time there were not enough qualified educators and advisers in England to promote and support constructive approaches through action research; or to lead on to scholarly approaches through practice-based research strategies and the building of local Communities of Practice. The two underlying teaching approaches, introduced in Chapter two, will be discussed in this chapter.

This one-year programme had been about e-learning: an encompassing term used by the UK government at that time to denote digitally mediated learning and e-facilitation (DfES 2003). The course combined scholarly and practical approaches to e-facilitation in the process of building a CoP. Professional reflection on practice constituted a significant element. It involved the e-facilitation of existing fora for teachers, as well as a project setting up and e-facilitating a forum with children or with peers.

The scholarly aspect of this PBR was strongly influenced by Pachler, then co-director at the Centre for Excellence in Work-Based Learning for Education Professionals (WLE

Centre) at the Institute of Education, University of London, where this pilot course was developed (Pickering, Daly and Pachler, 2007). It shared common features with an MTeach offered at the IoE. The common features included shared practice, collaborative learning networks and scholarly reflection on practice. The MTeach design aimed to develop a concept of professional learning based on the assumptions and experiences of teachers. The design highlighted the tensions and the generative synergies between 'academic' and 'workplace' knowledge, aiming to work through dichotomies between 'theory' and 'practice' that are prevalent within the teaching profession. In particular, the programme design was intended to mark 'a shift away from the transmission focused "information age" denot[ing] an altered perception of people as having the capacity for agency, and who share corporate responsibility for making their knowledge through collaborative processes (p.4)' (Pachler and Daly 2006).

A further area of agreement with Pickering, Daly and Pachler (2007) was the acknowledgement of the value of Virtual Learning Environments (VLEs) as a means of enhancing learning and meta-learning in a reflective learning space. The evidence suggests that computer-mediated communication by teachers, challenges notions of individual authorship and promotes an understanding of learning with others in mind, and highlights the value of multi-authored texts (Daly and Pachler, 2007). The use of an innovative VLE was an important element of the PBR programme.

Programme design

The PBR pilot in e-learning was designed on constructivist and social interaction principles (Pachler, 2005). The intention was to develop collaborative attitudes towards sharing of knowledge and evidence in face-to-face and online communication. The educators were engaged in e-facilitating for a during the course as one aspect of their projects. This design for learning represented a major shift away from tutor-dominated learning approaches in teacher education to a more egalitarian view of

teachers' own expertise. The independent evaluation commented on the innovative programme design, underpinned by an imaginative VLE, designed by the tutors as an journal (Earle, 2005).

Figure 5.1 PBR Braided Learning VLE Interface

This was used for collaborative exchange of knowledge developed in practice- based projects as well as discussion of assignments. Figure 5.1 shows how the interface was developed to underpin the stages of academic writing for teachers who had not engaged in this kind of writing for some years. This included e-peer review features and opportunities for web publication when the text was agreed. This methodological innovation encouraged interactions beyond the classroom that involved the co-production of knowledge, a co-determination of meaning, collective problem solving, and multiple perspectives on e-learning issues among teachers and between teachers and tutors.

The strategy was intended to provide an antidote to individualistic and competitive learning tendencies modelled in teacher education that filters down to the schools and the students. As such, the programme aimed to develop critical thinking at Masters' level permeated by a communitarian spirit and a sense of togetherness. Residential workshops, twenty-days of 'support cover' and resource bursaries meant that the teachers had time to extend their learning and develop work-based action research projects in their institutions. The independent evaluation noted that completion rates were good, and the grades obtained excellent: eleven 'A' grades amongst nineteen participants (Earle, 2005).

Methodology

Selecting the participants

Advertisements in the national newspapers attracted seventy-two applications to join this CPD programme. Twenty-five participants, who were teaching about digital technologies or managing their deployment in schools and regions, were selected. In order to avoid dominance in the group by educators with a technical approach to computers, a high level of technical expertise was not a criterion for selection for a fully funded place on this course.

The selection process was conducted by a combination of interviews, questionnaires and reference letters from employers. These processes were designed to identify educators who were willing to learn and to collaborate with their peers. Other selection criteria included a keenness to reflect on practice and expert knowledge in a relevant curriculum area as well as a willingness to contribute to an active CoP by web publication and forum discussion. To ensure an impact on the professional ecosystem locally and nationally, the applicants had to provide proof of their potential as staff tutors and of their established links into subject associations and regional professional groups.

Data collection procedures

At the start of the first workshop, the CPD programme director explained the underlying design principles of change and the expectation that the participants would be building a CoP during and after the CPD intervention. Discussions were held about the value of this collaborative approach in the context of e-learning, e-facilitation, communities of practice and the creation of knowledge.

The educators, the map makers in this study, were shown examples of well-known kinds of CMs; 'concept maps' and 'mind maps'. It was emphasised that these were just two of many possible shapes and assured the map makers that any interpretation of the term 'mind map' and 'concept map' would be acceptable: there were no 'right answers'. At this time, as has been noted already, digital maps were mentioned particularly the opportunity to develop collaborative maps and multilayered maps, but I did not expect the educators to have the resources to produce digital maps. None of the educators could have produced a first digital concept map. However, about 15% of the second maps were presented digitally which indicates how quickly digital technologies can be taken up over a year. In this cohort, therefore, there were examples of multilayered digital concept maps and a collaborative map on paper that constitute the special features of multimodal concept maps that I have identified. I

have drawn attention to these features by the term, Multidimensional Concept Map (MDCM).

The data collection procedures followed the outline in the research design in Chapter Two with one exception. The educators asked to negotiate the heading for the MDCM used at the beginning and the end of the programme which was, 'The impact of computers on my personal and professional life'. However, that time the UK government consultation process that was underway informed the groups' request to focus on 'e-learning' rather than 'computers'. The new heading was:

> The impact of computers on my personal and professional life with particular relevance to e-learning.

This heading was a more specific interpretation of the heading by the ImpaCT2 team for children's CMs which was 'Computers in my World' (Harrison, Comber et al., 2002; Mavers, Somekh et al., 2002; Mavers, 2004b; Mavers, 2007). The cohort's engagement with the title might have been motivated because they were invited to present their practice-based evidence to the Head of the Department for Education and Skills (DfES) Schools ICT division at the end of the PBR programme. The evidence was published in the public consultation on the UK E-learning Strategy (DfES, 2003).

As in the ImpaCT2 project, the participants had twenty minutes to work on their maps. Although the educators were not expected to follow any particular mapping model some were reluctant to engage in this exercise, as they were doubtful about their ability to draw. One educator, called Neil, injected an element of enthusiasm for CMs into the proceedings because he had already published his use of maps as a practice-based researcher. He explained his own practice in using CMs in his classroom as a vehicle for assessing the children's learning. His intervention was a significant catalyst in motivating the group to tackle the map. His own two CMs will be discussed later.

Only sixteen educators were present when the second maps were drawn. The sixteen pairs of maps in this sample were backed up by thirty-minute transcripts from the four group discussions at the end of the course.

In addition to the maps collected as data, there were discussions between the participants; these were transcribed, and at some points in this chapter I will make reference to this transcript where it provides supporting or confirming or additional material for the analysis of the main data set.

The researcher's role

The programme design was intended to interrupt the traditional divisions between the roles of teachers, tutors and researchers. My role as a researcher was thus complex: as an active member researcher I had designed the programme, trained the tutors and became a tutor myself for the duration of the course. I also engaged with the teachers in reflecting on the findings of this practice-based research project.

However, because some course members were also members of MirandaNet, my role could be defined as a complete member researcher, characterised by my total full-time involvement with them within and beyond the research period. In addition, by choosing to research this study for my doctorate I also took on some of the tasks of the conventional objective researcher, identified by Adler and Adler (1987) as a peripheral member researcher. The subject of researcher roles is developed in more detail in the comparisons between the three groups in Chapter Seven.

In the following, the data are analysed with the aim of seeking the value of the three types of analysis for the researcher, the tutors and the map makers. These three types of analysis are: by numbers of links and nodes; by kinds of words; by multimodal sign.

Analysis by number of links and nodes

To provide an overall picture in this section the numerical scores developed on the ImpaCT2 formula were recorded in Figure 5.2.a. As explained in Chapter Four where the table is designed on the same principles, first column, after the name and the map makers' number, shows the map makers' own estimate of their computer confidence that they offered in the questionnaire. They were asked to rate themselves from 1-3 – 1 being top competence. The next four columns show the numbers of links and nodes in the two maps. The score as a ratio for the two maps is in the pink column, six and seven.

			LINKS		NODES		SCORE		SPHERE OF THINKING		SPHERE OF THINKING		ZONES OF USE		ACTIVITY SCORE	
	ID	NAME	FIRST MAP	SECOND MAP	FIRST MAP	SECOND MAP	FIRST MAP	SECOND MAP	FIRST MAP	SECOND MAP	FIRST MAP	SECOND MAP	FIRST MAP	SECOND MAP	FIRST MAP	SECOND MAP
1	ID001	Tim	20	36	13	12	1.54	3.00	0	5	0	1	2	2	2	8
2	ID002	Bernice	31	56	24	42	1.29	1.33	7	11	3	0	2	4	12	15
3	ID003	Dennis	19	18	20	22	0.95	0.82	3	8	2	1	0	2	5	11
4	ID004	David	27	52	38	67	0.71	0.78	5	9	0	0	3	2	8	11
5	ID005	Larry	17	7	22	20	0.77	0.35	6	4	1	0	0	1	7	5
6	ID006	Kevin	6	18	14	16	0.43	1.13	3	10	3	0	2	5	8	15
7	ID007	Pippa	57	36	44	40	1.30	0.90	9	16	0	0	3	3	12	19
8	ID008	Alex	18	9	23	15	0.78	0.60	5	9	0	1	2	3	7	13
9	ID009	Mark	64	39	46	39	1.39	1.00	10	15	0	0	3	5	13	20
10	ID010	Richard	26	51	26	46	1.00	1.11	3	6	3	2	2	1	8	9
11	ID011	Mel	5	12	6	10	0.83	1.20	3	4	2	1	2	1	7	6
12	ID012	Paul	28	22	26	21	1.08	1.05	6	12	2	4	1	5	9	21
13	ID013	Martin	24	24	24	32	1.00	0.75	10	4	2	4	5	3	17	11
14	ID014	Neil	69	29	59	26	1.17	1.12	12	8	2	0	5	4	19	12
15	ID015	Malcolm	37	34	39	24	0.95	1.42	7	14	1	4	3	4	11	22
16	ID016	Kate	11	29	12	27	0.92	1.07	7	14	2	2	3	2	12	18
		AVERAGE	28.69	29.50	27.25	28.69	1.01	1.10	6.00	9.31	1.44	1.25	2.38	2.94	9.81	13.50

Figure 5.1.a.Tables showing PBR connectivity and activity scores

In the second half of the map the numbers represent the quantity of spheres of thinking and zones of use the map maker has presented. This number does not represent however, the quality of the concepts. The final two columns show the numbers of concepts the map maker has accumulated over time which I have called an activity score. This was my attempt to see if this other cumulative approach was relevant.

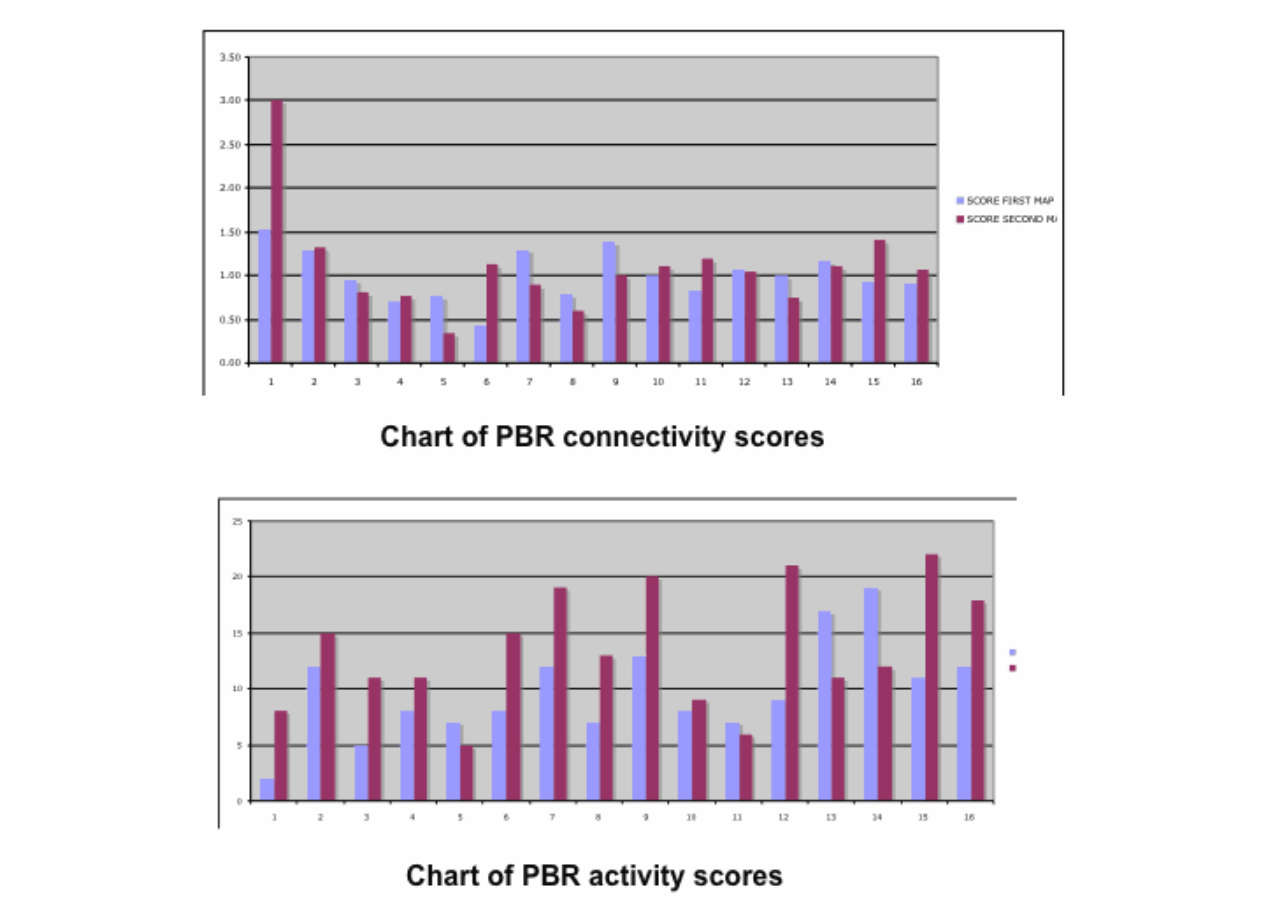


Figure 5.2.b. Charts showing PBR connectivity and activity scores

(Key: the blue bars show the first map and the red bar shows the score for the second map).

The table shows that the average gain in connectivity rises from 1.01 to 1.10. However, when these scores were matched with the analysis by sign for individuals the results differed. The activity score developed in the computer skills training pilot in Chapter One showed the accumulation of concepts across two maps simply by adding the first map score to the second score. These scores, ranging from an average of 9.81 to 13.50, were a little more consistent with the observations about individual learning from the semiotic analysis. The two charts, Figure 4.2.b. and c. seem to suggest a general pattern of increase for the PBR group over the year. The PBR activity scores (Figure 4.2.c.) shows some significant increases in the second map, for about one third of the teachers.

Analysis by kinds of words

The words used by the participants were extracted from the pairs of MDCMs and placed under score sheet headings from ImpaCT2 that indicate the teachers' awareness of the applications of computers and networks. A summary of the results is offered in Figure 5.3. In the group content analysis of the MDCM at the beginning and end of the course, the scores are represented for each subject under the headings Map One and Map Two.

The seven headings listed on the left are taken from the ImpaCT2 study. The headings indicate the kind of computer applications that the children had prioritised: computer systems and networks; information input; communication devices; publishing and correspondence; games; sound software as well as learning strategies. These provided a starting point for the analysis of the teachers' MDCMs because the heading of their map was so similar.

This overview of the words the teachers used to label the nodes indicates that their focus is measurably more sophisticated by the time they mapped their understanding of the impact of computers in their personal and professional lives for the second time. Over a year the most significant gain is in 'computer systems and networks': from 12 -

29 references. The increase of 17 words also illustrates an increased sophistication in the references to digital technologies: These changes are illustrated in the following Figure 5.3.

These references seem to be the result of growing awareness of the role of computers in e-learning during the year. For example, interactive whiteboards were not mentioned in the first map, but were in the second map. References to educational games software also double. This may be due to the PBR projects the participants shared with each other.

		Word counts	Differences
Computer systems and networks	Map One	12	
	Map Two	29	plus 17
information systems	Map One	31	
	Map Two	32	plus 1
Communications systems	Map One	30	
	Map Two	32	plus 2
Publishing and correspondance	Map One	13	
	Map Two	12	minus 1
Games	Map One	4	
	Map Two	8	plus 4
Sound	Map One	2	
	Map Two	8	plus 6
Learning	Map One	9	
	Map Two	17	plus 8

Figure 5.3. Changes in word count

At first inspection, the incidents of increased knowledge in the other fields look minimal from the numerical point of view. For example, the fourth row, publishing and correspondence, shows a reduction in numbers of references but the second map references are more sophisticated. They change from general comment on word processing in the first map to a more specific mention of school newspapers and the collaborative course e-journal as new means of publication. This awareness of the publishing potential emerged during the year.

In this analysis of content, many of the references in the second map are due as much to home use as to training in school or the CPD programme. A closer examination of the detail illustrates a new emphasis on interactive network tools like iChat, text and the Messenger software that are replacing less specific references to online learning in general. This suggests the educators were becoming more aware of interactive communication opportunities. Digital technologies, such as mobile phones that were also used in the home show significant increases, and references to the use of 'music' in a digital context, such as an MP3 player, quadruple. These scores suggest that the multimodal and interactive affordances of computers were increasingly appreciated as the year progresses. There is also a tentative indication in the maps that this is not just because of the presence of digital equipment at home, but also because of the influence of their own children who were frequently depicted in the maps as a source of educators' information.

Whereas the most outstanding numerical gain is in the factual area of computer and network applications, the second most outstanding gain over the year is found in the references to learning with computers. The scores nearly double and the words in the second map indicate a growing understanding of the subject and the potential impact on professional learning. The participants were more aware of their learning. They discussed long-term approaches to CPD overall more than they did in the first map. Some examples that relate to collaboration are: facilitating learning, e-learning and

self-development. In the second MDCMs the teachers also focused more on their own learning needs and achievements rather than on the learning needs of the pupils. This highlights a greater awareness of their own needs as teachers and their achievements as a CoP.

Analysis of MD signs

Two pairs of maps are selected to illustrate how different aspects of analysis in the semiotic framework shown in Chapter three, Figure 3.3 can be used to analyse the educators' understanding of digital technologies. These concept maps were chosen because they achieved high scores and they show how 'high scores' can be misleading: they are not directly or at all indicators of higher levels of understanding, etc. The semiotic framework provides the means to describe firstly what these two teachers' understanding at the start of the programme was and, secondly, whether their view of e-learning altered by the end of the programme. The Daly and Pachler indicators are relevant in investigating explicit understanding of the learning model that underpins the development of teachers as learners as a CoP.

The findings from the two map makers' concept maps, Tim and Neil, are linked with the biographical details provided in the participants' initial questionnaire to help the researcher focus on each individual's professional context.

Tim – the accomplished e-facilitator

Tim's CMs are selected because his connectivity scores are significantly higher than any of the other participants. Purists might argue with the scoring of the first map, as not a conventional CM (Figure 5.4.a.and b.). As mentioned, the participants had been assured that all forms of maps were acceptable. The maps do show significant conceptual sense, from the scoring point of view.

At twenty-eight, Tim was six years younger than the thirty four year old who was the next youngest participant. Yet, the questionnaire data indicated that Tim was an experienced professional e-learner in this group at the UK National College for School Leadership. He was moderating discussion between head teachers using a sophisticated learning platform called Talking Heads. He joined the course in order to work collaboratively with other e-facilitators to improve his technique.

In terms of composition an extract from the transcript of one of the group discussions offers the peripheral member researcher insights into Tim's thinking as he undertook the actual drawing of the CMs:

> I did one train of thought and then I kind of abandoned that because it got a bit of cluttered and I started another one …
>
> … then I looked at the concepts more in the second map.

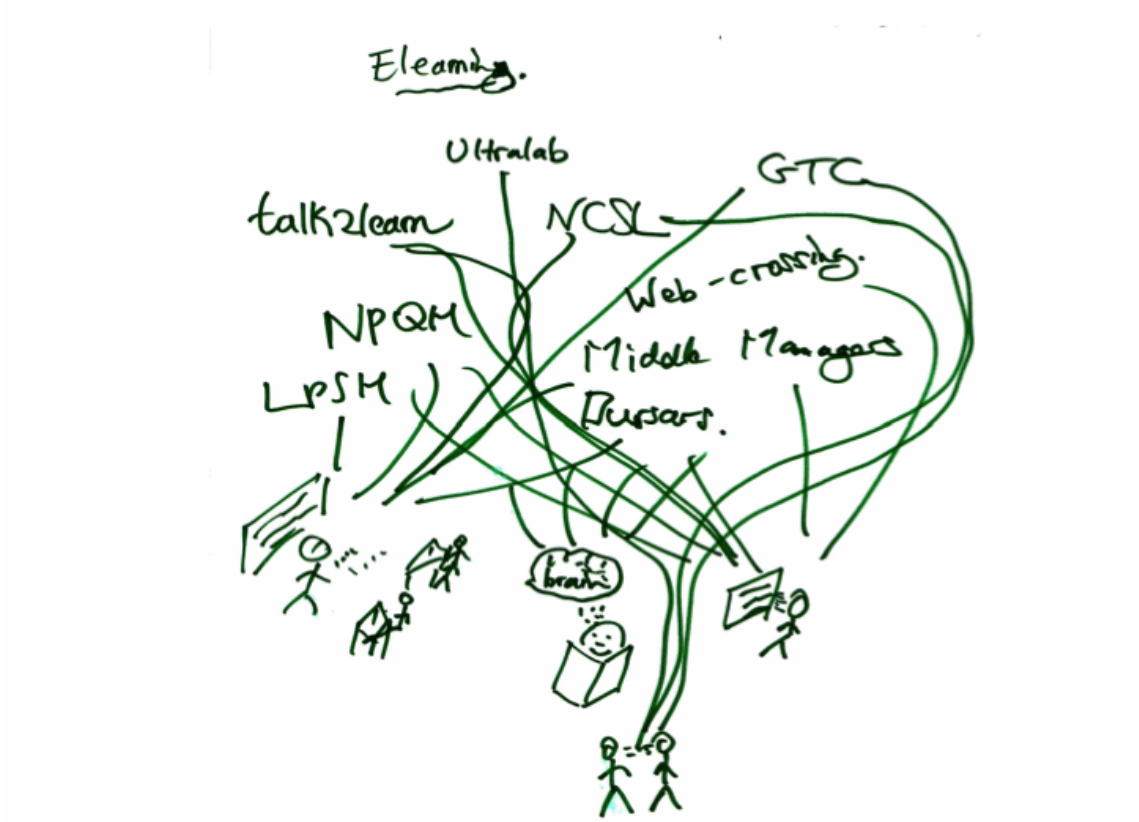


Figure 5.4.a Tim's first concept map

Tim's first map (Figure 5.4.a) already indicates a significant understanding, both in the labels and the connecting links, of how e-learning works. His professional knowledge was expressed 'autobiographically' in his references to all the organisations that were linked online into the National College for School Leadership (NCSL). The phrase 'web-crossing' seems to refer to the activity going on between key groups of professionals that are referred to by abbreviations such as GTC (standing for 'General Teaching Council'). Tim's technical knowledge is exemplified by the sophisticated package he names (LPSM means Linux Persistent Memory, a storage method that is open source).

The composition of the MDCM elements highlights collaboration between himself and other learners and tutors in the online CoPs to which he already belonged. His experience already spanned more than one community. The composition does not reflect the division in the heading between personal and professional uses of e-learning in the first map giving the impression that e-learning was all pervasive in his life. All the elements in this picture of cognition, technical and human, were given the same weighting in size. It is possible that personal and professional differences may have seemed irrelevant to Tim. This impression is reinforced by his depiction of his e-communities as a unifying concept overarching the learning platform.

The curving, dynamic connectors represent a nest of cables that also served as a metaphor for connections between the participants in the network and between their institutions. The integration of digital power and human thinking is shown as an electronic brain linked to his own brain. Learning inputs were derived from human agents using interactive whiteboards and traditional books, a mode he did not reject.

In terms of composition, Tim's second map (Figure 5.4.b.) was again an individualistic interpretation of a MDCM that is even less dependent on words than the first map. This time, a central line provides a clear division between the personal and the professional. In the professional top-half he repeated the e-communities with which he worked, and duplicated some technical terms from his first map. The new personal

section is liberal with graphics particularly light bulbs that indicated the creation of ideas. The light bulbs indicated his knowledge about computer icons in general use. The curving, iterative connecting links provided a strong sense of a collaborative e-community. He promoted personal research as well giving a strong visual focus to the e-learning benefits of access to information sources, time saving and convenience.

A second passage from the transcript confirmed Tim's commitment to the processes of human communication within the network in addition to his sophisticated understanding of the technicalities of e-facilitation:

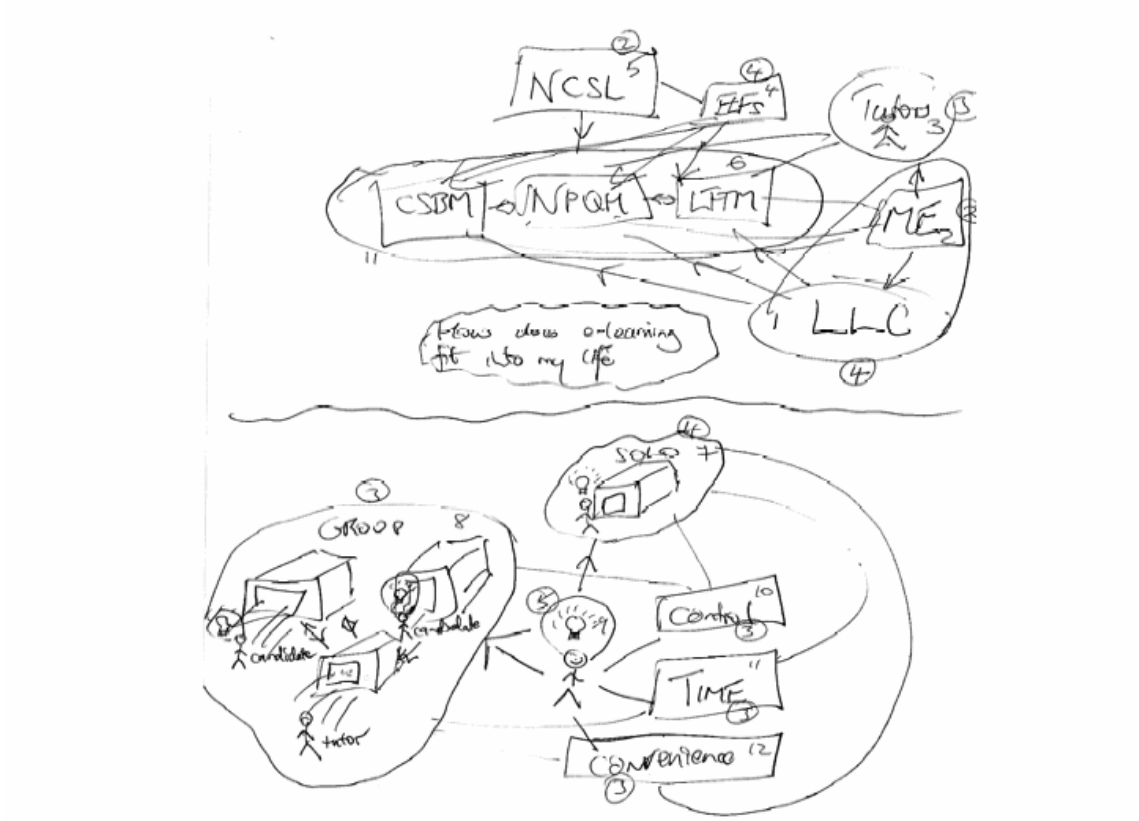


Figure 5.4.b. Tim's second concept map

> Basically what e-learning is all about is getting people to learn just using a different context and with the environments that we have… there's community forums, lifethink.com, where group discussion with tutors er… imparting knowledge and then allowing them to reflect on their learning and then there's solo learning environments where they find things out for themselves… it's at their own convenience, in their own time and they have control of what they do.

Neil – the expert map maker

Neil was the primary teacher who had been using CMs for some years in his own practice-based research project for the programme, and who was keen to share his four-year experience of CMs with his colleagues at the beginning of the CPD programme. What he learnt over the year becomes clear in the design of his two maps and the transcripts of his discussions about the maps with the group. An example of his sophistication in concept mapping theory, in the first map is shown because he labelled many of the links with adverbs like 'by' and 'through' indicating that he was familiar with Novak's methods of designing concept maps to illustrate learning in a pre-agreed way. This clear understanding of design was based on the projects he had developed for practice-based publications. Sharing his expertise in the interviews, proved revealing for my analyses.

His design decisions, for example, are well considered:

> Talking about mess… no drawings, there are absolutely no drawings on this because I've been doing mapping for a very long time and teaching the children how to map so it becomes almost second nature…

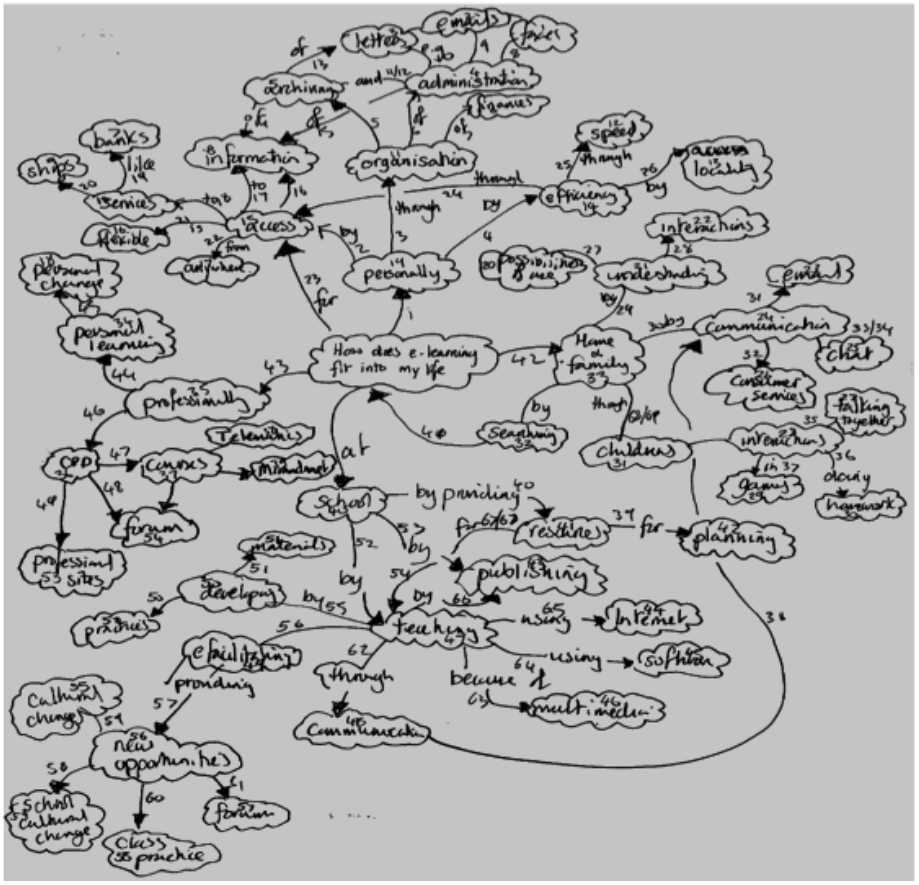


Figure 5.5.a. Neil's first concept map

This extract indicates that he had developed this particular approach to building a map with this class in which he followed clear rules that could not be known without the transcript as explanation.

Since he knew so much about the uses of computers, as well as of mapping, it is, perhaps, not surprising that Neil drew the most links and nodes in the time available. His first CM (Figure 5.5.a.) is a most sophisticated effort in combining words with other semiotic features.

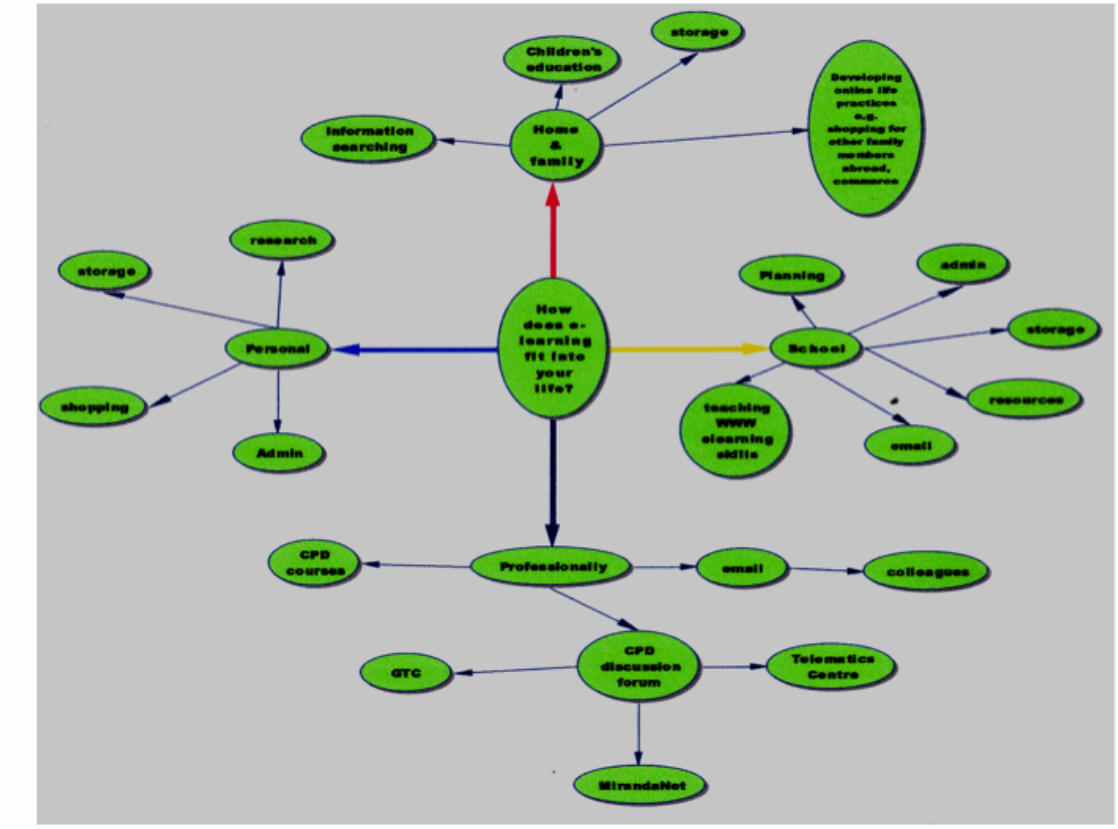


Figure 5.5.b. Neil's second map

Conceptually, Neil used a full range of terms to describe his personal and professional understanding of computing. To the 'personal' and the 'professional' concepts he also added 'home' and 'family' with an emphasis on his collaboration with his own children. Professionally he made a distinction between CPD activities like collaborating online with colleagues and the different ways in which he used the computer in school including some of the applications. He was also aware of professional forums for cultural exchange suggesting a keenness to engage in collaboration beyond his local horizon both in citizenship and CPD spheres. Neil's enthusiasm for e-learning, the affectual content, is underlined by the 'new opportunities' node he introduced and his references to the potential for personal learning and personal change.

This first CM gives a visual impression of fluency in composition. The very many links and nodes indicate a wide range of knowledge about computer applications. The

arrows with their emphatic heads create a sense of clarity and direction and activity. The wavy encircling of the nodes suggests an implied opposition to straight and rectangular borders – soft boundaries versus hard boundaries. However, the map requires real concentration to read. Neil has not made the relationship of each concept clear by positioning and size of nodes or links. The composition does not distinguish by levels to denote higher order concepts and subordinate ideas. This may be an accurate representation of his sense of the contingency and fluidity of these relations. Technicalities and abstractions are given equal semiotic weight.

Neil was the only educator in the cohort who offered a digitally produced map at the end of the CPD programme since by then he had the necessary software on his laptop (Figure 5.5..b.). This map can then be called a multidimensional map (MDCM). An immediate impression might be that this second map has far less 'content'. Here, as before, a simple counting of links may be simplistic. However, in terms of composition, it is easier to see which the main concepts are and which the subsidiaries are by position and size. What is clear is that the organizational, conceptual and hence compositional principles have changed profoundly from the first map.

In the final presentation to his peers, Neil explained that his negotiated practice-based research project involved experimenting with CMs and MDCMs for language analysis with his pupils. For this he had used Bloom's taxonomy of 'higher order thinking' to build and analyse the maps with his pupils (Bloom 1956). It was this approach that had led him to develop his second map in a completely different way from his first map.

These views about higher-level thinking were well expressed in the transcript in which he gave his own verdict on these maps. He told his peers that he judged his first map to be overcomplicated, difficult to read and inadequate in categorising the concepts to prove higher order thinking. As a result, he explained that in his second map, he had consciously drawn on Bloom's theory in using the affordances of digital mapping to refine and categorise his ideas to illustrate higher order thinking.

The layers underneath the top surface that he had created could not be seen on the paper version that he had handed into the researcher. However, on his laptop screen he demonstrated how clicking on the nodes of first order concepts revealed the layers of detail below.

This dimensionality had not been recognised in the initial analysis. In particular, no allowance had been made by me in the scoring for layers below the top screen. By attending Neil's presentation the value of the digital map was revealed to me.

The collaborative map

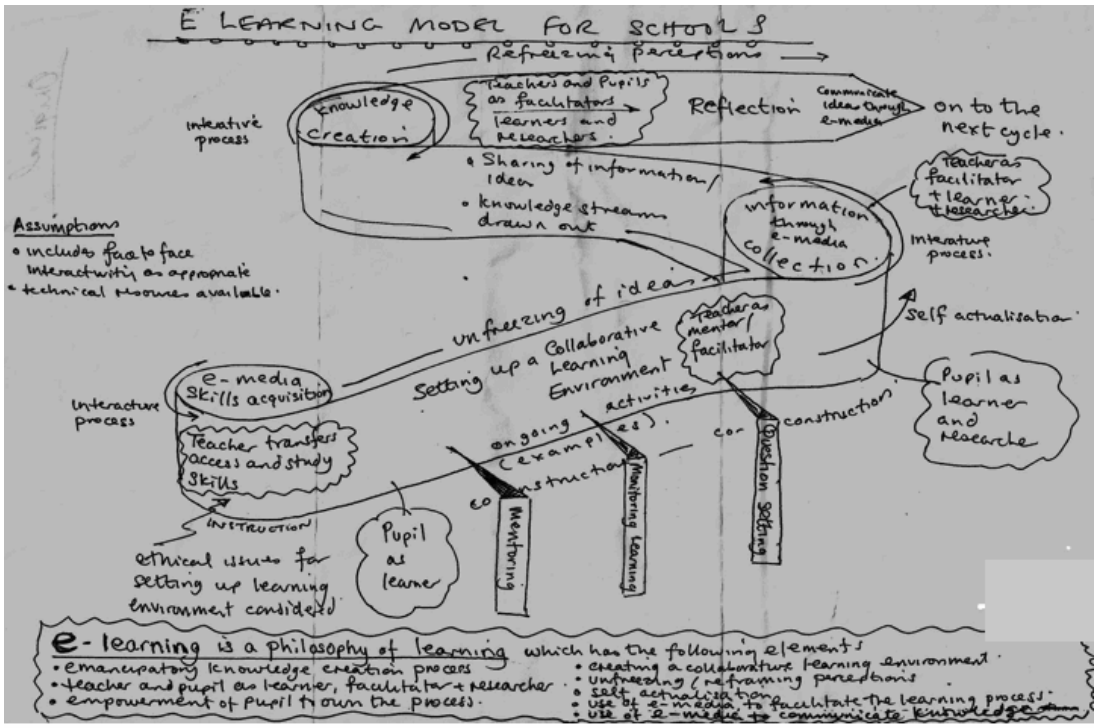


Figure 5.6. Collaborative map created by Collaborative Member Researchers.

Led by Malcolm, who runs the staff ICT CPD at his school, a small group of teachers developed a collaborative map (Figure 4.7.), during a coffee break about their new e-

learning theory. This activity had been inspired by the evidence from the groups' presentations of their practice-based projects. The attendance of the Head of the UK DfES school division, who was expecting to hear evidence from the teachers about e-learning for the consultation document (DfES 2003) provided some motivation.

This complex diagram extends the notion of how a MDCM should be constructed, although it is clearly inspired by mapping techniques. The aim is to show how e-learning ebbs and flows from the learning of skills to the creation of knowledge. The words on the map indicate these educators' grasp of the role of e-learning in social interaction and collaborative learning envisaged between the teacher and the learner. The detailed diagram attempts to indicate this dynamic iterative movement through arrows and swirling lines and shapes. Fixed points show how the teacher intervenes by mentoring. The key driver is the emancipation and empowerment of the independent learner contributing to knowledge creation (Preston and Cuthell, 2005).

This map, designed by the educators, became key element in the MirandaNet CoP's submission to the DfES e-learning consultation.

Using the transcript of group discussions

Finally, here is an example of some excerpts from the transcripts of discussions among the educators. Transcripts were made, of the conversations of sixteen teachers talking in groups of four for half- an-hour (Figure 5.4.). Exemplar comments from the transcripts have been organised under the five headings provided by Daly and Pachler (2007): knowledge construction, community, meta-learning, autobiography and cognition. These extracted comments provide evidence that the strategies developed in the CPD programme design are being absorbed and articulated even though the scale is small. In these exchanges it is possible to trace elements of knowledge building in a social and collaborative context that are based on group analysis of the meaning of the MDCMs. These learning themes are developed in more detail in the semiotic analysis of the individual maps in the next section.

Discussion

In this discussion, the value of the different methodologies are compared and contrasted in order to help researchers in deciding how the MDCMs can be useful in identifying understanding indifferent contexts of learning. I also reflect on the evidence of learning in a CoP and on my own role as a researcher in handling these different analytical methods.

Three analytical approaches

Number of links and nodes

The scores provided some insights into the cohort's understanding as a group and some patterns about learning emerged. However, this clarity often disappeared when individual positions were explored across the pair of maps. This is a problem identified in chapters 2 and 3. For example, I was not able to judge the quality of the concepts that were being expressed by looking at the connectivity scores alone.

Kinds of words

The 'content' analysis using the adapted ImpaCT2 score sheets provided some secure judgments about higher order or lower level thinking about computers in schools and beyond. Analysis of the patterns within the cohort suggested that knowledge about computer terminology – and by implication, of concepts - had in some cases doubled and in one case quadrupled. There was also strong evidence that more sophisticated computer concepts were being pointed to by the MAR and PBR groups in the second maps.

The Daly and Pachler analysis tool provides manifest and latent evidence of how the learning concepts of community, knowledge construction, cognition and meta-learning were being evidenced by the cohort. In terms of narrative, the role of autobiography in collaborative learning was also highlighted.

The analytical headings	Examples of comments made by the members of the PBR cohort in comparing their MDCM pairs
Knowledge construction	Because as a child you then throw things out the window you don't care, so you can draw anything you like, I mean I wouldn't draw smiles…but then it makes you think about what you've drawn ..you can say well that's good, so there has been a good aspect to that because it frees your mind a bit,…
Community	Here's little picture of me looking at other people telling me things cos it allows me to listen to other people and learn from other people, which obviously didn't get a chance before because we've got all that information highway, dig things up on the internet that you never thought were there, broadens everything you know,
Metalearning	I thought it was all about, the teachers I was working with online. Now I've realised that actually working through the process my own process has deepened…it seems to me a lot of talk in education circles out there is about taking learners from where they are to where you want them to be and often doesn't reflect on the learners own position and make connections between those two,
Autobiography	. Now I'm very lucky, I spend large box of time at my desk or I go out to schools and I work with schools and teachers, so the separation is easy for me, if I was back working in school again it would be much more fragmented and difficult and I would find myself in your position, at 10 pm at night, thinking well I can't be bothered reading that and switching off and watching newsnight or something for a bit of light relief.
Cognition	yeah things have moved on for me its developed but I think the links have become much more complex.

Figure 5.7. Exemplar transcript comments categorised under the Daly and Pachler indicators (2007)

This method provided deeper information about the PBR learning processes because the analysis was oriented towards learning by individuals and groups rather than on facts about computers. With this research tool it was possible to look at the transcripts of the interviews thus providing additional evidence of the cohort's notions of the impact of computers on learning.

Complex MD Signs

The discussion here is confined to MDCMs that highlight particular issues for the Research Question: the pairs of maps from Tim and Neil, and the group map just discussed. The commentaries are intended to shows how the maps can provide a significant opportunity for a researcher to explore teachers' understandings from a different perspective than 'traditional methods' discussed in Chapter two. It highlights that some of the initial judgments can be corrected in an interview with a map maker, or as in this case via access to the transcript of a group discussion.

Tim's maps

Tim's maps offer several learning points. As mentioned, his high connectivity scores might be explained because he was the most experienced e-learner in this group. There are two factors in Tim's professional background that a researcher might wish to consider in view of his fluency in drawing: his youth and his experience as an e-facilitator.

The compositional factors in his two maps give the impression of a confident learner, comfortable with digital technologies. The use of a conventional icon, the light bulb, to represent thinking, suggests that he expected others to understand these elements of communication. This is also underpinned by his use of technical terms. All provide insight into his understanding prior to the CPD.

Tim's representations and interactions indicate an outstandingly clear view of the role of the community in e-learning, commenting on the activities of other players in the

networked community. The frequency with which he depicted people reinforces his concept of the network as a dynamic tool for human engagement in a collaborative community.

The way in which Tim combined words, pictures and lines with drawings of stick people is an effective graphic means of indicating the priority he gave to the human being within the electronic network. In the second map the connections between all the learners represented by the light bulbs, suggest knowledge construction as well as community connections. The light bulbs might suggest cognition and meta-learning processes.

The notion of community appears in Tim's discussion with his peers in the transcript. All the Daly and Pachler indicators are covered, either manifestly or by inference. All the indicators together give confidence in a high level of understanding and of practice in collaborative learning before the course began. The second map indicates that sense of community improved further by the end of the course.

Neil's maps

Neil's first map has the highest connectivity score in the cohort whereas his second map is in the average zone. On first impression a researcher might conclude that Neil knew less at the end of the course than he did at the beginning:, because there are fewer connections in his second map. His complex first map, drawn in twenty minutes, seems an outstanding example of how a CM should look, even in the absence of pictures. The complexity is remarkable.

Until I had read the transcript of Neil's conversation with his group, I had tended to rate hand drawn CMs with pictures more highly than those without. Neil's comment made it clear that whether to include pictures or not was a design decision that should be respected by the analyst. He explained that in his own teaching he used the

Novakian method, meaning that the method of map construction is agreed with the class before they begin.

The second digitally produced MDCM did not seem to me to be as aesthetically pleasing as a hand-drawn map. This judgment too was overturned by Neil's comments in the transcript. I began to question how much latitude an analyst should have in allowing ideas of aesthetics to count in judging a map. Researchers should also consider whether their observations might be based on their own lack of understanding of the map makers' motivations.

Neil's judgments about the higher level thinking in his maps were particularly illuminating. As mentioned he had consciously used the affordances of digital mapping to refine and categorise his ideas to illustrate higher order thinking by using layers. This new level of map structure should be specifically represented in the overall semiotic account.
His use of layering in the MDCM was a key factor in my understanding of the differences between a concept map hand-drawn on paper and a digital map that could use multi-layering to express levels of thinking in a more sophisticated way. It was also clear from Neil's work in the classroom that he was able to capitalise on the value of collaborative mapping in learning.

Comparisons of the three analytical approaches

Scoring MDCMs

This second PBR study confirms the problems found in the scoring approach in the computer skills training analysis. A simple-minded application of the method for establishing the connectivity scores does not provide a useful means of 'getting at' understanding. In the PBR case, the MDCM scoring techniques produced limited insights and misleading understandings. The high scores relate to the complexity of the composition, and not to the quality of understanding. A more subtle and carefully judged mix of methods is required.

Analysis of kinds of words

Some limitations also emerge in the ImpaCT2 score sheets when the words as one semiotic unit are analysed. These were grouped around the functions of computer hardware and software. Only one category concerned 'learning'. The Daly and Pachler indicators (2007) enriched the analysis by concentrating on learning processes rather than the content of the MDCMs.

The addition of the transcripts as a 'back-up data-set' significantly increased understanding of the map makers' understandings and indicated the value of discussion about the MDCMs by the map makers themselves; even though the time constraints of transcribing audio and video tape are very significant. Videoing group work is now becoming more accessible with an automatic transcript is just emerging as an alternative but the costs are very high. Nevertheless, video offers the subtle play on meaning of gaze, inflection, facial expression, tone of voice and other semiotic modes in collaboration that are very difficult to capture only in sound. However, costs and difficulties of transcription multiply here compared to the transcription of sound alone. There is a danger that reasons of cost might lead to decisions to choose a mechanistic scoring method, sacrificing essential insights.

Analysis as MD signs

Both sets of maps show how unique and complex the maps are and how complex and subtle each interpretation is. The evidence here suggests that research needs to consider the effects of means of producing maps – for example hand-drawn versus maps created digitally in any study that is undertaken. Each medium has benefits and limitations. In this study map makers were given a free choice. This study draws attention to such factors, for instance if lack of experience in using the software package is affecting the capacity to create the meanings wished for. There are also creative limitations in software: arrows cannot be curved thus losing the dynamic characteristics of a hand-drawn MDCM. Another limitation is the time required to

learn all the features. For example, Neil was not yet ready to employ the affordances of colour provided by the software developers. Only the default colour, green, had been utilised for the nodes although he has experimented with different coloured arrows. Another issue for the researcher is the collection of data, whether in digital form or in any other mode. If the map is not viewed on a computer, layers and other multimodal features like sound and animation in the nodes may be missed; but digitally produced maps do not show the evidence of changes as in the case of hand-drawn maps.

Group understanding in a CoP

The self-regulated group activity that produced the collaborative map on e-learning theory provided an unexpected item of evidence. This was evidence that had not been planned for in the original research design; though there was no question that I should use it. As a researcher I was able to observe the way in which this group of educators became a self-regulated CoP learning to develop their own agenda. As I was present throughout the final weekend of the course, I was able to gauge the impact on the educators of seeing all the group's individual presentations of their projects. I had also arranged for them to be invited to present their evidence in some form for the government e-learning strategy consultation. In these circumstances I was able to recognise the value of the map that the teachers developed in their coffee break.

This map was a turning point in my respect for the contribution of educators as researchers. What was striking was that by developing ideas about theory in this MDCM, the group had, themselves, created new knowledge about e-learning theory rather than reproducing what had been taught. This collaborative community knowledge creation provided a new slant on what could be achieved when the maps were used as a creative tool in meaning making.

This submission fulfilled Sachs's aim to encourage teachers to become activist professionals by providing evidence that impact on policy (2003). Another outcome

was that Malcolm, who led this creative group of teachers, found the confidence from leading this collaborative theory creation activity to apply to do his doctorate.

Reflecting on my own participation in a CoP

My engagement in this research was not from the seeming objective perspective of the traditional researcher (as in Adler and Adler's distinctions between types of researcher (1987), outlined in Chapter two). Acknowledging my complex role as researcher meant that I could reflect my own understanding and how it might impinge on the study. Involving the advisers as co-researchers in their own right had the effect of creating an interest in the uses of MDCMs in their own professional reflection. Twelve of the mappers were sufficiently inspired by the potential impact of e-learning in the classroom to set up a two-year working group on the subject. This yielded a paper on e-learning published in the peer reviewed academic e-journal Reflecting Education (Howell Richardson and Preston, 2005). This was important in establishing a tradition of practice-based researchers having influence on theory and practice. A second volume of Reflecting Education (Howell Richardson and Preston, 2007) on MDCMs themselves reflected their growing confidence as writers. Other members of the group who wanted to publish practice-based practitioner papers for other teachers produced a volume of the MirandaNet e-journal, called Mapping Inspiration (Preston and Cuthell, 2008). The working groups were funded by Inspiration, the mapping software developers, who support MirandaNet research into the uses of concept mapping in learning. This support is not dependent on the use of their product (Preston, Cuthell et al., 2007).

Conclusions

What has emerged from this second study is the potential for the use of CMs and MDCMs from the researcher perspective. In the evaluation of the computer skills course in Chapter Two, the peripheral member researcher had no access to the views of the map makers. In that respect this second study adds to this knowledge by investigating the value of the scoring, the content analysis and the semiotic approach

from the point of view of researchers who have different relationships with the map makers. In addition, the portfolio of research tools in this second study includes transcripts of discussion between the map makers about their perspective on the maps. The insights gained from the transcripts suggest that judgments made by a researcher who has no access to the map makers thinking may well be insecure.

Not only did the active and complete member researchers in this second study have a closer connection to the map makers, but the researcher can see how the map makers themselves learned with each other and from each other. Some insight is provided by the transcripts of their conversations. The collaborative map designed spontaneously by the group, and not planned in the original design, is a real and strong clue to the power of collaborative learning.

In one sense the map makers also become co-researchers in their own right. This notion leads onto another area of learning associated with a CoP that is difficult to quantify. While they rightly rejected aspects of the scoring system, making judgments across the MDCMs verbally was successful in promoting spontaneous collaborative thinking about their understanding of digital technologies and their progress over the year in the CPD programme. This kind of exchange that acknowledges the nuances within the CoP, cannot be understood by outsiders and is difficult to quantify formally. In this case, it leads to further collaborative construction of knowledge that emerged spontaneously from a collaborative increase in understanding.

The map makers' demonstration of their 'ownership' of their own learning is new, in this second PBR study: both through the collaborative MDCM and by the publications the group produced after the course. My role become less and less central, whether as co-researcher and editor, as the members of the CoP learnt more about the use of the MDCMs in learning in classrooms. These autonomous actions by the map makers are several steps removed from the first situation where I, as a peripheral member researcher, tried to identify their understandings 'objectively' from an analysis of the

maps. The collaborative map is an example of these educators developing a scholar/practitioner approach to theory. Not only did they learn about theory, but also produced their own theory in a collaborative environment – an area where little is yet known about the processes involved. By collaborating on the production of new knowledge and theory, these educators proved their capacity to become 'activist professionals' in a CoP.

In the last chapter I return to this notion of the map makers as co-researchers, and to the importance of social interaction in professional learning and building a CoP. Some of the members of this Practice-Based Research (PBR) group came to South Africa (SA) to mentor educators in the introduction of digital technologies. The aim was to improve the employability of a provincial workforce in SA. In the next chapter I use the same research technique to explore the usefulness of the MDCMs that were created by these South African educators.

Chapter six: MDCMs in a South African Mentored Action Research CPD programme

Framing

My framing here is more extensive to those I have hitherto provided. This is due to the fact that the context was different to the programmes in which I had collected the data for the preceding two chapters. This was in post-apartheid South Africa; with very different cultures, very different histories to England; and very different politics. All these had their effects on the programme and, therefore, on the data. In my view, these differences did not invalidate the data: but they had effects, which I will describe.

In 2002, the international MirandaNet Fellowship was invited to begin a long-term partnership with one of the South African provinces on a ten-year plan to embed digital technologies throughout all its educational establishments. The CPD programme, designed with colleagues from the Free State provincial government team, aimed to achieve the South African government's goal to ensure that every South African learner would be 'e-competent' by 2013. 'E-schools' with good basic infrastructure and connectivity were being planned throughout the country. Leaders in policy and practice in schools, regions and provinces were expected to learn to use digital technologies effectively both within the curriculum and for administration. 'E-competent' learners would contribute to virtual learning environments, sharing knowledge. Standards would rise and human dignity would be celebrated. Evaluation of these processes was seen as a vital aspect of successful learning (DfE 2002).

The provincial government was motivated by a strong commercial incentive for introducing digital technologies into in this economically weak province, in order to improve the 'e-capacity' of the citizens. As there were few natural resources, the provincial policy makers had decided to concentrate their efforts on creating a

workforce with outstanding skills in ICT. By 2002 provincial teams of educators in e-learning policy and communications had been identified in the province, five regional resource centres were being set up and ICT projects were already underway in ninety schools out of twenty thousand. Many of these were remote farm schools with five to ten pupils, which created a variety of logistical challenges that digital technologies were expected to alleviate. For example, this new programme was designed to promote democratic pride and participation within the province. The aim was to embed digital technologies in the schools as a catalyst to improve the learning environment and to raise awareness of the power of computers in communications and literacy.

The provincial policy team had chosen the MirandaNet Fellowship after visiting ten potential partners in South Africa, the UK and America. By joining an international CoP of educators, the South Africans believed they would be able work with teams of colleagues to decide which national policies and practices were most appropriate in the South African situation. A second reason for choosing the MirandaNet Fellowship was because of their 'ecological' approach to embedding digital technologies in schools and their communities as a team (Preston, 2004; Davis, Preston and Sahin, 2009a and 2009b): This perspective promotes local CPD programme designs. Joint internal evaluation was considered to be particularly important, in order to develop local capacity, because computers were being installed for the first time in many of the education centres (Davis, 2008). Fellows believed that unless an ecological approach was taken, there would be a danger that European models for the use of computers in schools would not reflect the different needs and cultural approaches in South Africa.

The MirandaNet ecological approach was further underpinned by three theories connected with learning: action research to promote constructivist approaches to knowledge making; building a sustainable CoP to promote social interaction and interculturalism advocated by Pacher and Daly (2006). In their paper about online learning for teachers in intercultural groupings, they promoted interculturalism as a

key element in building professional identity as the impact takes effect of greater opportunities in CPD from cross-national, cross-cultural, cross-linguistic, cross-institutional discourse and learner interaction.

In addition, in this long-term programme practice-based research that includes a scholarly strand was to be included for some of the educators in a follow-up stage thus developing a deeply embedded capacity to design their own programmes.

The data described in this chapter relates to the peer evaluation of the first phase of this project after the design period, called 'Fast Gains, 2005-2006'. In this phase, the provincial parliament carefully selected twelve schools from the ninety schools that were being resourced as pioneers. They were representative of the full range of primary and secondary schools, city and township schools, rural and special needs establishments. Twelve SA teachers, one from each school, were chosen to be Action Researchers (ARs) mentored by the Fellows from England. There were also five Provincial ICT Educators in in the team. Between January and March 2003, provincial officials with guidance from the provincial government assembly had chosen the South African Action Researchers with great care. Because the SA Action Researchers were expected to mentor their SA colleagues, they were chosen above all for their leadership qualities and 'emotional intelligence' (Goleman, 1996). As a result, their computers skills were variable. However, the Province had planned a BCS computer skills course for each of them before the MirandaNet Mentors (MNMs) arrived in August (described in Chapter four).

The team of twelve mentors fielded by 'MirandaNet Mentors', were practising teachers or regional educators, who were experienced in promoting the management of change in education through action research and community building. These twelve Mentors were selected from more than twenty who had volunteered to mentor South African (SA) educators. Six of this group, who had participated in the MirandaNet Knowledge Creation programme described in Chapter five, had, therefore,

encountered theories about professional collaborative learning. The aim was to build an 'e-community of practice' called E-lapa across the province. This would link with the international MirandaNet 'e-community' for teachers and the 'e-community' for children, World Ecitizens. The twelve South African Mentored Action Researchers (MARs) in each of the twelve participating school negotiated classroom projects with the twelve MirandaNet Fellows. In this chapter the SA group is called the Mentored Action Research (MAR) cohort. The international MirandaNet team is called the MirandaNet mentors (MNMs).

The next stage was to be a transition to practice-based research when some of the growing SA cohort would begin to engage with theory. The employers of the mentors from England expected this experience to contribute to their professional development as well as impact on their schools. The MirandaNet mentors had a two-day course in London. Then the whole group of English and South Africans attended a two-day workshop run by the Fellows in the SA provincial capital. Afterwards the MirandaNet mentors travelled out to the schools with their SA colleagues. Here they worked for ten days with the South African Mentored Action Researchers and their school staff on ways of using the new digital systems both in the classroom and in administration. The purpose of their visit was to develop a project to be mounted on a website called 'The Sights and Sounds of our Province; Past, Present and Future'. Teachers and students were encouraged to use their new equipment to submit local and personal reflections on the unique elements of their culture. As the project developed the web-based knowledge base grew into an education portal available to the schools that already had broadband connections as well as to other schools that could reach the regional resource centres.

The South African organisers had promised that each school would be fully equipped with computer networks, interactive whiteboards, digital cameras, printers and scanners as well as broadband connections before the MirandaNet mentors arrived. Computer-skills training in all the necessary applications were also planned for all the

school staff. However, what had been promised by the public authorities was not always provided on the ground. One of the mentors reported his experience in one of the remote rural schools in a MirandaNet online debate:

> Most of the people on the ground (as opposed to those in the Education Office) were more than slightly dubious as to how the whole project might play out. In reality there had been no organised programme of skills training before my arrival as had been promised. There were also problems with the installation of necessary equipment. In my school, for example, the interactive whiteboard was temporarily installed on the Thursday of my week in the school – and I left on the Friday. So there was limited time to introduce it. At the end of each day it had to be packed up and taken to the secure strong room to prevent it from being stolen – along with the other computers that hadn't been properly installed. Only half of them had been networked, so they didn't have access to all of the software. And so on. The miracle was that enthusiasm remained high, and was sustained (Mirandalink 2007).

During the six months after the visit to South Africa, the MirandaNet mentors kept in touch with their South African peers online, by letter and on the telephone. The children from the twelve English schools and the twelve schools in South Africa also communicated in the Sights and Sounds project. The following Christmas, 2005, eleven SA MARs, ten other teachers and educators as well as twenty-nine children from the twelve schools visited their partner schools in the England to see how the staff used computers. Demonstrations, CPD workshops and school visits were set up to achieve a good exchange of ideas.

Christmas was the mid-point in the Fast Gains phase. Just before Christmas a new provincial project director was appointed who had significant tribal, political and strategic differences with the original director who had set up the project. For example he opposed the selection of twelve pilot schools on the grounds of equity. His view was that, either all two thousand schools in the province should be involved in the project pilot, or no schools should be. Scaling up to the inclusion of two thousand schools was not financially viable so the Fast Gains projects in the twelve schools were abandoned before the joint evaluation and the research into the Fast Gains

achievement phase was complete. This was disappointing as no lessons were learnt from the significant expenditure that had been agreed by the provincial government in 2004. In addition, the final bills for the Fast Gains project were not paid and the £12 million twelve-year rollout was never completed. As a result, the most important aspect of the knowledge transfer, the processes that lead to the joint research and evaluation report, were not completed.

Some MirandaNet Fellows have continued to mentor their partner schools and to learn more about how digital technologies can further learning in a different culture that is far less well resourced than Europe both in equipment and personnel. However, all formal connections have been abandoned. The impact on this research was that the CMs that are investigated here were collected mid-way in the project.

Methodology

Training in MDCM techniques began in the London workshop in February 2005 with the twelve English MAR mentors. This workshop also covered mentoring where Fellows discussed the importance of respecting the South African approach to digital technologies in order to help them find a way forward that took account of the eco-system of the school and the region. MDCMs were agreed as one of the jointly designed research and evaluation tools that also included interviews and questionnaires. In this project, MDCMs were expected to draw attention to multimodal means of making meaning as one way to even-out opportunities for making meaning between those who did and those who did not have English as a first language.

The project director covered the subject of MDCMs as an evaluation tool at a workshop in the provincial capital for the South African teacher researchers and the twelve English mentors who were going to supervise the mapping exercise in the twelve schools. The main principles were explained as part of the discussion about

South African ownership of the research results and the joint evaluation with MirandaNet.

In each of the twelve schools, the heading for the maps was the same as for the CST group:

> The impact of computers on my personal and professional life.

The conditions of production of the maps were kept constant as far as the contingencies already mentioned allowed. The teachers and students were shown examples of maps in the style of Novak and Buzan; however, they were encouraged to be as creative as possible, use pictures and to include any cultural references that seemed to be appropriate. Both teachers and children were given twenty minutes to work on their map. The children's maps are not discussed here.

The second maps were drawn when eleven of the South African MARs arrived in England, in January 2006, with colleagues and children from the twelve SA schools. They were all interested how the UK government investment in digital technologies looked in the classroom since the 1980s.

The MDCMs taken at this time were intended to provide an interim position about developments in the kinds of understanding in the period. However, they have been analysed in the section that follows, and treated as the final set of maps, as the premature ending of the Fast Gains period prevented maps from being collected then.

Analysis by number of links and nodes, by words and as complex multimodal signs

The MDCMs from the MAR cohort are analysed, as in the other two studies, using the three approaches of the number of links and nodes, the use of words and MD sign. Comparisons between these scores and the CST and the PBR scores are given in the final chapter.

Analysis by number of links and nodes

Connectivity

ID		COMPUTER CONFIDENCE	LINKS Map 1	LINKS Map 2	NODES Map 1	NODES Map 2	SCORE Map 1	SCORE Map 2
1	DANIE	4	25	26	17	17	1.47	1.53
2	INA	4	17	41	19	35	0.89	1.17
3	NICOLETTE	4	19	16	19	18	1.00	1.13
4	LERETO	3	10	13	13	16	0.00	0.94
5	ROCKIE	4	7	5	7	23	0.00	0.90
6	NOZI	4	4	9	22	13	1.75	0.83
7	DIKOLE	4	7	5	7	5	1.00	1.00
8	DRIENETTE	3	45	9	44	9	1.02	1.00
9	FANIE	4	0	15	0	17	0.00	0.88
10	KARIN	4	12	11	11	14	1.09	0.79
11	JOAN	1	18	23	18	20	1.00	1.15
	AVERAGE	3.55	14.91	15.73	16.09	17.00	0.82	1.02

Activity

ID		SOT*:USES Map 1	SOT*:USES Map 2	SOT*: ABSTRACTS Map 1	SOT*: ABSTRACTS Map 2	ZONES OF USE Map 1	ZONES OF USE Map 2	ACTIVITY Map 1	ACTIVITY Map 2
1	DANIE	8	7	0	3	3	2	11	12
2	INA	8	9	0	1	3	3	11	13
3	NICOLETTE	8	10	0	0	2	3	10	13
4	LERETO	9	10	0	2	2	3	11	15
5	ROCKIE	6	10	0	1	2	2	8	13
6	NOZI	7	7	0	2	3	3	10	12
7	DIKOLE	4	5	2	2	1	2	7	9
8	DRIENETTE	6	8	0	2	3	1	9	11
9	FANIE	3	8	0	1	1	3	4	12
10	KARIN	4	8	0	3	3	3	7	14
11	JOAN	4	9	5	3	2	3	11	15
	AVERAGE	6.09	8.27	0.64	1.82	2.27	2.55	8.80	12.40

Figure 6.1. a. & b. MAR connectivity and activity scores

Figure 6.1.a. is the same as the table of all the scores collected for the CST and the PBR group. The first column, after the name and the map makers' number, shows the map makers' own estimate of their computer confidence that they offered in the questionnaire. They were asked to rate themselves from 1-5 – 1 being top competence. The next four columns show the numbers of links and nodes in the two maps. The score as a ratio for the two maps is in the pink column, six and seven.

In the second half of the map the numbers represent the quantity of spheres of thinking and zones of use the map maker has presented. This number does not tell represent, however, the quality of the concepts. The final two columns show the numbers of concepts the map maker has accumulated over time which I have called an activity score. This was my attempt to see if this other cumulative approach was relevant.

The numerical analysis shows that in six months the MAR connectivity scores have changed on average from 0.82 to 1.02 (Figure 6.1). If the connectivity hypothesis were to be accepted, this would suggest a substantial increasing in understanding in a comparatively short time. The same increase shows up more markedly in the activity scores. The MAR teachers' scores begin higher at 8.80 and finish at a 12.40. The average gain in concepts / words in a six-month period is 3.6. The MAR group range from 0.00 to 1.75 in the pre-course maps and 0.79 to 1.53 in the post course maps. Figure 6.2. a. & b. show how the changes in the group at the beginning and end of the course are mainly in a 'positive' direction.

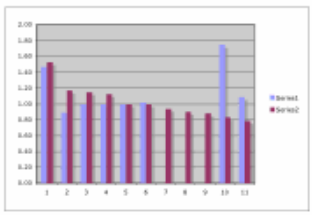
The MAR group's activity scores in Figure 6.2. c. a & d. range from 4 to 11 pre-course and from 9 to 15 after six months in the second set of maps. The graphs indicate a more coherent pattern of change across the South African cohort than the connectivity scores show. The MAR individual class positions pre-and mid-course are rather more confused as the charts show (Figure 6.2 b. and d.).

Analysis by words

This section deals with the observations about the use and kinds of words and phrases in the group. A five-page spreadsheet was designed so that all the words on the maps could be compared. The eleven participants had one row set aside for the words on the first map and another row beneath for the second map. There were seven headings form the ImpaCT2 study: computer systems and networks; information and communication; publishing and correspondence; games; sound; learning. The resulting table is too big to reproduce, but it provides a cumulative score for each section from the start and finish of the course. These sheets were eventually printed out and stuck together with clear tape so that the changes could be seen. Key words were coloured with different coloured pens so that they could be easily seen across the four-page expanse of paper.

		LINKS		NODES		SCORE		Position
ID		Map 1	Map 2	Map 1	Map 2	Map 1	Map 2	
1	DANIE	25	26	17	17	1.47	1.53	1
2	INA	17	41	19	35	0.89	1.17	2
11	JOAN	18	23	18	20	1.00	1.15	3
3	NICOLETTE	19	16	19	18	1.00	1.13	4
7	DIKOLE	7	5	7	5	1.00	1.00	5
8	DRIENETTE	45	9	44	9	1.02	1.00	6
4	LERETO	10	13	13	16	0.00	0.94	7
5	ROCKIE	7	5	7	23	0.00	0.90	8
9	FANIE	0	15	0	17	0.00	0.88	9
6	NOZI	4	9	22	13	1.75	0.83	10
10	KARIN	12	11	11	14	1.09	0.79	11

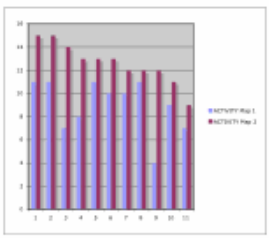
a. Table for connectivity class positions



b. Chart for connectivity class positions

	SOT*:USES		ABSTRACTS		ZONES OF USE		ACTIVITY	ACTIVITY	Position	Comparison
ID	Map 1	Map 2	Map 1	Map 2	Map 1	Map 2	Map 1	Map 2		
1	4	9	5	3	2	3	11	15	1	1
5	9	10	0	2	2	3	11	15	2	8
2	4	8	0	3	3	3	7	14	3	4
4	6	10	0	1	2	2	8	13	4	7
6	8	9	0	1	3	3	11	13	5	10
9	8	10	0	0	2	3	10	13	6	9
7	7	7	0	2	3	3	10	12	7	5
10	8	7	0	3	3	2	11	12	8	11
11	3	8	0	1	1	3	4	12	9	3
3	6	8	0	2	3	1	9	11	10	4
8	4	5	2	2	1	2	7	9	11	6

c. Table for activity class positions



d. Chart for activity class positions

Figure 6.2. a.b. c. & d. MAR connectivity and activity scores class positions

(Chart key: the blue bars show the scores from the first maps and the red bars show the scores in the second map).

There are some clear differences in concepts between the words used at the beginning and those used in the last map even in six months. In pre-course maps the MAR group did not mention titles of hardware and software at all. The educators wrote mainly of 'computers' and unspecified hardware and software. In the second map the group mentioned a range of previously not mentioned types of equipment: desktop computers, laptops, printers, scanners, data projectors, interactive whiteboards, web cameras, digital cameras and the internet. There was a strong sense that computers can be used interactively here.

The same evidence of significant concept development is shown in the second columns devoted to information, communications, and publishing and correspondence and data. Several teachers were using digital cameras at home and two teachers suggested using the cameras for the creation of art work in school. Another teacher played games to relax and two more were able to listen to music on the computer. The majority were aware of the uses of digital technologies in planning, administration and finance, but only one mentions personal shopping in the second map. The places cited by MAR teachers about where computers were used are the home, the school, the library, the media centre and the workplace. The majority mentioned the world as a stage where they were now participating online.

These observations are helpful for researchers who want to see how the group was thinking about the topic of CPD. However, it seems more useful to include words as one of the elements of a sign in the next analysis that deals with individuals' learning progress: the reason being that frequently, neither writing nor drawing function without each other. As Mavers points out each mode takes on related but complementary functions, that she calls 'co-fixing' (Mavers, 2004a; Mavers, 2004b; Mavers, 2007).

Analysis as a complex MD sign

Chart Position	ID	Positions in class	
		Connectivity	Activity
i.	ii.	iii.	iv.
1	1	1	1
2	4	4	7
3	5	6	10
4	7	7	5
5	8	10	11
6	9	11	3
7	11	8	6

Figure 6.3. A journey of understanding for seven map makers

The different shading for each map maker is intended to facilitate the visual reading of this complex table about educators' understanding of digital technologies (Figure 6.3.). The wide range of rankings will be discussed in detail in relation to the different map makers. Seven pairs of maps have been chosen for more detailed description and listed here in order of discussion here: Fanie, Joan, Danie, Lorato, Karin, Dikole and Drienette. None of these are first language English speakers. There is a spread of thoe who live in the town and in rural areas. Only Joan thinks her computer competence is worth a score of 1.

These seven have been chosen to illustrate research observations that have not already been covered in the other two case studies, CST and MAR. These seven have been compared in order to look again at scoring consistency, but there is no clear pattern that can be traced in these figures. Indeed by this time in the study it seems clear to me that the detailed scores are adding very little indeed to what can be observed by a careful observation of the semiotic features. It is also clear that the words are also very important for many of the map makers who have not yet been exposed to a culture of marketing which promotes short sentences and key words to communicate a message. I, therefore, do not focus on the scores on these maps but

do pay particular attention to the words that are used as part of the multimodal ensemble rather than separating them out from the composition. .

Investigating seven maps

There were only six months between the first map and the second map; further, it is important to remember that these second maps were drawn not in SA but in England. This took place after visits to the SA schools of mentors and joint workshops between English and South African teachers and children. The second method is to seek 'manifest' and 'latent' evidence of the Daly and Pachler's indicators shown in Chapter Three Figure 3.2: cognition, knowledge building, autobiography, community and meta-learning. The analysis of each of the seven maps now follows.

Fanie – the fast learner

Fanie's first map has no connectivity score because there are no discernible links and nodes (Figure 6.4. a. & b.) But her first map still communicates her forecast about what she expected to use computers for in words. The map includes playing games as a leisure pursuit. She explains the tasks in everyday language, such as 'finding relevant information', because technical expressions such as 'information retrieval' or 'surfing the web' were not yet in her lexicon. Despite her lack of exposure to computers she scored reasonably well in the activity score, as she understood some key concepts. She provided a realistic computer drawing in two dimensions. Her careful scaling of the three detailed elements, computer, keyboard and server was accurate. This suggests keen observation. The comparative size of the computer, in effectual terms, communicates the significant impression that the hardware has made on her.

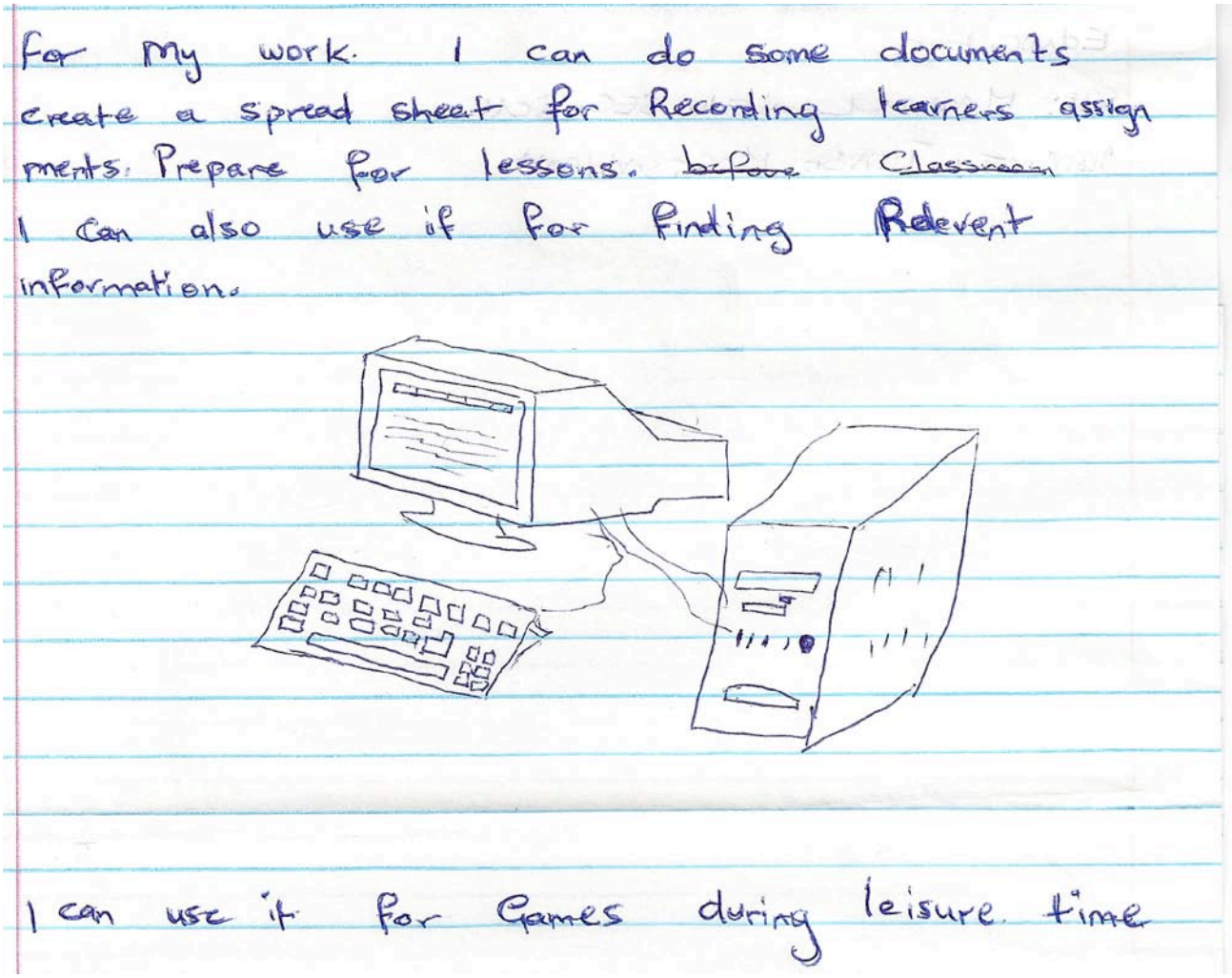


Figure 6.4.a. Fanie's first map

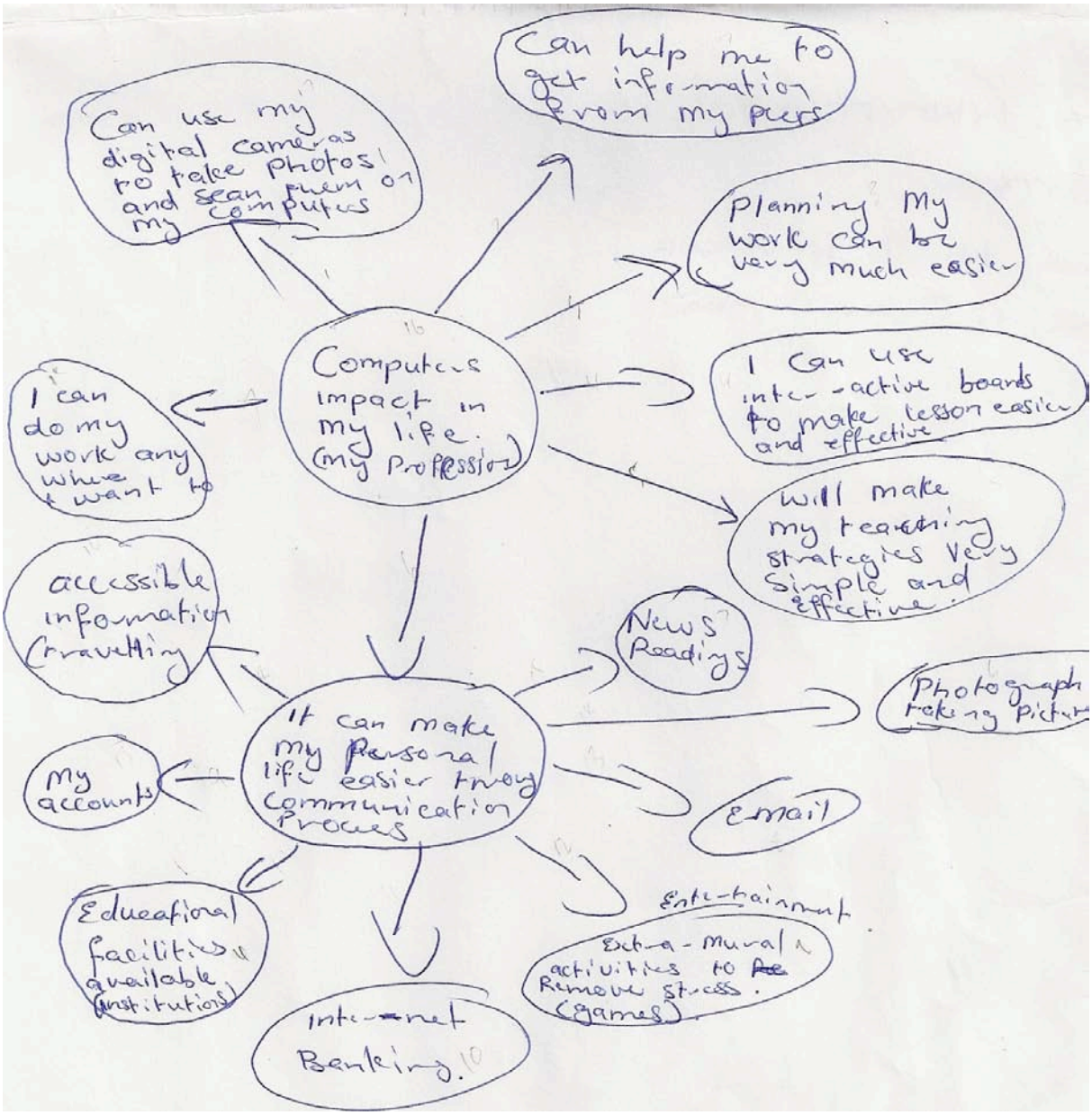


Figure 6.4.b. Fanie's second map

Fanie's second map comes top in the sequence in terms of complexity as column e. in Figure 6.3. illustrates. According to connectivity approach, this score suggests that she had learnt to communicate information in the form of a concept ma about the role of computers in her personal and professional life over the six months when she had been using computers. In compositional terms, she answered the question by splitting nodes into those most relevant to her personal and her professional life. Her two

central nodes are in the radiant style associated with Buzan although she had not yet mastered the principle of reducing the concept to a single noun for a mind map (Buzan, 2002).

Fanie is one of the very few to use the dynamic affordances of the maps. The arrowheads suggest dynamic energy in the new experience she was expressing conceptually. A comparison of the two maps suggests that Fanie seems to have made the most progress in this cohort from the point of view of mapping conceptual thinking.

Joan - the optimistic learner

Joan assesses her competence in computers at I- the highest score. However, her questionnaire indicates that lives in the country, not in the town where many Afrikaans have the same access to computers as rich Europeans. However, the words in Joan's first map (Figure 6.5.a.), contrast the optimistic promises she had heard about digital technologies in education with her skepticism about whether computers are actually was the panacea for economic renewal. Her first map traces a biographical approach to her understanding of computers that is a pleasure to read both from the professional and the personal perspective. In fact, her first map reads less like a conventional concept map and more like an outline for a narrative communicating her responses to computers and that of her pupils. Concept maps are frequently recommended for use as a scaffold for story composition as noted in Chapter two.

Professionally Joan notes that 'learners adore computers'. But although she acknowledges that computers are supposed to make tasks 'easier and faster', 'neater and more creative' she is not convinced. In her observation, computers are not always available or they can be broken. Using them can be time consuming.

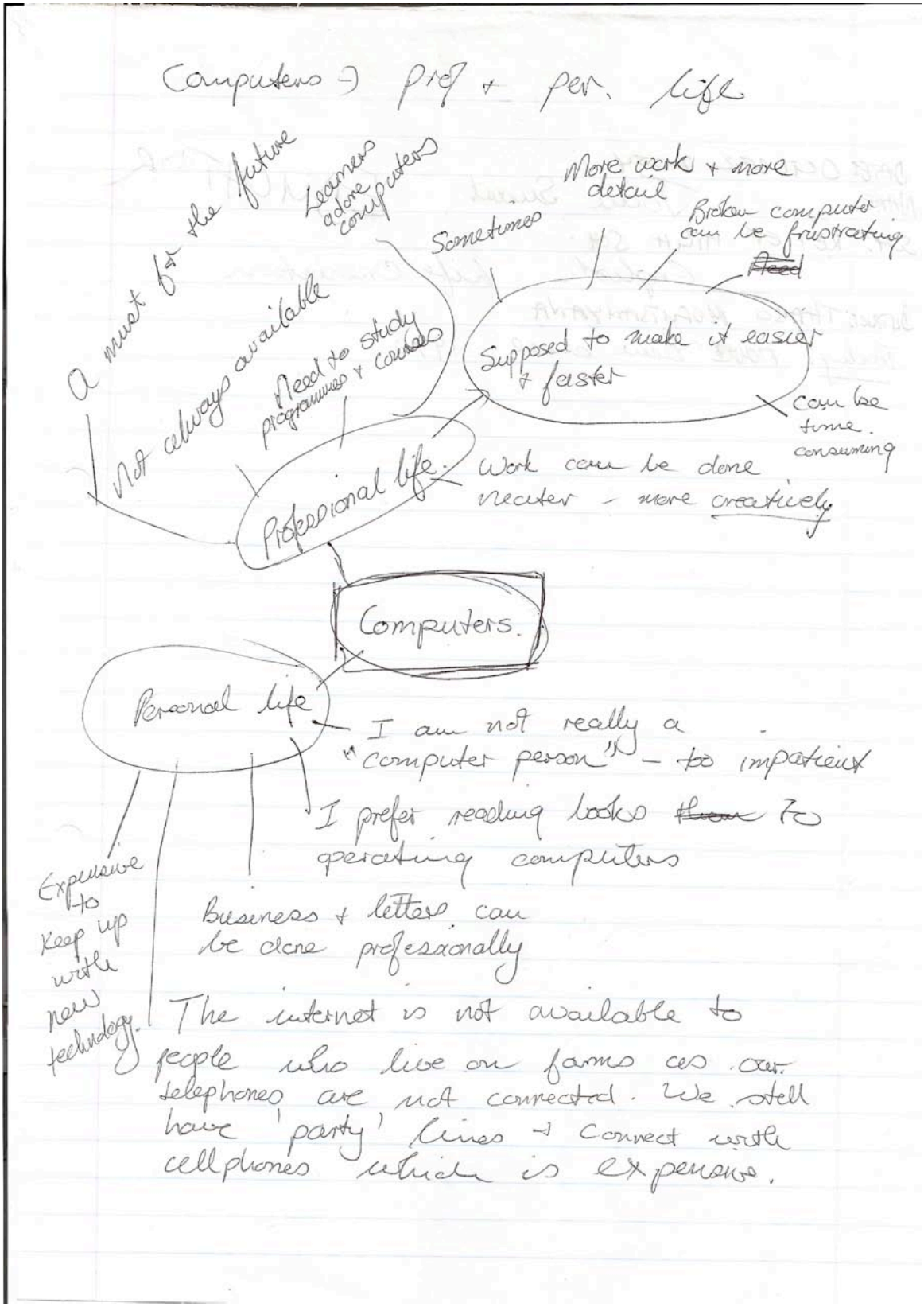


Figure 6.5.a Joan's first concept map.

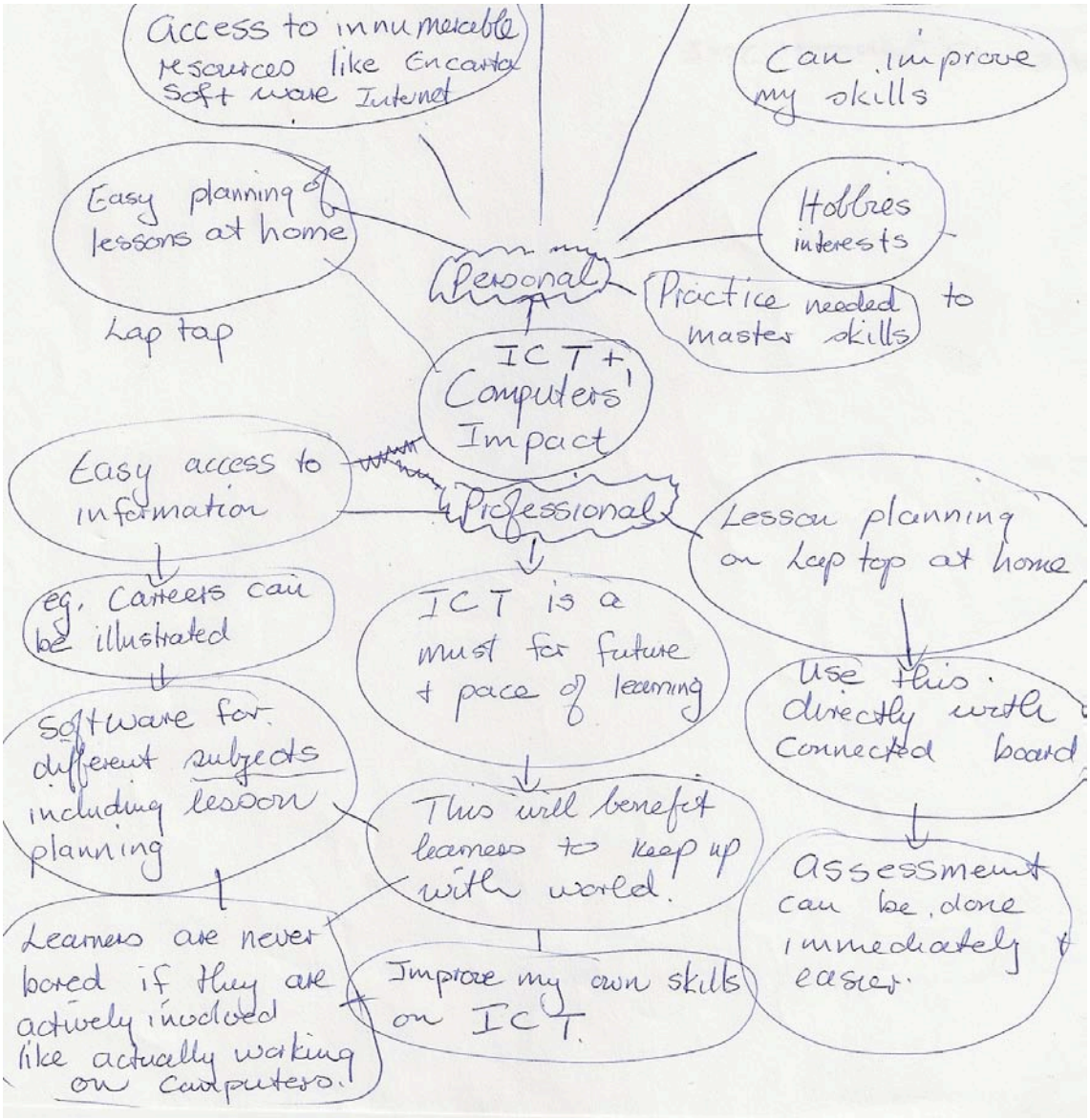


Figure 6.5.b. Joan's second concept map

From the perspective of her personal life Joan admits that she is not really a 'computer person' because she is too impatient. She prefers to read books. She points out that it is expensive to keep up with the new technology, but she thinks computers are useful for producing professional looking letters. She also reminds us that like many rural communities all over the world the telephone lines are not configured to provide adequate internet access.

Joan's first map is understandably word orientated and the composition is linear with long sentences used to express ideas rather than single words for concepts. Joan's second map (Figure 6.5.b.) still tends to use phrases rather than single words for concepts in the nodes.But the composition illustrates a growing understanding of the way that concept maps are designing and a more confident execution. The statements, clearly divided into personal and professional concerns, make far more impact than they do isolated in the content analysis spreadsheet.

The most unusual semiotic feature is the complexity of the mapping. She has begun to experiment with links and arrowheads that indicate a complex web of associations. She imagines a clear navigation intention for the links because she erases those that did not finally match with the method she was developing. The exuberant design of the map underscores the enthusiasm of her words in which she suggested that six months' use of computers convinced her that both her professional and her personal life had been enriched by these additions to the classroom. The learning of her pupils seemed to have benefitted as well. The phrase, 'ICT is a must for the future pace of learning', suggests a growing mood of optimism in the execution of her second map in contrast to her initial skepticism.

Danie – the sophisticated practitioner

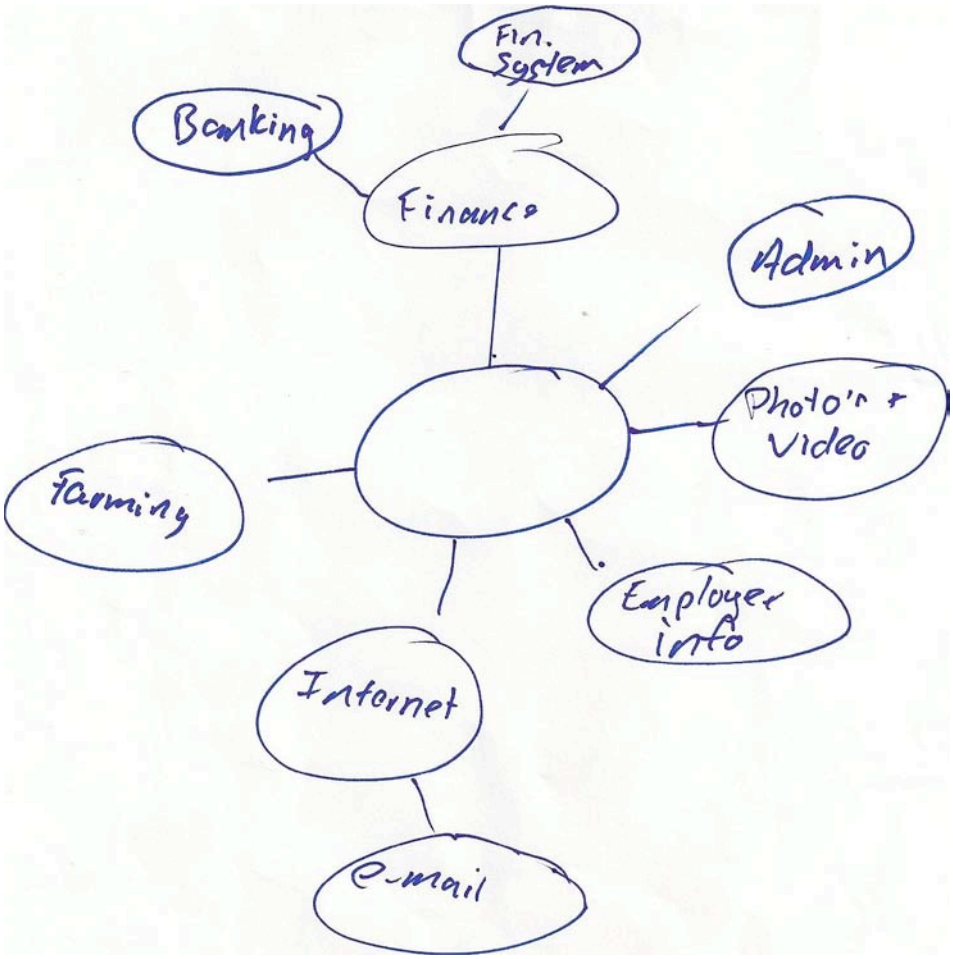


Figure 6.6.a (1). Danie's first concept map: personal life

Danie understood the semiotic principle behind creating concept maps from the first (Figure 6.6.a. (1) and (2). He used two pages to give full detail to his ideas about computers in the two aspects of this life: personal and professional. He was also one of the most accomplished map maker in editing the themes he was promoting down to one word: reports, memos, internet, brochures and so on. He also made an attempt to group these nouns into conceptually coherent groups: school administration, learners, teachers, and parents. He also highlighted different processes such as school administration and school information. In the composition of his first maps Danie had a blank centre which perhaps would have been the computer given more time.

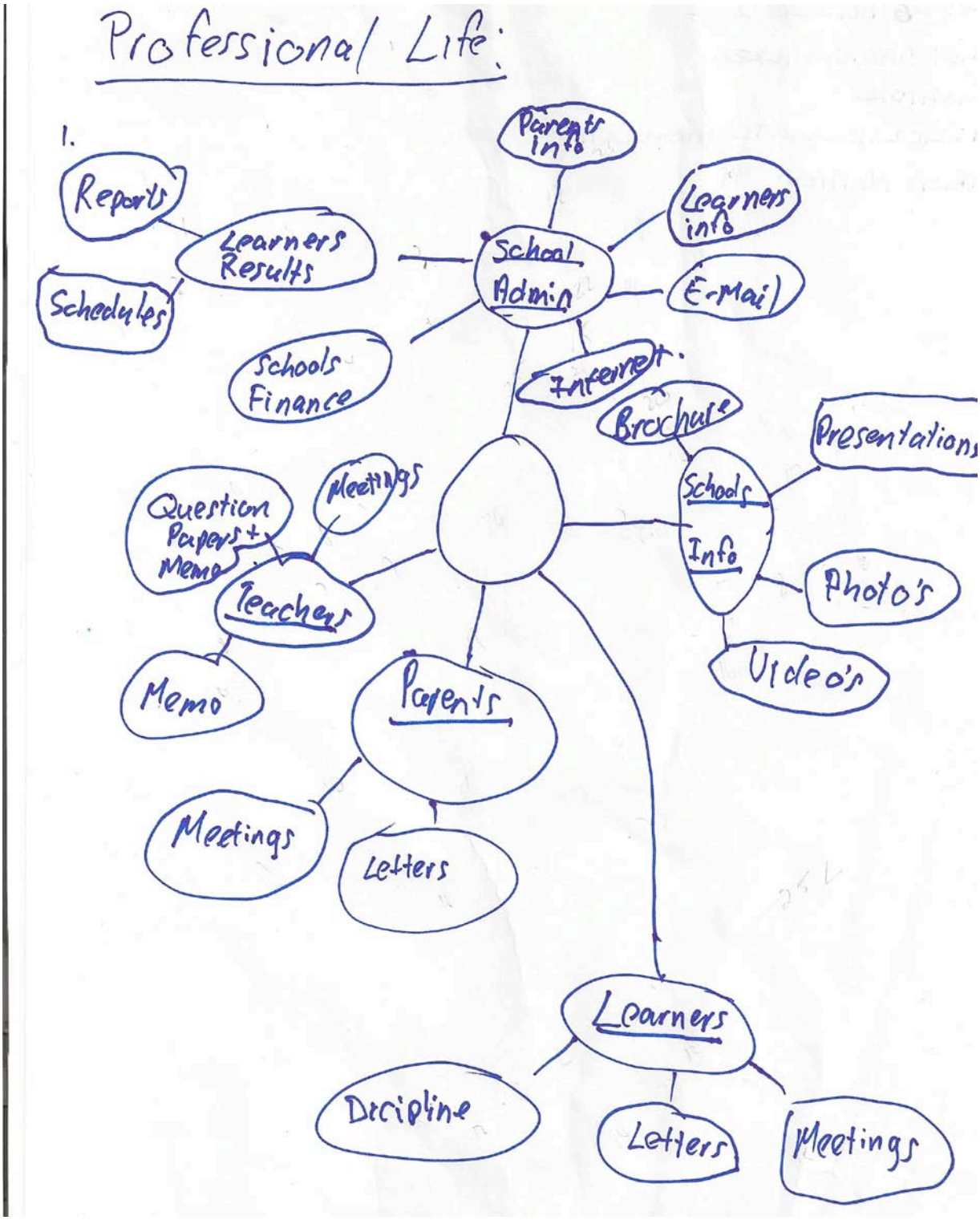


Figure 6.6.a. (2) Danie's first concept map: professional life

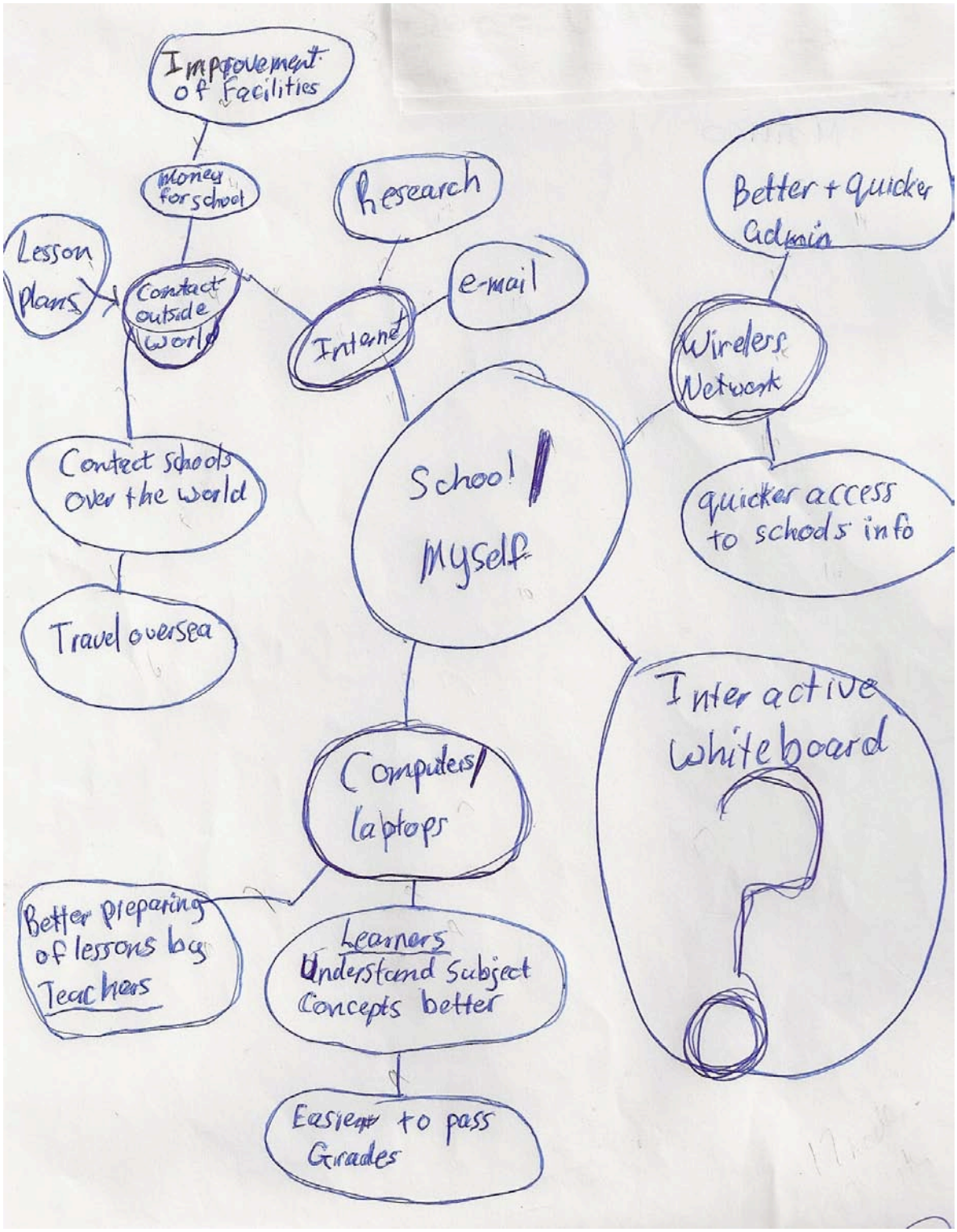


Figure 6.6.b. Danie's second concept map

However, in the second map he placed himself and his school firmly at the centre and arranged the computer parts around this node (Figure 6.6.b.). This gives the clear impression that the human beings are in charge of the technology rather than technology dominating. The largest node is dedicated to his greatest priority – a question mark over interactive whiteboards. This gesture shows a keen awareness of the viewers of the image.

Lerato - an individualist

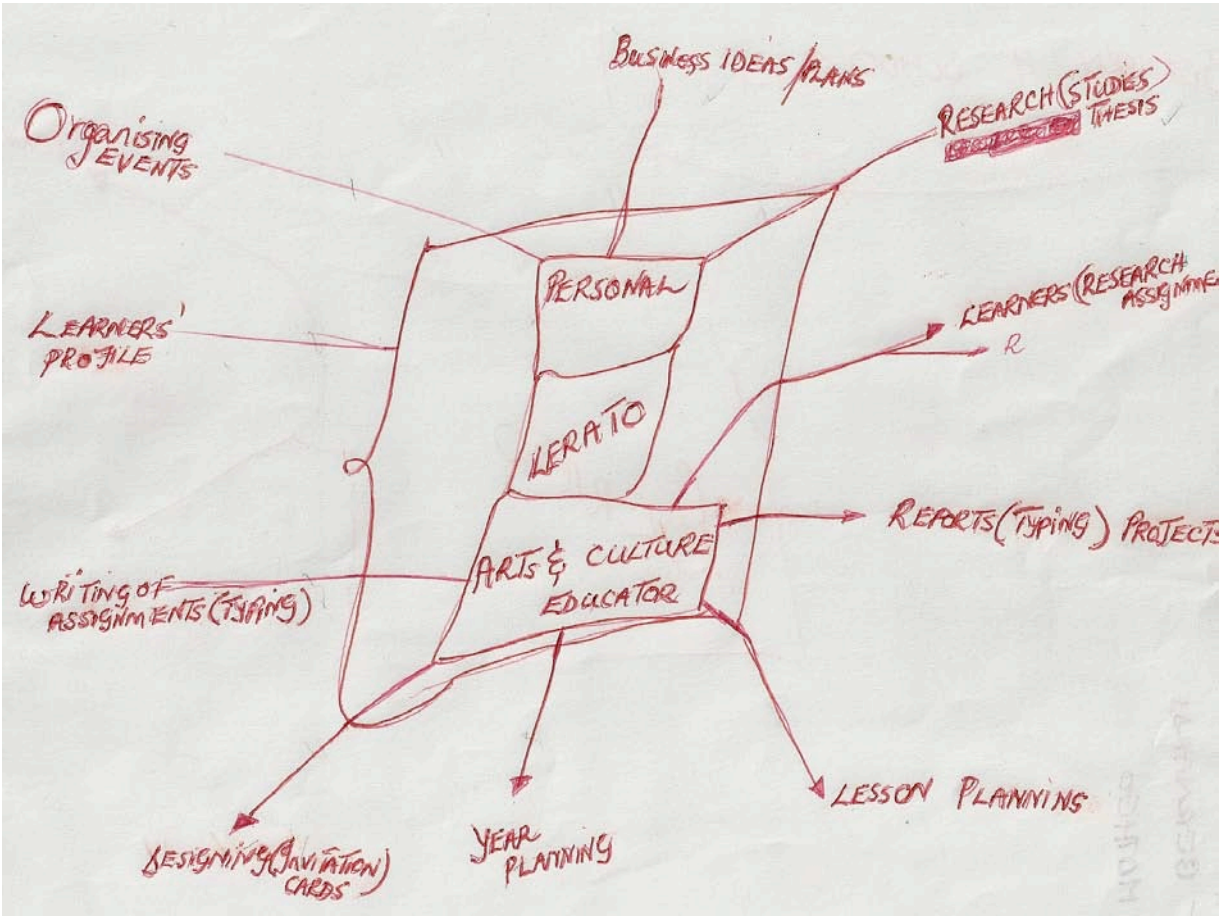


Figure 6.7.a. Lerato's first concept map

Lerato[35] brings a personal style to the map that seems to be based on a rectangle as a compositional theme rather than a circle (Figure 6.7.a.). This may be a visual reference to the shape of a computer. She took ownership of the centre in her dual role as an arts and culture educator, and as a private citizen. She reserved the dynamic arrowheads for the representation of her professional activities that perhaps suggested that life at home was more leisurely.

The second map is much the same with rectangular nodes taking the place of round ones (Figure 6.7.b.). This design makes the maps distinctly individual. Because the design is not based on the conventional approach, it demands more attention from the viewer. Each phrase begins with a verb that denotes action. This is the basis of communication in which she has edited the message she wants to put across. He pleasure in communication is In her personal life, she demonstrated her keenness to use the computer both to type her poems and novels and to equip her own child for the future. In her professional life, she is open to the new influences of digital technologies and the opportunities to make her teaching more interesting.

[35] Lerato is not the real name of the map maker who chose tthis a a pseudonym.

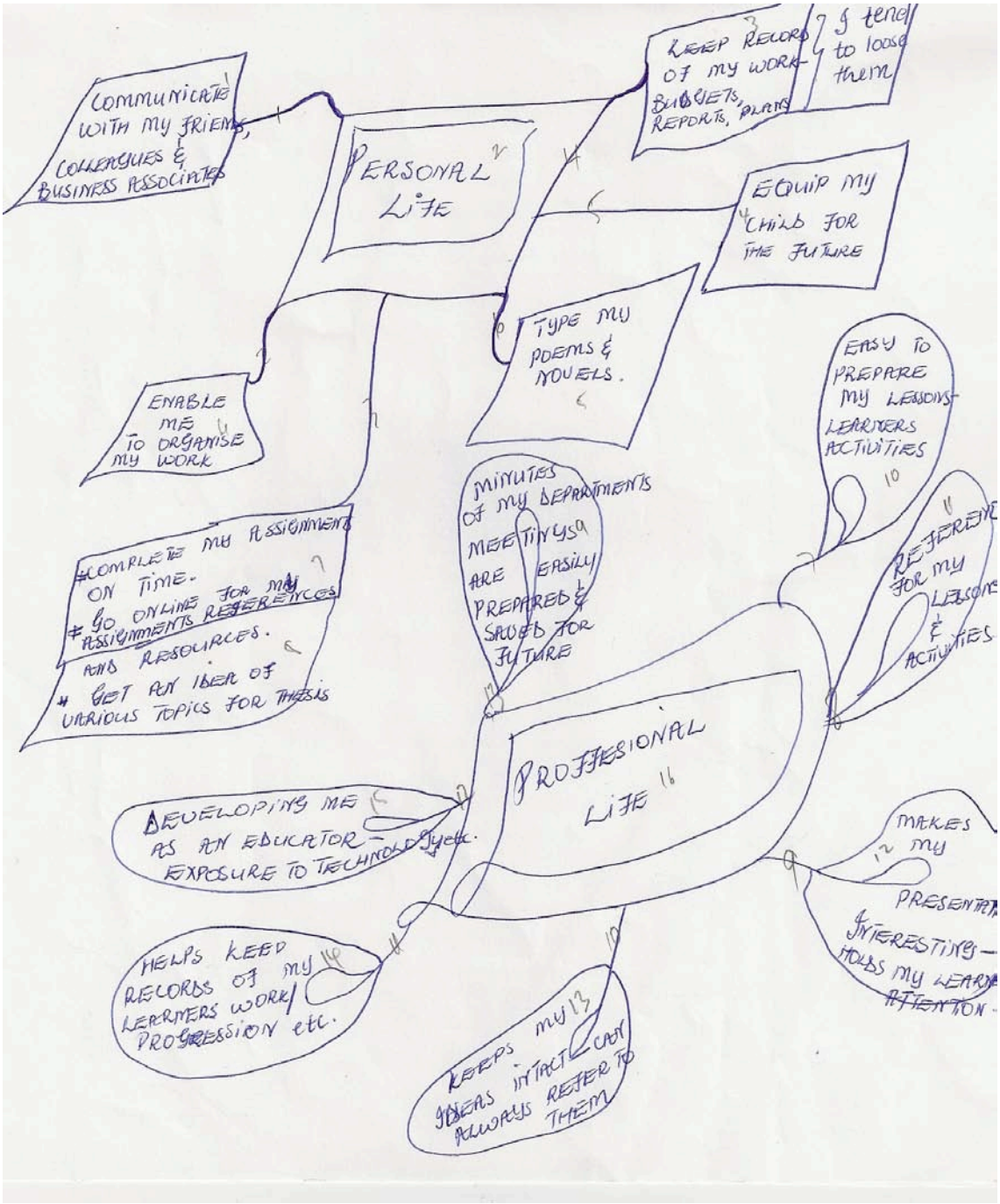


Figure 6.7.b. Lerato's second map

Karin – the planner

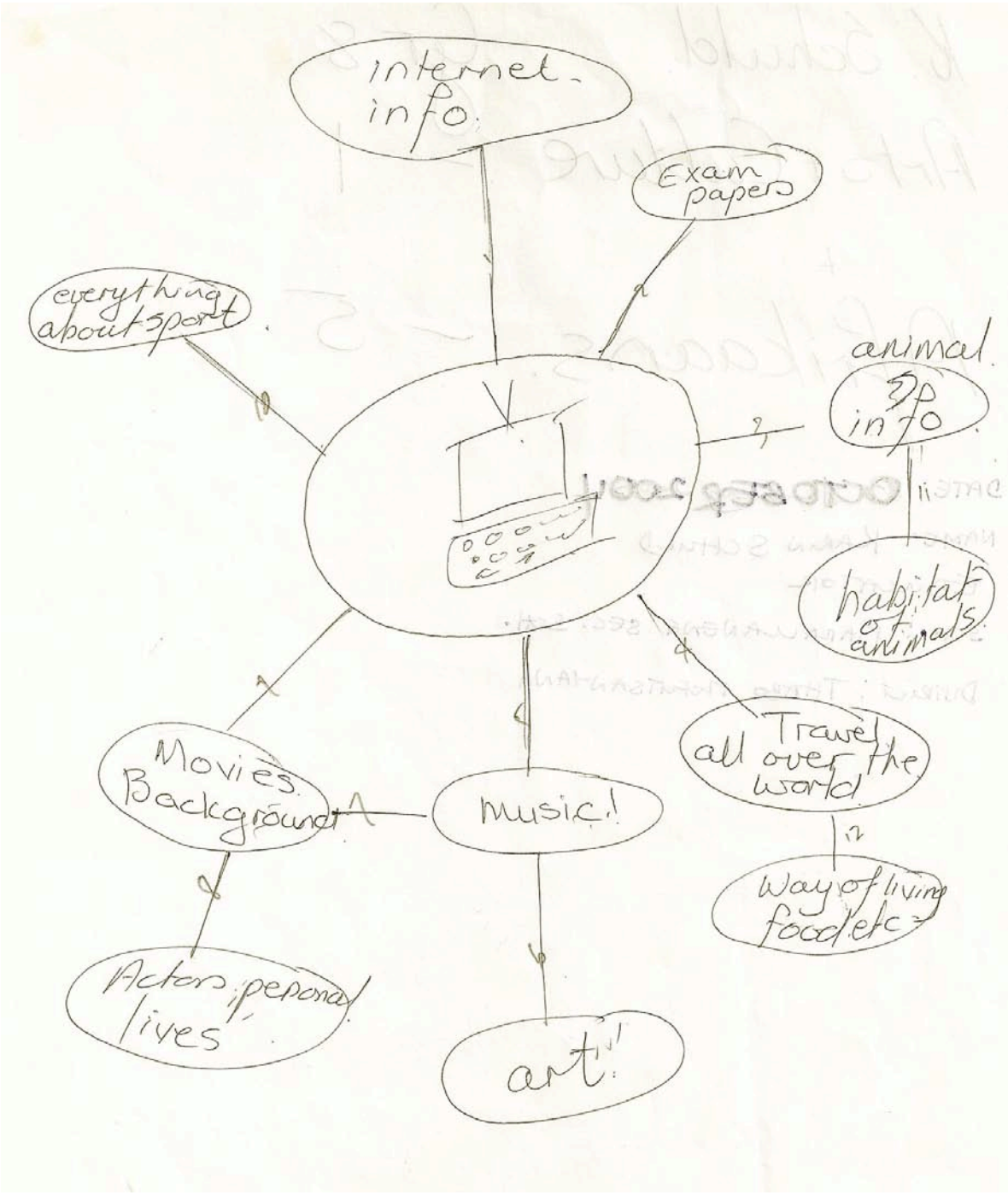


Figure 6.8.a. Karin's first map

Karin clearly has an extensive knowledge about how computers might be used to enliven children's learning in her first map. This is reflected in her sketch of a computer that includes antennae to denote an internet connection.

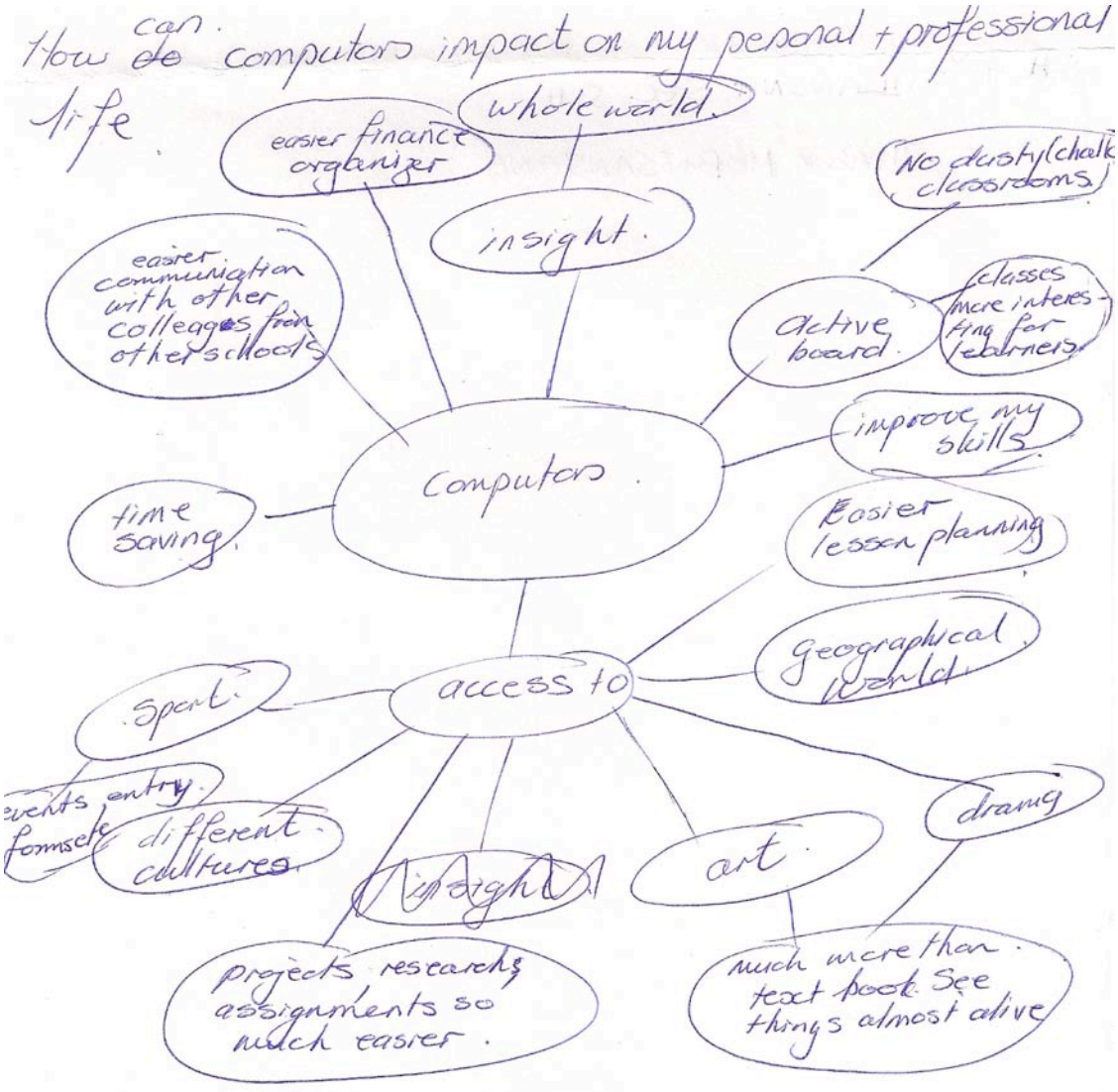


Figure 6.8.b. Karin's second map

She is a teacher of arts and culture and Afrikaans according to her questionnaire. The nodes of her map refer to knowledge that can be found. In addition the ways in which this knowledge is communicated on the computer promotes the idea of activity and

process rather than static written knowledge: for example; actors lives; travel: music and sport. She does, however, indicate that exam papers might arrive via the internet- a futuristic concept when she was making this map but prophetic.

In her second map Karin's composition is far more ambitious and innovative. She does not follow the title and divide the map into personal and professional divisions as the other map-makers have done. Instead she creates two key concepts of her own: access and insights. She shows how the computer provides access to information but also how the computer can offer insights into knowledge. In the 'access' section at the bottom she expands her idea in the first map - that computers work at a multimodal level: 'much more than a text book. See things almost alive.' She also develops the notion of access to other cultures. In her insight section at the top she talks about communication with local and global colleagues as well as the ways in which computers are challenging traditional pedagogies. In a discussion with colleagues this second map would help others to see the potential for the profession that she had seen on her visit to England.

Dikole – the idealist

Dikole did also not understood the conventions of how to use concept maps to enhance the meaning of his words at first, or did not choose to do this (Figure 6.9.a.). His first map is nearer conventional mapping style than his second map. In affective terms, he was comfortable with expressing high ideals: for example, '[computers] can help our learners and educators to be able to compete with the rest of the world as a far as education is concerned'. His creativity with computers and capacity to reach out was hinted at when he mentions designing websites. The sentence at the bottom, in contrast, could be interpreted as an indication that he was in danger of being overwhelmed by lack of resources, and that this situation would undermine the integrated plans that he described in his map.

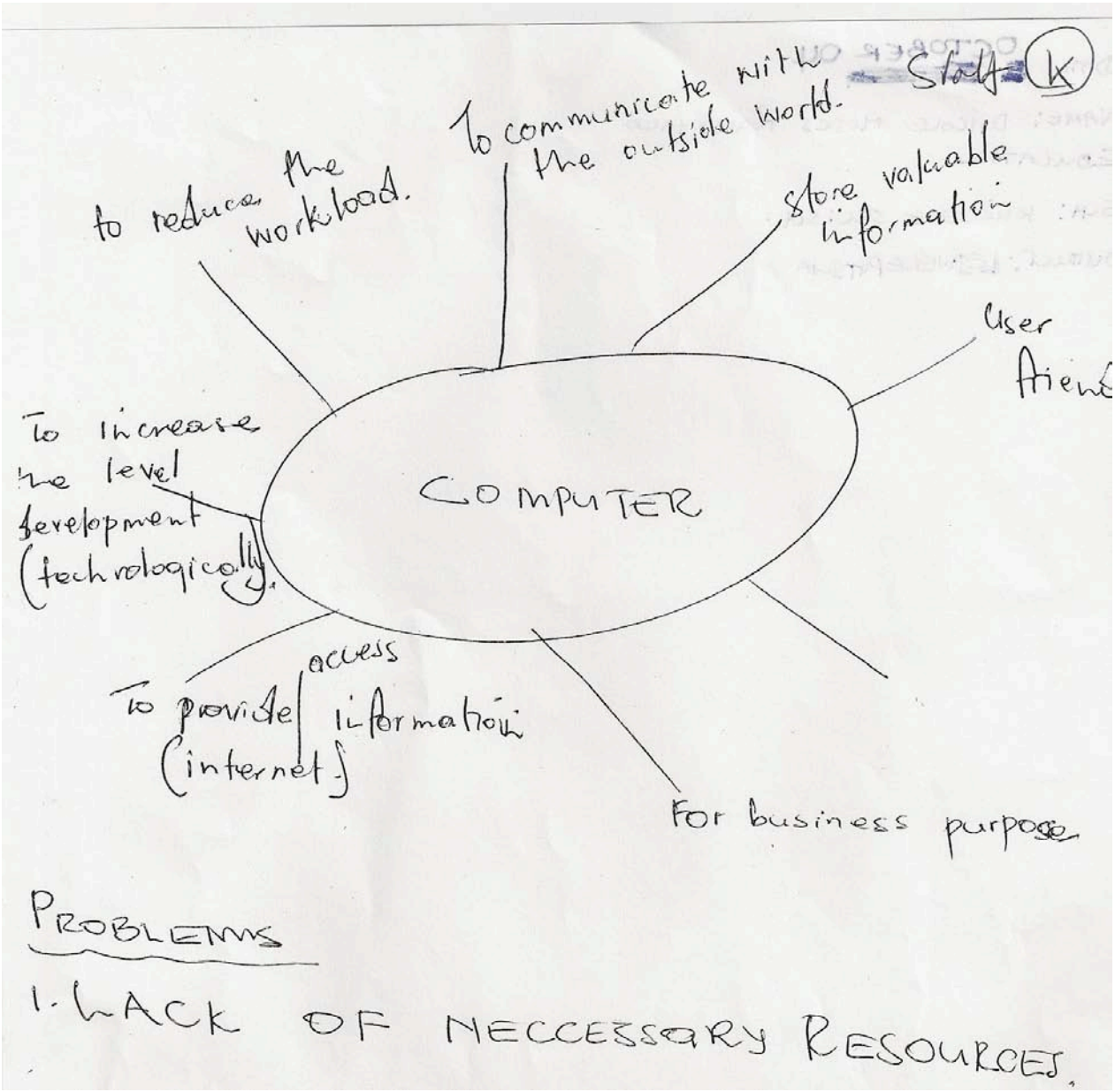


Figure 6.9.a. Dikole's first concept map

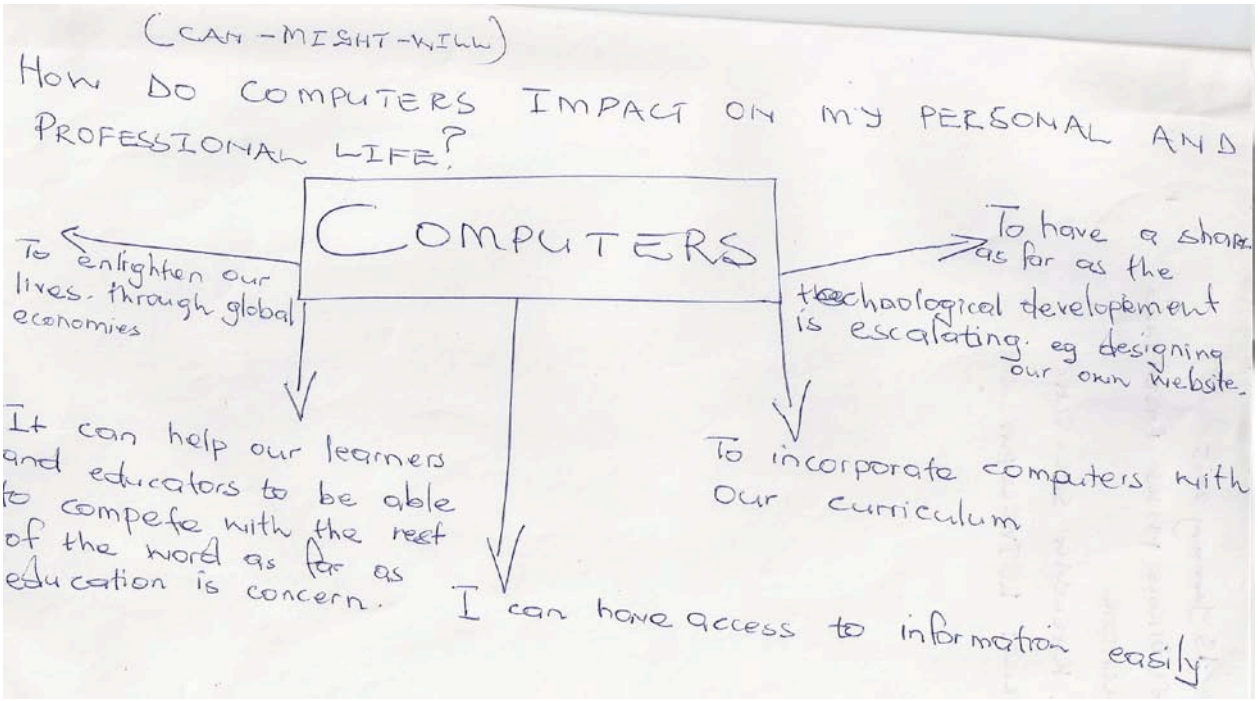


Figure 6.9.b. Dikole's second map

Drienette – the experienced practitioner

Like Dikole, Drienette's second map comes lower in score than the first (Figure 6.10.a.b.) Her first map, elegantly produced in a desktop publishing package, suggests significant skill with computers. (The address of the school had been covered with a black box to preserve anonymity). The sheet with the map was laminated with a heavy plastic cover like a sign on a door. The sign positions her as a network manager with a good personal assistant. Each of the staff members who deal with aspects of computers was mentioned with the tasks that they handled: This seems to be an existing artefact from the school. It may be that this sign was not designed specifically for the mapping exercise, but does provide an explanation of what was happening in this school as well as showing her desktop publishing skills. This sign tells the reader that the school had sophisticated computer systems that had been in place for some time.

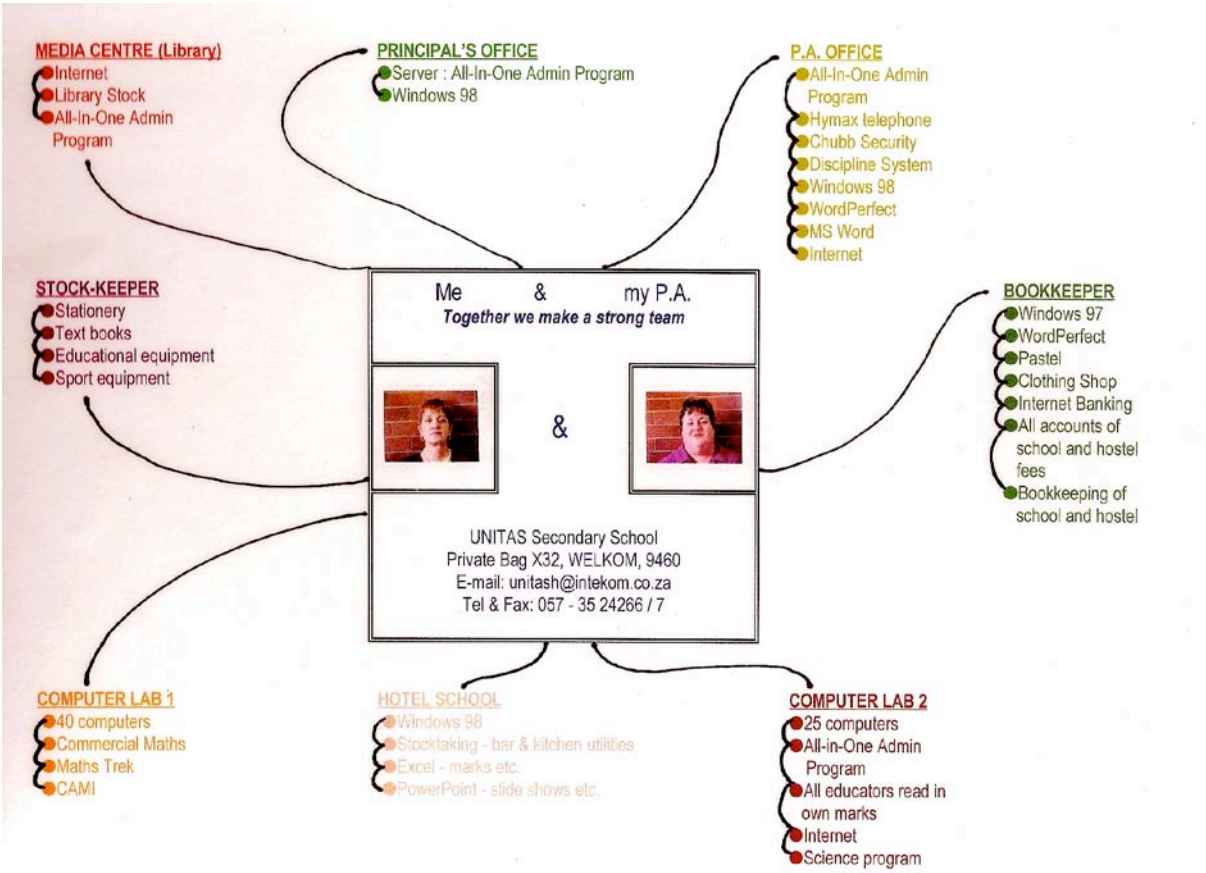


Figure 6.10.a. Drienette's first map

Drienette's second map is more like a set of bulleted notes arranged around the central idea of using computers in her class. Her thinking about how computers might be used in schools was developing, possibly based on what she was seeing in English schools. A sense of learning with a CoP is clear in the drawing a sophisticated view of how computers now impacted on her life.

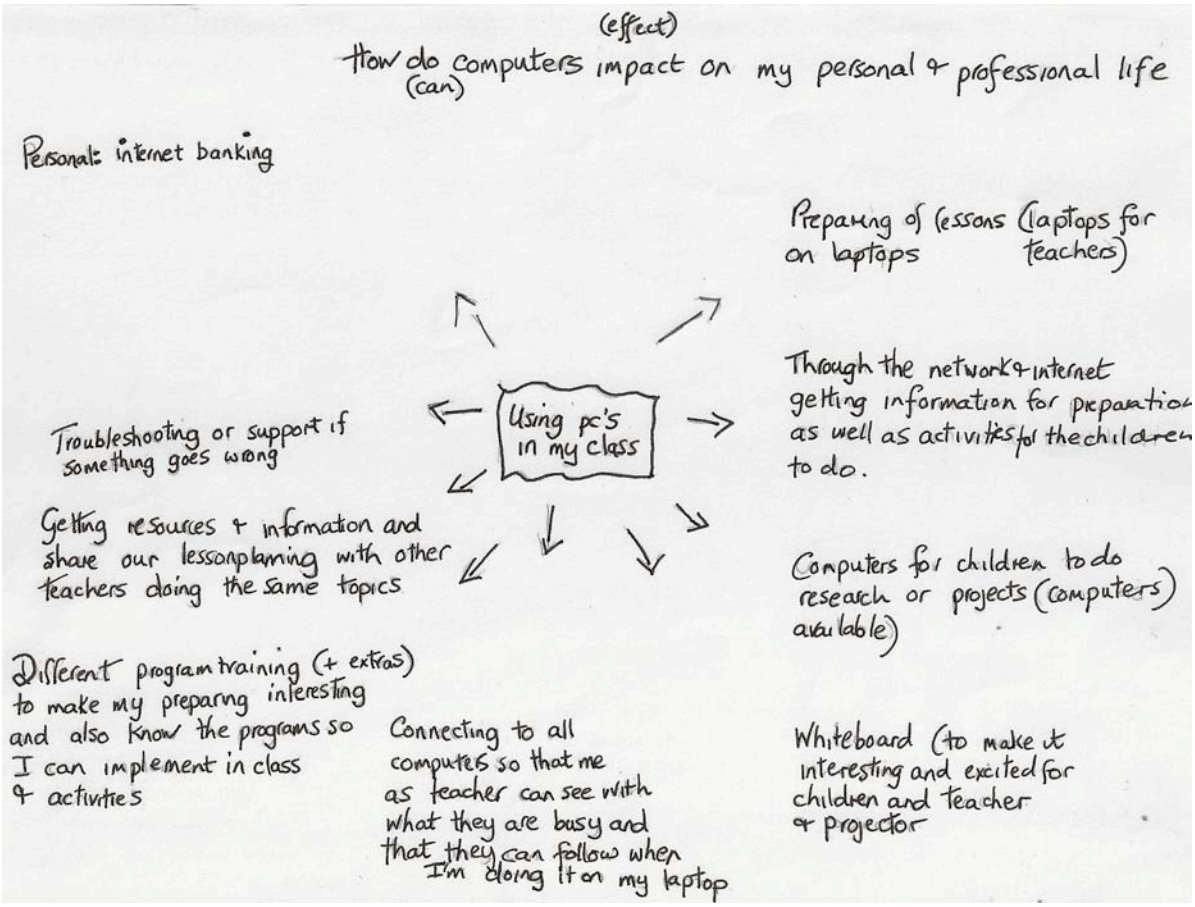


Figure 6.10.b. Drienette's second map

Discussion

By number of links and nodes

Both the connectivity and the activity scores were useful in making a broad judgment that the South Africans as a group increased their understanding in the comparatively short period of six months. However, when the scores for individuals are compared, inconsistencies are revealed. They are evident in the progress of individuals and across the group. These results confirm the problem of the unreliability of the hypotheses built into the approach, also found in the other two case studies.

By kinds of word

In these maps the use of words highlights some cultural differences between the South African cohort and the two English cohorts. The South African group was more reliant on phrases and even whole sentences rather than one word. What is most remarkable in the large majority of the MAR second maps is the sudden introduction of verbs that indicate excitement about their involvement in exploring digital communications in the six months within a supportive community. There is purpose and energy in the tasks they allotted themselves. The selection of verbs provides a flavour of the group's task-orientated trajectory: prepare, access, browse, get, obtain, share, email, type, research, create, make, store, keep, write, record, mark and distribute information.

These South African teachers had not had time in six months to assimilate all the technical vocabulary, so verbs like 'write' are still used rather than 'word process' in the second map. However, these comments were in the context of making writing and publishing tasks easier to complete and to sharing and distributing knowledge about using digital technologies. Some MARs also talked about creating websites in their second map. Most of the computer skills training promised before the MAR programme began had not materialised. This might be the reason why, in their first maps, the technical vocabulary of the majority is quite limited in terms of computer systems and networks.

Systems of distribution are different in South Africa. Commercial software developers had not yet become household names in the more remote regions of the province. As a result, in the data-handling column, Excel, the software in the Microsoft Office package, is the only commercial software named throughout the study. This is in contrast to the computer skills training cohort (CST) who used the titles of the Office packages as shorthand for their function.

Judging from this small study it is possible that the reduction of sentences and phrases to one word to label a node is a subliminally understood manifestation of experienced

computer use. The reason for this observation is that many of South Africans in the townships and the rural areas, both pupils and teachers, seemed to have little or no exposure to this kind of linguistic abbreviations. In their first maps they found the mode challenging. They tended to continue to express their concepts in full sentences and phrases. They also referred to their general emotions, their hopes and their fears at length. English practitioners, in contrast, used irony and prefer to draw cartoons about their conflicting emotions around the use of computers instead of using words.

Another point where the difference in attitudes to teaching and learning are palpably different between the two groups is where they expressed their hopes and fears about the impact of computers. Negative comments referred to the length of time it takes to learn, although the digital artefact is preferred. MARs also expressed some anxiety in the rural schools about the problems with the installation of the internet, the limited breadth of the band that has been installed and the prohibitive costs. 'Broken computers can be frustrating' said one experienced MAR. The idealism and hope engenders respect for these enthusiastic learners since many are in challenging circumstances.

Although internet connection and computer installations had not progressed smoothly in all the schools, the CMs suggest that the South African educators who participated in this project still took a positive attitude towards computers. In terms of learning theory some of the teachers articulated the intention of making lessons more interesting in map two. A keenness to learn new skills and strategies was paramount in the comments and the intention to enhance learning and make concepts easier to assimilate. They expected computers to lessen workload; improve their teaching skills; provide better links between school and home; and, to increase their share of escalating digital knowledge. Some of their phrases encapsulate the tone of the group: 'let's be neater and more creative' and 'no more dusty, chalky classrooms'. The phrase, 'All the magical things that will not be done otherwise', exemplified their hopes.

An issue that will need to be considered further is that these MDCMs were completed in English at the express wish of the South African programme director who believed that a common language for all SA school children would ensure their participation on the world stage. Later this was one of the grounds for closing this project because of the charge of élitism. The South African educators and the children were expected to confine their communications to their own tribal language in the new regime. This directive would make their ambitions to reach out to schools in other countries more difficult to realise in the future.

By complex multimodal sign

The South African CMs raise some new points about the need for the active member researcher to understand different computer cultures and to have some local knowledge in order to ensure that a sensitive ecological strategy is promoted.

Computer cultures

Some differences in features between the maps of English and the South African educators can be explained by the differences in exposure to computers. This was a group with mixed experiences but for Joan, in her remote town the sight of computers had made such an impression that she wanted to draw the details carefully in her first map.

In other 'first maps', many of the South African educators find mapping conventions of connecting and multi-layering ideas by the use of links and nodes challenging. Loreto's example shows how the analysis of the creative qualities of a MDCM is often in contrast to the scores that measure conventional MDCM design. In connectivity, she came bottom with the first score and seventh in the group, in the middle, with the second score. In activity, she came seventh with the first map and fourth with the second map. These average positions and scores show up best in Figure 6.3. Nevertheless, the raw figures are difficult to compare with the visual impact of the two

maps. These are striking in the holistic message they communicate about this person's understandings, whereas the scores fail to convey her individuality of response.

The participants were encouraged to express their local culture in the CMs promoting a more ecological approach to CPD than the kind of programme that promotes a pre-designed body of information and skills. An example of how this has worked is the significant progress that Fanie made over six months. The mentors, the other teachers and the students all did the first mapping exercise in the school and discussed the results together. Perhaps it is not surprising, therefore, that within six months the second map indicates how much Fanie learnt from her mentor, her colleagues and her students about mapping indicating the value of community learning. However, she was not afraid to express the political concern in her remote area about the expense of digital technologies, and about the capacity of the rural South African phone lines to cope. These views were justified by her experience.

Local knowledge

It is also important to note that the analysis depends on local knowledge. Karin's questionnaire indicates that she was and arts and culture teacher. She also mentions the power of interactive whiteboards and it is clear that from the beginning she is aware that the increasing use of computers will challenge traditional 'chalk and talk' teaching methods.

Local knowledge was also required when Drienette drew her second map. At this time she was in London with the MAR group looking at how their English mentors were working with digital technologies in their schools. Whereas her first map was led by systems thinking, this second one was about personal and professional practice from a classroom perspective rather than as a manager. She did not communicate a growing knowledge of how to use CMs to express her thinking in this second map, but this seems less important in the grand scale than her obvious engagement in this exchange exercise. A sense of learning with a community is clear in the second map.

Overall, the conclusions that can be drawn about understanding from the semiotic perspective are that, although none of the South Africans had had any exposure to MDCM design at the beginning of the project, they learnt quickly. All the seven selected participants had understood the main principles of design by the time they drew the second map. This might have been because they were encouraged to share and compare their maps as a learning community where there was reinforcement by peers and by their mentors. Also by the time that they drew the second map they had all been involved in creating school websites and publishing their pupils work for an audience of peers. This provided more exposure to the subliminal visual communication culture of the web that is layered and requires significant summarisation of wordy documents.

Conclusions

In terms of individual understanding of the content analysis in combination with the individual semiotic analysis has provided greater insight into the South Africans' understanding than the numerical analysis.

All the analytical methods, by number, by word and by multimodal sign, have offered interesting findings about the understanding of this SA group as a whole. Often working in English as a second language, the practitioners adapted quickly to this new mode of communication. They had high hopes of how computers might improve their lives at the beginning and showed significant signs of making this a reality only half way through the project.

There is, therefore, some evidence that having mentors helps to accelerate their learning in comparison with the two UK groups.

Individual learning stories seem to have great potential within this CoP. The growth of complexity in the maps and in the confidence of the map makers over six months is particularly remarkable. This suggests that working with educators on reading the MDCMs may have useful applications in community learning. The greatest loss was that the SA community was not being involved in the final joint research and evaluation processes that would have fed into the next project stages as they took ownership of this programme.

Insights into some interesting cultural differences that impact on understanding emerge from this first stage, that was shorter than expected. What stands out is the keenness of the SA teachers to express and share their hopes and aspirations for the future. Further shared research in this area, carried out by teachers, might benefit the profession through comparing their situations on the world stage. However, it will be difficult to develop this kind of mentoring and evaluation activity in this SA province in the near future because the government has decided not to use English as a common language in education. Each language group will work in the indigenous language. Given this possibility, developments of other semiotic means such as concept mapping may prove to be an effective way of sharing teachers' research across the province and between the different language groups in SA.

Because the time span between the initial and the second maps was only six months instead of the year that was planned, comparisons between the three cohorts, MAR, CST and PBR, must be undertaken with caution.

Chapter seven: discussion, emergent tools, conclusion and postscript

Introduction

This final chapter revisits the research question that forms the basis of this thesis. I compare and contrast the findings in Chapters three, four and five in order to see how the different analytical methods for multidimensional concept maps (MDCMs) provide insights into educators' understandings of digital technologies. In that discussion I explain how the three different perspective on learning - information transmission, constructivism and social interaction underpinning the CPD programmes - are reflected in the MDCM designs. I also discuss the relationships between researchers and educators as map makers within a community of practice as opposed to a conventional research study where educators are the 'subjects' of the researchers' observations. Some emergent research tools are then offered for educators to develop in collaborative contexts in the pursuit of data for practice based and action research projects. After the conclusions, I offer some reflections on how my own professional practice has changed as a result of what I have learnt from this study.

Background

To summarise, the three case studies compared and contrasted in this chapter cover forty -eight pairs of maps from map-makers who were either members of:

a computer skills training (CST) cohort in the UK

or

a practice-Based Research (PBR) cohort in the UK

or

a mentored action research (MAR) cohort in South Africa

The underpinning learning perspective in the design of these courses was

CST - information transmission;

PBR and MAR - constructivism and social interaction.

In each case, I evaluated the multidimensional concept maps (MDCMs) using three methods of analysis. These were findings concentrating on different semiotic modes in the MDCM ensemble:

numbers of nodes and links, expressed as a ratio;
words (that is, kinds of words and numbers in different categories);
complex multimodal signs

All were discussed from the learning perspectives of information transmission; constructivism; and social interaction

Comparing three sets of findings

In comparing and contrasting the findings across the three cohorts, I concentrated on:

pre and post-course map results for each individual to see what changes there had been;

the results of the groups to show changes for the groups overall and the direction of change in as far as that was discernible;

transcripts of the learning exchanges of one group

The aim is to develop further the tools used in the analytical process, with particular reference to the strengths and weaknesses of MDCMs as a form of data. These tools are particularly designed with the needs of educators as co-researchers, action researchers and practice-based researchers in mind and will be most useful on collaborative research contexts.

In the following the quantitative and qualitative findings from the three cohorts of educators are compared and contrasted and then discussed. Each set of findings is discussed under each research method: numbers, words and complex MD signs.

Comparing scores

This comparative exercise is possible in the context of scoring because:

each cohort was approximately the same size;

the educators had similar roles;

the time period was similar;

the topic of each course was the use of computers in classrooms;

each map-maker was given a similar heading, the same tools and the same completion time.

$$\text{Connectivity} = \frac{\text{Number of links}}{\text{Number of nodes}}$$

Figure 7.1. Connectivity formula

Figure 7.1. above shows the formula used by the ImpaCT2 team to identify connectivity: a ratio obtained by dividing the number of nodes into the number of links. I interpreted the connectivity score as a means of identifying what changes in understanding there might have been from the first to the second map. I also used them as means of drawing distinctions between individuals and groups. In the literature the suggestion is that 'cognitive activity' is reflected in the complexity of the maps. I will make comments on that later.

Connectivity scores

	Pre-map connectivity average	Pre-map connectivity average	increase	Pre-map node range	Post map node range	Pre map median	post map median
CST	0.83	0.9	0.7	30 to 3	52 to 3	0.82	0.95
PBR	1.01	1.1	0.09	59 to 6	67 to 10	1.29	1.52
MAR	0.92	1.02	0.2	44 to 0	35 to 5	1	0.94

Figure 7.1.a. Comparisons of connectivity scores from CST, PBR and MAR cohorts

Figure 7.1.a. details the scores across the three cohorts. This table shows the average ratio scores in the first map followed by the average scores in the second map. The 'increase' column shows how the connectivity score has increased during the year. In order to show how varied the maps are in complexity the 'pre map node range' shows how widely the number of nodes varied in the first map. The next column provides a comparison over a year. The median scores show the middle point rather than the average, which provides a different perspective on how the maps vary.

Some clear differences in understanding seem to emerge. For example, the average connectivity scores for the Computer skills training (CST) cohort in the UK and the Mentored Action Research (MAR) cohort in South Africa are much the same in the pre-course scores: CST is 0.83 and MAR is 0.82. However, at the end of these courses, the MAR group's connectivity score has increased: CST 0.90 and MAR 1.02. Surprisingly the greater MAR increase had been achieved in only six months, whereas CST had one year to develop their learning priorities. This suggests that the MAR group's understanding increased at a faster rate during the period of the course than that of the CST group. This result may indicate a significant effect achieved by the constructive learning and social interaction programme design enhanced by the mentoring process. It may also reflect a lower starting point and hence a more rapid and greater 'intake' of what to them had hitherto been quite unfamiliar material, unlike for the other two groups. That seems to be borne out by the comments in the next paragraph.

The table in 7.1.a. illustrates that the UK Practice-Based Research (PBR) cohort who follow the most 'scholarly' programme, begin at a higher connectivity level than the MAR group: 0.82 as opposed to 1.01. However the column recording the 'increase' in scores shows that the MAR connectivity score seems to be increasing at a faster rate, especially as the MAR group only had six months in the CPD programme: PBR increase is 0.09 as opposed to MAR increase at 1.02. The chart in Figure 7.1.b. provides an image of these average connectivity scores between the three groups pre- and post-map. Comparing the learners in cohorts in this way suggests that the scoring patterns are consistent and meaningful between the groups.

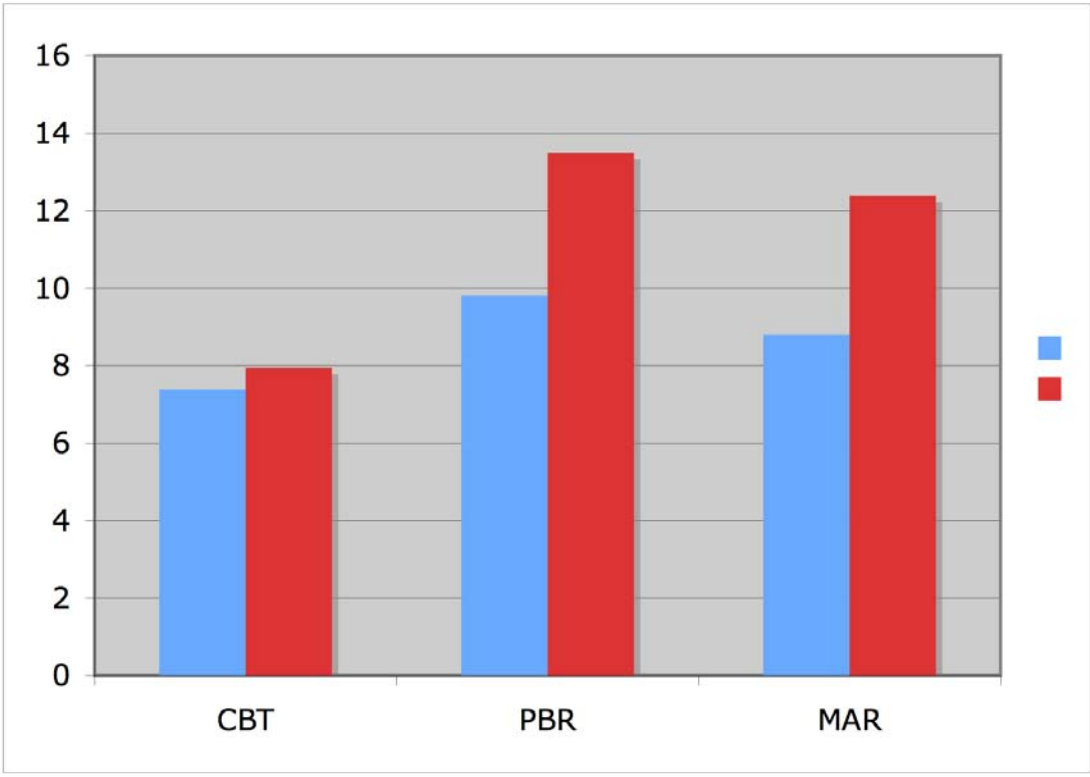


Figure 7.1.b. Graph comparisons of connectivity scores from CST, PBR and MAR cohorts
Key: blue represents first map scores: red represents second map scores.

Range and median scores

The rest of the scores on table 7.1.a. the range and median, indicate patterns of the individuals rather than the groups. When the scores of individuals are compared a far more complex pattern emerges for understanding both within the groups and between the groups.

In the first measure, the range, the separation between the scores is wide in each group indicating substantial differences between individuals' learning priorities in both pre and post maps. The range is smaller, however, in the PBR group and the MAR group in the second map, whereas the range in the CST maps becomes wider in the second map. These range variations suggests that the average marks are disguising significant variations between individuals. My interpretation of this phenomenon is that transfer of knowledge within these two CoPs, MAR and PBR, is increasing the homogeneity of the understanding of the whole group. In contrast, the CST group shows the same diversity at the start and the end of the course. This can suggest that there has been no transfer of knowledge within the group that would reduce the range.

The median was the second measure introduced to discover where the scores were clustered. This was used because averaging the connectivity scores highlighted significant individual differences. For example, the second CST average is higher because of one exceptional CST individual score at 52, but the next highest score is in the 20s and most are lower. The highest connectivity score for the MAR group is 46 by a teacher who scores consistently highly. The PBR range in the first maps, 59-6 and second maps, 67-12, is wider than the other two groups. Possibly, therefore, some of those who chose to do a scholarly course are already engaging in greater complexity of learning priorities. One of the members of the PBR group, Neil, indicates that he is an expert mapper, but his are the second highest scores. The highest connectivity is scored by an adviser, David, who struggles to complete his written assignment, but already uses concept mapping in his professional life and in his personal life to explore his own ideas and to express them. This suggests that concept mapping may advantage some visual learners.

Whereas the CST and the PBR median scores increase in the second map, overall MAR scores drop, in contrast to all the other trends upwards that they show. This suggests that more than half the MAR cohorts are not learning to map their priorities at the same fast rate as the others in the group. One reason might be that these South African mappers may have had less exposure to this way of presenting information because there is a lack of computers in some of the remoter provincial regions. Urban areas compare more closely with the UK as far as personal access for teachers is concerned.

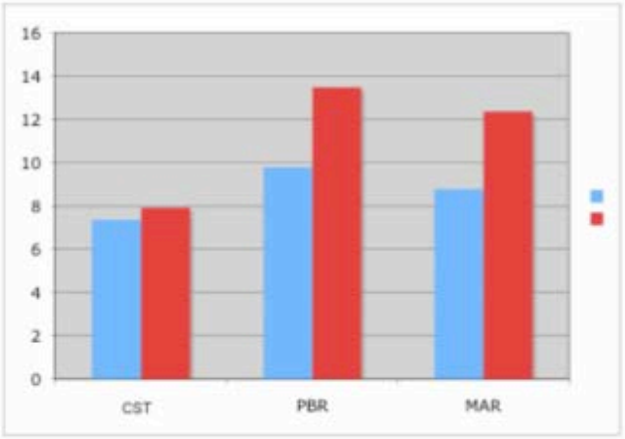
Activity scores

This table shows, in the first two columns, the activity scores before and after the course. The increase column shows what changes have happened and the final two columns indicate the range over which the maps spread in terms of complexity.

The activity score was designed specifically for this study because the connectivity score did not seem to be reliable in understanding individual educator's priorities. Differences in individual scores show up even more markedly in the activity scores: Figure 7.2. The activity score assumes that the map makers still knew the concepts recorded as priorities in the first map although they may not have restated them in the second map. The graph provides a more visual impression of this data. The security of this assumption could be tested in a new study.

	pre map activity average	post map activity average	increase	pre map range	post map range
CST	7.38	7.95	0.57	13 to 4	16 to 0
PBR	9.81	13.5	3.69	19 to 5	22 to 6
MAR	8.8	12.4	3.6	11 to 4	15 to 9

Comparisons of activity scores from CST, PBR and MAR cohorts.



Comparisons of activity scores from CST, PBR and MAR cohorts.

Figure 7.2. Comparisons of activity scores from CST, PBR and MAR cohorts in a table and a chart (Key: blue represents first map scores: red represents second map scores).

In this comparison, using the average activity score in map two, the CST group scores the lowest; MAR is in the middle and PBR at the top. The CST group does less well than the other two groups in this iteration as well. In fact, the second PBR score, 13.5, is nearly double the second CST teachers' score, 7.95. The PBR activity scores, however, show high gains in the second map for about one third of the group. The range increases in the second map for the PBR group suggesting some participants are pulling ahead. The median shows that the cluster for the MAR group is found below the mid-way point, whereas PBR and CST educators show a slight rise above the mid way point. This result conflicts with the other gains of the MAR group and promotes questions about the reliability of these activity scores.

Overall the findings from the MDCMs produced at these two points in time suggest that connectivity scores and activity scores should be used with great care and considerable skepticism

as far as the 'official assumptions' are concerned. They might be useable to establish patterns between groups. If this is so then there is a significant finding because the scores for the CST group, suggest that a significant proportion of map makers appear have to less understanding at the end of the course than they did at the beginning. The implication here is that the information transmission model has not been as successful as the other models. However, as soon as the details are investigated, this conclusion is undermined because of the inconsistency of the score for each individual. This phenomenon is most marked when the researcher moves from peripheral member role to active or complete member role. Knowledge of the individual educators who are in the cohort brings different factors into the equation that makes the validity of the scores doubtful.

Doubts about the validity of scoring the maps seems to be one of the core findings; short of abandoning the use of the method, this will need to be further explored in great detail, in further studies.

Discussing scoring

A further reason for the differences in the scores, that I argue is more plausible, is that professionals with different attitudes towards learning and teaching were attracted by the different ways in which the courses were described. In the CST group, for example, there were higher numbers of participants with qualifications or roles that emphasised computer science, information and communications technology as a subject or responsibility for network management. They were also expecting an information transmission course. Might they have felt, therefore, constrained to guess at what computer science information was required in this mapping test? The CST course was also being tested by multi-choice questionnaires requiring one-word items. This may again have set their expectations incorrectly about the purpose of the MDCMs. In contrast, the PBR and MAR programmes were described very differently when the participants were choosing to register their interest. Some signals about constructivist and social interaction principles underpinning the programmes were overt and some not when the courses were advertised and the selection undertaken. In this case, expectations aroused might have affected the potential participants' perception of the creativity required in the MDCMs right at the start.

An expansion of the former point is that potential course participants, who are sympathetic to a particular pedagogical approach, seek out courses that are designed on those principles. For example, teachers who teach in this way themselves, and prefer to learn by rote might have chosen the CST programme. Does this mean that the PBR and MAR cohorts who elect to join constructivist and social interaction programmes have more learning priorities on average when they begin and end their programmes than the CST group? Alternatively is the discrepancy in the scores caused because the teachers who were attracted to the programmes that gave them more agency were also more motivated about the potential of the programme to address challenges in their own professional and personal lives? This could be a convincing explanation of the discrepancies between the scores because the South African MAR group scores begin nearly the same as the CST cohort, but end with higher scores than the CST group. In addition, connectivity scores in the PBR group exceed the MAR group only very slightly. I would interpret this effect as evidence that the mentors are assisting in a knowledge transfer process within the E-lapa CoP that is more rapid. The cause might be that social interaction as a learning perspective provides space for this kind of interchange grounded in practice and shared objectives. Interpreting the scores in this way suggests that learning through information transmission tends to be more socially isolated because individual rote learning and essay writing are taking place.

What is intriguing about the scoring for the CST is the contrast between the formal evaluation and the evidence of the maps. The formal CST evaluation (Danby and Preston 2004) suggests that the teachers and their trainers considered the course to be successful. Their questionnaire data showed that the majority of these twenty-one map makers had passed the formal multi-choice tests for four to seven modules by the end of the year of study which was seen as criteria for success. The scores for the maps, however, show that in many cases the connectivity score has dropped. The other two methods, analysis by number and by MD sign confirm this and are considered in more detail in the next two sections on words and MD signs.

Nevertheless, before examining the evidence on scoring words and MD signs, I want to return for a moment to the ImpaCT2 study and list the arguments that question the validity of the formula for connectivity itself. Although some valid conclusions have been drawn from the patterns that have been observed in large groups there is an underlying concern. This concern comes from a comparison between the educators' maps and the children's maps in ImpaCT2.

The comparison is valid because the subject matter of the question in this study was much the same as the ImpaCT2 study, and so was the time allotted to the drawing of the map. The same ImpaCT2 formula is deriving a connectivity score from dividing the number of links into the number of nodes. This ratio was used to compare the levels of cognitive activity between children of different ages. The difference between children's and adults' understanding is the only factor that is in contention. However, it has already been shown that many young people are as sophisticated in their knowledge of digital technologies as some adult professionals (Cuthell 2002). The results here seem to confirm that this is so. There is no doubt in this evidence that this kind of multidimensional concept map can promote insights into understanding for both adults and children as learners as well as for adults as educators. There is no evidence yet in this study about children as the teachers of adults; another potential area of exploration in the future.

However, although the ImpaCT2 formula seemed to work well in the analysis of two thousand children's maps, the difficulty for the analyst is that the scores only identify a neutral concept of 'connectivity', not the quality of what has been learnt. The epistemological and ontological unknowns are considerable.

In a study of the scores it becomes evident that, whereas it may be possible to support the notion of connectivity to separate cohorts of learners, the formula becomes differently useable when applied to individuals. There are many inconsistencies as the map-makers in this study have been compared. The first key point is that if the number of links and nodes are the same the ratio of 1 gives no real indication of what is happening in understanding. Percentage points above one are also poor indicators of detailed understanding.

Furthermore, in the prescriptive Novakian tradition the pupils are taught how to map, whereas the map makers in ImpaCT2 were at a disadvantage because they are not taught to map. Neither does the scoring system make allowances for map makers with previous experience like Neil. A new issue emerges in the example of Neil who was the only map maker in the three cohorts who had extensive previous expertise in mapping: Neil's second top-layer digital map scored significantly lower than his first hand-drawn map because he applied higher-order thinking (Bloom 1956) to create hierarchical categories. He is disadvantaged in his scores, however, for thinking more deeply about his understanding of the concepts and how they relate to each other.

Whichever way the formula is applied it only rewards the quantity of links and nodes: the quality of meaning and the layers of hierarchical levels are not defined or scored.

In their defence, the ImpaCT2 team was using quantitative methods in response to a key demand of the government funders: to provide information about learning achievements that could be compared with traditional examination methods. This funding requirement, the team explained, would not of course, 'preclude qualitative, holistic analysis of individual maps as a second stage' (Mavers, Somekh and Restorick 2002 p.5.). This deep analysis that takes place with the young people comes from a more democratic view about teaching and learning in which the subject is deeply involved.

In terms of the scores, however, this study proves that this scoring method cannot be used to compare the progress between two MDCMs of sophisticated learners because they are marked down if they generalise their ideas the second time around – and, thereby, have fewer nodes and links but a more abstract and maybe more generally useful account. Additionally, the second map is influenced by too many other variables in the interim. The results are also influenced by how much the map maker shares with the tutor about strategies in the first place. More training of map makers would make comparison more reliable but this would dampen creative and ingenious strategies.

Conclusions about scoring

In the light of these comparative findings scoring the MDCMs seems to be the least reliable method overall although some insights were provided into patterns occurring within and across the cohorts. Scoring is, probably, best used by researchers for investigating patterns in large groups or, with individuals in conjunction with interviews to explore the reasons for the changes. The evidence here indicates that scoring would need far more refinement before these methods could be used in a formal assessment of learning because the variables over a period of time are so numerous.

Overall the findings from the MDCM produced at these two points in time suggest that connectivity scores and activity scores should be used with great care and some scepticism as far as the 'official assumptions' are concerned. They might be useable to establish patterns between

groups. If this is so then there is a significant finding because the scores for the CST group, suggest that a significant proportion of map-makers appear to have fewer learning priorities at the end of the course than they did at the beginning. The implication here is that the information transmission model has not been as successful as the other models. However, as soon as the details are investigated, this conclusion is undermined because of the inconsistency of the score for each individual. This phenomenon is most marked when the researcher moves from peripheral member role to active or complete member role. Knowledge of the individual educators who are in the cohort brings different factors into the equation that makes the validity of the scores doubtful.

This seems to be one of the core findings; short of abandoning the use of the method, this will need to be further explored in great detail, in further studies.

Comparing word findings

This comparison of the word findings on the concept maps across the three cohorts draws on both the methods used: the quantitative method used by the ImpaCT2 team; and the qualitative process driven method offered by Daly and Pachler (2007) to analyse online contributions.

By word frequency and meaning

In the first quantitative method in ImpaCT2 (2002), the team were concentrating on what the pupils knew about networks mainly in a factual content sense. The frequency of mentions is a key point for the older pupils only as the younger children are asked to use pictures and no words. The ImpaCT2 indicators that emerged from their analysis were, therefore, concerned with the hardware, software, operations, systems and uses of computers in the world of the children. This fits in with Novakian styles of reconstructing concepts in new ways. 'Learning' was the only indicator that looked at process. The ImpaCT2 approach worked best when applied to the CST data because there was a syllabus for the course based on computer science concepts. This syllabus vocabulary could easily be compared with the words on the map.

Surprisingly, however, the analysis of the words on the first maps provided evidence that the large majority of this CST cohort were not beginners as expected. Many already knew more about multimodal applications and the internet, than the step-by-step programme offered to teach them. The content analysis shows that the computer concepts depicted in the second map are

often fewer than in the first map. It seems that a large majority of these educators simply focus on the course content in their second map. They seem to have restricted their learning priorities only to mapping concepts that replicate the software packages transmitted in the syllabus. The references to wider knowledge found in the first maps have largely been dropped from the second map, thus giving the impression from the content analysis scores that these educators know less at the end of the course than they do at the beginning.

The second investigation based on the Daly and Pachler indicators (2007) identifies learning processes: cognition, community, knowledge construction, meta-learning and autobiography. These emerged from their analysis of online dialogues between teachers on the MTeach programme based on constructivism and social interaction as processes, rather than on content. The evidence was limited when the Daly and Pachler (2007) indicators were used to analyse the CST cohort's concept maps because manifest and latent clues about the individual and social learning processes were not present. In this CST group most of the social interaction appeared not be professional but personal in nature. Of most concern to potential tutors in the second CST maps would be some references to emotions betraying distress about the subject and unease about the tests that was not evident in the first maps. These affective issues are returned to in the section on complex multimodal signs.

The ImpaCT2 indicators produce different results when the PBR and MAR maps are analysed. There was no agreed body of knowledge to be transmitted in these two programmes based on constructive and social interaction principles so individual project vocabulary was expected to differ significantly. Nevertheless some useful patterns also emerge. What is common in the group content analysis results for MAR and PBR is the growth in manifest variables that showed how concrete computer concepts are accumulating between the first concept maps and the second.

The South Africans presented fewer concrete computer concepts than the CST group in the first map because the majority has had limited exposure to computers. However, even at this first stage the South Africans had a greater understanding of the general opportunities that computers provide than the CST group and clearly articulated aims about why they wanted to master computers. At the start of their digital journey, they were not inhibited about expressing their hopes and fears about the ways in which digital technologies would improve their opportunities in

education and in employment. They were also more aware of opportunities for exchanging information with international partners.

By the time of the second map, the South Africans' concrete concepts expanded although they had not followed a formal computer syllabus. Their basic concepts in the second map, especially in interactive and multimodal areas as well as potential computer locations, ranged wider than the CST group who undertook a formal one-year computer skills course. This awareness of abstract computer uses also expanded in the PBR cohort. In addition, the content analysis provides particular information about cultural attitudes and e-maturity that scores based on numbers do not identify. For example, the lack of jobs in the South African province emerges from these concept maps.

When the Daly and Pachler indicators are applied to the concept maps in the MAR and PBR groups there is pronounced evidence of awareness of the value of autobiography and community. Furthermore, in the PBR group where 'building a community of practice' aspects of the design extended beyond the end of the course, latent linguistic indicators illustrate growing self-awareness of the learning processes they are experiencing. These include knowledge construction and learning community development.

The transcript analysis

The most important element in understanding the map makers' priorities emerges from the transcripts of conversations between members of the PBR group. Here the greatest value of the Daly and Pachler indicators is illustrated in uncovering participants' awareness of the innovative learning processes they are experiencing. Transcripts of discussions could not be recorded in the other two groups because the CST research was conducted remotely, and because the MAR project was cancelled before the joint evaluations of the concept maps had taken place.

Discussion of word analysis

All this has thrown up some significant doubts about the value of scoring the links and nodes of a concept map, in the manner advocated by the proponents of the method. I will return to this issue

later, Analysing the word content proves to be valuable in gaining insights into learning priorities whether this is done quantitatively or qualitatively.

Taken at face value, the results suggested that most of the CST teachers either did not learn anything new or chose to restrict their communications to the software packages they were mastering step-by-step. This runs counter to other – even if informal evidence; it suggests that the reasons for the sense of achievement expressed by the CST cohort in their final multi-choice test were not necessarily the success of the course design but the relief at passing the test. What, then, can be deduced from the formal tests about the real state of the educators' knowledge? Many knew far more, even before the course, than the tests revealed.

By contrast, PBR group vocabulary indicates self-awareness of the learning processes and valuing of the 'scholarly' exchanges through social interaction. Even though I have not introduced the materials on which the following comment is based as 'official data' this hunch about the group becomes evident in the transcripts of the interviews which I conducted with participants.

The word analysis was effective at identifying PBR and the MAR expansion of learning priorities between their two maps as groups. Perhaps as a result of working with mentors from England, the MAR group shows particular keenness for the learning potential of global social interaction in CoPs. Nevertheless just as in the scoring results, the differences in conceptual growth and priorities were far more individualistic when each educator was considered as opposed to the patterns across the groups.

Conclusions about word analysis

Overall, the words used by the map-makers provided rich insights into the learners' priorities across all the concept maps, as well as highlighting some cultural and professional differences. A new perspective on the meaning of words was introduced from a multimodal perspective, because of the realization that their (material) size, their 'style' and the relationship to other objects also transmits meaning. This was the reason why words were included as an equal element of a holistic MD sign in the next section.

Comparing the findings for complex multimodal signs

In this section the findings about concept maps as complex multimodal signs are compared across the three case studies in order to answer questions about the value of the three methods. In the first place some general observations are required about the balance maintained between signs with a focus on words and other multimodal signs in this final stage of the analysis. The words on the maps that have been discussed in the previous section are, indeed, a rich source of information. However, the emphasis in this section on holistic MD sign analysis is intended to focus attention on all modes of expression, which means modes that are not only linguistically based. In this context, semiotic features, such as the relative 'graphic' sizes of words and phrases, under-linings and vigorous rubbing out, 'imaginative' use of punctuation and accompanying graphics are all part of the meaning of the maps. The analysis shows that in this approach, MD signs 'transcended' the 'literal meaning' of the words on the maps.

What also needs to be noted is that the individual details of hand-drawing that are so meaningful are not present once digital concept maps are used. One issue therefore is to understand how such meanings - of emphasis, foregrounding and so on - are expressed in digitally produced maps. There is also the question of multiply authored maps where gains in collaboration of any kind, whether facilitated by digital means or not. Some of the possibilities of expression of the manually produced maps may be lost, unless we discover how such meanings appear in digital form.

The first stage analytical framework used for the 'holistic analysis' of the MD signs is shown in Chapter three, Figure 3.3. It was treated separately with respect to the three pedagogical divisions representing the CPD programme designs: information transmission; constructivism; and social interaction as the headings.

A few teachers in the groups did not illustrate the heading as given: they did not divide concepts into professional and personal. Looking across the groups, in the information transmission category the main differentiating element between map makers is the propensity to put the computer in the centre of the map rather than images of themselves. Some computer graphics are comparatively large, which may suggest a meaning of dominance of computers over humans.

The CST group, the first group, used pen and paper only, as requested. However, although they were offered black pens and paper only, several teachers in the groups found coloured pens to

realise their meaning. Some PBR educators chose desktop publishing and digital mapping and even some of the MAR group, with the most limited resources, still managed to gain access to desktop publishing.

Dimensionality is displayed in one map in the PBR, where Neil uses the affordances of software to 'layer' linked maps (Figure 5.6.b.)**.** To show dynamic connections, some map-makers used arrows, indicating how elements of networks link, whilst others used arrows to show how they personally link with other learners, their communities and their families.

Under the rubric of 'constructive learning' – i.e. learning in the constructivist environment- what is striking about many CST second maps is the seeming lack of progress in depicting their increased understanding: a feature I have mentioned at the beginning of this chapter. In many cases there seems to be a reduction in content. Overall there seems – on a superficial reading - to be less confidence in the drawing of the second maps. One hypothesis is that the map-makers have become confident enough to generalise: simplicity as a sign of a deeper understanding. The other explanation is as I have suggested earlier: the preferred, canonical' account about reading maps is too crude. Yet in the other two groups, MAR and PBR, many second maps are more complex and innovative. Humorous details and autobiographical comments increase and there are more graphics in place of writing, although this is not a strong trend for all. Many use the complex multimodal signs to portray their meanings by size, colour, graphic elements, various emphatic devices and humour: methods that transcend what words can convey. In other words, to reiterate, a much subtler approach, with detailed information about the map makers needs to accompany the use of concept maps in professional learning situations.

Three resources for educators

The comparisons between the three methods of analysis suggest that as a research tool the concept map has a potential role in studies about professional learning. But this semiotic approach to meaning making is still quite new to researchers and educators who have been training to use words in data gathering and analysis, but often have far less experience and knowledge in how to make use of multimodal forms of expression.

In this section, therefore, I describe the three research tools that I have designed in an effort to provide scaffolding for researchers and educators who are keen to experiment with methods of gaining insights into professionals' understanding of digital technologies. These tools are, by no means, definitive and colleagues are invited to critique them in use and share the results for others who want to tread the same path. These resources are also designed to be used by groups of educators and researchers who are defining their task through debate rather than by individuals who do not have the opportunity for social interaction in their project. The resources might be used in the context of action research or scholarly research (see section, Constructivism or Constructionism p. 59), or they may be used in research projects where the researcher is an active member researcher and the subjects of the research have an agential role as a co-researchers (Preston,Leask and Preston 2011, in press). All three resources below are designed to be used as scaffolds in collaborative research contexts.

The first resource is a tool to help researchers and educators to identify what kind of researcher they might be in projects where there is a clear division between the roles of researchers and subjects as well as projects where the relationship between lead researchers and their 'subjects' is more equal.

The second resource is a framework to support researchers and co-researchers who want to gain some more detailed knowledge of existing multimodal theory that can be used to analyse complex multidimensional signs to gain insights into the learners' understanding.

The third resource is a digital concept map showing some of the benefits and challenges in using concept maps for different learning outcomes. This concept map, intended as a guide for further thinking, could be used to trace what kind of learning perspectives are associated with different types of maps: information transmission, constructive learning and social interaction. The concept map is intended to be used as a tool to promote discussion amongst researchers and educators rather than a definitive concept map of all the benefits and challenges.

Resource one: a framework for identifying researchers' multiple perspectives

So far the main concentration in this last chapter has been on the findings from this study that focus on insights about professional understanding of digital technologies derived from situations

where the learning perspectives were information transmission and constructive learning. In terms of social interaction as a learning principle, both the PBR and the MAR course designs were predicated on the concept of the members of the course being treated as a community of practice that would have a life beyond the duration of the course. However it is a limitation of the methodology that only two data sets that illustrate social interaction as a learning principle are the PBR group discussions about the pairs of maps and the collaborative map that members of the PBR group created spontaneously.

The lack of opportunities for illustrating the power of collaboration in a CoP is a limitation that was not foreseen when the research methodology was devised. The limitation has been overcome, however, not in this study, but in further research into the value of collaborative maps that took place during the time when this study was being reviewed (Leask and Preston, 2011, in press).

The purpose of the table in figure 7.3, *A framework for identifying researchers' multiple perspectives,* is to trace my progress as a researcher in this study and what I envisage as a potential future for research into professionals' understanding of digital technologies. The framework can be used groups of professionals who want to think more deeply about how research into practice might be conducted, what the role of the researcher might be and how influence over policy might be achieved. Overall my observation was that in the complex 'communities of practice' context where there is professional trust, learning, teaching and researching roles naturally flow into each other. In the community of practice, complete member researchers are learners (or maybe 'lead-learners') whether they are teacher educators, advisers, teachers, or even pupils. These complex learning relationships blur the boundaries between researchers, learners and educators in the liminal space discussed on p.25. This liminal space is an intellectual space in which the learner allows the ideas of the group to influence their trajectory.

The remotely-authored digital concept map that is now used in MirandaMods was inspired by the hand drawn concept map drawn by member of the PBR group. This digital space becomes a liminal space in which collaborative knowledge can be created in a visual form as it develops. A similar role was envisaged for the digital concept map in a study of the ICT CPD Landscape (Pachler, Preston, Cuthell, Allen and Pinheiro Torres, 2011).

The various roles of the researcher in a project about education	The role of the professional educator in a research project	The impact of the educator on professional policy and practice
Peripheral member researcher (PMR) Adler and Adler 1987	When an educator is the subject of research rather than being engaged in the process the profession gains little from the exercise. Too often the subjects of research reports do not have the opportunity to read them, or, if they do find the academic language obscures the value for their practice. (An example is the Computer Skills Training evaluation that was not available to the subjects).	Little or no impact on professional policy and practice.
Active member researcher (AMR) Adler and Adler 1987	During a research project the educators are aware of the aims of the project and have access to the data to use in order to build their own professional knowledge. Their observations can also enrich the researchers' insights into their understanding. (An example is the analysis of the PBR cohort's own pairs of maps in the group exercise in order to gain insights into their own learning).	Professionals can have impact on the practice and policy of their own community of practice when they reflect together and gain insights into what seems to work and what does not. This professional engagement in professional activity is substantially different from being told what to do.
Complete member researcher (CMR) Adler and Adler 1987	In the action (or practice based) research context in this study, an accredited course, professionals negotiate their own topics in relationship to their personal and institutional learning agenda and share the findings as well as submitting them for accreditation.	Impact on practice and policy only becomes a reality when professionals have some ownership of what is to be researched as well as the opportunity to share their findings. (in this study the members of the PBR course submitted their practice based research findings to a consultation about e-learning by the UK Department of Education).
Collaborative member co-researchers (CMCR) Sachs, 2003 The activist professional Zeichner, 2008 The Third Space Leask and Preston, 2011 (in press) The collaborative co-researcher	The hand drawn collaborative map created by members of the PBR group in this study was the stimulus for designing a research methodology in a later study (Leask and Preston, 2011, in press) that involved ICT professionals as co-researchers in a project exploring the potential of ICT Tools for Future Teachers. The data collection tools were a series of digital multidimensional concept maps created by groups of professionals analyzing what they knew.	Professionals need to develop a publishing route for themselves in order to be heard by government and to have real impact on policy and practice. (However, publishing in the academic genre still debars many professionals from writing and from reading the results).

Figure 7.3. A framework for identifying researchers' multiple perspectives

The framework is intended to ensure that discussion about these potential roles and processes are explicit from the start if educators are undertaking different levels of research. The intention is that the framework will encourage more educators to engage their students as equals and professionals in learning. In detail, the first column on Figure 7.3, *The various roles of the researcher in a project about education*, cites the literature that I have drawn on in defining the researchers' different roles: peripheral researcher; active member researcher; complete member researcher; and, collaborative member co-researcher. This column, reading down, traces my move from a traditional 'objective researcher' through to being a complete member researcher, and into a new role of working alongside others as a co-researcher. The intention is that educators can reflect on their relationship with their 'students' by deciding on their place in the chart when they are in different teaching situations. This exercise is intended to support educators in defining the role they want to have with their students as much as researchers with their subjects.
If the emphasis on the researcher's potential role and their relationship is understood, this will help, in my view, to clarify the value of the data.

The framework records the difference between the way I viewed research activity at the beginning of this study and the way that I view a researcher's role now. As a researcher during this experimental project (see My Doctoral Journey p.13) I observed a significant change in my relationships with the subjects of my research. I passed through all the categories identified by Adler and Adler (19870: peripheral researcher; active member researcher; complete member researcher. Finally I realised, when the PBR students created their own collaborative map of e-learning theory, that I was in a new relationship that could not be entirely explained from the perspective of ethnography (Denzin and Lincoln 2000). This fourth role, a complete member co-researcher working alongside 'students' as co-researchers, is distinctive in the sense that the 'subjects' become agents in the research. The lack of hierarchy in the role-relationships can be an important impetus for social interaction in a CoP particularly if this grouping is set up to provide informal professional learning by the members themselves. Agency begins to shift from the external funder's agenda to a CoP agenda: research topics generated from the grassroots.

The framework in 7.3. is, therefore, intended to assist researchers who want to promote social interaction not just as a means of learning, but as an analytical mode of reflection. This framework is intended to help the community to define roles and professional relationships collaboratively at

the beginning of a project. It should support a group vision about who are the agents in the research and who are the 'subjects'.

The second column, The role of the professional educator in a research project, is dedicated to defining what teachers have to gain from being involved in research projects. The examples are taken from the case studies. The CST teachers who provided the maps for the computer skills course had no opportunity to gain insights into understanding from their own map, because my role as a researcher was to collect the data remotely. Much research is done by sending questionnaires by post or posting them on the internet. The researcher has to hope that the respondent understands what the context of the study is and what kind of response is required. Although some checks can be put in, the researcher cannot be sure that the respondent has given their full attention to the answers or even told the truth. The response rate to such questionnaires is usually poor. In our case only two trainers of the five who were organizing the pilot responded to the request for completed questionnaires and pairs of concept maps. Low levels of response are not surprising as neither the trainers nor their trainees had much to gain from taking on this exercise at the end of a busy session.

In conventional research there are some advantages in not knowing the respondents because the researcher cannot be accused of bias. But my dissatisfaction with remote data collection was focused on the needs of the map-makers who I never met. In this case, the research design was developed by the funders who decided that the time and cost of travelling to collect the data could not be afforded. The educators who gave time to this questionnaire were not able to learn from the experience unless they happened to see the research report by accident. The MirandaNet team had no way of sending the report to these teachers as the responses were anonymous. The issues in the CST evaluation illustrate in a small way the kinds of challenges that emerge when teachers are used for research information, but do not gain any reward in learning.

The rows that follow in this column that correspond to data collection points in the other two studies under review, PBR and MAR. The columns illustrate how the different forms of data collection give these education professionals in a community of practice growing control over how the data is interpreted. In the final column the collaborative map, hand-drawn by members of the PBR group, becomes the stimulus for giving professionals more opportunity to analyse their own data in later studies.

The professional value of engaging teachers in their own professional growth is encapsulated in the third and final column, *The impact of the educator on professional policy and practice*. Here it is clear in the first row that educators, like the CST group, who are not engaged in the aims of the research are not able to have any impact on policy or practice. The second row describes what can happen when teachers are engaged in a data collection exercise: in this case analyzing their pairs of maps in couples and groups after the 'objective' researcher had volunteered a 'score'. Disagreements with the 'objective' scores were high. In contrast, there were indications that in the sharing of each others' understanding of digital technologies, many insights into understanding were gained within the groups. Sadly there was not as much data as expected in this category, but others might like to pursue this trajectory.

Row three picks up a more formal approach to research within a course which is accredited. The PBR group were pursuing practice based and action research for the duration of the Masters module where they were able to chose their topic within the parameters of e-learning. Some took the chance to share their findings at local level and had the experience of impacting on the development plan of their institution or even their region. The PBR group also had a national opportunity because presented their findings to a representative from the Department for Education and Skills and combined those findings in a submission to a national consultation on e-learning. A course like this can create the experience of a belonging to a community of practice even if finite. However, some members of the PBR group who belonged to the professional community of practice, MirandaNet, mentored the MAR group. Volunteering to support the South African venture was endorsed by their schools as a CPD opportunity. This also gave the mentors the taste of international professional influence which has since been reproduced in China, India and Mexico.

Row four represents the most professional situation for teachers when they become co-researchers in research projects. This gives them authorship and ownership of research findings that can influence professional policy and practice through publication in the same way that doctors and lawyers do.

Resource two: a framework to support the analysis of complex MD signs

This discussion focuses on a particular outcome from the findings: an emerging framework for the semiotic analysis of a multi-dimensional concept map. Figure 7.4. This is an adaptation and extension of the original framework used for the analysis shown in Figure 3.3. Chapter three designed to help the researcher, especially the work based practitioner, to see words in a new relationship with other modes of communication.

MDCM features	Evidence	Key theorists
	information and transmission	
Concepts inclusive of the linguistic metafunctions ideational and intrapersonal meaning	Grouping of ideas and themes towards a key summarising node; symbols used for ideas and how they are juxtaposed and connected in clusters; a classificational or an analytical design with some political implications: a hierarchical shape or network style map perhaps denoting authoritarian or liberal knowledge patterns.	Kress and Van Leeuwen 2007, Halliday 1978
Cognition and metalearning	As above	Daly and Pachler 2007
Compositional elements and their interrelations	Framing. Positions on the page, sizes, foregrounding and marginalising etc.	Kress and Van Leeuwen 2007 Mavers, Somekh & Restorick 2002
Modalities	The features of the map that promote veracity from the point of view of the map-maker- shading, colour, brightness etc.,	Kress and Van Leeuwen 2007(second edition) Mavers, Somekh & Restorick 2002
Materiality of Meaning	Surface textures, inscriptions and additions	Kress and Van Leeuwen 2007(second
Dynamics (1)	direction of links and arrows: animation of images and lettering showing interrelationships between concepts	Mavers 2004
Dimensionality	Multilayering and hyperlinking	Kress and Van Leeuwen 2007(second
The Third Dimension shifting the potential research perspective from viewer, reader and audience to user	MDCM in 3-D sculpted materially or designed digitally for passive or interactive use. For example, participants could walk on a map sculpted on a floor or walk around an MDCM built in Second Life and act from a node.	Kress and Van Leeuwen 2007(second edition)
	Constructive Learning	
Narrative inclusive of the metafunction of textual meaning	Trajectories that tell a story to a viewer, a reader or an audience	Kress and Van Leeuwen 2007 Jewitt 2003 Halliday 1978
Knowledge construction and autobiography	As above	Daly and Pachler 2007
Affectual factors, ludic qualities	Indications that the learning was not only cognitive but affective.	Kress and Van Leeuwen 2007
	Social Interaction	
Representations and interactions inclusive of the metafunction of textual	Indications of relationships between the map-maker and viewer, reader or audience	Kress and Van Leeuwen 2007. Jewitt 2003 Halliday 1978
Community	As above	Daly and Pachler 2007
Dynamics (2)	Direction of links and arrows showing interrelationships between people within communities of practice	Mavers 2004

Figure 7.4. An emerging framework for analysing multidimensional maps

The Daly and Pachler indicators (2007) have also been added to the framework as a reminder that understanding can be expressed both by content and in evidence of processes of interaction. And while these indicators were developed to explain features of online discussions between teachers they seem to work well in highlighting some of the learning processes illustrated by the map makers.

Resource three: identifying learning perspectives

Some important evidence that concept maps can scaffold change in learning was found in the transcripts of group conversations discussing the maps. The teachers' exchanges indicated that concept maps were an effective tool in a CPD process in which the educators as the co-researchers had real interest in the outcomes. In this social interaction they were comfortable sharing as equals their observations about their understanding.

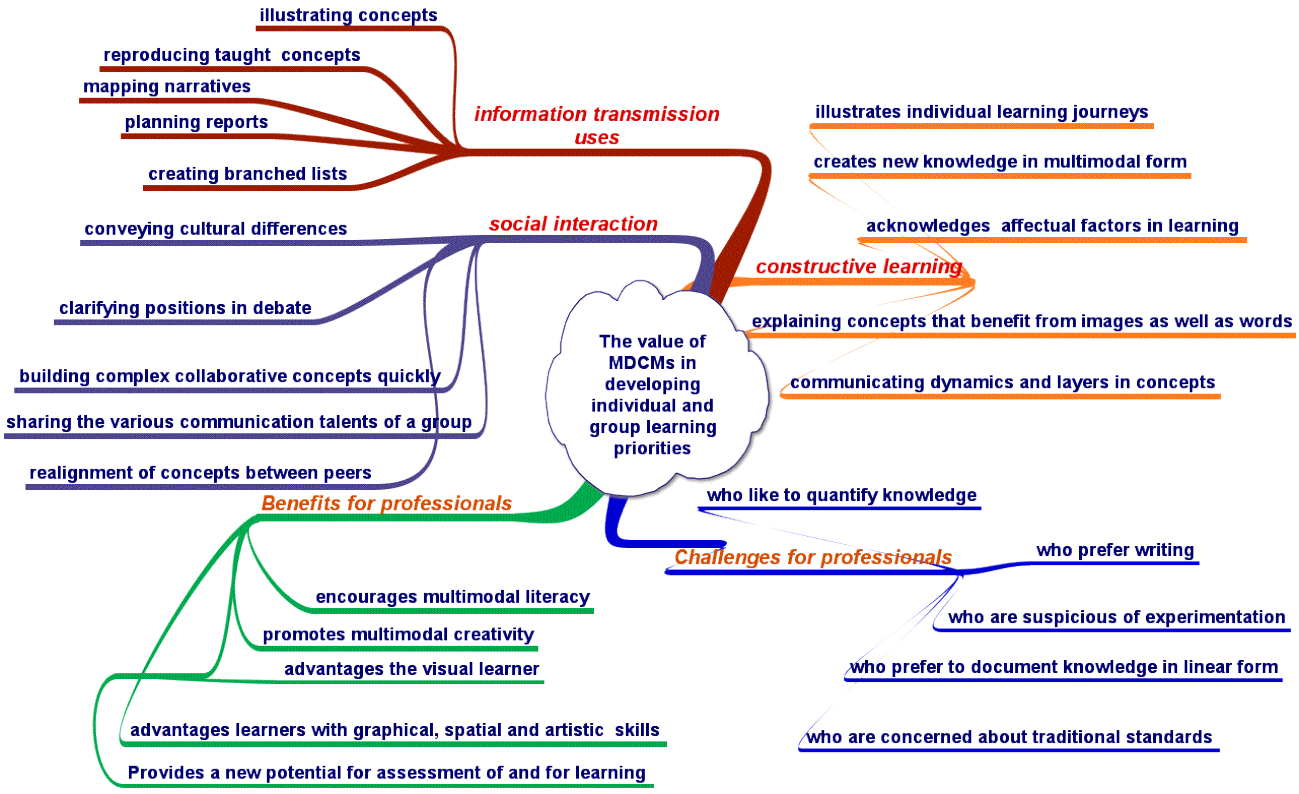


Figure 7.5. The value of concept maps in identifying individual and group learning perspectives

In the light of this finding I brainstormed the uses of concept maps in the classroom with a group of MirandaNet Fellows which resulted in the collaborative map shown in Figure 7.5: the value of concept maps in identifying individual and group learning perspectives. This map is not intended to be definitive, but to provide a scaffold for educators as researchers who want to use concept maps as tools in the context of different learning perspectives: information transmission; constructive learning and social interaction.

In detail, the first branch to be discussed refers to concept maps used in information transmission contexts. The only evidence was in the computer skills course because there was a clear syllabus with detailed subjects to be mastered. By correlating the syllabus vocabulary with the words on the concept maps it was possible to see how much the map-makers knew before the course began, how many of the subjects they were still referring to at the end of the course and how much they had added from their own wider knowledge. From the semiotic point of view, the shape or position of the key word sometimes indicated how the map maker perceived the importance of that subject against others. Some of the first maps showed a wide-ranging knowledge about computers with references to networks and desktop publishing. In analysis the data showed overall that many of the map makers restricted their input on the second map to elements of the syllabus that they had been expected to cover. In this context, creating a branched list was an effective method of recalling structured information within a computer topic. The concept analysis process also encouraged the editing and restricting content to the syllabus topics, skills that amplify the ability to answer a question appropriately. The findings suggest that concept maps, for example, can be used to outline an argument that does not stray off the point. Activities might be mapping a narrative and planning a report. As the Novakian school have proven the concept maps provide a useful medium to illustrate ideas and concepts that had been imbibed, such as the relationships between the elements of an integrated software package.

Whereas many CST teachers constrained themselves in the second map from straying beyond the syllabus, the PBR and the MAR groups adopted no such constraints, as they had been encouraged to define their own learning topics for practice-based research. They used the second maps, for example, to reconstruct the knowledge they were gaining from their work-based projects in a form that would speak to their audience. Members of all three groups also used the concept maps to illustrate features on their professional and personal learning journey and to depict the frustrations and triumphs they had experienced. The semiotic affordances of both the hand-drawn

and the digital maps also allowed them to depict the more dynamic and layered elements of the concepts, like networks, that they were aiming to describe.

The MirandaNet authors of this visual aid also mapped the benefit and the challenges of using concept maps in classrooms for other teachers to consider and perhaps add to particularly if they are engaged in research projects using concept maps.

The final importance of this map is that it shows how a group of professionals can map a field in about one hour on a large screen that may be of benefit to colleagues in the future. The concept map offers a visual overview of a collaborative knowledge building episode on one page or screen. It might be useful in stimulating the research project planning of work-based researchers and was the beginning of MirandaNet research into the use of collaborative maps in MirandaMods[36].

Conclusions about the three analytical methods

The greatest gains in the analysis of the hand-drawn concept and digital maps in this study as multimodal signs seems to be the potential of the commentaries on individual learning journeys for researcher, tutors and the map-makers. Some of these illuminating journeys have been covered in Chapters Four, Five and Six. Any other set of choices of concept maps would, of course, have produced somewhat differently shaped stories given the range and depth of learning experiences that the map-makers communicated.

Here I have presented an emerging framework for the semiotic analysis of concept maps. My sense is that in the future the concept maps – in a rethought fashion and augmented by detailed data about the map makers - will have an important role to play in the reconstruction of meaning by individuals and groups in order to create their own version of existing knowledge. For that to happen some of the problems that I have identified and to which I have drawn attention will need to be resolved. Some of these are issues such as reading complexity versus simplicity; using the maps with groups rather than individuals – and identifying what they do, differently, in each case; 'mapping' the starting points of the understanding of each individual carefully. My study does not

[36] www.mirandanet.ac.uk/mirandamods

lead me to dismiss the usefulness of the method: the maps, properly used and understood, offer a significantly different route to describing and tracking changes in understanding the multiple ways in which learners engage with the world presented for their engagement. It reveals learning as a significantly different process from simply repeating 'facts' that had been presented. These newly minted concept maps, will help educators to experience and theorize some of the processes of learning in the twenty first century. It shows understanding, from the semiotic stance of meaning making, to be intricately linked – identical maybe - with the making of signs and the making of concepts (Kress and Pachler 2007).

Overall conclusions

In particular, the thesis has contributed to concept mapping theory and practice in terms of its methodological orientation around concept maps:

a critique of scoring methods using in government funded projects;

an endorsement of the value of the words used in on concept maps in analysing understanding of digital technologies;

the establishment of an emergent framework for the multimodal analysis of concept maps;

the establishment of the differences between the value of digital maps and hand drawn maps as data in gaining insights into professional understanding.

Other gains are also recorded that will assist educators working with adults and with children using concept maps in different teaching contexts and from different learning perspectives:

the professional value for map-makers who talk about their concept maps in pairs and groups;

the value of encouraging a collaborative approach to map-making in gaining insights into digital technologies;

the value of professional publication of practice based research.

Other observations are also relevant. My original hypothesis was that the use of concept mapping as a research tool might provide researchers with more understanding about changes in educators' understanding relating to digital technologies, more than conventional research methods could do. It has emerged that concept maps have value for the educators as map makers as well in gaining insights into their own understanding of digital technologies. In this overlapping of roles I have gained as a researcher and also as a professional teacher educator.

Overall the thesis answers the research question in chapter two and the theme that threads throughout. To summarise:

> How does multimodal concept mapping provide insights into educators' understanding about digital technologies?

The main findings that I have identified about the value of multidimensional concept maps in providing insights into educators' understandings are that:

- scoring results are heavily influenced by particular contexts and complex variables. It will require much theoretical, and practical work to smooth out the real difficulties at the moment especially for teachers engaged in research in their classrooms.

- multidimensional concept maps do appear to have potential as a research tool to highlight the value of different learning perspectives and to trace learning journeys. There are indications that there is significant value when the map-makers themselves are given the opportunity as individuals and in groups to be reflective about their professional learning. This benefit comes into play mainly when they draw maps as co-researchers. The maps can also be used to draw the attention of professional educators to affective issues that may be impacting on their understanding.

My initial research question had not, however, predicted some of the findings that emerged. I had not foreseen, for example, that this research project would advance the study of looking in more detail at all the features of maps (what might be regarded as their 'multimodality') in its dynamic and multidimensional aspects in the social interaction context. In this context this study:

- establishes the value of the affordances of concept maps;
- presents emergent tools designed for educators engaged in practice-based or action research to develop further;
- provides an emergent framework for a broader analysis of concept maps;
- provides a framework for educators to use in scholarly or practice based research to identify the roles of the map makers, the teachers and researchers in the project;

- offers a digital mind map identifying the benefits and challenges of concept maps as a tool to be used in designing teaching and learning projects.

Overall the emphasis on the use of the maps as a means of describing changes in understanding is a major shift away from hierarchical learning approaches to a more 'horizontal' view of learning. Some claim is made that concept maps can promote the co-production of knowledge, a co-determination of meaning, collective problem solving, and multiple perspectives among learners and between learners and teachers. Concept maps provide a distinctive new tool for collaborative knowledge sharing because they provide a means of making meaning that is visual. These findings provide new perspectives on the MirandaNet Braided Learning approach to creating knowledge online which is work-based and seeks relevant practices to share (Haythornthwaite 2007; Preston 2008; Cuthell and Preston 2009; Preston 2010). Altogether the evidence suggests that the teaching profession can be the agents of their own professional learning agenda and of collaborative involvement in professional change – fulfilling Sachs' hopes for an 'activist profession' (2003).

Publication outcomes

The publications that have emerged from this thesis have developed the notion that professionals should be agents of change. Five key publications have emerged so far. The notion of professional practitioners, as activists, using concept maps to influence policy that is explained in Chapter five, provided a book chapter about how the collaborative map was used to influence national policies on e-learning in England and Wales (Preston 2009). In another study, funded by the Becta, the government agency in England and Wales for ICT, practitioners developed group concept maps based on related to education phases. In a mode of Braided Learning where the map-makers are privy to the aims of the research, they shared ideas about the *Future of ICT Tools* in schools, and analysed the results in order to advise government and industry on future directions (Leask and Preston, 2011). In another Becta study, representatives of the ICT community in the UK were asked to build a concept map about how teachers' need for ICT CPD was being met in 2010 (Pachler, Preston, Cuthell, Allen and Pinheiro Torres 2011). Understanding how the maps can be used is also being extended and deepened in the knowledge creation activities stimulated by MirandaMods (Preston 2011: Cuthell, Preston and Cych 2011 in press).

Postscript

I have inserted this postscript in order to reference projects that have emerged from study, to discuss the limitations of this study and to mention the insights that were gained beyond the scope of the research question.

There are comments also to make about the limitations of the study and the insights gained because this thesis is a representation of an earlier text. Consequently some of the limitations of the earlier text have been addressed. These concerns, broadly speaking, are encompassed by my attempt to limit the content and avoid too broad and ambitious an approach. The present text aims to be, in that respect, more focussed in its scope, providing more secure insights for me and I hope for others who may wish to study this subject.

Nevertheless, there are some comments that I would like to make in hindsight: about the material limitations I unwittingly imposed on the study; about the limitations of the methodology I choose; and, about the value for me as a reflective professional.

Material limitations

It is, of course, the case that the data was 'collected' between 2003 and 2006. Much has happened in the field of concept mapping since then, most particularly the growing availability and affordances of digital concept mapping and the greater emphasis on collaborative mapping (Chaka 2010).

With hindsight, a major frustration towards the end of the data collection period was the limitations I felt I had imposed on the map makers materially. On the one hand, for example, I provided A4 paper only so that I could scan the maps easily for the analytical stage: in doing that I restricted the size of concept map that the educators could aim for and limited their creativity. On the other hand, more map production training and time would also have been needed if the teachers were to have had a more reasonable opportunity to make meanings more fully, whether manually or with digital maps software.

However, the limitations that I both wittingly and unwittingly imposed on the creation of the maps had one advantage in terms of multimodal analysis. I discovered that the design of a digital map is largely defined by the software designer. There may still be occasions when researchers have good reasons to use digital mapping, but the advantages of using paper and pens in terms of ease of access and freedom of design restraint in composition is considerable. If I had found ways to ensure that all the participants used digital concept mapping the rich semiotic texture of the hand drawn maps would have been missed. In thinking this through now I am surprised to realise that were I to repeat concept mapping evaluation in a situation where all the teachers were trained to use concept maps and had access to them I would still choose hand-drawn maps if I was looking for an assessment of the individual's understandings.

Methodological considerations

I now turn to the methodological considerations that hindsight has clarified. It is now a matter of regret that significant effort was expended on detailed comparisons of the concept maps in the sample by means of 'scoring'. The methods had been developed by combining Novak's methods and the ImpaCT2 approach. Because of my respect for these researchers, I expected more from the techniques than perhaps I should have done.

I might have realized in my research design, the difficulties that would be created in trying to establish correlations or even cause and effect between the perspectives on learning I had identified and the connectivity scores. The variables in this process are far to great to allow valid correlations to emerge.

I am also critical from the first in this study about the ImpaCT2researchers' notion that evidence of the volume of thinking activity in the concept maps was proof of understanding digital technologies. The scoring only showed how much information had been committed to the concept map. This score was not an indication of the map makers capacity to decide on the appropriateness of the thinking or to provide an analysis of what had been learnt. Yet, when the data in this study proved 'inconclusive' and 'unreliable' I did not abandon the effort because scoring was not illustrating understanding. In fact, I tried other formulae when, in hindsight, it might have been better to state early on that small differences in scores cannot illuminate the realities of holistic learning. However, throughout the study I was attracted by the possibility that if patterns could be traced across large groups - in the way that ImpaCT2 appeared to prove - then

the scores might have value for understanding individuals. The PBR map makers confirmed my suspicion that the scores alone - as established by the Novak / ImpaCT2 method - had no meaning for individuals. In their group interviews, the PBR group intuitively rejected the scores given to them by me as the 'objective' researcher. The richness of those discussions displayed more about holistic learning than notions of learning measured as 'connectivity score' could offer.

A somewhat trivial yet real point was that the scoring method was complicated and tedious; more important was the fact that it did not produce the kinds of results that would give an educator more insights and understanding, because the differences were too variable and, in any case, based on a doubtful theory of cognition. Less time spent on this would not have compromised the outcome of the research.

As it turned out, a core methodological means would have been the group interviews about the concept map evidence at the end of the PBR and the MAR courses. That was something that only emerged as the real limitations of the recommended ways of using the scoring methodology appeared. But the – for me highly important - conclusion that I draw, now, from this, is the methods of concept maps alone was definitely in need of complementation by, for instance, interviews and group discussions; though other forms of data could easily be imagined. In later studies I have been far more focused on what the map makers can gain from the experience in terms of insights into their own understanding as individuals and as groups (Preston 2010: Leask and Preston 2011 in press).

One other point that has become clear to me in this revision is that much more attention could have been paid to specific aspects of concept maps. So, for instance, where the maps had become simpler over the year – a negative feature in the recommended approach – a closer examination of features of the maps might have revealed that the words, for instance, pointed to terms – whether as word or as image – that expressed generalisations. This would of course be positive in terms of understanding.

Becoming a reflective professional

The first thing to confirm from my perspective, is that, as I said in My Doctoral Journey (p.13), I welcomed the opportunity of the Ed.D. as a means of systematic reflection on my work as a professional, and in this, to shape that experience in a more general way. However, because I saw

this study as a means of reflecting on my practice, the data that I had to hand emerged in the course of my professional work. The 'data' was not collected with the same kind of systemization that a Ph.D. student would rightly organise in relation to a Research Question. That means that there is necessarily some 'unevenness' in the data, more than there might be in a well-planned and well-executed Ph.D. data collection.

That can be seen as a weakness, if the Ph.D. model is the only standard; or it can be seen as a strength of the Ed.D. in terms of a building a professional's capacity for reflection. My aim was to make sense of the messiness of the material I have to deal with in my everyday professional life in the spirit of practice based research. That is very much how I now think about the three case studies – what they have in common is that they arise in the course of very ordinary professional work – both for those who participated and for me. They also have in common the factor that everyday life intrudes, in all sorts of ways that can perhaps be better screened out in Ph.D. data collection. This exercise has, however, prepared me to work with teachers in messy classrooms with more empathy than I might have had before.

The greatest insight for me was that the concept of a 'researcher' became a far more fluid concept in this Ed.D. context than I was expecting. As the study progressed I became more drawn to the use of the term as a label for all educators who change their professional practice through action and practice-based research. What the PBR group taught me, in particular, was that the professional who joins a CoP to learn can actively implement the potential gain of concept maps by considering carefully how they might be used to improve all the partners' insights into CoP members' understandings.

In conclusion, the research reported here as part of the work for a Ed.D. is not the end of my own professional work. So, although these insights may be somewhat late, they have already been of benefit in my continuing support for teachers who are undertaking practice based research. In as far as I will continue my work with other professionals – in teaching, in collegial activity and in publication – I will of course disseminate these insights into the method of concept mapping, to the benefit, I hope, of those who will discover new techniques for developing professional understanding through my work.

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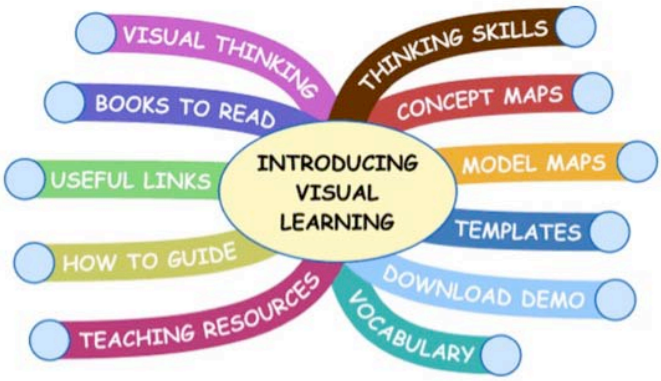
Appendix: PBR Group: map creation instructions and permissions

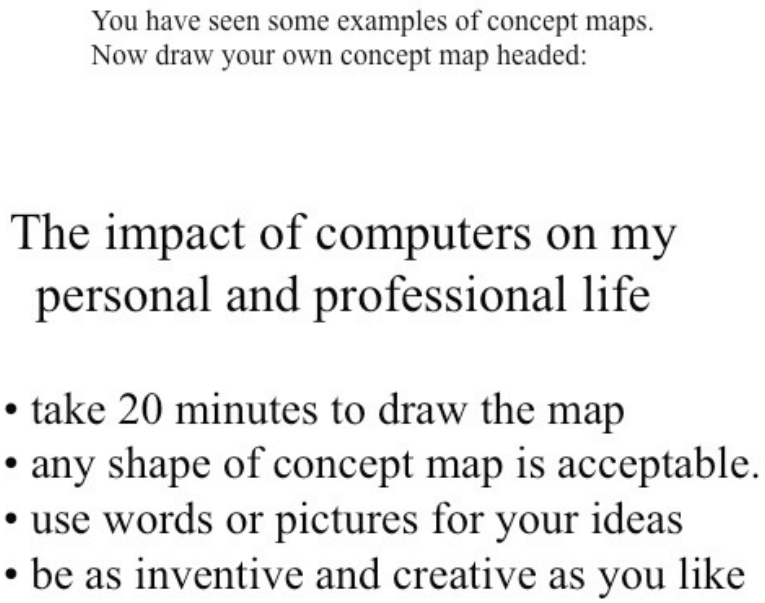
Powerpoint Slide: Here are some concept map designs (for discussion with the group)



A Buzan radiant-style mind map

A Novakian tree style concept map

Concept map drawing instructions on the back of the A4 paper used to draw the map



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MirandaNet Fellowship researchers (www.mirandanet.ac.uk) would like to use your concept map in studies about professional educators' understanding of digital technologies. Some maps may be published with commentaries although all names will be anonymised. Details of publications will be on the MirandaNet website (http://www.mirandanet.ac.uk/pubs/) and enquiries can be made to enquiries@mirandanet.ac.uk. If you agree to publication please sign and date below.

PRINT NAME

Sign:

Date: